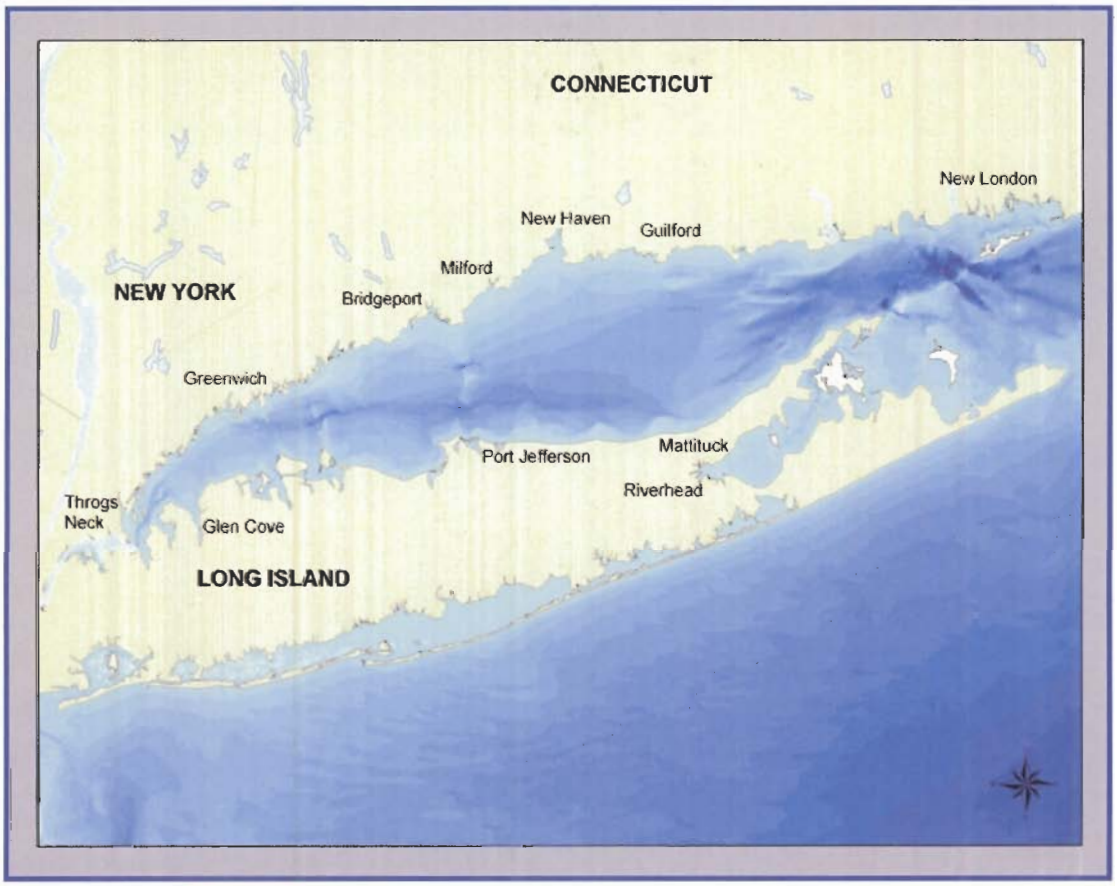
Environmental Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York

Draft

Prepared by U.S. Environmental Protection Agency
New England Region

In cooperation with U.S. Army Corps of Engineers
New England District



EPA

US Army Corps of Engineers

September 2003

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

FOR THE

DESIGNATION OF DREDGED MATERIAL DISPOSAL SITES IN CENTRAL AND WESTERN LONG ISLAND SOUND CONNECTICUT AND NEW YORK

Prepared By: U.S. Environmental Protection Agency – New England Region

In cooperation with:

U.S. Army Corps of Engineers – New England District

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DRAFT ENVIRONMENTAL IMPACT STATEMENT

PROPOSED ACTION:	Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York
LOCATION:	Long Island Sound, Connecticut and New York
DATE:	September 2003
SUMMARY OF ACTION:	DEIS considers the environmental acceptability of alternative locations for the designation of open water dredged material sites.
PREPARED BY:	U.S. EPA New England Region
COOPERATING AGENCIES:	U.S. Army Corps of Engineers National Marine Fisheries Service Connecticut Department of Environmental Protection New York State Department of Environmental Conservation Narragansett Tribe Eastern Pequot Tribe
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FINAL DATE BY WHICH COMMENTS MUST BE RECEIVED:	October 27, 2003

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
DESIGNATION OF DREDGED MATERIAL DISPOSAL SITES IN CENTRAL AND WESTERN LONG ISLAND SOUND CONNECTICUT AND NEW YORK

Prepared by the:
U.S. Environmental Protection Agency
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In cooperation with:
U.S. Army Corps of Engineers
National Marine Fisheries Service
Connecticut Department of Environmental Protection
New York State Department of Environmental Conservation
Narragansett Tribe
Eastern Pequot Tribe

Abstract: This Draft Environmental Impact Statement (DEIS) describes the environmental effects of designating a dredged material disposal site(s) in western and central Long Island Sound. The DEIS describes the evaluation of open ocean, upland, beneficial use, treatment technologies, and four open-water alternatives for dredged material disposal and a No Action Alternative. Initial screening eliminated the open ocean, upland, beneficial use, and treatment technology alternatives. The remaining alternatives (four open-water and the No Action alternatives) were then assessed throughout the document. The primary potential effects identified include: temporary increase in suspended solids and burial of aquatic resources. The Environmental Protection Agency's Preferred Alternative is to designate the Western Long Island Sound and Central Long Island Sound Dredged Material Disposal sites.

Comments should be sent to Ms. Ann Rodney at the U.S. Environmental Protection Agency New England Region, One Congress Street, Suite 1100, Mailcode CWQ, Boston, MA 02114-2023. For additional information about this Environmental Impact Statement, contact: Ms. Ann Rodney, Telephone (617) 918-1538.

Comments on this Draft Environmental Impact Statement must be received by October 27, 2003.

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ACRONYMS AND KEYWORDS

ASTM	American Society for Testing and Materials
AVS	Acid Volatile Sulfide
AWOIS	Automated Wrecks and Obstructions Information System
BIOS	Biological database attached to STORET (EPA)
BRAT	Benthic Resource Assessment Technique
°C	Degrees Celsius
CDF	Confined Disposal Facility
CEQ	Counsel on Environmental Quality
CFR	Code of Federal Regulations
CFDS	Cornfield Shoals Dredged Material Disposal Site
CLIS	Central Long Island Sound Dredge Material Disposal Site
cm	Centimeters
CO	Carbon Monoxide
Corps	U.S. Army Corps of Engineers
CPUE	Catch Per Unit Effort
CS-2	Cap Site 2
CSDS	Cornfield Shoals Disposal Site
CSO	Combined Sewer Overflows
CT	Connecticut
CTDAG	Connecticut Department of Agriculture
CTDEP	Connecticut Department of Environmental Protection
CTDPH	Connecticut Department of Public Health
CTPGP	Connecticut State Programmatic General Permits
CWA	Federal Water Pollution Control Act *a.k.a* the Clean Water Act
cy	cubic yard
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
DDT	1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
deg	Degree
DEIS	Draft Environmental Impact Statement
DEP	Department of Environmental Protection
DIP	dissolved inorganic phosphorous
DMMP	Dredged Material Management Plan
DMSMART	Dredged Material Spatial Management Record Tool
DO	Dissolved Oxygen
DRI-WEFAM	Data Resources Incorporated-Wharton Economic Forecasting Association
DRP	Dredging Research Program (Corps)

E	East
EIS	Environmental Impact Statement
EFH	Essential Fish Habitat
ENSR	Environmental and Energy Development Solutions
EPA	Environmental Protection Agency
ERDC	Engineering and Research Development Center
ER-L	Effects Range-Low
ER-M	Effects Range-Median
ESA	Endangered Species Act
°F	Degrees Fahrenheit
FDA	Food and Drug Administration
FEIS	Final Environmental Impact Statement
ft	Feet
FVP	Field Verification Program
GIS	Geographic Information System
GM	Grant Madsen
GSP	Gross State Product
HAB	Harmful Algal Blooms
HARS	Historic Area Remediation Site
HPCDD	Heptachlorinated dibenzodioxin
JODCC	Joint Ocean Dumping Coordinators Committee (EPA and the Corps)
Lbs	pounds
LIS	Long Island Sound
LISS	Long Island Sound Study
LPC	Limiting permissible concentrations
LTFATE	Long-term Fate of Dredge Material Disposal in Open Water
m	Meter
MAs	Marcrohage Aggregates
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service (Department of the Interior)
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
N	North
NAAQS	National Ambient Air Quality Standards
NAD83	North American Datum 1983
NEPA	National Environmental Policy Act
NH_3	Ammonia
NLDS	New London Dredged Material Disposal Site
NMFS	National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NO	Nitric Oxide
NO_x	Nitrate + Nitrite
NRC	National Research Council
NST	No Sonar Target
NS & T	National Status and Trends
NY	New York
NYSDEC	New York State Department of Environmental Conservation
NYSDOS	New York State Department of State
O_2	Oxygen
O_3	Ozone
O&M	Operation and Maintenance
OCDD	Octachlorinated dibenzodioxin
ORD	Office of Research and Development
OSI	Organism Sediment Index
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEIS	Preliminary Environmental Impact Statement
PON	Particulate Organic Nitrogen
ppb	parts per billion (*i.e.*, ng/g, µg/kg, ng/L)
ppm	parts per million (*i.e.*, µg/g, mg/kg, µg/L)
psu	Practical Salinity Unit (approximately equivalent to parts per thousand)
RHA	Rivers and Harbors Act
RIDEM	Rhode Island Department of Environmental Management
ROD	Record of Decision
RPD	Redox Potential Discontinuity
RTR	Ratio-To-Reference
SAIC	Science Applications International Corporation
sec	Second
SEM	Simultaneously Extracted Metal
SHPO	State Historical Preservation Officer
SIP	State implementation plan
SLCL	Straight Line Carapace Length
SMMP	Site Management and Monitoring Plan
SOD	Sediment Oxygen Demand
SPI	Sediment Profile Images
SQT	Sediment Quality Triad
SSS	Side Scan Sonar
STFATE	Short-term Fate of Dredge Material Disposal in Open Water for Predicting Deposition and Water Quality Effects
SUNY	State University of New York

TBT	Tributyltins
TCDF	Tetra chlorinated dibenzofuran
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total phosphorus
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers, New England District
U.S.C.	United States Code
USCG	United States Coast Guard
USEPA	United State Environmental Protection Agency
USFWS	United States Fish and Wildlife Service (Department of the Interior)
USGS	United States Geological Survey
WCRM	Warren C. Reiss Marine
WCUS	Waterborne Commerce of the United States
WLIS	Western Long Island Sound Dredged Material Disposal Site
WRDA92	Water Resources Development Act of 1992 (Public Law 102-580)
WWTP	Wastewater Treatment Plant
YOY	Young of the Year
ZSF	Zone of Siting Feasibility

CHAPTER 1 – INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is considering designation of one or more open-water dredged material disposal sites in the western and central regions of Long Island Sound, off the coasts of Connecticut and New York (see Figure 1-1) consistent with the Marine Protection, Research, and Sanctuaries Act (MPRSA, also known as the Ocean Dumping Act), 33 U.S.C. §§ 1401 *et seq*. Disposal of dredged material in the waters of Long Island Sound from projects that are either Federal actions or non-Federal actions involving more than 25,000 cubic yards (cy)(19,114 cubic meters) of dredged material must comply with the requirements of MPRSA. *See* 33 U.S.C. § 1416(f). Although EPA hopes to designate one or more disposal sites to facilitate the environmentally sound disposal of dredged material, EPA recognizes that no sites will be designated if none of the alternative sites under consideration satisfy applicable provisions of law (*e.g.*, the MPRSA, the Endangered Species Act).

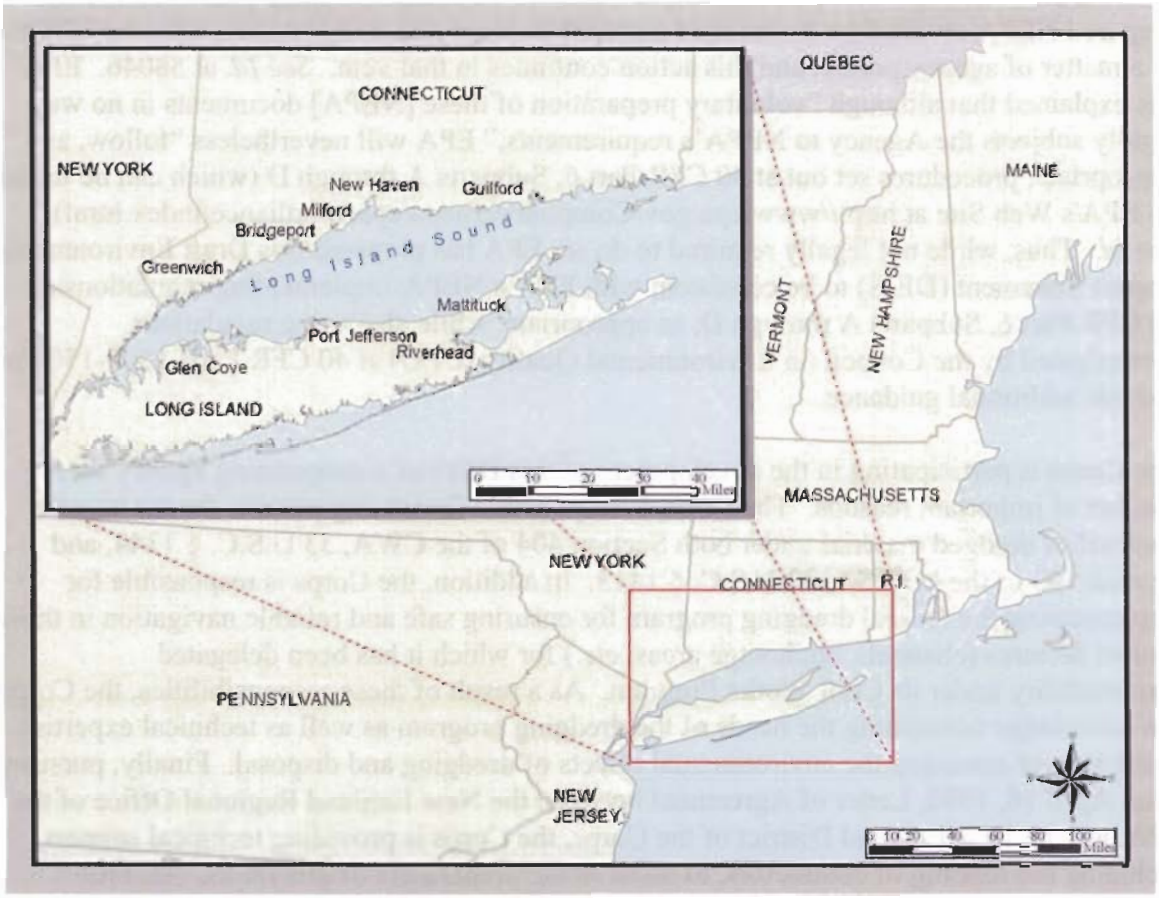

Figure 1-1. Location of Long Island Sound

EPA has identified four potential alternative open-water dredged material disposal sites. Two of the sites are currently active dredged material disposal sites, and two are presently inactive historic dredged material disposal sites. If designated, one or more of these sites could be used for disposal of material dredged from navigation projects and other sources

from Connecticut and New York rivers, harbors, and coastal areas, if the material is found to be suitable for ocean disposal. EPA's designation of an open-water disposal site does not authorize disposal of material from any particular source or project at any designated site. Such material may be dredged and disposed of only in accordance with the U.S. Army Corps of Engineers (Corps) authorities consistent with Section 404 of the Clean Water Act (CWA), 33 U.S.C. § 1344, Section 103 of the MPRSA, 33 U.S.C. § 1413, Section 10 of the Rivers and Harbors Act (RHA), which applies to the dredging itself (as opposed to the disposal), and other relevant provisions of law. In other words, EPA disposal site designation only makes a site available for consideration as an open-water disposal option for proposed dredging projects in the area.

EPA is not legally required to subject its disposal site designations under the MPRSA to environmental review under the National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321 et seq., but EPA has nonetheless conducted a NEPA review pursuant to the agency's "Statement of Policy for Voluntary Preparation of National Environmental Policy Act (NEPA) Documents." 63 Fed. Reg. 58045 - 58047. EPA has for many years voluntarily prepared NEPA reviews for its dredged material disposal site designations under the MPRSA as a matter of agency policy, and this action continues in that vein. *See Id.* at 58046. EPA has explained that although "voluntary preparation of these [NEPA] documents in no way legally subjects the Agency to NEPA's requirements," EPA will nevertheless "follow, as appropriate, procedures set out at 40 CFR Part 6, Subparts A through D (which can be found on EPA's Web Site at http://www.epa.gov/Compliance/nepa/epacompliance/index.html)." *See Id.* Thus, while not legally required to do so, EPA has prepared this Draft Environmental Impact Statement (DEIS) to be consistent with EPA's NEPA-implementing regulations at 40 CFR Part 6, Subparts A through D, as appropriate, while also using regulations promulgated by the Council on Environmental Quality (CEQ) at 40 CFR Parts 1500-1508 to provide additional guidance.

The Corps is participating in the development of this DEIS as a cooperating agency for a number of important reasons. The Corps is responsible for issuing permits for the aquatic disposal of dredged material under both Section 404 of the CWA, 33 U.S.C. § 1344, and Section 103 of the MPRSA, 33 U.S.C. § 1413. In addition, the Corps is responsible for implementing the federal dredging program for ensuring safe and reliable navigation in those project features (channels, anchorage areas, *etc.*) for which it has been delegated responsibility under its Civil Works Program. As a result of these responsibilities, the Corps has knowledge concerning the needs of the dredging program as well as technical expertise in the area of assessing the environmental effects of dredging and disposal. Finally, pursuant to an April 16, 1998, Letter of Agreement between the New England Regional Office of the EPA and the New England District of the Corps, the Corps is providing technical support, including the funding of contractors, to assist in the preparation of this DEIS. All final decisions regarding any site designations will be made by EPA. To take advantage of expertise held by other agencies, and to ensure compliance with all applicable legal requirements, EPA is also closely coordinating with other Federal agencies (*e.g.*, the National Marine Fisheries Service [NMFS]), state agencies (*e.g.*, environmental agencies of the States of Connecticut and New York), local governments, and Indian Tribal governments. Some of these entities are also participating as cooperating agencies. *See* 40 CFR § 1508.5. In

addition, EPA and the Corps have held many meetings with members of the interested public to explain the process, gather information and learn about concerns held by the public.

This DEIS is now being circulated for review and comment by other federal agencies; state, local, and tribal agencies; and members of the public. Following consideration of the comments received by mail and at public hearings, EPA will issue a Final EIS (FEIS) that includes a preferred alternative. At least 30 days after the issuance of the FEIS, EPA will issue a Record of Decision (ROD) that, among other things, states what the agency decision is, identifies all alternatives considered, and states whether all practical means to avoid or minimize environmental harm from the proposed action have been adopted (see 40 CFR § 1505.2). However, the use of any disposal area(s) designated by EPA would only occur after review and issuance by the Corps of either (1) a permit covering work by parties other than the Corps, or (2) a NEPA document covering activities by the Corps, with concurrence by EPA. Both types of activities would be subject to NEPA analysis and documentation requirements, individual evaluation under the CWA and MPRSA, and public involvement in the evaluation process. The dredged material disposal evaluation process for any Federal or non-Federal project requires consideration of a range of disposal alternatives including open-water and non open-water alternatives, as well as the quality of the material to be disposed. Consideration of such disposal alternatives as beneficial use, upland, material treatment and open-water disposal, would be required on a project-specific basis. Corps disposal determinations are made using EPA guidelines and criteria, *see* 40 CFR Parts 227 and 230, and are also subject to EPA review and potential veto. *See* 33 U.S.C. §§ 1344(c) and 1413(c).

1.1 History of Dredging and Disposal in Long Island Sound

In order to facilitate safe navigation and marine commerce, dredged material from projects in Connecticut and New York rivers, harbors and coastal areas has been disposed of at open-water sites in Long Island Sound since at least the 1870s. While detailed records of dredging activities extend back to this time, disposal 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 disposal sites were active in Long Island Sound (Dames & Moore, 1981). Since the early 1980s, dredged material has been placed predominantly at four disposal sites: Western Long Island Sound (WLIS), Central Long Island Sound (CLIS), Cornfield Shoals (CSDS), and New London (NLDS). These sites were evaluated and chosen to receive dredged material pursuant to programmatic and site specific EISs prepared by the Corps in 1982 and 1991 (USACE, 1982a, 1982b, and 1991) (see Section 1.4, Other Relevant NEPA Documents). Based on information collected through the Corps' Disposal Area Monitoring System (DAMOS), it is estimated that about 37 million cubic

Estimated Sediment Disposal Volumes in Western and Central Long Island Sound, 1941-2001, from all Dredging Sources (USACE file data, 2003)

Disposal Site	Volume (cy)
Central LIS	14,006,443
Western LIS	1,710,116
Stamford	2,904,884
Eatons Neck	12,972,303
Norwalk	1,313,150
Bridgeport	4,404,428
Milford	398,965
Total	37,710,289

yards (28 million cubic meters) of material may have been disposed of in western and central Long Island Sound since 1941.

Since 1977, the Corps, EPA, and the States have evaluated and regulated disposal of dredged material in Long Island Sound under the provisions of the CWA amendments to the Federal Water Pollution Control Act. 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 disposal, the number of actively used disposal sites in the Sound was reduced, leading to the current system of four open-water sites by the mid 1980s. At the same time, the Corps began to address the need for information on the environmental impact of disposal activities through a research and monitoring program which eventually became known as DAMOS. The DAMOS program has actively monitored the four active disposal sites and has done limited examinations of some of the discontinued "historic" disposal sites.

The Corps, under its Civil Works Program is responsible for maintaining some 55 navigation projects along Long Island Sound and adjacent waters (from Hell Gate to Block Island Sound), 31 in Connecticut and 24 in New York. These projects include navigation channels, anchorage areas, turning and maneuvering basins for vessels, breakwaters, jetties and other structures. The majority of these projects require periodic maintenance dredging to assure reliable navigable depth for vessel traffic. Disposal from maintenance of these Federal civil works projects, and improvement of newly authorized Federal civil works projects in this region, requires the same analysis as for projects by parties other than the Corps under permit from the Corps, including state, municipal, and private projects and projects undertaken by other Federal agencies.

Authorized navigation projects in Connecticut and New York in and around Long Island Sound include:

Connecticut

Greenwich Harbor	Housatonic River	Essex Cove Harbor
Mianus River	Milford Harbor	Eight Mile River
Stamford Harbor	West River	Connecticut River
Westcott Cove	New Haven Harbor	Niantic Harbor
Fivemile River	Branford Harbor	New London Harbor
Wilson Point Harbor	Stony Creek Harbor	Thames River
Norwalk Harbor	Guilford Harbor	Mystic Harbor
Norwalk Harbor	Clinton Harbor	Stonington Harbor
Southport Harbor	Duck Island Harbor	Pawcatuck River
Black Rock Harbor	Patchoque River	
Bridgeport Harbor	North Cove	

New York

Port Chester Harbor	East River	Greenport Harbor
Milton Harbor	Flushing Bay	Peconic River
Mamaroneck Harbor	Little Neck Bay	Sag Harbor
Larchmont Harbor	Hempstead Harbor	Lake Montauk Harbor
Echo Bay Harbor	Glen Cove Harbor	Hay-West Harbor
New Rochelle Harbor	Huntington Harbor	
East Chester Creek	Northport Harbor	
Westchester Creek	Port Jefferson Harbor	
Bronx River	Mattituck Harbor	

1.2 Legal Requirements

The primary authorities that govern the disposal of dredged material in the United States are the CWA and the MPRSA. All dredged material disposal 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 disposing of greater than 25,000 cubic years of dredged material must comply with the requirements of the MPRSA. Some key provisions of these statutes are described in the following sections.

1.2.1 Clean Water Act, Section 404

CWA § 404, 33 U.S.C. § 1344, governs the disposal 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 like 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. Any lawful disposal of dredged material into waters landward of the Baseline must first be authorized by the Corps and must be conducted in compliance with the conditions of such authorization.

It should be noted that for Federal dredged material disposal projects undertaken by the Corps itself, the Corps does not actually issue itself a permit, but rather applies the same standards and general procedures under the CWA, to determine whether the disposal should be authorized.

In making its permit decisions and recommendations under its civil works program, the Corps 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. *See* 33 U.S.C. § 1344(b). The Corps also applies its own regulations promulgated at 33 CFR Parts 320 to 338. In addition, other provisions of applicable law must also be satisfied (*e.g.*, applicable State water quality standards, applicable requirements of State coastal zone management plans, the Endangered Species Act). Corps permits and civil works decisions

under CWA § 404 are subject to review, and potential veto, by EPA. Section 1.2.4 describes the CWA Section 404 permit process in more detail.

1.2.2 Marine Protection, Research, and Sanctuaries Act

The MPRSA regulates dredged material disposal only in waters seaward of the Baseline, which are referred to as "ocean waters" under the statute. *See* 33 U.S.C. § 1402(b). These waters include the three-mile band extending seaward of the Baseline, which is referred to as the "territorial sea," and beyond (While not relevant for the present case, it is worth noting that CWA § 404 jurisdiction actually extends to the seaward edge of the territorial sea, thus overlapping with MPRSA jurisdiction within the territorial sea. However, EPA regulations direct that only the MPRSA program will be applied to regulate dredged material disposal in the territorial sea, while the CWA program will be applied to discharges of fill material. *See* 40 CFR § 230.2(b)).

As stated in Section 1.2.1, the waters of Long Island Sound lie landward of the Baseline and, thus, would be expected to be subject to regulation under CWA § 404 and *not* the MPRSA. However, in 1980, the 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, and as currently enacted it reads as follows:

> "In addition to other provisions of law and not withstanding 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 disposal in Long Island Sound of dredged material from Federal projects (both projects carried out under the Corps civil works program or the actions of other Federal agencies), or from non-Federal projects involving more than 25,000 cubic yards (19,114 cubic meters) of material, must satisfy the requirements of both CWA § 404 and the MPRSA. Disposal from non-Federal projects involving less than 25,000 cubic yards (19,114 cubic meters) of material, however, are subject only to CWA § 404.

Like the CWA, the MPRSA prohibits the disposal of dredged materials into water under its jurisdiction unless conducted in compliance with, a permit issued by the Corps or approval under the Corps civil works program. 33 U.S.C. §§ 1411(a) and 1413(a). Corps dredged material disposal permits and authorizations are issued under MPRSA § 103 and may include conditions deemed necessary by the Corps related to the type of material to be disposed, time of disposal, and other matters. 33 U.S.C. §§ 1413 and 1414(a). (EPA is responsible for review and permitting of any proposals to dump anything other than dredged material into ocean waters. *See* 33 U.S.C. §§ 1412(a) and (b).) The Corps is to issue a permit, or approve a project under its civil works authority, only if it has determined that dredged material

disposal "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 § 404 program, however, the Corps is to make MPRSA § 103 determinations by the standards set forth in EPA regulations. 33 U.S.C. § 1413(b). EPA has promulgated its ocean dumping regulations pursuant to MPRSA § 102(a), 33 U.S.C. § 1412(a), at 40 CFR Parts 220 to 229. Corps permit determinations and civil works approvals are also subject to any applicable requirements of other laws (*e.g.*, the Endangered Species Act, the Coastal Zone Management Act). In addition, Corps authorizations under MPRSA § 103 are also subject to EPA review and concurrence, and the potential for EPA to either veto or add conditions to the permit or civil works approval. 33 U.S.C. §§ 1413(c) and 1414(a). As with the CWA § 404 program, the Corps does not issue permits under MPRSA for Corps dredged material disposal projects under its civil works authority; rather, it authorizes its own disposal projects by applying the same substantive and procedural requirements "in lieu of" the permit procedures. 33 U.S.C. § 1413(e). Such Corps authorizations for Corps projects are subject to the same EPA review and concurrence process as described above.

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

- The need for the proposed disposal;
- The effect of the disposal 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 disposal;
- The effect of disposing of particular volumes and concentrations of such materials;
- Appropriate locations and methods of disposal or recycling, including land-based alternatives;
- The effect on alternate uses of oceans.

Under CWA § 404, dredged material at a particular site is authorized on a project-specific basis, subject to the terms of the authorization. Under the MPRSA, however, the identification of sites for the potential disposal of dredged material is handled differently. MPRSA § 102(c) authorizes EPA to "designate" sites for long-term use for dredged material disposal. Such long-term site designation by EPA is conducted apart from consideration of any particular project's dredged material. Material from particular projects is instead evaluated under the Corps' authorization program under MPRSA § 103. As stated above, material from non-Federal projects involving less than 25,000 cubic yards (19,114 cubic meters) of dredged material are evaluated under the CWA § 404 requirements. EPA is to designate disposal sites using its site designation criteria regulations promulgated at 40 CFR Part 228. 33 U.S.C. § 1412(c)(1). EPA is to designate sites and time periods for disposal, and can restrict site use, as necessary to "mitigate adverse impact on the environment to the greatest extent practicable." 33 U.S.C. § 1412(c)(1).

For each designated disposal site, EPA and the Corps must develop a site management plan that includes a baseline assessment of conditions of the site, a program for monitoring the site, special management conditions or practices to be implemented at the site to protect the environment, consideration of the quantity of material to be disposed of at the site and the presence of contaminants in the material, consideration of the anticipated use of the site over the long term, and a schedule for review and revision of the plan (33 U.S.C. § 1412(c)(3)). A designated disposal site may not be used until a site management plan has been developed for the site (33 U.S.C. § 1412(c)(4)).

In determining whether to issue an authorization consistent with Section 103 of the MPRSA, the MPRSA directs the Corps to evaluate the "potential effect of a permit [or Corps project authorization] denial on navigation, economic and industrial development, and foreign and domestic commerce of the United States, [in order to] . . . make an independent determination as to the need for the dumping." 33 U.S.C. § 1413(b). Related to this, the statute also directs the Corps to "make an independent determination as to the other possible methods of disposal and as to appropriate locations for the dumping." *Id.* With respect to locations for disposal, the statute requires the Corps to utilize EPA-designated disposal sites to the "maximum extent feasible." *Id.* Where use of an EPA-designated site is infeasible, however, the Corps is authorized to "select an alternative site." *Id.* Thus, Corps selection of an alternative site is conducted in conjunction with a specific project.

In considering "selection" of an alternative site, the Corps must use the same site selection criteria that EPA uses in designating disposal sites (*i.e.*, 40 CFR Part 228). *Id.* Corps selection of an alternative disposal site is subject to EPA review and concurrence. *Id.* While EPA-designated disposal sites are specified for long-term use, and the statute does not specify a specific term of years to which such use must be limited, the statute does place a specific time limit on the use of Corps-selected sites. MPRSA § 103(b) provides that "disposal at or in the vicinity of an alternative site shall be limited to a period of not greater than 5 years unless the site is subsequently designated [by EPA] . . .; except that an alternative site [selected by the Corps] may continue to be used for an additional period of time that shall not exceed 5 years if – (1) no feasible disposal site has been designated by the Administrator [of EPA]; (2) the continued use of the alternative site is necessary to maintain navigation and facilitate interstate or international commerce; and (3) the Administrator [of EPA] determines that the continued use of the site does not pose an unacceptable risk to human health, aquatic resources, or the environment." 33 U.S.C. § 1413(b)(1), (2) and (3). Thus, a Corps-selected site may be used for disposal for a maximum potential period of ten years.

The time limits for use of a Corps-selected disposal site (*i.e.*, the five-year period, with potential for a five-year extension) were added to the MPRSA by an amendment to 33 U.S.C. § 103(b) made by Section 506(b) of the Water Resources Development Act of October 31, 1992 (WRDA92). The time limits did not apply prior to that date. Thus, EPA and the Corps interpret Section 103(b) to mean that these time limits began to apply to Corps-selected sites used for disposal after the October 31, 1992, amendments to the statute. Furthermore, EPA and the Corps interpret any second term of (up to) five years for use of a Corps-selected site to commence upon proper approval to extend the time for use of that site.

Therefore, if there is a gap in time between the end of the first five-year term and the beginning of any second term, that time is not counted against the second term because it is the *use* of the site for disposal that is limited by the statute and the site is not being used during any such gap. The time period for any second term of use begins to run with the approval extending use of the site, thus ensuring that the site will not be used for disposal for any more than ten years. *See* September 27, 2001, Letter from Brian E. Osterndorf, Corps, to Arthur J. Rocque, Jr., CTDEP; October 10, 2001, Letter from Robert W. Varney, EPA, to Arthur J. Rocque, Jr., CTDEP; December 13, 2002, Letter from Robert W. Varney, EPA, and Thomas L. Koning, Corps, to Dennis P. O'Leary, Esq., of the Neufeld & O'Leary law firm (Appendix A-4).

Applying these time limits to the WLIS and CLIS disposal sites, both of which were actively used after October 31, 1992, and are being evaluated for possible EPA designation in this DEIS, results in the following conclusions. The CLIS site was first used under the Corps' site selection authority in 1993 for disposal of material from the federal navigation channel in New Haven, Connecticut. Thus, the first five-year term ended in 1998. The second 5-year term for disposal at the CLIS disposal site as a Corps-selected site began in February 1999 and will, therefore, end in February 2004. The WLIS disposal site was not used as an Corps-selected alternative site until 1995; all projects using the WLIS site before that time were non-Federal projects involving fewer than 25,000 cubic yards (19,114 cubic meters) of material and, therefore, did not trigger MPRSA § 106(f). Therefore, its first five-year term expired in 2000. It has yet to be selected for a second term of use for disposal. *See* September 27, 2001, Letter from Brian E. Osterndorf, Corps, to Arthur J. Rocque, Jr., CTDEP; October 10, 2001, Letter from Robert W. Varney, EPA, to Arthur J. Rocque, Jr., CTDEP (Appendix A-4). Both the CLIS and WLIS disposal sites are among the alternative sites being considered in this DEIS for possible EPA disposal site designation.

Under MPRSA Section 103 (33 U.S.C. § 1413), the Corps may issue authorizations for ocean disposal for specific projects at specific selected sites if the disposal "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 Corps must apply the site designation evaluation criteria described in MPRSA Section 102 and must determine whether there are other possible methods of disposal or other appropriate locations for the disposal (33 U.S.C. § 1413(b)). In considering appropriate locations, the Corps must, to the maximum extent feasible, use the sites designated under MPRSA Section 102 and obtain EPA concurrence on the selected site. Disposal at a site is limited to 5 years, unless the site is subsequently designated as a disposal site by EPA or circumstances (set forth in the statute) require an additional 5-year disposal period.

Prior to issuing an authorization for a specific project, the Corps must notify EPA, which must review the proposal and related materials, determine compliance with the site designation criteria, and decide whether to concur with the authorization issuance. If EPA declines to concur, the authorization will not be issued (33 U.S.C. § 1413(c)).

The Corps also prepares dredged material management plans (DMMPs) on a project-specific basis where a continued need for maintenance dredging is demonstrated and available disposal site capacity is determined insufficient to meet the project's needs for at least a 20 year period, for the quantity and quality of materials to be dredged. A DMMP is not required for designating or selecting disposal sites under MPRSA. However, the designation of disposal sites under MPRSA does require the development of Site Management and Monitoring Plans (SMMPs). The SMMPs for sites recommended for designation are included in the supporting documentation for this EIS.

1.2.3 Coastal Zone Management Act

In 1972, the Coastal Zone Management (CZM) Act established a national program to encourage coastal states to develop and implement coastal zone management plans. Both Connecticut and New York have developed Coastal Zone Management plans and programs that were federally approved under CZM. Section 307 of CZM 1972, as amended, requires Federal agencies proposing activities within or outside the coastal zone that affect any land or water use or natural resource of the coastal zone 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. As part of this DEIS process, EPA will prepare a Federal determination of consistency with applicable state approved Coastal Zone Management Programs.

1.2.4 Corps Permitting Process

A Corps permit is required for any discharge of dredged material in waters of the United States by a party other than the Corps. The Corps has jurisdiction for this permitting under Section 10 of the Rivers and Harbors Act, 33 U.S.C. § 403, and, depending on where the discharge occurs, under either Section 404 of the Clean Water Act or MPRSA Section 103. Generally, Section 404 of the Clean Water Act applies to discharges landward of the Baseline of the territorial sea and in instances seaward of the Baseline when the intent is to fill or nourish a beach and MPRSA Section 103 applies to discharges seaward of the Baseline of the territorial sea. In Long Island Sound, both CWA and MPRSA are applicable to dredging projects (depending on project size and proponent) due to the Ambro Amendment.

The Corps is the lead federal agency for all permit actions dealing with open-water disposal of dredged material. In order to ensure that this disposal will not unduly degrade or endanger the marine environment and will not adversely affect human health, the marine environment or other ocean uses, the Corps works cooperatively with federal and state regulatory and resource agencies throughout the permitting process. The Corps solicits comments from the NMFS, U.S. Fish and Wildlife Service (USFWS), EPA, the Connecticut Department of Environmental Protection (CTDEP), Office of Long Island Sound Programs, and the state of New York, as appropriate, in preparing the sampling and testing plans and the determinations of suitability for open-water disposal that initiate the permit process. Under Section 404 of CWA, with the exception of EPA, the role of these agencies is advisory, but the Corps rarely, if ever, issues a permit if any of these agencies advise against it. Under Section 103 of MPRSA, however, the Corps cannot issue a permit until the EPA determines that the disposal will comply with the criteria in 40 CFR 227.4. Thus, for projects disposing of more than

25,000 cubic yards (19,114 cubic meters) of dredged material in Long Island Sound and for all dredged-material disposal from federal projects, it is the EPA and not the Corps that has final decision-making authority.

As mentioned above, one of the first steps in the permit application review process for both CWA and MPRSA projects is for the Corps, working with the state and federal resource agencies and the applicant, to develop sampling and testing plans to determine the suitability of the material for open-water disposal. Applicants will perform sampling and analysis based on these plans and the Corps and federal agencies will 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 disposal at a given site. National guidance for determining whether dredged material is acceptable for open-water disposal is provided in the Ocean Testing Manual (Green Book; USEPA and USACE, 1991) and in the Inland Testing Manual (USEPA and USACE, 1998). The Regional Implementation Manual, consistent with the Green Book and the Inland Testing Manual, provide specific testing and evaluation methods for dredged material projects at specific sites or groups of sites. The Regional Implementation Manual that covers Long Island Sound is currently under review by EPA and the Corps, and should be finalized in 2003.

If the material is determined appropriate for open-water disposal, the Corps will consider open-water disposal as one option in the analysis of disposal alternatives for its permit review. Other options for disposal include beneficial use, upland disposal, and treatment technologies. Under CWA, material may be permitted for open-water disposal only if there is no practicable alternative location or methods of disposal or reuse available that have less adverse environmental impact on the aquatic environment or a smaller potential risk to other parts of the environment (Section 404 (b)(1) Guidelines).

Candidate open ocean (or, in the case of Long Island Sound, open-water) areas are governed by MPRSA Section 102. Site designation identifies an area that would be suitable to receive dredged material if a permit were issued, and does not constitute approval to use the designated site for the disposal of dredged material. For a specific project involving the disposal of dredged material under MPRSA Section 103, analysis of the Corps project or permit activity must demonstrate that no practical alternative locations or methods, including non-ocean alternatives, are available. For this reason, the Corps' alternatives analysis evaluates available alternative locations and methods (ocean and non-ocean), as well as recycling and treatment. If other low impact or beneficial use alternatives are practicable, a MPRSA Section 103 permit authorization would not be issued. Readers interested in further information on comparing all dredged material alternatives should refer to Evaluating Environmental Effects of Dredged Material Management Alternatives – A Technical Framework (USEPA and USACE 1992).

In addition to the CWA and MPRSA permit process described above, both new improvement and maintenance dredging projects with disposal in open-water may be reviewed under the Connecticut State Programmatic General Permits (CTPGP), provided that the quantity of material to be dredged is less than 25,000 cubic yards (19,114 cubic meters). The CTPGP offers an expedited review process with coordination and agreement of the federal and state

agencies with resources of concern. For projects involving quantities greater than 25,000 cubic yards (19,114 cubic meters) or those projects that do not meet the terms and conditions of the CTPGP, the proposals are reviewed under the standard individual permit process. This process involves a public notice and a more detailed review of the impacts and outcomes of the proposal. The sampling plans and suitability determinations require the same level of detail regardless of the permitting process.

Ultimately, the decision to deny, approve, or place restrictions on a permit must meet the regulatory standard that the action causes no "unacceptable adverse impact." As a result, federal and state agencies cooperatively set permit conditions by considering the range of potential impacts and the environmental, economic, social, and political conditions associated with the proposed activities.

Enforcement of the CWA and MPRSA and their accompanying regulations is a joint responsibility of EPA and the Corps. The Corps may revoke disposal permits or suspend them for a specified period of time if any of the conditions of the permit are violated. Additionally, disposing of dredged material into the ocean without a permit is a violation of MPRSA. EPA is responsible for assessing the civil liability of the violator and known violations of permit conditions may be punished by imposing fines up to $55,000 per event or imprisonment up to one year, or both. Enforcement is an important site management tool because it ensures that the requirements set out in the disposal permit are complied with, and that no unanticipated impacts can occur without consequences.

As stated earlier, while the Corps does not issue itself permits for activities the Corps carries out under its civil works authority, the same evaluations under the CWA and the MPRSA are conducted for those projects prior to the Corps' approval of the NEPA documents and other authorizations for that work.

1.3 Scope of the EIS

In 1999 EPA, in cooperation with the Corps, issued a Notice of Intent to prepare an EIS to consider the potential designation of one or more dredged material disposal sites in the waters of Long Island Sound under MPRSA Section 102 (64 Fed. Reg. 29865 (1999)). The notice stated that the EIS would provide an evaluation of the four existing sites (WLIS, CLIS, CSDS, and NLDS), "as well as additional alternatives including other open-water disposal sites, other types of dredged material disposal and management, and the no action alternative." Public scoping meetings were held in Connecticut and New York in June 1999; additional public working group meetings have been held since that time (reports from working group meetings can be found in Appendix A).

Some Alternatives to Open Water Disposal of Dredged Material

- ***Upland Disposal*** – Disposal of dredged material in any inland habitat type for construction purposes, wildlife habitat, or recreational development;
- ***Containment*** – Disposal of dredged material in a facility (*e.g.*, confined disposal facility (CDF)) to contain the material as an island or on a shoreline for purposes of construction, wildlife, or recreation;
- ***Beach Restoration*** – Disposal of clean, sandy dredged material on existing beaches;
- ***Treatment Technologies*** – Example: The combustion of dredged material to reduce its volume and volatile organic compounds;
- ***Resource Reclamation*** – Use of dredged material as a soil enhancer for landscaping, agricultural purposes, or construction material.

The Zone of Siting Feasibility (ZSF) is an appropriate area of consideration to ensure that a full range of reasonable and practicable alternatives is considered. The EPA site designation guidance manual (USEPA, 1986) describes the factors that should be addressed in identifying the ZSF. Specifically, EPA recommends locating open-water disposal sites within an economically and operationally feasible radius from the point of dredging. Other considerations include navigational restrictions, political or other jurisdictional boundaries, distance to the edge of the continental shelf, the feasibility of surveillance and monitoring, and operational and transportation costs (Pequegnat *et al.,* 1990). Thus, the ZSF represents the area from within which a range of reasonable specific alternatives may be selected for evaluation.

In 1999 EPA developed the ZSF for this DEIS in cooperation with the Corps, USFWS and NMFS. Once the ZSF was delineated, EPA identified and evaluated a range of such reasonable specific disposal site alternatives found within the ZSF (see Chapter 3). The suitability of these alternative sites has been evaluated using the five general and eleven specific criteria for disposal site designation (40 CFR §228.5 and §228.6). This analysis subjected this set of reasonable alternative sites to an objective evaluation.

The ZSF analyzed in this DEIS includes the region of Long Island Sound between the confluence of the East and Harlem Rivers at Hell's Gate on the western end and Mulberry Point, Connecticut (near Guilford, Connecticut) to Mattituck Point, New York on the eastern end. The eastern boundary was chosen because it is marked by a change in sediment texture and depth, representing a transition from the depositional basin of the central region into the more active eastern region of Long Island Sound. This ZSF meets the dredging needs in the western and central regions of Long Island Sound, and its outer limits represent a reasonable haul distance for marinas, boatyards, commercial docks, and federal harbors and anchorages in those regions. The expected dredging needs area for disposal sites evaluated in the EIS would extend about 25 nautical miles beyond the eastern (CLIS) and western-most boundaries of the sites evaluated (WLIS), or from about the upper arm of the East River and its tributaries in New York in the west to the area of Westbrook, Connecticut in the east.

In March 2002, EPA and the Corps issued a notice to identified stakeholders (all agencies, organizations and individuals that had participated in or expressed an interest in the EIS) that the ZSF for locating potential open-water disposal sites would be modified to encompass the western and central regions of Long Island Sound (*Environmental News*, "Update on the Evaluation of Potential Dredged Material Disposal Sites for Long Island Sound," March 2002). The DEIS is evaluating the designation of one or more sites in western and central Long Island Sound to serve communities and projects that may evaluate use of open-water sites in those areas together with other project specific alternatives to open-water disposal. The evaluation of eastern Long Island Sound for potential designation of open-water disposal site(s) would be addressed in a subsequent NEPA document, such as a supplement to this EIS.

The primary reasons for the decision to modify the zone of siting feasibility were:

- The dredging and disposal needs and alternatives of the western and central Long Island Sound regions are geographically and environmentally separate from those of the eastern Long Island Sound region;
- The need to assess, in a timely manner, the appropriateness of maintaining operational continuity and continued use of a central Long Island Sound disposal site;
- The change in scope would not preclude consideration of a comprehensive range of alternative for disposal sites in all three Long Island Sound regions for specific proposed dredging projects.

Identified stakeholders were notified of the change in scope and public working group meetings were continued to be held. Therefore, EPA and the Corps determined that an additional scoping period and additional scoping meetings were not necessary.

Thus, this DEIS examines the potential environmental impacts associated with the use of potential open-water dredged material disposal sites in the western and central area of Long Island Sound and the no action alternative. Figure 1-2 shows the current assessment area (referred to as the Zone of Siting Feasibility), as compared to the area originally proposed for assessment.

Figure 1-2. Original and Modified ZSF

Of the four currently active dredged material disposal sites in Long Island Sound, only the WLIS and CLIS disposal sites are included in the modified ZSF (see Figure 1-2). These two sites are analyzed in the DEIS and, as described in more detail in Chapter 3, a site screening methodology was used to identify other alternative sites for analysis in the western and central regions.

1.4 Other Relevant NEPA Documents

The NEPA documents described in the following section were prepared by the Corps for the disposal of dredged material in Long Island Sound.

Final Programmatic Environmental Impact Statement for the Disposal of Dredged Material in the Long Island Sound Region (USACE, 1982a). The Corps prepared this document as a result of a 1976 agreement with the Natural Resources Defense Council. It evaluated seven proposed disposal sites in Long Island Sound and identified generic impacts associated with a range of disposal alternatives for dredged materials. This document also sought to provide an informational basis upon which future NEPA documents could be developed for site-specific projects in the Long Island Sound region. The Programmatic EIS concluded that open-water, upland, containment, beach restoration, incineration, and resource reclamation were viable alternatives and that the most appropriate alternative chosen for disposal would be determined on a case-by-case basis depending on the conditions prevalent at the time a project was proposed. The EIS also found that three of the seven sites in Long Island Sound were the least environmentally damaging and practicable alternative open-water disposal sites. These three sites were the CLIS, Cornfield Shoals, and New London disposal sites.

Final Supplemental Environmental Impact Statement for the Designation of a Disposal Site for Dredged Material in Western Long Island Sound – WLIS III (USACE, 1982b). This document addressed open-water disposal of dredged material in the western Long Island Sound region. This EIS concluded that there was an economic and navigational need for a dredged material disposal site in the western region of Long Island Sound. The WLIS disposal site was selected as the least environmentally damaging and practicable alternative for open-water disposal in the western region of Long Island Sound.

Final Supplemental Environmental Impact Statement for a Dredged Material Disposal Site in Western Long Island Sound (USACE, 1991). This supplement was prepared to address deficiencies in the first WLIS EIS, as found by the U.S. Court of Appeals (*Town of Huntington v. Marsh*, 859 F.2d 1134 (2nd Cir. 1988)). In particular, the supplemental EIS applied the criteria described in MPRSA Section 102 in evaluating potential new disposal sites and addressed the types, quantities, and cumulative effects of dredged material disposal at the WLIS disposal site. As a result of this analysis, the Corps reiterated its earlier conclusion that the WLIS disposal site was the least environmentally damaging and practicable alternative for open-water disposal in the western region of Long Island Sound.

Long Island Sound Dredged Material Containment Facilities Feasibility Report (USACE, 1985) This report examined the potential for siting and constructing a dredged material containment facility along the shore of Long Island Sound for disposal of dredged material.

The report identified at least one potential site for a containment project of limited volume, however, after public review, no potential sponsors willing to participate in construction and management of such a facility were identified.

1.5 Public Involvement

This section describes the formal scoping process, other public and agency meetings that have been held regarding this EIS, and future opportunities for public involvement.

1.5.1 Public Scoping

In addition to the Notice of Intent published in the *Federal Register* in June 1999 (64 Fed. Reg. 29865 [1999]), EPA and the Corps published legal notices in several local newspapers and issued a press release informing the public of the intent to prepare an EIS for the designation of disposal sites in Long Island Sound and announcing public scoping meetings. Three formal scoping meetings were conducted over a 2-week period in June 1999 (Stony Brook, New York; Groton, Connecticut; and Stamford, Connecticut) to ensure that interested communities, groups, and individuals had the opportunity to provide input on the scope of the document, including alternatives and impact analyses. These meetings provided a forum for the public to ask questions, to express their concerns regarding dredged material disposal, and to comment on the need for the project.

In general, the public comments involved:

- ***Regulatory issues*** (compliance with MPRSA, the Clean Water Act and other laws and regulations; consistency with the Coastal Zone Management Act);
- ***Concerns for the natural environment*** (contamination of fish and fish habitat, contamination of benthic organisms and habitats; health impacts of consumption of contaminated seafood, dispersion of contaminants in Long Island Sound, water quality, monitoring, need for additional field studies, impacts on endangered species and unique habitats, and air quality and odors);
- ***Socioeconomic issues*** (cost of disposal, economic impacts on coastal communities, recreational impacts, impacts on coastal property values, potential for groundings, aesthetics, and impacts on shipwrecks and diving);
- ***NEPA documentation and analysis issues*** (use of existing data, assessing disposal alternatives, and use of a Geographic Information System for alternatives analysis).

EPA and the Corps carefully considered all comments received and have used these comments in preparing the analysis presented in this DEIS. The comments and issues raised during the scoping period are described in the Summary of Scoping Meetings found in Appendix A, Public Involvement.

1.5.2 Public Workshops and Working Group

In addition to the formal scoping process, EPA and the Corps held public workshops. These workshops were held in October 1999 (Port Jefferson, New York) and April 2000 (Groton, Connecticut) to further refine the scope and initial steps of the EIS, provide project status, and discuss the screening of potential disposal sites.

The informal workshops led to the formation of a Working Group consisting of the marine industry, boaters, environmental groups, fishing interests, local towns and other individuals. Working Group meetings were informal so that members could engage and discuss the issues of concern and the information gathered during the development of the EIS (see Appendix A). Working Group meetings were held in:

- July 2000 (Old Lyme, Connecticut);
- April 2001 (Bridgeport, Connecticut);
- March 2002 (Port Jefferson, New York);
- July 2002 (Bridgeport, Connecticut);
- November 2002 (Stamford, Connecticut).

In addition, EPA and the Corps met with representatives of the fishing industry several times to discuss potential disposal alternatives, sampling plans, and other concerns.

1.5.3 Interagency Group

EPA has also formed an Interagency Group during the development of this DEIS. This group includes representatives from EPA New England and Region 2 offices, the Corps New England and New York Districts, USFWS, NMFS, CTDEP, New York State Department of Environmental Conservation (NYSDEC), and New York State Department of State (NYSDOS) and the Narragansett and Eastern Pequot tribes. The purpose of the Interagency Group is to review and guide the process and findings of the EIS.

1.5.4 Future Opportunities for Public Involvement

This DEIS is being published together with draft site SMMPs for public review and comment. Such comments may be provided in writing (by mail, facsimile, or electronic mail). In addition, during the public comment period, EPA will hold public hearings in which interested parties may submit comments. Information regarding the locations, dates, and times of the public hearings will be provided in the *Federal Register,* included in public notices and press releases, and mailed to the existing mailing list. This information is also posted on the EPA website (http://www.epa.gov/region01/eco/lisdreg/).

EPA and the Corps will carefully consider all timely comments in preparing the FEIS. The FEIS will be issued for public comment. EPA will not make a decision regarding the designation of one or more disposal areas until at least 30 days following the issuance of the FEIS.

Commenting on the Draft EIS

EPA encourages comments on the draft EIS for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound. Comments may be submitted:

- By mail to
  Ann Rodney
  U. S. EPA - New England Region
  One Congress Street, Suite 1100
  Mailcode CWQ
  Boston, MA 02114-2023
- By facsimile to [617-918-1505]
- By electronic mail to
  Rodney.Ann@epa.gov

1.5.5 EPA Rulemaking Process

A draft of the proposed rulemaking is published in the *Federal Register* for public comment. Following issuance of the FEIS, EPA will publish a formal rulemaking.

1.6 Structure of the EIS

This DEIS consists of the following chapters, appendixes and associated documents: an Executive Summary, the EIS divided into eleven chapters, a public involvement appendix containing correspondence and documents from the public involvement program, nine technical appendixes, most of which are further divided into subsections, and draft SMMPs for the sites recommended for designation.

The DEIS is structured to lead the reader through the investigation and decision-making process for site designation. Chapter 1 provides an introduction to the issues involved in the EIS, the history of dredging and disposal in Long Island Sound, the statutory, regulatory, and legal framework in which the study was conducted, an overview of the scoping process and public involvement program, and a description of the remaining steps in the process. This introduction provides the necessary background information for an understanding of the purpose and need for the DEIS set forth in Chapter 2. Chapter 2 describes the need for alternative means of disposing of dredged material from the many public and non-Federal projects that occur in the rivers and harbors around Long Island Sound. This chapter also discusses the purpose of investigating open-water disposal options and alternatives to open-water disposal, to provide long-term practical means of meeting the needs of the Long Island Sound region.

Chapter 3 describes the process for identifying long-term open-water disposal options for the Long Island Sound region. This chapter provides a general overview of the alternatives evaluated throughout the EIS process including the potential environmental impacts of not designating any dredged material disposal areas in Long Island Sound (the No Action Alternative). An identification of the preferred alternative(s) at the end of Chapter 3 provides the reader with a focus for understanding the technical evaluations presented in Chapters 4 and 5.

Chapter 4 describes the affected environment of Long Island Sound with a focus on the western and central basins. This establishes the existing condition in which the anticipated impacts of any designation action will be addressed and evaluated. This information and evaluation draws from numerous available sources, Federal, state, academic and private, and the many investigations undertaken specifically in support of the DEIS, to describe the environment and uses of the Sound; the baseline setting in which the remaining analysis will take place.

Chapter 5 presents the identification and evaluation of the environmental consequences, or the anticipated impacts, of site designation in the western and central areas of the Sound and surrounding regions. Impacts to water quality, the benthic community, fish and shellfish, endangered species and other ecological impacts are evaluated. Socioeconomic impacts to fisheries, navigation, recreation, cultural resources, and other human uses of the Sound are also evaluated. These evaluations provide the technical rationale for the alternative sites analysis and recommendation for the preferred alternative presented in Chapter 3.

Chapter 6 contains a listing of statutes, regulations, executive orders, and other policies pertaining to this DEIS. NEPA requires that supporting documents clearly define the proposed action's compliance with applicable laws, regulations and other Federal authorities. The list shows which authorities apply to a dredged material disposal site designation in Long Island Sound.

Chapter 7 describes the public involvement program undertaken by the EPA and the Corps for this DEIS. This program is presented in greater detail in Appendix A – Public Involvement. This effort consisted of a formal scoping process, public workshops, involvement of a public working group, interagency meetings, and a general solicitation of public comment on individual studies and the overall effort throughout the EIS process. The concerns and issues raised by the public, cooperating agencies and other agencies and interested groups during this process assisted in framing the scope of investigations conducted for the EIS as discussed in Chapters 3 and 4. Further, the evaluations presented in Chapter 5 also drew focus from the public and agency input made through the workshops and working group sessions.

Chapter 8 lists the references consulted in preparation of the EIS.

Chapter 9 contains a list of preparers of the DEIS. Chapter 10 will include a list of all agencies, organizations and individuals who received copies of the DEIS. Chapter 11 provides an index to the DEIS.

Several technical appendixes are included which provide detailed documents supporting the discussions, evaluations, and recommendation in the EIS. These include: Appendix A – Public Involvement, Appendix B – Dredging Needs, Appendix C – Upland/Beneficial Use Site Resources, Appendix D – Alternative Analysis, Appendix E – Socioeconomics, Appendix F – Sediment Analyses (including chemistry and toxicity data), Appendix G – Physical Oceanography/Water Quality/Meteorology), Appendix H – Biological Resources of Open Water Sites (including benthic community analyses, finfish surveys, fisheries and

lobster surveys, tissue testing, essential habitat, and risk assessment), Appendix I – Historical and Archaeological Resources, and Appendix J – Site Monitoring/Management Plans for the sites recommended for designation.

CHAPTER 2 – PURPOSE AND NEED FOR AGENCY ACTION

Dredging is periodically needed in the waters of Long Island Sound. Dredged material from these activities must be disposed of in some manner. This DEIS will evaluate alternative means for such disposal, focusing on the potential designation of dredged material disposal sites in Long Island Sound for long-term use. Consistent with EPA's voluntary NEPA review policy, as discussed in Chapter 1, EPA is preparing this DEIS to aid in this consideration.

The purpose of EPA's action is to determine whether one or more environmentally sound open-water dredged material disposal sites can and should be authorized for future long-term use in Long Island Sound and, if so, to designate the site or sites accordingly and consistent with applicable law. The need for this effort derives from the following facts: (1) there are currently no disposal sites designated for long-term use within Long Island Sound, (2) the currently used sites are authorized under short-term authority that will be expire at various times in the relatively near future for each site (as early as February 2004 for the CLIS site), (3) periodic dredging and dredged material disposal is unavoidably necessary to maintain safe navigation and marine commerce, (4) the MPRSA's requirements authorize an EPA designation for any long-term dredged material disposal site. The legal, environmental and navigation/commerce aspects of the purpose and need for EPA's action are discussed below.

2.1 Legal

The legal regime applicable to dredged material disposal in Long Island Sound is described in significant detail in Chapter 1 and will be discussed here only as it relates to the purpose and need for EPA's present effort. MPRSA § 106(f) states the disposal of dredged material from either federal projects or non-Federal projects involving more than 25,000 cubic yards (19,114, cubic meters) of material must comply with the requirements of the MPRSA. While the Corps can "select" disposal sites for short-term use under MPRSA § 103 (*i.e.*, for a term of up to 5 years with the potential for an extension of up to 5 years), only EPA can "designate" a disposal site for longer-term use. In addition, the Federal Government entered a Settlement Agreement with various private parties in settlement of the case of *Fishers Island v. Corps of Engineers* (No. CV-95-4374) (E.D.N.Y.) (June 18, 2002), and agreed that, among other things, after June 18, 2002 (the effective date of the Settlement Agreement), disposal of dredged material from projects subject to MPRSA § 106(f) would only occur at disposal sites that had either been designated by EPA or selected by the Corps consistent with the provisions of MPRSA §§ 102(c) and 103(b), respectively. *See* Settlement Agreement ¶¶ 16 and 35.

There are presently no dredged material disposal sites designated by EPA for long-term use in Long Island Sound. Only EPA is authorized to designate disposal sites for long-term use. Since the 1992 amendments to the MPRSA, use of Corps-selected sites is limited to a maximum of five years with a possible five-year extension. This plainly raises the problem that the time period for using current Corps-selected sites will expire in the relatively near future. For example, as discussed in Chapter 1, the time for use of the CLIS disposal site — the principal site used in the central region of the Sound in recent years — will expire in mid-

February 2004. Use of the remaining selected sites in the Sound, including WLIS, will expire within no more than five years after their next use by any project covered by MPRSA § 106(f) (*see* September 27, 2001, Letter from Brian E. Osterndorf, Corps, to Arthur J. Rocque, Jr., CTDEP; Appendix A-4).

Unless sites for dredged material disposal in the western and central regions of Long Island Sound are designated by EPA, dredged material from projects covered by MPRSA would require alternative disposal options. Even if one of the currently active sites is determined to be environmentally suitable or even environmentally the best site[1], it could not be used after its selection periods have expired. Further, if EPA neither designates these sites nor some alternative sites, then other future disposal sites would need to be selected by the Corps for short-term use, applying the same site selection criteria that EPA applies in a site designation study. In that event, only short-term use would need to be considered for a Corps site selection study.

EPA's site designation evaluation seeks to address these problems. It will enable the agency to determine whether or not the CLIS disposal site ought to remain available for use beyond February 2004, and whether the WLIS site should also remain available for long-term use. It will also consider other dredged material disposal alternatives as well (see Chapter 3). In addition, by determining whether one or more disposal sites may be appropriately designated for long-term use, this effort may help to minimize how often the Corps and EPA need to engage in future site selection studies under the Corps' short-term site selection authority. Finally, the Federal Government is hopeful that this public disposal site designation process might, in the long run, help to prevent, minimize or narrow the scope of any future litigation related to dredged material disposal in Long Island Sound (April 16, 1998, Letter of Agreement between the New England Regional Office of the EPA and the New England Division of the Corps).

2.2 Environmental

EPA designation of a long-term dredged material disposal site(s), if an appropriate site(s) can be located, would offer several possible environmental advantages. First, as mentioned above, where use of a site under the Corps site selection authority is due to expire, designation by EPA is the only way to authorize continued use of that site even if the site is environmentally suitable or even environmentally preferable to all other sites. This possible problem will be faced at the CLIS site in February 2004 and will be faced at the WLIS site in the relatively near future. EPA's site designation studies will determine whether or not these or any other sites should be designated for continued long-term use.

Related to the above issue, EPA has concluded that it is *generally* preferable to designate disposal sites in areas which have been used for disposal in the past, rather than to locate sites in new, more pristine areas (40 CFR § 228.5(e) expressing general preference for historically used sites). The other agencies participating with the Interagency Group have agreed that

[1] MPRSA § 103(b) makes clear that a site used under the Corps site selection authority may later be considered for possible designation by EPA.

this general preference should be applied in this evaluation (Appendix D; USACE, 2002c). Since use of the Corps-selected sites will soon expire, the only way that these sites can continue to be used in the long-term is if they are designated by EPA. This study effort will determine whether or not these sites ought to be so designated.

It should also be noted that Congress has directed that the disposal of dredged material should take place at EPA-designated sites when such sites are available. *See* MPRSA §103(b). Thus, Congress appears to have identified an environmental preference for use of EPA-designated sites. The current study effort will determine whether one or more such sites should be made available in the western and central regions of Long Island Sound.

Another possible environmental benefit that could result from this effort is that if a disposal site were designated, a "site management plan" would be developed for that site consistent with MPRSA § 102(c)(3). Future environmental benefits could result from such enhanced site management. Finally, even if this study effort were not being conducted for the purpose of considering potential site designations, it would have the potential environmental benefit of producing information concerning the past effects of disposal at existing sites that could help guide future management of dredged material disposal.

As mentioned above, in addition to evaluating existing open-water disposal sites, EPA has reviewed alternatives to open water disposal. These alternatives are described in Chapter 3.

2.3 Navigation and Marine Commerce

Periodic dredging and, therefore, dredged material disposal are essential for ensuring safe navigation and facilitating marine commerce. This is because the natural processes of erosion and siltation results in sediment accumulation in federal navigation channels, harbors, port facilities, marinas, and other important areas of our water bodies. This accumulation of sediment can reduce water depths to the point that it threatens or prevents safe navigation and interferes with marine commerce. Moreover, unsafe navigational conditions not only threaten public safety, but can also pose an environmental threat from an increased risk of spills from vessels involved in accidents.

Designation of a long-term disposal site would assist the Federal Government, states, local communities, and private parties in planning to meet dredging needs with the knowledge that a specific, potential disposal site exists. Of course, as explained in Chapter 1, each particular project would still need to satisfy all applicable permitting requirements, including demonstration of suitability for disposal at a particular site, before it could be issued a permit for actual disposal.

The ability to dredge and affordably dispose of dredged material is critical to maintaining the large amount of navigation-dependent businesses and industries in the western and central Long Island Sound region. Through their direct, indirect, and induced impacts, navigation related businesses contribute more than $3 billion in gross state product (GSP) ($1.55 billion in Connecticut and $1.45 billion in New York) and account for more than 27,700 jobs in this two-State area. These industries also produce $441 million in tax revenues in this area (USACE, 2001d; USACE, 2003b; Appendix E).

Important businesses that rely to varying degrees on dredging and disposal, include shipping (especially the movement of petroleum fuels and the shipping of bulk materials), recreational boating, boat sales and repair, marinas, commercial fishing, and waterborne passenger transportation (ferries). These businesses provide important supplies and services to the Long Island Sound region, and employ thousands of people. Continued access to harbors, berths, and mooring areas is vital to ensuring the continued economic health of these industries, and to preserving the ability of the region to import fuels, bulk supplies, and other commodities at competitive prices. The continued ability to dredge and dispose of dredged material will preserve the significant economic benefits that these industries bring to the region in terms of sales, income, employment, and tax revenues. More detailed information regarding the economic importance of these industries is contained in Section 4.14.2 and in Appendix E.

For Long Island Sound, a dredging needs assessment was completed in 2001, and projected future dredged material quantities from the western and central regions were estimated, based on contact with 555 navigation-dependent facilities (146 responded) (USACE 2001b). Data on dredging needs and the importance of navigation to various water-dependent industries was solicited via a questionnaire distributed to port and harbor facilities and coastal municipalities around the Sound. Interviews were also conducted with major port users. The study consolidated the geographical areas of dredging needs into logical groupings referred to as "dredging centers" (Figure 2-1). Table 2-1 shows the total dredging needs estimated for the western and central regions of Long Island Sound over the next 20 years. Maintenance needs include maintenance dredging of Federal river and harbor channels based on surveys and historic shoaling trends, and maintenance of channels and facilities carried out under permit as developed from the questionnaire respondents and from evaluation of past permit activities (to account for facilities that did not participate in the questionnaire). Improvement needs include a select few proposals for Federal project deepening that have been evaluated in recent years and are expected to be re-examined within the 20-year period of the dredging needs analysis (principally the main channel deepening of New Haven Harbor). The dredging needs assessment is contained in Appendix B.

The majority of the total projected volume of dredging needs indicated in Tables 2-1 and 2-2 comes from maintenance dredging of larger federal navigation projects, chiefly the Bridgeport, New Haven, Housatonic River, Milford Harbor, and Norwalk Harbor areas. Maintenance dredging is necessary to maintain channel depths authorized by Congress to permit continued navigation. However, many of the private facilities contacted indicated that their need to perform maintenance work was, in part, dependent on predictable access to their facilities via federal channels that are maintained to their authorized depths (Appendix B). Thus, the projected dredging volumes for the western and central regions of Long Island Sound include a mix of large and small federal navigation projects and many small private dredging projects (marinas, boatyards, and harbors, and a few large private projects). This is consistent with the pattern of dredging in Long Island Sound over the past 20 years (CTDEP, 1998).

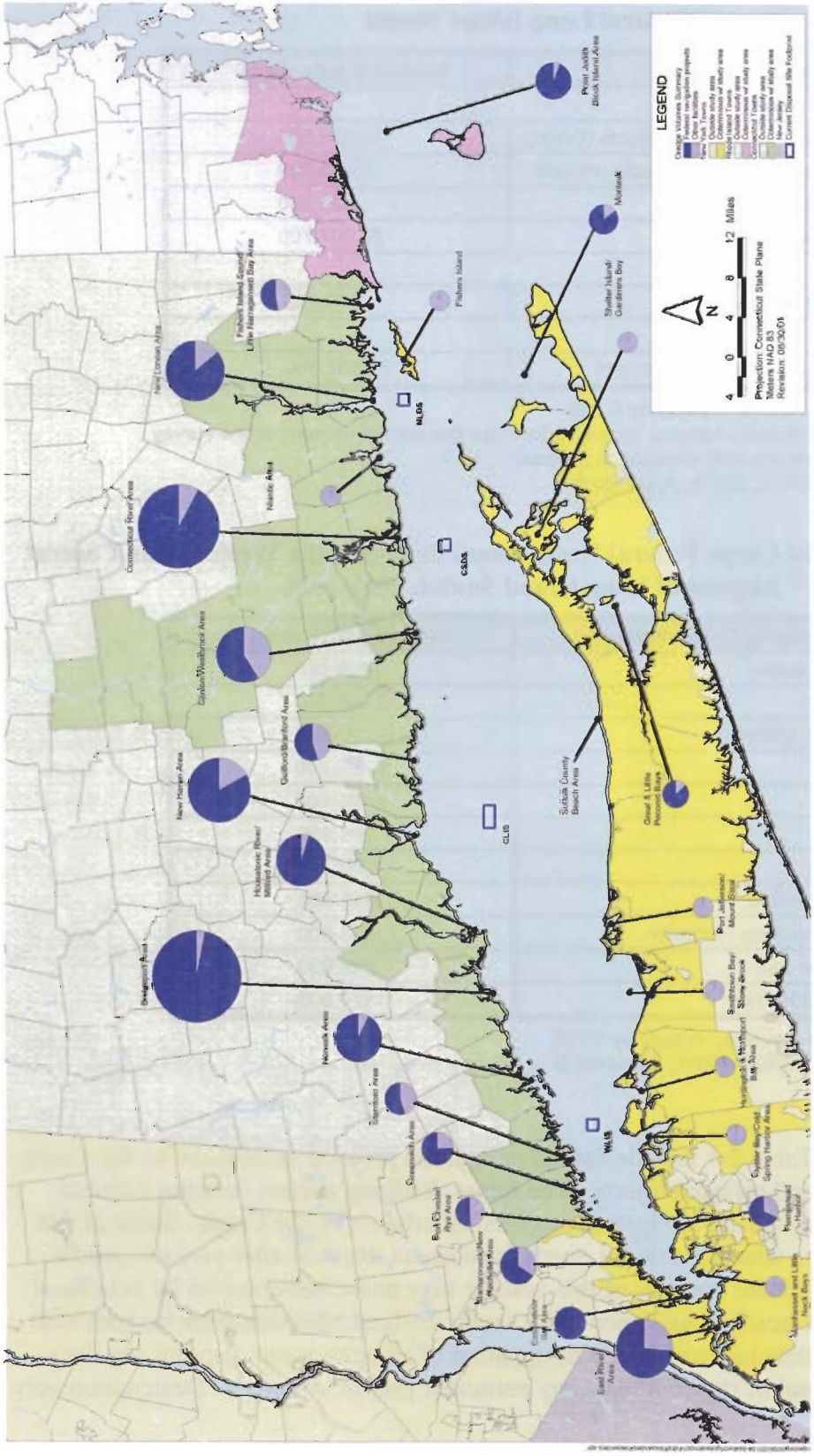

Figure 2-1. Dredging Centers Identified During the Dredging Needs Survey 2001

Source: USACE, 2001b; Appendix B

Table 2-1. 20-Year Estimated Dredging Needs for Western and Central Long Island Sound

Dredging Type	Volume (cubic yards)[1]
Maintenance Needs	
Federal navigation projects (Corps)	13,878,800
Other Federal and private projects	6,045,900
Projections [2]	683,000
Total Maintenance Needs	20,607,700
Improvement Needs	993,650
Total Maintenance and Improvement	21,601,350

[1] For cubic meters, multiply by 0.765.
[2] Based on historic dredging cycles for facilities that did not respond to the survey but that have required dredging in the past.
Source: USACE 2001b; Appendix B

Table 2-2. Projected Corps Federal Navigation Projects in the Western and Central Regions of Long Island Sound, 2001-2020

Dredging Center Project	Volume (cubic yards)[1]
Guilford/Branford	429,000
New Haven	2,348,000
Housatonic/Milford	1,273,600
Bridgeport	5,483,300
Norwalk	1,065,500
Stamford	241,100
Greenwich	259,200
Port Chester/Rye	145,000
Mamaroneck/New Rochelle	423,600
Eastchester Bay	240,000
Hempstead Harbor	171,500

[1] For cubic meters, multiply by 0.765.
Source: USACE 2001b; Appendix B

The volumes listed in Table 2-1 include federal navigation projects undertaken by the Corps, other Federal actions, and private projects. The future dredging project volumes listed in Table 2-2 are specific to federal navigation projects undertaken by the Corps. Some of this volume may prove to be unacceptable for unconfined ocean disposal after project specific testing and evaluation. Other portions of this volume may prove better suited for beneficial use alternatives such as beach nourishment with sandy dredged materials from harbors with adjacent beaches. As stated above, EPA's designation of an open-water disposal site does not authorize the disposal of material from any particular project or harbor. Designation only

makes a site available for consideration as an open-water disposal option for each proposed dredging project in the area.

The above information indicates a substantial need for dredged material disposal capacity in the western and central region of Long Island Sound over the next 20 years. The current Corps-selected sites cannot legally meet that need because of their near-term expiration dates. Therefore, EPA's site designation studies will investigate whether one or more disposal sites should be designated for long-term use to meet some or all of this disposal need.

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CHAPTER 3 – ALTERNATIVES

The purpose of this DEIS is to determine whether one or more environmentally sound open-water dredged material disposal sites can be designated for future long-term use in the western and central regions of Long Island Sound. This chapter provides a general overview of the alternatives evaluated throughout the EIS process, including the No Action Alternative.

In accordance with NEPA, alternatives to open-water disposal were considered during the overall EIS process. These included beneficial uses, upland alternatives, and treatment technologies. A brief description of the consideration of the beneficial use, upland, and treatment technology alternatives is given in Section 3.1. This evaluation determined that none of these alternatives would meet the long-term regional dredged material disposal needs of the western and central regions of the Sound. Therefore, these alternatives were not evaluated in detail in Chapter 4 and 5.

Detailed evaluation focused on dredged material that would be deemed suitable for unconfined open-water disposal when applying CWA and MPRSA criteria and the requirements of the Interim Regional Testing Manual (USEPA and USACE, 1998a) and Regional Implementation Manual (USEPA and USACE, 2002). Disposal of materials deemed unsuitable for unconfined open-water disposal was not considered in this DEIS.

This DEIS analyzes the potential environmental impacts associated with four alternative open-water dredged material disposal sites which were identified as potential candidates following the site screening process. The four sites analyzed (from west to east) are:

- Western Long Island Sound Alternative (WLIS);
- Bridgeport Alternative;
- Milford Alternative;
- Central Long Island Sound Alternative (CLIS).

Figure 3-1 identifies the Long Island Sound area and the four alternative dredged material disposal sites.

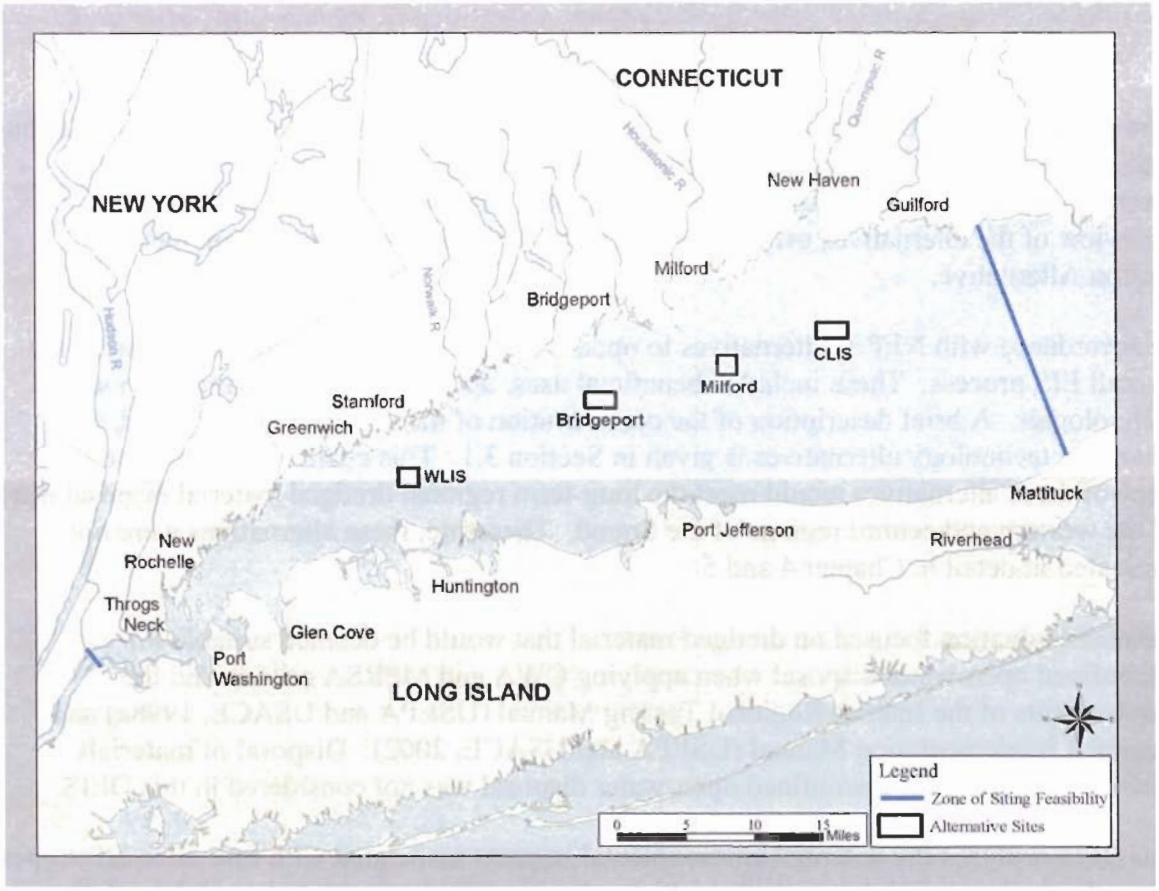

Figure 3-1. Alternative Open-Water Dredged Material Disposal Sites Evaluated in this DEIS

3.1 Initial Screening Process — Alternatives to Open-Water Disposal in Long Island Sound

Early in the process of identifying potential open water sites, the Corps and EPA reviewed all potential locations where dredged material could be disposed as alternatives to locations within the waters of Long Island Sound. The area considered (Figure 3-2) during the review of non-open water alternatives included all of Connecticut, New York's Westchester, Bronx, Queens, Brooklyn, Suffolk, and Nassau counties, and Rhode Island's Washington County (USACE, 2001c; Appendix C). This section describes the evaluation and screening of those alternatives. As part of the initial screening process, EPA and the Corps solicited public input to the identification of potential non-open-water alternatives in Long Island Sound. The EPA and Corps worked with Connecticut and New York to identify alternative disposal options that would satisfy the need for a long-term regional disposal alternative.

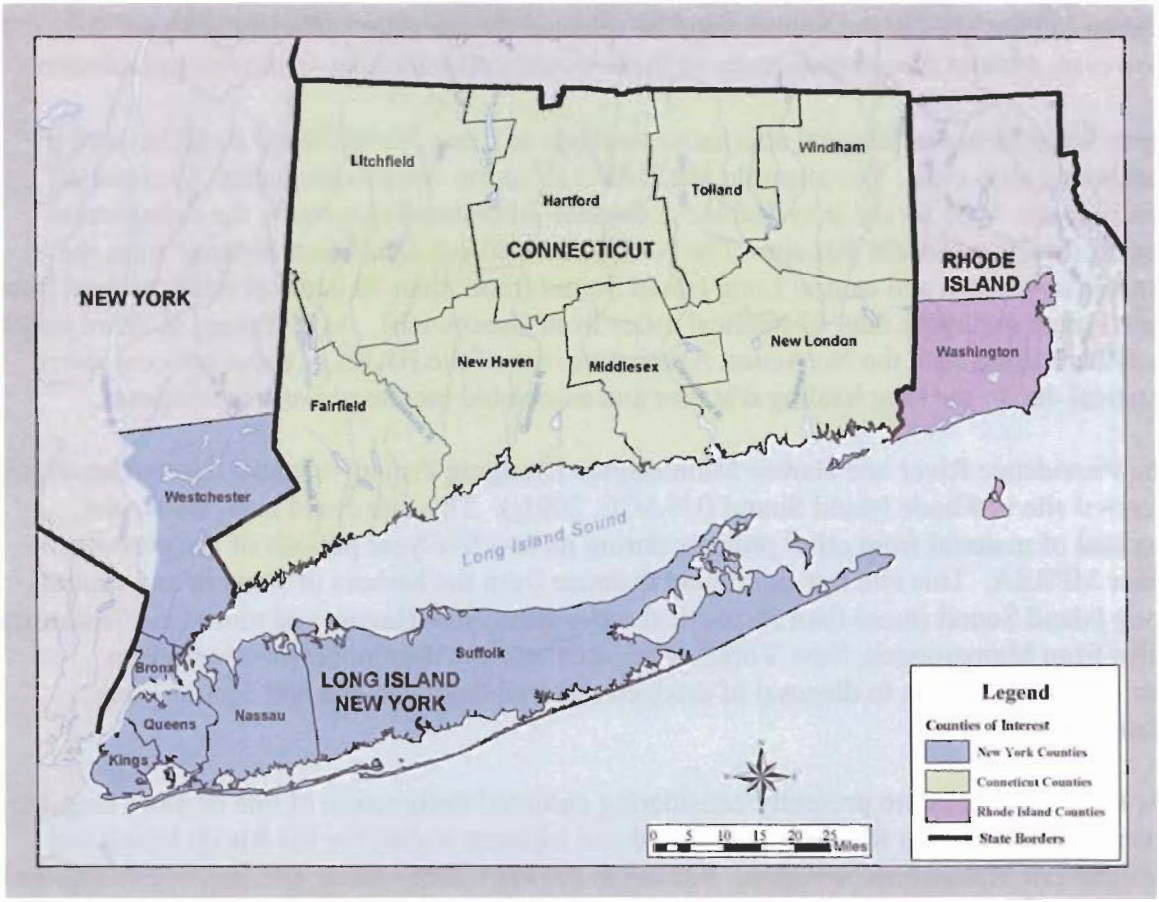

Figure 3-2. Area Considered During the Non-Open Water Alternative Evaluation

Alternatives to open-water disposal within western and central Long Island Sound include: disposal at active open-water sites in other areas of the Sound, disposal at open-water or ocean sites outside of the Sound, upland disposal within or outside of the Long Island Sound area of Connecticut and New York, treatment and re-working of the dredged material into commercial products (landscaping soil, building material, *etc.*), and beneficial use of the dredged material. Beneficial use can be either for an ecological benefit (*e.g.*, beach nourishment, marsh creation) or an economic benefit (*e.g.,* port development fill). For projects in western and central Long Island Sound subject to MPRSA (non-Federal projects over 25,000 cubic yard (19,114 cubic meters) and Federal projects) not designating open-water disposal sites in the Sound would necessitate resorting to these other alternatives, or a curtailment in dredging activity.

3.1.1 Ocean Disposal Alternatives

Outside of the western and central regions of the Sound, active disposal sites exist in the eastern region of the Sound at Cornfield Shoals and New London. These two sites are available for use under their second five-year selection periods and could be used for a limited period of time should there be no available alternatives for the western and central

regions. Other sites in the Sound could be selected for use after sufficient analysis. However, without designation, none of these would present a long-term regional solution.

Open-water or ocean disposal alternatives outside of Long Island Sound could be used if designated sites exist. For example, the HARS (Historic Area Remediation Site) site off Sandy Hook, New Jersey is available for disposal of material that meets the definition of remediation material for this site. The HARS site is also a significant distance from the harbors of western and central Long Island Sound (more than 70 nautical miles by haul from New Haven and more than 43 nautical miles from Greenwich). As discussed in detail under sections dealing with the No Action Alternative, use of the HARS site was not considered practical due to the long hauling distance and associated increased costs for disposal.

The Providence River and Harbor Maintenance Dredging Project recently selected an ocean disposal site in Rhode Island Sound (USACE, 2001j). This site could be available for disposal of material from other projects during its two five-year periods of use permitted under MPRSA. This site is a significant distance from the harbors of western and central Long Island Sound (more than 56 nautical miles from New Haven, and more than 78 nautical miles from Mamaroneck, New York). This site therefore does not offer a long-term cost effective solution to disposal of dredged material from western and central Long Island Sound.

The Corps and EPA are presently considering potential designation of one or more long-term ocean disposal sites in Rhode Island Sound and adjacent waters for the Rhode Island and southeastern Massachusetts region. Similar to the Providence River site, any site designated for use in Rhode Island Sound would also be a significant distance from the harbors of western and central Long Island Sound.

Consideration of the outer continental shelf or continental slope for designation of ocean disposal sites is required by MPRSA and has been suggested by the public. The continental shelf extends about 61 nautical miles south of Montauk Point New York outside of Long Island Sound. A site located on the continental slope would be a nearly 104-nautical mile haul from New Haven. Even a site closer inshore on the continental shelf, as near as 17 nautical miles off Montauk, would be nearly 61 nautical miles from New Haven, and nearly 78 nautical miles from Mamaroneck. Such a site would be a significant distance from the harbors of western and central Long Island Sound.

As described in Section 3.3, the significant distances associated with hauling dredged material outside of Long Island Sound render these areas economically and operationally infeasible for site designation.

3.1.2 Upland and Beneficial Use Alternatives

Upland disposal alternatives were investigated within the Long Island Sound region (Appendix C). This review of existing landfills and other upland sites found no specific sites of sufficient capacity that could be permitted for long-term use as a regional disposal alternative. This does not preclude the requirement for individual port and harbor dredging

projects to investigate and evaluate the potential for upland disposal alternatives for specific project purposes.

Beneficial use of dredged materials is encouraged where a need for such use exists and any additional cost associated with that method of disposal is justified by the benefit. The most common form of beneficial use is beach nourishment using 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 disposal is commonly used for the maintenance of entrance channels and beaches for the harbors of Long Island, and to a lesser extent for Connecticut harbors.

Other beneficial use alternatives, such as fill for port development, are evaluated on a project-specific basis. These alternatives are generally not of such capacity as to provide a regional disposal alternative. In New England, such sites are not generally available for long-term use even for the port in which they are located in. In Long Island Sound, the last such fill sites, at New Haven and Bridgeport, have long since been filled to capacity and developed for other purposes. Historically, such sites involved the filling of tidelands, including salt marshes and intertidal flats, to create industrial space, parks, and highways. These activities are discouraged today due to their significant impact on the environment. No opportunities for long-term regional disposal sites of this nature were identified.

One type of beneficial use is the confined disposal facility. These facilities are typically constructed either for port fill or to create parkland or habitat. 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. In these cases, intertidal and or shallow subtidal lands are diked and filled over a period of years or decades. After filling and years of drying and consolidation, the created land is then used for industrial development. An example of a confined disposal facility created and managed for habitat development is the Poplar Island site in Chesapeake Bay, which is used for disposal from the Port of Baltimore and other Maryland harbors. Prior to the use of dredged material as fill for a port development project, the port development project itself would require extensive review pursuant to applicable laws and substantive requirements. Demonstration of compliance with the CWA §404(b)(1) Guidelines with respect to the Port Development aspect is critical irregardless of they type of fill that may be used. Except as provided for under CWA §404(b)(2), "no discharge or dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences."

Limited opportunities exist for development of confined disposal facilities in Long Island Sound waters as a long-term regional site. A 1985 study of potential containment sites in the Sound by the Corps identified one potential site of limited capacity at Clinton Harbor (USACE, 1985); however, no non-Federal Sponsor willing to share in implementation of such a facility was identified. In addition, construction of such a facility to accommodate the long-term needs of the western and central Sound region's ports and harbors, whether for port fill or other purpose, would likely convert hundreds of acres of tidal and open-water

habitat to a containment facility. While this could create an environmental or social benefit (*i.e.*, creation of terrestrial habitat or parkland) its impact would be a permanent loss of aquatic habitat. Creation and use of the sites also entails substantial costs for dredging projects due to the need for armored dikes, rehandling berths, internal drainage, and drying management, and long-term operation of the facility.

Upland disposal of dredged material outside of the Long Island Sound region would require drying and rehandling of the material for some form of transport (truck or rail) and hauling the material to the final destination. In the congested landside of most ports and harbors in the region, open space is not available for dedication to a drying and rehandling operation. Even where such space may be available, its use in lieu of other purposes to which it may be put carries a cost to its owners. Further, landside transportation adds significant cost to the disposal of the material. For contaminated dredged materials found not suitable for other disposal options, such methods are sometimes the only available option, so cost is less of a consideration. However, for suitable dredged materials where other options exist, the high cost of upland transport is impractical.

3.1.3 Treatment Technologies

Whereas there has been significant progress made in demonstrating the viability of sediment treatment technologies with beneficial use applications over the last several years, treatment technologies are not stand alone as an alternative to ocean disposal but are considered a component of an overall regional dredged material management program. A dredged material management program (DMMP) is determined by the Corps on a project specific basis, as needed for long-term projects, rather than for a region overall. For the Long Island Sound area, a DMMP has not been pursued. Work conducted by EPA Region 2 and the Corps New York District under the auspices of the Water Resources Development Act, as well as the New Jersey Department of Transportation Office of Maritime Resources, has shown that sediment treatment with beneficial use can be realized on a commercial scale level. The cost of treatment will certainly be more expensive than open water disposal based on the sheer cost of infrastructure development, energy requirements, materials handling *etc.* For the most contaminated material, treatment technologies may be a viable cost-effective alternative in the future. Full and commercial-scale demonstrations will be underway during 2004 in the New York/New Jersey harbor region. More information can be found at www.wrdadcon.bnl.gov and at www.state.nj.us/transportation/maritime.

Despite these recent advances in the development of treatment technologies, it has been determined that the high cost and low throughput processing rate generally make such options impractical for large or long-term dredging projects at this time. A treatment processing methodology that handles only a few hundred cubic yards a day can not work in tandem with dredging equipment that generates several thousand cubic yards a day. Further, once treated, the material must be rehandled and hauled away to an upland disposal site, or transported and further processed for use in a commercial application. The costs and throughput rates for such alternatives make them impractical for use in this evaluation as long-term regional disposal alternatives.

3.1.4 Summary of Initial Screening Process — Alternatives to Open-Water Disposal in Long Island Sound

This evaluation determined that no alternatives to open-water disposal in Long Island Sound would satisfy the need for long-term regional disposal options for the ports and harbors of western and central Long Island Sound. Individual projects proposing disposal of dredged material will need to investigate and evaluate these alternatives for specific project purposes. Open-water disposal within Long Island Sound was determined to be the only practical solution to the regional long-term disposal needs of the ports and harbors of western and central Long Island Sound.

3.2 No Action Alternative

NEPA requires that an EIS evaluate the "No Action Alternative." *See* 40 CFR 1502.14(d). In cases involving 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 effects that would result if the action did not take place. These effects can then be assessed and compared with the effects of the proposed action and other "action" alternatives. In this case, the No Action Alternative to the proposed action would be not to designate open water site(s) for the long-term disposal of dredged material from the harbors, navigation channels, and inlets in the western and central regions of Long Island Sound.

While it is impossible to be certain of how dredging needs resulting from sediment build-up in the central and western regions of Long Island Sound would be handled if no disposal sites are designated, several hypothetical scenarios might reasonably be considered. First, disposal site authorization for private projects involving less than 25,000 cubic yards of material would simply continue being evaluated on a project-specific basis under CWA § 404. Second, for projects subject to MPRSA §106(f) (*i.e.,* either federal projects or private projects involving greater than 25,000 cubic yards of material), project proponents would need to pursue one or more of the following courses of action:

(1) Utilize an alternative open-water site either inside or outside of Long Island Sound that has been "selected" by the Corps and concurred with by EPA under MPRSA § 103;

(2) Use an already designated site outside of the central and western Long Island Sound;

(3) Await EPA designation of a different disposal site outside of the central and western portions of Long Island Sound;

(4) Develop and utilize appropriate land-based disposal/reuse alternatives;

(5) Cancel the proposed dredging projects.

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

3.3 Initial Screening Process — Open-Water Alternative Sites in Long Island Sound

The next step undertaken in the process of screening possible dredged material disposal options for the western and central Long Island Sound area was a review of possible open-water alternatives. This process began with the development of a Zone of Siting Feasibility (ZSF) for open-water alternatives then continued through a two tiered screening process, resulting in the identification of four open-water alternatives.

3.3.1 Zone of Siting Feasibility for Open-Water Alternative Sites

The EPA site designation guidance manual (USEPA 1986) describes the considerations that should be addressed to define a ZSF. Building on information in other publications (*e.g.*, Mathis and Payne, 1984), EPA (1986) recommends locating open-water disposal sites within an economically and operationally feasible radius from the point of dredging. Other considerations include navigational restrictions, political or other jurisdictional boundaries, distance to the edge of the continental shelf, the feasibility of surveillance and monitoring, and operational and transportation costs (Pequegnat *et al.,* 1990).

Long Island Sound is 110-miles (177 kilometers) long, with harbors and inlets throughout its 600 miles (966 kilometers) of coastline (USACE, 1998). These harbors and inlets are shallow depositional areas that require periodic dredging to maintain their recreational and commercial use. The overall size of Long Island Sound presents a wide range of haul distances and navigational limitations with respect to dredging project sites (*e.g.*, shallow, non-navigable areas). In addition, several factors limit the dredging schedule in Long Island Sound, including environmental windows, seasonal conditions, and the availability of equipment suitable for dredging federal projects, marinas, and harbors (USACE, 2001b).

As specified by EPA (1986), development of the ZSF should take into consideration an area which is economically and operationally feasible. As demonstrated in dredged material disposal EISs written for other projects in New England (*i.e.*, Providence River and Harbor Maintenance Dredging Project, Seawolf Class Submarine Homeporting on the East Coast of the United States), disposal of material at open-water or ocean sites located farther away from the point of dredging cost more than closer sites due to travel time, fuel costs, and in the case of continental shelf dumping, additional crew costs for trips greater than 12 hours long. In some cases, sites located farther from the point of dredging also demand the use of larger equipment suited for open ocean travel, which is also an additional cost (*i.e.*, daily rate for use and amount of fuel used is increased).

Most dredging projects throughout Long Island Sound, including some federal and non-Federal projects over 25,000 cubic yards (19,114 cubic meters), are in shallow non-navigable areas where large ocean suitable tugs and barges can not be operated. In addition, dredging of most Long Island Sound projects is conducted by local area contractors that have small barges and tugs designed for short distance disposal.

Based on this evaluation, candidate disposal sites more than 25 nautical miles (46 kilometers) from a dredging center, including those on or beyond the continental shelf break (about 75 to

150 nautical miles (139 to 278 kilometers) from the dredging centers of Long Island Sound) were determined to not be economically and operationally feasible.

The Notice of Intent to prepare an EIS to evaluate potential open-water dredged material disposal site(s) within Long Island Sound published in 1999 (FR 64:106, June 3, 1999) identified a ZSF including all of Long Island Sound, defined as the area between the confluence of the East and Harlem Rivers at Hell's Gate in the west and Montauk Point, Long Island to Lewis Point on Block Island and from Sandy Point on Block Island to Point Judith, Rhode Island in the east (Figure 3-3). In March 2002, the EPA in conjunction with the Corps and after consultation with CTDEP and NYSDEC modified the scope of the current EIS to consider the potential designation of one or more open-water dredged material disposal sites for the western and central regions of Long Island Sound (EPA *Environmental News*, March 2002). The primary reasons for this decision were:

- The disposal needs and alternatives of the western and central Long Island Sound regions are geographically and environmentally separate from those of the eastern Long Island Sound region;
- The need to assess, in a timely manner, the appropriateness of maintaining operational continuity and continued use of a site serving the needs of the central Long Island Sound region.

This change in scope did not preclude consideration of a comprehensive range of alternatives to open-water disposal sites for all three Long Island Sound regions, although it did defer the evaluation for eastern Long Island Sound sites to a later date. As a result, a modified ZSF (USACE, 2002c) was developed (Figure 3-3). The eastern boundary of the modified ZSF is based on a generalized physiographic boundary between the central and eastern regions of Long Island Sound. The eastern boundary is marked by a change in sediment texture and depth representing the transition from the depositional basin of the central sound into the more active region of the Mattituck Sill and the eastern basin (Figure 3-3; USGS, 2002). The United States Geological Survey (USGS) and the Connecticut Geological Survey have described this margin as the transition zone from the depositional processes in the central basin to the broadly erosional processes in the eastern basin (USGS, 2000). This modified ZSF eastern boundary is defined by a line drawn from Mulberry Point, Guilford, Connecticut to Mattituck Point, New York. The western border remains at the confluence of the East and Harlem Rivers at Hell's Gate. This modified ZSF also corresponds to an area approximately 25 nautical miles (46 kilometers) from the western and central Long Island Sound dredging centers.

3.3.2 Open-Water Alternative Sites Screening Process

EPA, in accordance with NEPA, worked with Federal and state agencies to identify specific sites within the ZSF. Because WLIS and CLIS are currently active dredged material disposal sites in Long Island Sound, they were included among the alternative sites considered in this DEIS. The EPA and Corps followed MPRSA to facilitate the selection of alternative sites

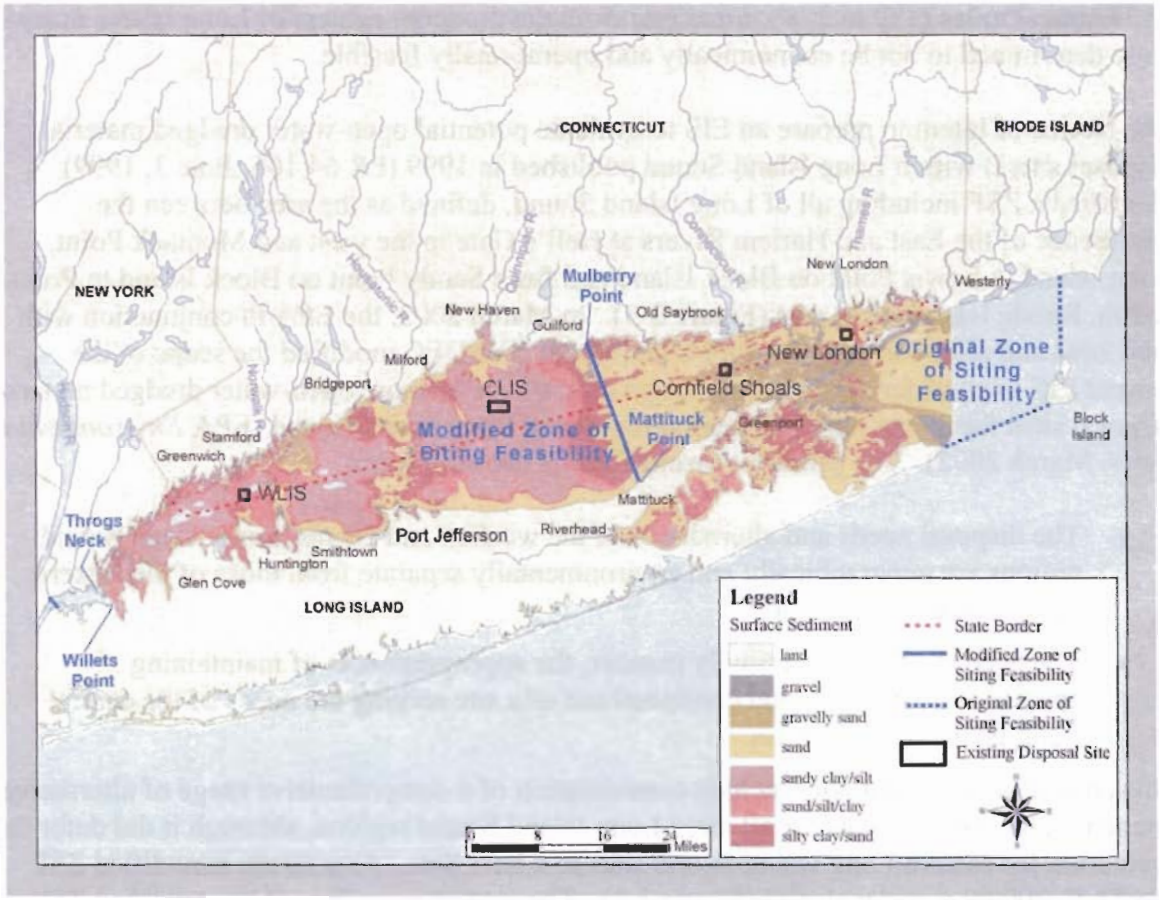

Figure 3-3. Original and Modified Zone of Siting Feasibility

that are sufficiently removed from ecologically sensitive or incompatible use areas to avoid or minimize potential impacts on these areas.

The five general and eleven specific criteria in 40 CFR 228.5 and 40 CFR 228.6 (Table 3-1) guided the process used to identify alternative sites (USACE, 2002c). Additionally, the Long Island Sound Dredged Material Disposal Site Designation EIS Working Group prepared a summary of evaluation factors for site screening (USEPA, 1999). To facilitate the selection of alternative disposal sites for Long Island Sound, the general and specific criteria from 40 CFR 228.5 and 228.6 were organized to develop a screening process that would:

- Identify areas within the modified ZSF not acceptable for locating an open-water disposal site designated under the MPRSA (Tier 1 screening);
- Identify specific alternative disposal site(s) within the acceptable area(s) for further evaluation in the EIS (Tier 2 screening).

Table 3-1. Required Considerations in the Evaluation and Designation of Ocean Dredged Material Disposal Sites (40 CFR 228.5 and 228.6)

Sec. 228.5 General Criteria for the selection of sites	
(a) The dumping of dredged material into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.	
(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations of effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.	
(c) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Section 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.	
(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation site study.	
(e) USEPA will, wherever feasible, designate ocean dumping sites beyond the edge of the Continental shelf and other such sites that have been historically used.	
Sec. 228.6 Specific criteria for site selection	
(a) In the selection of disposal sites, in addition to other necessary or appropriate factors determined by the Administrator, the following factors will be considered:	
(1)	Geographical position, depth of water, bottom topography and distance from coast;
(2)	Location in relation to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile phases;
(3)	Location in relation to beaches and other amenity areas;
(4)	Types and quantities of wastes (dredged material) proposed to be disposed of, and proposed methods of release, including methods of packaging the waste (dredged material), if any;
(5)	Feasibility of surveillance and monitoring;
(6)	Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;
(7)	Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);
(8)	Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;
(9)	The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;
(10)	Potentiality for development or recruitment of nuisance species in the disposal site;
(11)	Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.
(b) The results of a disposal site evaluation and/or designation study based on the criteria stated in paragraphs (1) – (11) will be presented in support of the site designation promulgation as an environmental assessment of the impact of the use of the site for disposal, and will be used in the preparation of an environmental impact statement for each site where such a statement is required by EPA policy. By publication of a notice in accordance with this Part 228, an environmental impact statement, in draft form, will be made available for public comment not later than the time of publication of the site designation as proposed rulemaking, and a final EIS will be made available at the time of final rulemaking.	

Site screening and potential alternative sites were identified by Federal and state agencies at a meeting held at the offices of the CTDEP in Hartford, Connecticut on May 16, 2002. Participating agencies included EPA New England and Region 2, the Corps, NMFS, CTDEP, NYSDEC, and NYSDOS. Full details of the screening process and results can be found in Appendix D *Alternative Site Screening*.

Data from Corps and EPA field studies conducted throughout Long Island Sound as well as studies conducted by the State of Connecticut, the State of New York, and USGS were included in the site screening process. When data were not available for both Connecticut and New York state waters, it was so noted during the discussion and additional efforts were made to obtain any available data layers for review.

3.3.2.1 Tier 1 Screening

Tier 1 screening defined areas within the revised ZSF not acceptable for locating an open-water disposal site, thereby reducing the area considered for Tier 2 screening (USACE, 2002c) (Figures 3-4 and 3-5). The consensus of the Federal and state agencies was that, for site screening purposes, both New York and Connecticut State waters should be given equal consideration [40 CFR 228.6(a)(1)]. The remaining factors used in the Tier 1 screening ruled out areas based on the following:

- The preferred areas for consideration for the alternative disposal sites would be "containment areas[1]" as opposed to "dispersal areas[2]," and water depth would be a surrogate for sediment stability. Waters shallower than 59 feet (18 meters) were eliminated from consideration because wave and storm driven bottom currents in these shallow depths in Long Island Sound frequently are strong enough to resuspend bottom sediments and, thus, would be considered "dispersal areas";
- Alternatives would not be placed near beaches, state or Federal Reserve areas, artificial reefs, or other conservation areas [40 CFR 228.6(a)(8), 228.6(a)(3)] (Figure 3-4);
- Pipeline and cable areas, including approved projects yet to be constructed, would be avoided [40 CFR 228.6(a)(8), 228.6(a)(3)]. A minimum 200-foot (60-meter) buffer zone around each pipeline and cable was assumed during the screening (Figure 3-4);
- Shellfishery resource areas would not be considered for alternative sites [40 CFR 228.5(a)] (Figure 3-4);
- Surface sediment texture data could be used to describe Long Island Sound marine habitats. Therefore, hard-bottom and gravel areas of the Sound were considered important marine habitats because they provide topographic relief important to living resources (Figure 3-5). Hard-bottom (rock outcrop) areas in the Sound were also considered fish havens [40 CFR 228.5(a)];
- Areas of erosion and areas of coarse-grained sediments, based on USGS interpretation, were considered. In addition, bottom areas classified as sorting and reworking (resulting from biological, not physical processes) were considered gray areas – not screened out in Tier 1 but given special consideration in Tier 2 [40 CFR 228.6(a)(6)].

[1] Containment areas have physical and geological features that restrict movement of bottom sediments from the area to surrounding areas. Examples of containment areas are deep holes, or places where currents are so low, sediments are not resuspended.

[2] Dispersal areas have physical and geological features that disseminate materials from its area to surrounding areas. Disposal areas may have high currents that resuspend bottom sediments and carry the sediment out of the area.

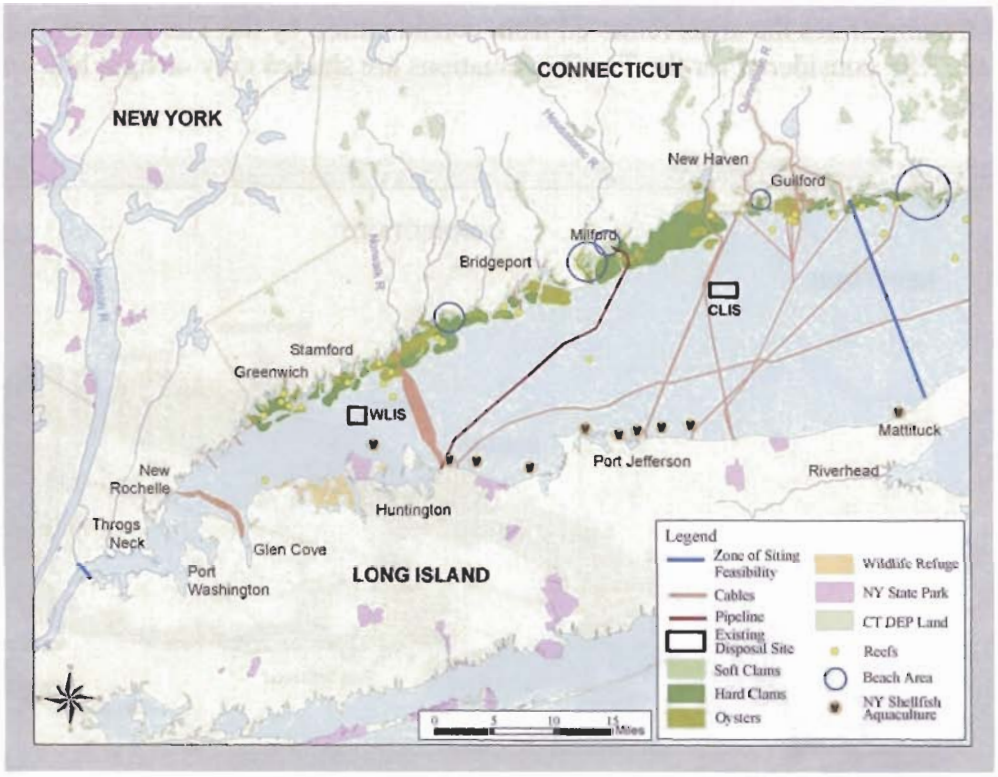

Figure 3-4. Example of Data Types Considered Under Tier 1 Screening

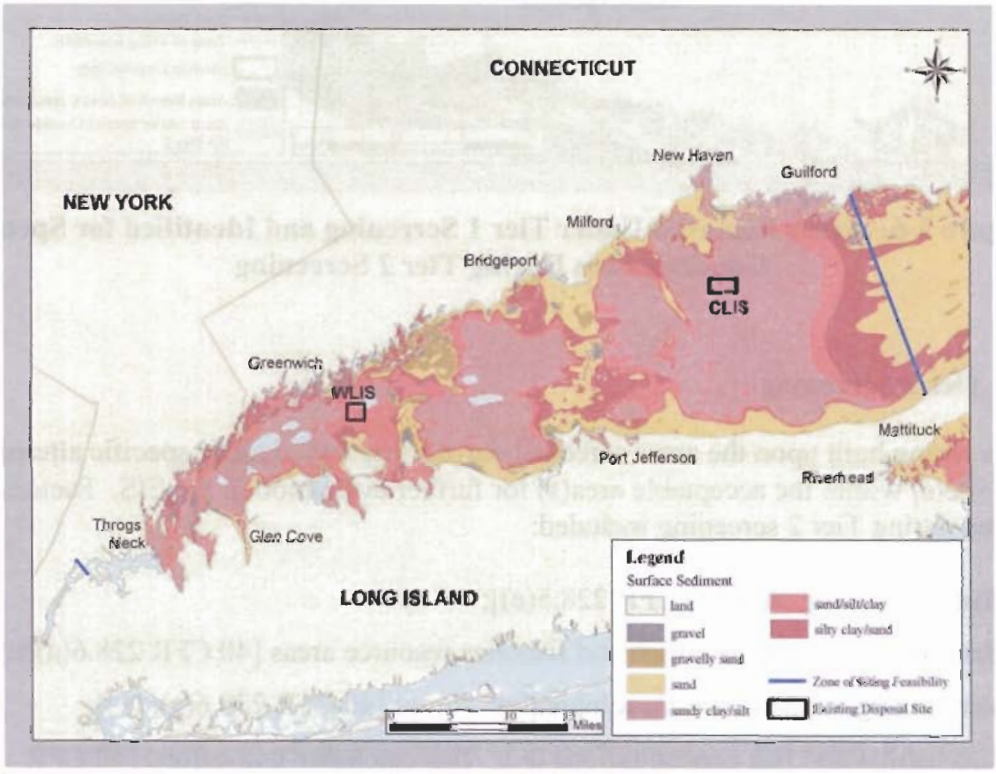

Figure 3-5. Sediment Texture Considered During Tier 1 Screening

Source: Poppe *et al.*, 2000

Figure 3-6 summarizes the areas removed from consideration by the Tier 1 screening. The areas of the ZSF considered for the Tier 2 evaluations are shaded gray or light blue in Figure 3-6.

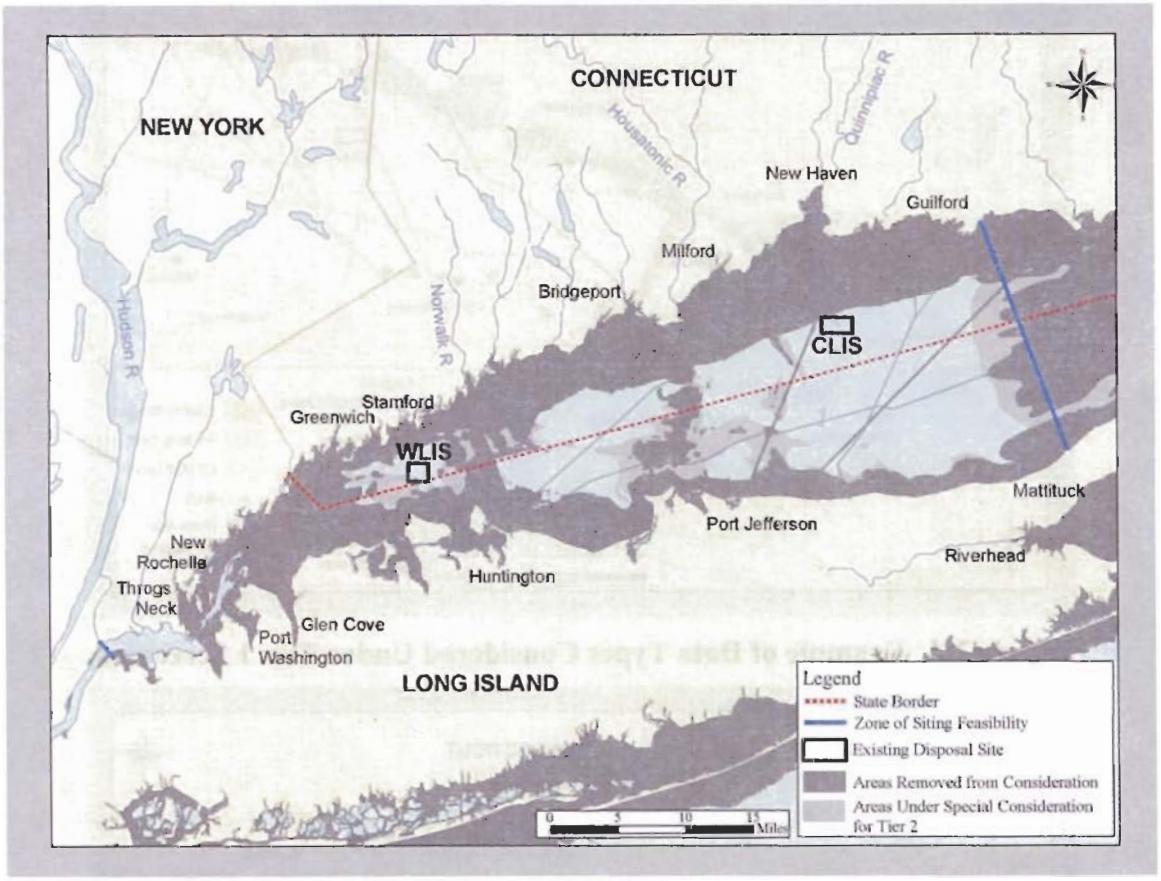

Figure 3-6. Areas Removed Under Tier 1 Screening and Identified for Special Consideration During Tier 2 Screening

3.3.2.2 Tier 2 Screening

Tier 2 screening built upon the areas screened during Tier 1 to identify specific alternative disposal site(s) within the acceptable area(s) for further evaluation in the EIS. Factors considered during Tier 2 screening included:

- Historical dump sites [40 CFR 228.5(e)];
- Benthic community, shellfish and fisheries resource areas [40 CFR 228.6(a)(6)];
- Minimizing impacts to archaeological resources [40 CFR 228.6(a)(11)];
- Fish habitat and fish concentrations (*e.g.,* fish catch-per-unit-effort) [40 CFR 228.5(a), 228.6(a)(9), 228.6(a)(8)];

- Living resources (*i.e.*, breeding, spawning, nursery, feeding and passage areas) [40 CFR 228.6(a)(3)];
- Contaminant distribution, bulk sediment properties (texture and total organic carbon) [40 CFR 228.6(a)(6)] (USACE, 2002c).

Because of the large number of historic disposal sites throughout Long Island Sound there was strong agreement among agency members that preference should be given to selecting historic disposal sites in Long Island Sound to avoid modifying bottom type and habitat of additional areas of the Sound and to address any potential adverse sediment quality issues resulting from historic use of these sites. This consideration is consistent with 40 CFR 228.5(e) which directs EPA to, "*wherever feasible, designate ocean dumping sites ... that have been historically used.*" Previously considered or used open-water disposal areas in western and central Long Island Sound are presented in Figure 3-7.

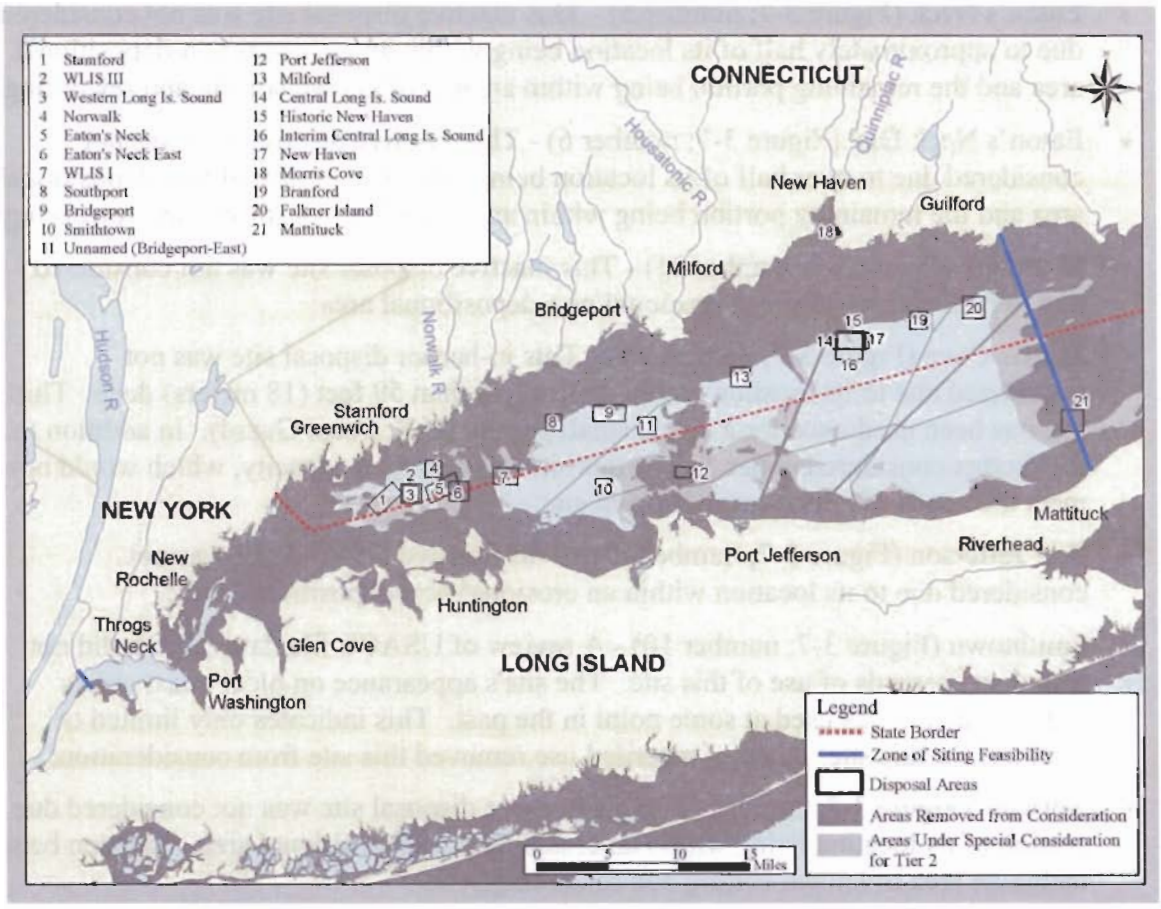

Figure 3-7. Previously Considered or Used Open-Water Disposal Areas in Western and Central Long Island Sound

Throughout western and central Long Island Sound there have been 21 previously considered or used open-water disposal areas of which two have been located at the present WLIS location (the existing WLIS site was referred to as WLIS III during the 1982 EIS for the Designation of a Disposal Site for Dredged Material in Western Long Island Sound [USACE,

1982b]) and four have been located at the present CLIS location (the existing CLIS site, an Interim CLIS site, a New Haven Disposal site, and a Historic New Haven Disposal site). For this DEIS, the existing CLIS Disposal Site (Figure 3-7, number 14) will be the only site considered out of the four located in this area. At the WLIS and CLIS sites, only the currently used sites were assessed. However, based on the findings of the alternative analyses in the EIS, the boundaries of these sites may be modified if the sites are chosen as designated open-water disposal sites and a need for site boundary modification is deemed necessary.

When the previously considered or used open-water disposal areas were overlaid on the Tier 1 figure, several historic disposal sites were screened out based on location within erosional/non-deposition and sorting/reworking areas as well as the extent of their previous use:

- Eaton's Neck (Figure 3-7; number 5) - This inactive disposal site was not considered due to approximately half of its location being within an erosional/non-depositional area and the remaining portion being within an area of known sorting and reworking;
- Eaton's Neck East (Figure 3-7; number 6) - This inactive disposal site was not considered due to over half of its location being within an erosional/non-depositional area and the remaining portion being within an area of known sorting and reworking;
- Mattituck (Figure 3-7; number 21) - This inactive disposal site was not considered due to its location within an erosional/non-depositional area;
- Morris Cove (Figure 3-7; number 18) - This in-harbor disposal site was not considered due to its location within waters less than 59 feet (18 meters) deep. This site has been used once for a single small project (U.S. Coast Guard). In addition to the factors considered under Tier 1, this site has a limited capacity, which would not meet the needs of a long-term disposal site;
- Port Jefferson (Figure 3-7; number 12) - This inactive disposal site was not considered due to its location within an erosional/non-depositional area;
- Smithtown (Figure 3-7; number 10) - A review of USACE file data (2003), did not reveal any records of use of this site. The site's appearance on older coast charts suggests that it was used at some point in the past. This indicates only limited or brief use for this site. Lack of recorded use removed this site from consideration;
- Norwalk (Figure 3-7; number 4) - This inactive disposal site was not considered due a portion of its location being within an erosional/non-depositional area, a portion being within an area of known sorting and reworking;
- Stamford (Figure 3-7; number 1) - This inactive disposal site was not considered due to over half of its location being within an area of known sorting and reworking;
- Unnamed Disposal Site (Bridgeport -East) (Figure 3-7; number 11)- This 1 nautical mile-square inactive disposal site located east of the larger Bridgeport disposal site was not considered because of its proximity to the Iroquois pipeline and potential use of the area for additional pipelines in the future;

- WLIS I (Figure 3-7; number 7) – This site was an alternative in a prior EIS (USACE, 1982a) and has never been used for disposal. It was removed from consideration because, based on USACE file data (2003), this site was never selected or actually used as a disposal site.

Several historic disposal sites were identified that passed the Tier 1 screening criteria, therefore, the agencies agreed that it was not necessary to evaluate areas that have not been historically used. Each of the identified sites was further evaluated with respect to the additional Tier 2 factors.

While reviewing CTDEP shellfish bed classification information it was brought to the attention of the agencies that Connecticut restricts shellfish harvesting within 1000 feet (300 meters) of dredged material disposal sites and that areas found to have water quality problems (*i.e.*, bacterial and organic/inorganic contaminants) are closed from the shoreline to the state boundary. Based on this information the agencies felt it was not appropriate to position alternative sites within areas approved for shellfish harvesting. This decision removed the Southport, Branford, and Faulkner Island historic disposal sites from consideration as alternatives (Figure 3-8). The shellfish bed classification also would have screened out WLIS I, Morris Cove, and Norwalk had they not already been removed based on the Tier 1 screening.

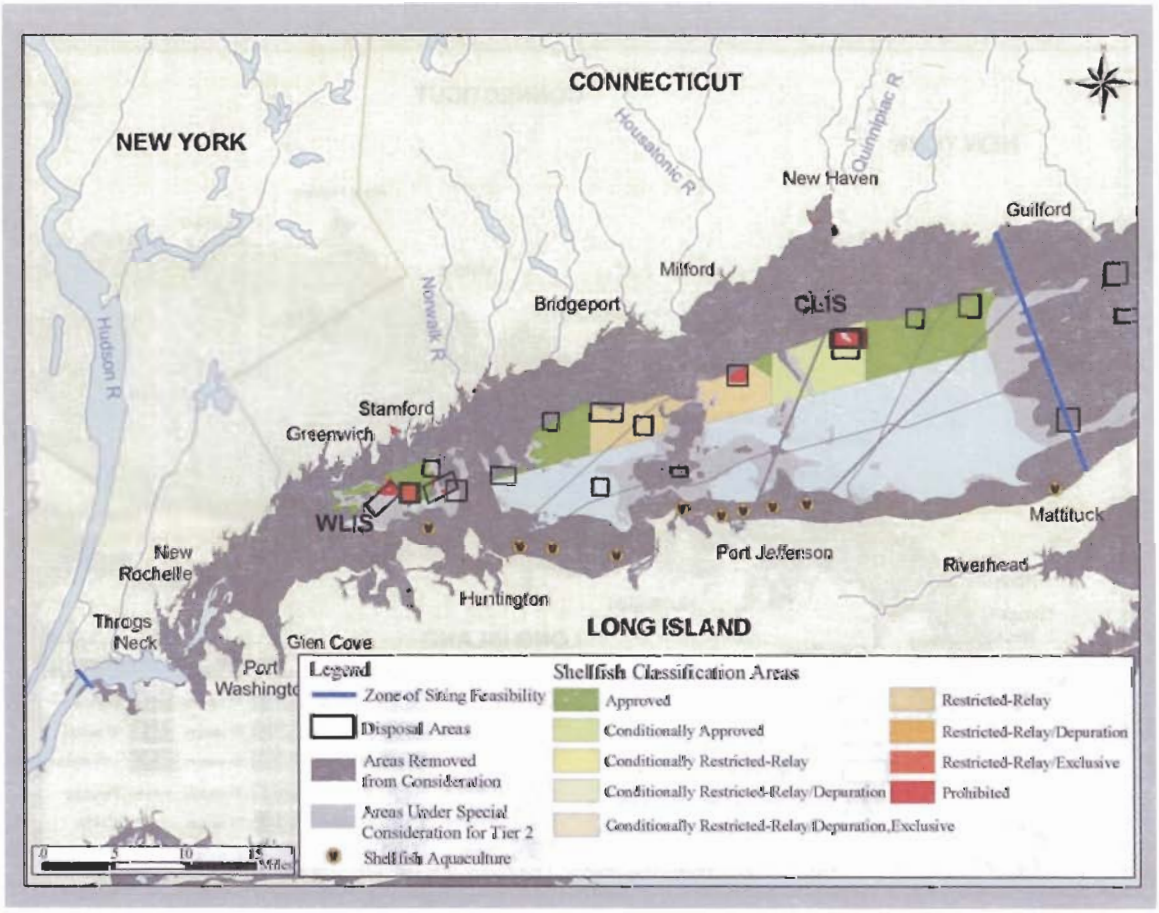

Figure 3-8. Tier 2 Shellfish Bed Classification Site Screening

After applying the Tier 2 screen, two historic sites remain (Bridgeport and Milford). Because WLIS and CLIS are currently active dredged material disposal sites in Long Island Sound, they will be considered in this DEIS along with the remaining two historic sites Bridgeport and Milford. Review of available data for these sites (archaeological, fish catch per unit effort, benthic community, sediment chemistry, and sediment total organic carbon) showed no additional discriminatory features of the remaining historical sites.

Although a small portion of the historic Milford site is located in waters shallower than 59 feet (18 meters), this was not considered a strong argument against selecting the site as an alternative. However, the agencies did agree that if the site was still under consideration after the Tier 2 screening was completed, adjustment of the site boundaries (towards deeper waters) should occur before evaluation in the DEIS.

Based on these results the agencies chose to assess the WLIS, Bridgeport, Milford and CLIS sites in the DEIS (Figure 3-9). From the site screening process, the agencies also determined that additional data needed to be collected for Bridgeport and Milford including: archaeological, benthic community, lobster usage, sediment chemistry, and sediment toxicity data. Surveys and an assessment of these areas were subsequently conducted in the summer of 2002. The data from these assessments have been included throughout Chapters 4 and 5 of this DEIS and in various appendices to this document.

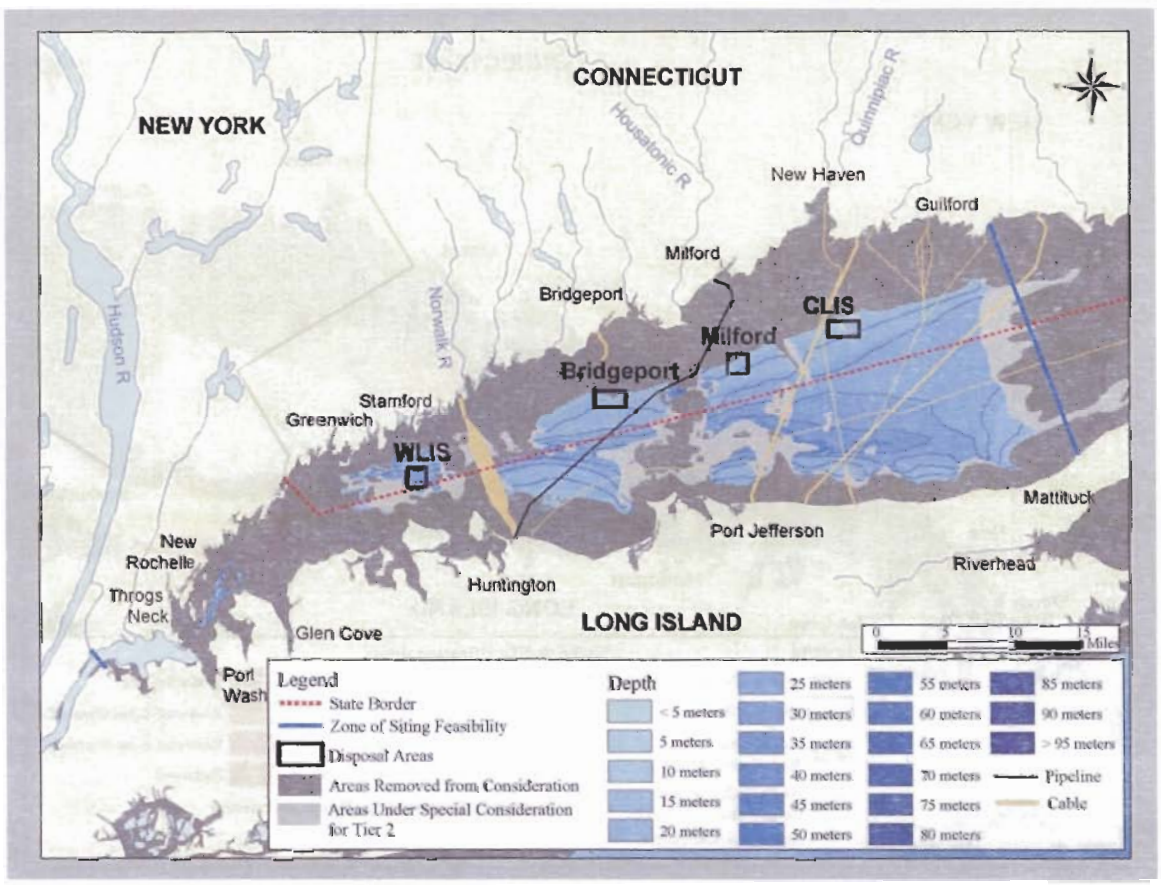

Figure 3-9. Results of Tier 2 Site Screening

3.3.3 Open-Water Alternative Sites within Long Island Sound

This section describes the four open-water dredged material disposal sites analyzed in this DEIS. Section 3.6 provides a comparison of the environmental impacts of each of the alternative sites, including the No Action Alternative, and identifies the preferred alternative. Section 5.7 provides a more detailed summary of potential impacts.

3.3.3.1 Western Long Island Sound Alternative (WLIS)

The WLIS Alternative is the existing WLIS disposal site currently in operation (see Figure 3-10). It is a 1.2 by 1.3 nautical mile (2.2 by 2.4 kilometers) rectangular area that has been used for dredged material disposal since 1982. After completion of a draft EIS (USACE, 1982a and 1982b), the site was established in 1982 as a regional dredged material disposal site to serve the needs of the western area of Long Island Sound. It is the newest of the currently active disposal sites in Long Island Sound and is adjacent to three historic disposal sites (Eaton's Neck, Norwalk, and Stamford) that collectively received over 18.9 million cubic yards (14.5 million cubic meters) of dredged material between 1954 and 2001. Between 1982 and 2001 WLIS received 1.7 million cubic yards (1.3 million cubic meters), with an average annual volume of 85,000 cubic yards (65,000 cubic meters) (USACE file data, 2003).

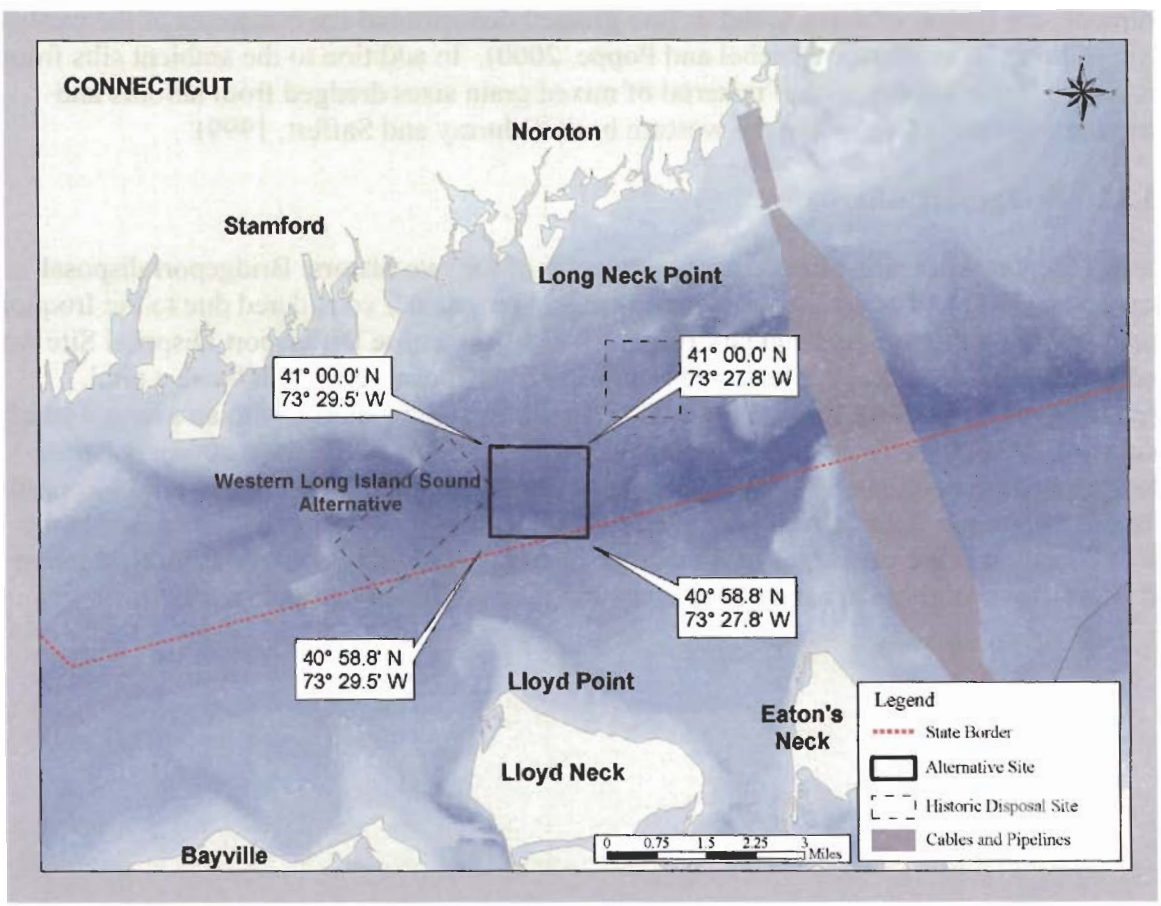

Figure 3-10. Location of the Western Long Island Sound Alternative

The site is centered at 40° 59.4' N, 73° 28.5'W (NAD 83) (see Table 3-2 for corner coordinates), 2.7 nautical miles (5 kilometers) north of Lloyd Point, New York and 2.5 nautical miles (4.6 kilometers) south of Long Neck Point near Noroton, Connecticut, in water depths of 79 to 118 feet (24 to 36 meters). The site is positioned over an east-to-west depression on the seafloor with a relatively flat bottom. A minimum water depth of 79 feet (24 meters) is found at the northwest corner of the site and a maximum depth of 118 feet (36 meters) is found over the east-west trending depression before shoaling to 82 feet (25 meters) at the southern site boundary (Figure 3-10).

Table 3-2. Site Boundaries (NAD 83) of the WLIS Alternative

Corner	Latitude	Longitude
WLIS — NW	41° 00' N	73° 29.5' W
WLIS — NE	41° 00' N	73° 27.8' W
WLIS — SW	40° 58.8' N	73° 29.5' W
WLIS — SE	40° 58.8' N	73° 27.8' W

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 and 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 and Saffert, 1999).

3.3.3.2 Bridgeport Alternative

The Bridgeport Alternative incorporates the larger of the two historic Bridgeport disposal sites (Figure 3-11). The smaller Bridgeport (East) site was not considered due to the Iroquois pipeline passing through its boundary (Figure 3-11). The entire Bridgeport Disposal Site was used for local projects from at least 1954 until 1977. Disposal records indicate a total disposal volume of 4.4 million cubic yards (3.4 million cubic meters), with an average yearly volume of 190,000 cubic yards (145,000 cubic meters) (USACE file data, 2003). Limited information exists on the sediment characteristics or the origin of dredged material disposed of at the Bridgeport Alternative. However, the bulk of the dredged material disposed at the site (1.7 million cubic yards [1.3 million cubic meters]) was likely dredged from Bridgeport and Black Rock Harbors between 1960 and 1963 (Caporelli and Browning, 1996).

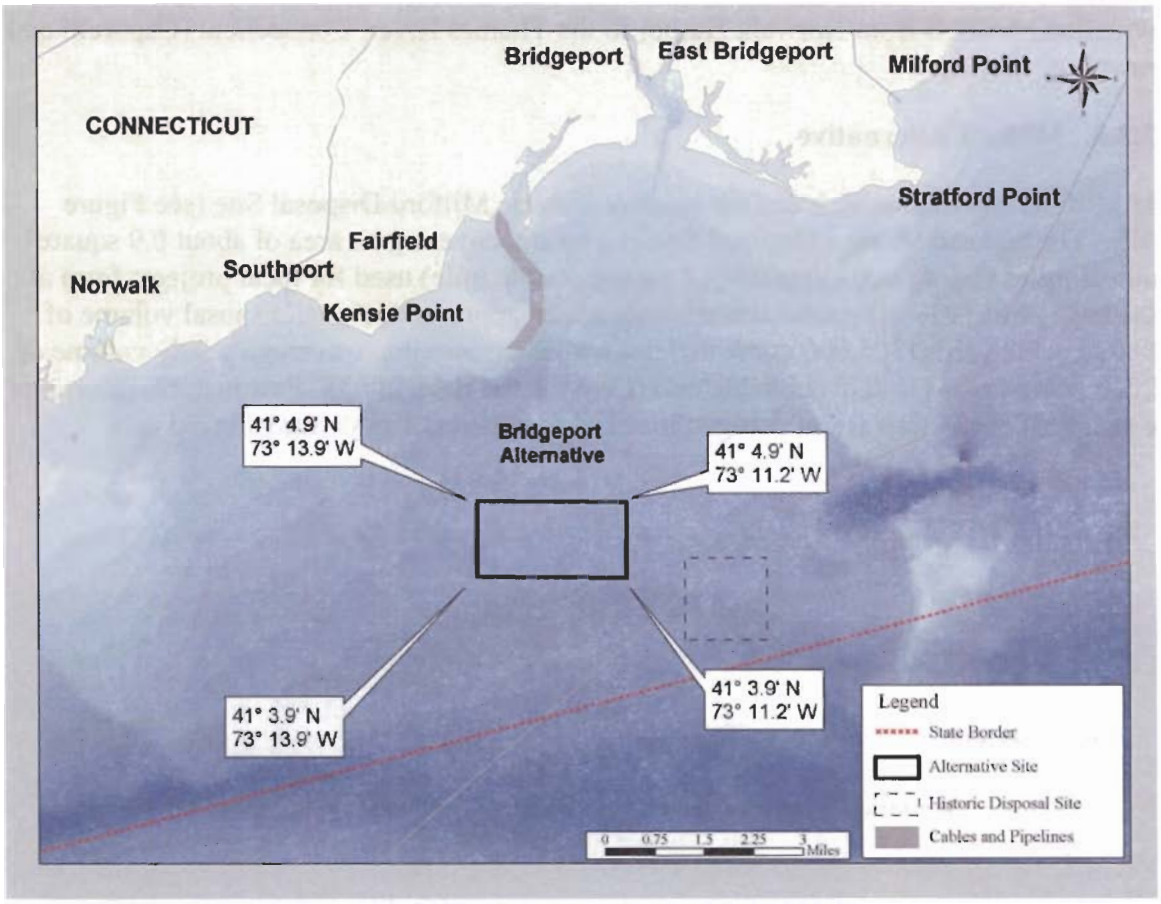

Figure 3-11. Location of the Bridgeport Alternative

The site is rectangular in shape, 2 nautical miles by 1 nautical mile (about 3.7 by 1.9 kilometers), centered at 41° 4.41' N 73° 12.57'W (NAD 83) (see Table 3-3 for corner coordinates), located 3 nautical miles (5.6 kilometers) southeast of Kensie Point, Connecticut, in water depths from 60 to 68 feet (18.5 to 20.7 meters). The site is located in a wide flat area that slopes gently from north to south.

Table 3-3. Site Boundaries (NAD 83) of the Bridgeport Alternative

Corner	Latitude	Longitude
Bridgeport — NW	41° 4.9' N	73° 13.9' W
Bridgeport — NE	41° 4.9' N	73° 11.2' W
Bridgeport — SW	41° 3.9' N	73° 13.9' W
Bridgeport — SE	41° 3.9' N	73° 11.2' W

The sediments at the site are relatively uniform clayey silt (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 and Poppe, 2000). In addition to these ambient silts, the site contains small deposits of material of mixed grain sizes dredged from harbors and

navigation channels from Norwalk Harbor to the Thames River, Connecticut (Caporelli and Browning, 1996).

3.3.3.3 Milford Alternative

The Milford Alternative includes the inactive historic Milford Disposal Site (see Figure 3-12). The historic Milford Disposal Site is a square covering an area of about 0.9 square nautical miles (1.6 square kilometers, 1 square statute mile) used for local projects from at least 1954 until 1971. Disposal records indicate an approximate total disposal volume of 400,000 cubic yards (305,000 cubic meters) with an approximate average yearly volume of 22,000 cubic yards (17,000 cubic meters) (USACE file data, 2003). Few historic records of the sediment characteristics of dredged material disposed at the Milford site exist.

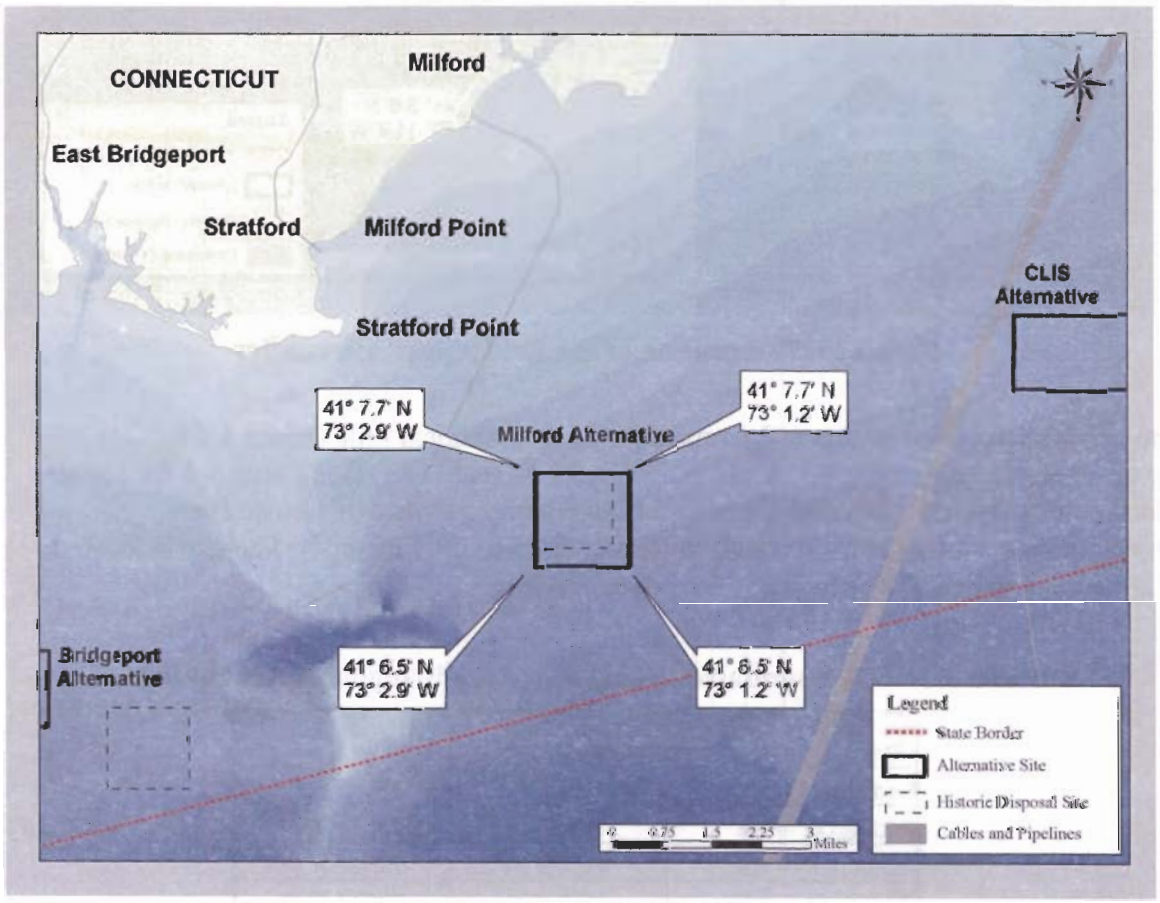

Figure 3-12. Location of the Milford Alternative

The Milford Alternative boundaries under consideration were expanded by the Corps and EPA southerly and easterly beyond the general boundaries of the inactive historic site, to yield a square site of similar area to the current CLIS site; an area of about 1.7 square nautical miles (3.2 kilometers; 2 square statute miles)[3]. The Milford Alternative is a square centered around 41° 7.1' N and 73° 2.1'W (NAD 83) (see Table 3-4 for corner coordinates) located 2.8 nautical miles (5.2 kilometers) southeast of Stratford Point, Connecticut, in water depths from 52.5 to 75 feet (16 to 23 meters).

Table 3-4. Site Boundaries (NAD 83) of the Milford Alternative

Corner	Latitude	Longitude
Milford — NW	41° 7.7' N	73° 2.9' W
Milford — NE	41° 7.7' N	73° 1.2' W
Milford — SW	41° 6.5' N	73° 2.9' W
Milford — SE	41° 6.5' N	73° 1.2' W

The sediments at the site are relatively uniform clayey 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 and Poppe, 2000). In addition to these sediments, it is likely that the site contains some deposits of material of mixed grain size dredged from harbors and navigation channels near the site.

3.3.3.4 Central Long Island Sound Alternative (CLIS)

The CLIS Alternative is the existing CLIS disposal site currently in operation (see Figure 3-13). It has been one of the most active dredged material disposal sites in New England. The CLIS site has the longest known continuous record of use of any disposal 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. Overall, CLIS has received close to 14 million cubic yards (11 million cubic meters) since 1941 (USACE file data, 2003). CLIS receives the largest volumes from federal navigation projects in New Haven and Bridgeport harbors, with numerous smaller harbors in Connecticut and New York contributing to the total disposal volume. The CLIS site was evaluated as part of the programmatic EIS for Long Island Sound (see Section 1.4). Between 1982 and 2001 CLIS received approximately 7 million cubic yards (5.4 million cubic meters), with an average annual volume of 350,000 cubic yards (268,000 cubic meters) (USACE file data, 2003).

[3] A portion of the Milford historic disposal site is in waters shallower than 59 feet (18 meters) therefore the boundaries of the site were adjusted toward deeper waters at least 18 meters deep.

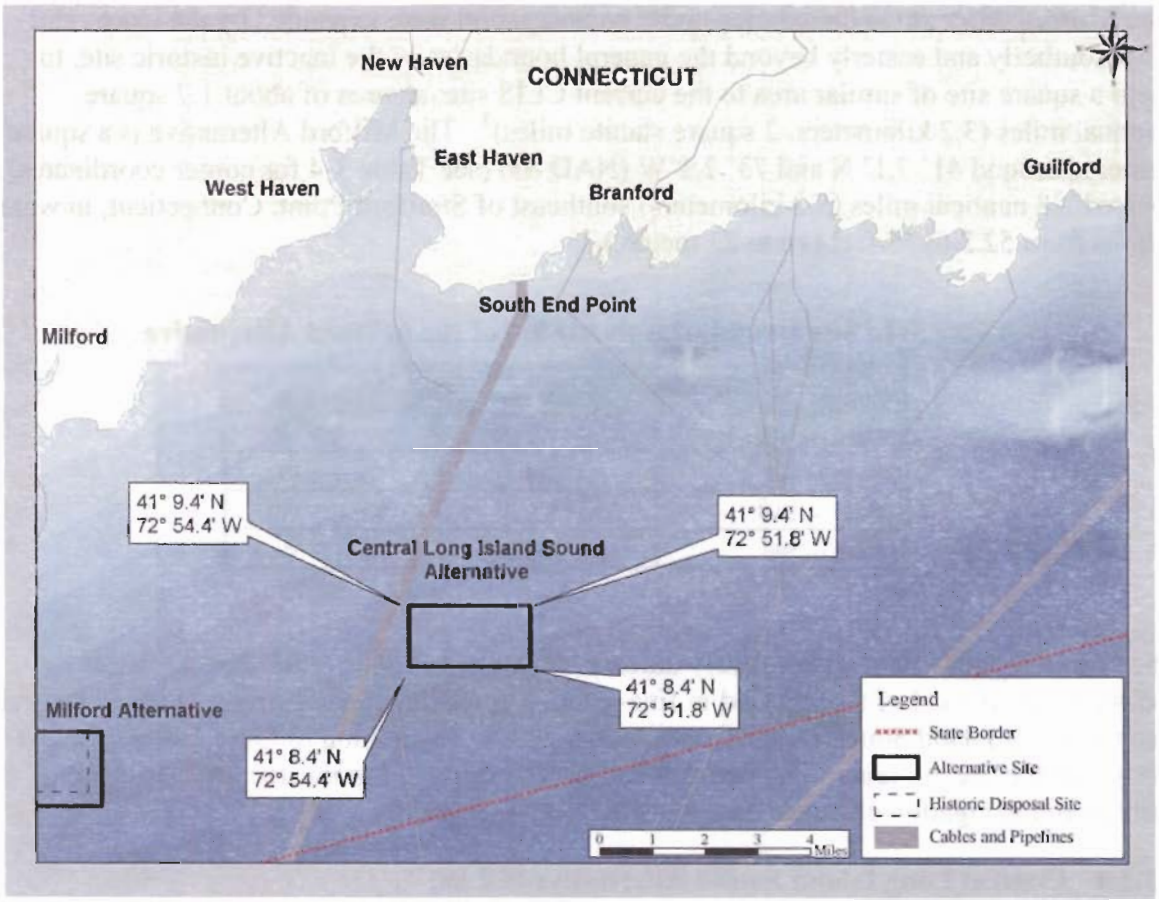

Figure 3-13. Location of the Central Long Island Sound Alternative

The site is a rectangular shape, approximately 2 nautical miles by 1 nautical mile (3.7 by 1.9 kilometers), located at a center of 41° 8.9' N, 72° 53.1' W (NAD 83) (see Table 3-5 for corner coordinates), 5.6 nautical miles (10.3 kilometers) south of South End Point near East Haven, Connecticut, in water depths from 59 to 74 feet (18 to 22.5 meters). The site occupies a wide flat area of the seafloor in a depositional area with a gradually sloping bottom from 59 feet (18 meters) depth in the northwest corner to 74 feet (22.5 meters) in the southeast.

Table 3-5. Site Boundaries (NAD 83) of the CLIS Alternative

Corner	Latitude	Longitude
CLIS — NW	41° 09.4' N	72° 54.4' W
CLIS — NE	41° 09.4' N	72° 51.8' W
CLIS — SW	41° 08.4' N	72° 54.4' W
CLIS — SE	41° 08.4' N	72° 51.8' W

The sediments at the site are predominately 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 and 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 basin (SAIC, 2002a).

3.4 Summary of Impacts and Identification of the Preferred Alternative

The initial site screening process led to the identification of four alternative sites for further evaluation with respect to MPRSA site selection criteria, in addition to the No Action Alternative. Impacts from these alternatives are evaluated in detail in Chapter 5 and summarized in Table 3-6. The two preferred alternatives are the Western Long Island Sound (WLIS) and Central Long Island Sound (CLIS) disposal sites. Each of the preferred alternatives and rationale for their selection is discussed in more detail in Section 5.7. Both of these sites are currently used for dredged material disposal and have been used as such for approximately 20 years. EPA regulations (40 CFR 228.5(e)) state that it is generally preferable to designate disposal sites in areas that have been used in the past, rather than to locate sites in new, relatively undisturbed areas. Monitoring of the WLIS and CLIS disposal sites has determined that past and present management practices have been successful in minimizing the short- and long-term, and cumulative adverse impacts to water quality and benthic habitat.

Table 3-6. Summary of Impacts for the Five Alternatives Evaluated [1]

Impacts (*reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	Bridgeport	Milford	Central Long Island Sound	No Action
Sedimentation and Erosion (*§ 228.6(a)(7)*)	No impact	Impact	Impact	No impact	No impact
Water Column (Transport) (*§ 228.6(a)(6)*) and Water Quality (*§ 228.5(b) and § 228.6(a)(9)*)	Impact[2]	Impact[2]	Impact	Impact[2]	No impact
Sediment Quality (*§ 228.6(a)(4)*)	No impact	No impact	No impact	No impact	No impact
Plankton and Larval Forms (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*) (*§ 228.6(a)(10)*)	No impact	No impact	No impact	No impact	No impact
Benthos (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*)	No impact[5]	No impact[5]	No impact[5]	No impact[5]	No impact
Fish, Lobster, and Other Invertebrates (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*)	No impact[5]	Impact	No impact[5]	No impact[5]	No impact
Birds, Mammals, Reptiles (*§ 228.6(a)(2)*)	No impact	No impact	No impact	No impact	No impact
Endangered Species (*§ 228.6(a)(9)*)	No impact	No impact	No impact	No impact	No impact
Bioaccumulation Potential (*§ 228.6(a)(9)*)	No impact	No impact	No impact	No impact	No impact
Fishing Activities (*§ 228.5(a) and §228.6(a)(8)*)	No impact	Impact	Impact	No impact	Impact
Shipping, Navigation (*§ 228.5(a) and §228.6(a)(8)*)	No impact[3]	Impact	No impact[3]	Impact[4]	Impact
Beaches and Swimming (*§ 228.5(b) and §228.6(a)(3)*)	No impact	No impact	No impact	No impact	No impact
Parks / Natural Areas / Sanctuaries and Research Preserves (*§ 228.5(b) and §228.6(a)(8)*)	No impact	No impact	No impact	No impact	No impact

(Table Continued)

Table 3-6. Summary of Impacts for the Five Alternatives Evaluated (continued)[1]

Impacts (*reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	Bridgeport	Milford	Central Long Island Sound	No Action
Historic / Archaeological Resources (*§ 228.6(a)(11)*)	No impact	Impact	Impact	No impact	No impact
Other Human Uses (*§ 228.5(a) and §228.6(a)(8)*)	No impact	No impact	No impact	No impact	No impact
Use of previous disposal sites (*§ 228.6(a)(7)*)	No impact	No impact	No impact	No impact	No impact
Air Quality/Noise (*NEPA Requirement*)	No impact	No impact	No impact	No impact	Impact
Economic Impacts (*§ 228.5(a) and §228.6(a)(8)*)	No impact	No impact	No impact	No impact	Impact
Cumulative Impacts (*§ 228.6(a)(7)*)	No impact	Impact	Impact	No impact	Impact

[1]MPRSA criteria 228.5(c) 228.5(d) and 228.5(e), 228.6(a)(4) and 228.6(a)(s) were addressed during the site screening process. See Section 5.6 for further discussion.
[2]Results of the water quality modeling predicted potential impacts at this Alternative, however, it is expected that these impacts can be mitigated or prevented through site management practices.
[3]Long-term impacts to shipping and navigation are not expected because they can be mitigated by notice to mariners and other site management practices.
[4]The Corps will coordinate with the USCG to shift the designated lightering zone boundary adjacent to CLIS to ensure that dredged material deposited at the site now and in the past is not disturbed by anchors.
[5]It was determined that there may be minimal short-term impacts to fish and benthos. However, it was determined that there would not be any long-term or cumulative impacts to these resources.

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CHAPTER 4 – AFFECTED ENVIRONMENT

This chapter provides a description of the environment of Long Island Sound, focusing on the western and central regions (the ZSF) as described in Section 1.3. In addition to a description of the physical location and setting (Section 4.1), this chapter summarizes the key physical, biological, and socioeconomic resources within Long Island Sound, relevant to the five general and eleven specific MPRSA site selection criteria and other factors raised by the public during initial scoping meetings. These include: bathymetry (measurement of water depth) (Section 4.2), geological setting and geomorphology (Section 4.3), meteorology (Section 4.4), physical oceanography (Section 4.5), sediment quality (Section 4.6), water quality (Section 4.7), biological resources (including threatened and endangered species) (Sections 4.8 through 4.13), and socioeconomic environment (including archaeological resources) (Section 4.14). A general discussion of each of these topics is provided for the overall environment within Long Island Sound, followed by a description of the available data specific to each of the four alternative sites when appropriate. Consideration of the potential impacts associated with disposal of dredged material is provided in Chapter 5, Environmental Consequences.

4.1 Physical Location and Setting

The following sections describe the physical setting of Long Island Sound in general and the specific location of the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS.

4.1.1 Long Island Sound

Long Island Sound is a 110-mile (177 kilometers) long, semi-enclosed estuary located between the coastline of Connecticut and the northern coastline of Long Island, New York (USACE, 1998; see Figure 4-1). The Connecticut-New York state border 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.

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. As described in Section 1.3 and shown in Figure 4-1, the ZSF includes most of the western and central basins. Two of the alternative sites evaluated (WLIS and Bridgeport) are located in the western basin; Milford and CLIS are within the central basin. This DEIS does not analyze potential dredged

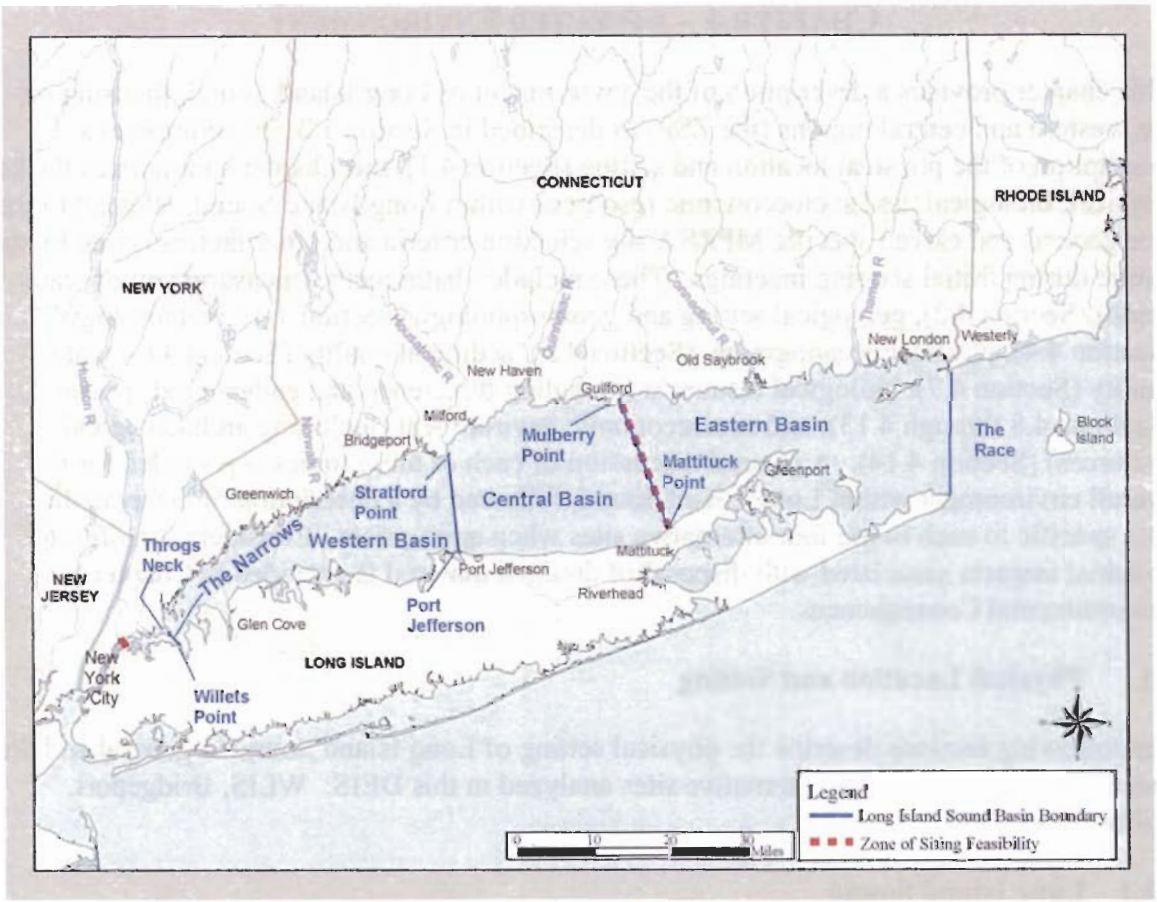

Figure 4-1. Long Island Sound

material disposal areas in the eastern basin (see Section 1.3); designation of one or more dredged material disposal sites in the eastern basin will be analyzed in a subsequent NEPA document, such as a supplement to this DEIS.

Long Island Sound is adjacent to one of the most densely populated and industrialized regions in North America, with approximately 8.4 million people living within its 16,000-square-mile (41,440-square-kilometer) watershed and roughly 20 million people residing within a 50-mile (80-kilometer) radius. Cargo and petroleum products are shipped through Long Island Sound to or from the New York City area and several ferries traffic people and goods between Long Island and Connecticut. Three of the major rivers that empty into Long Island Sound (the Housatonic, Connecticut, and Thames) originate farther north in New England, effectively connecting Massachusetts, New Hampshire, and Vermont to Long Island Sound.

Along the Connecticut coast of Long Island Sound, where approximately 40 percent of the state's population resides, heavy urban and suburban development has diminished natural habitats, although many restoration projects are underway (USEPA, 2001). New York City, located at the far western end of Long Island Sound, is the most populous city in the United

States and is a major shipping and commerce center. The New York coast of Long Island Sound is also heavily populated, particularly at the western end where the New York City Borough of Queens is located. According to the 2000 U.S. census, approximately 3 million people reside in towns along Long Island's north shore (this figure includes all of Queens County) (Long Island Power Authority, 2001).

4.1.2 Western Long Island Sound Alternative

The WLIS Alternative is located approximately 2.5 nautical miles (4.6 kilometers) south of Long Neck Point, Noroton, Connecticut. It is a 1.2 by 1.3 nautical miles (2.2 by 2.4 kilometers) rectangular area, centered on 40°59.4'N, 73°28.5'W (NAD 83) (see Figure 4-2 for corner coordinates). The WLIS Alternative occupies an area of seafloor located in the western basin of Long Island Sound.

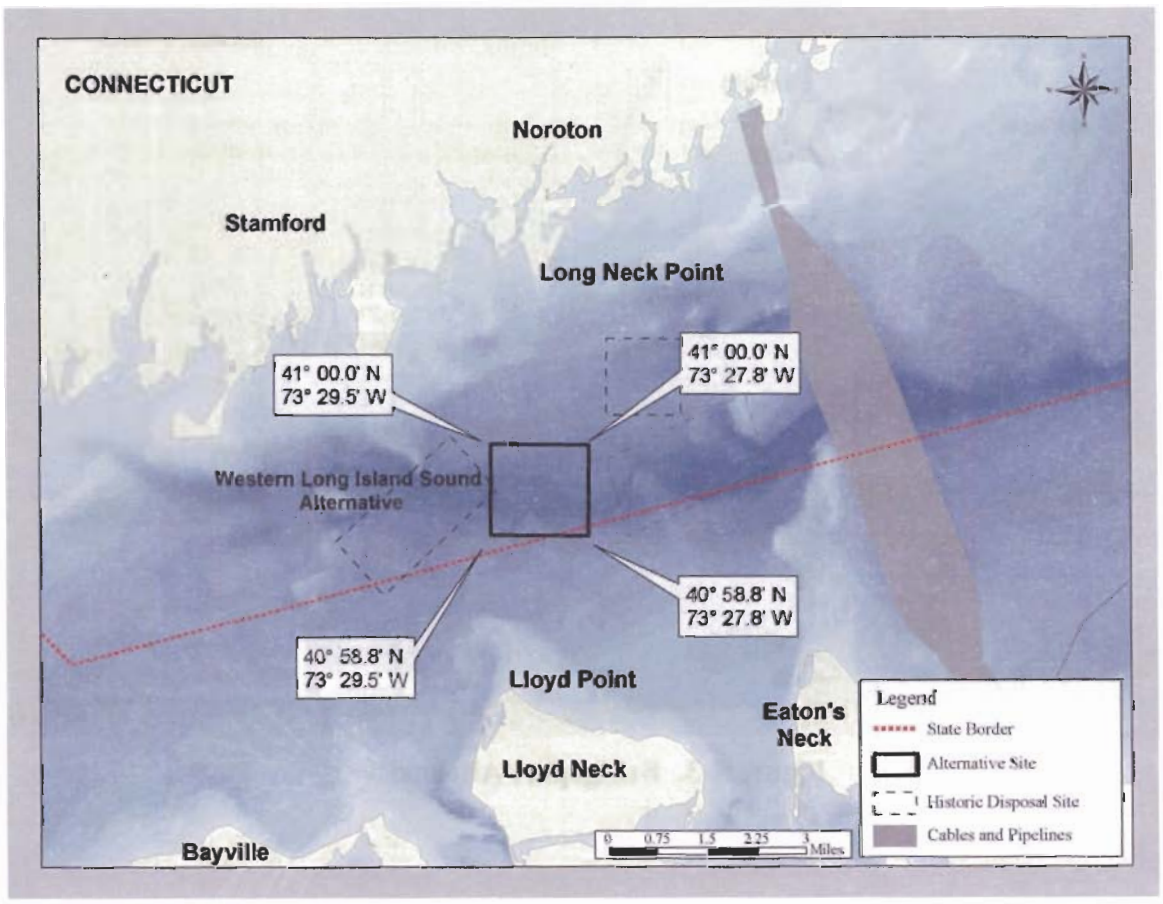

Figure 4-2. Western Long Island Sound Alternative

4.1.3 Bridgeport Alternative

The Bridgeport Alternative is located approximately 3 nautical miles (5.6 kilometers) southeast of Kensie Point, Fairfield, Connecticut and about 4.5 nautical miles (8.3 kilometers) south of Bridgeport. It is approximately 2 square nautical miles (2 by 1 nautical miles; 3.7 by 1.9 kilometers) in size, centered on 41°4.41'N, 73°12.57'W (NAD83) (see Figure 4-3 for corner coordinates). The Bridgeport Alternative occupies an area of seafloor located in the western basin of Long Island Sound.

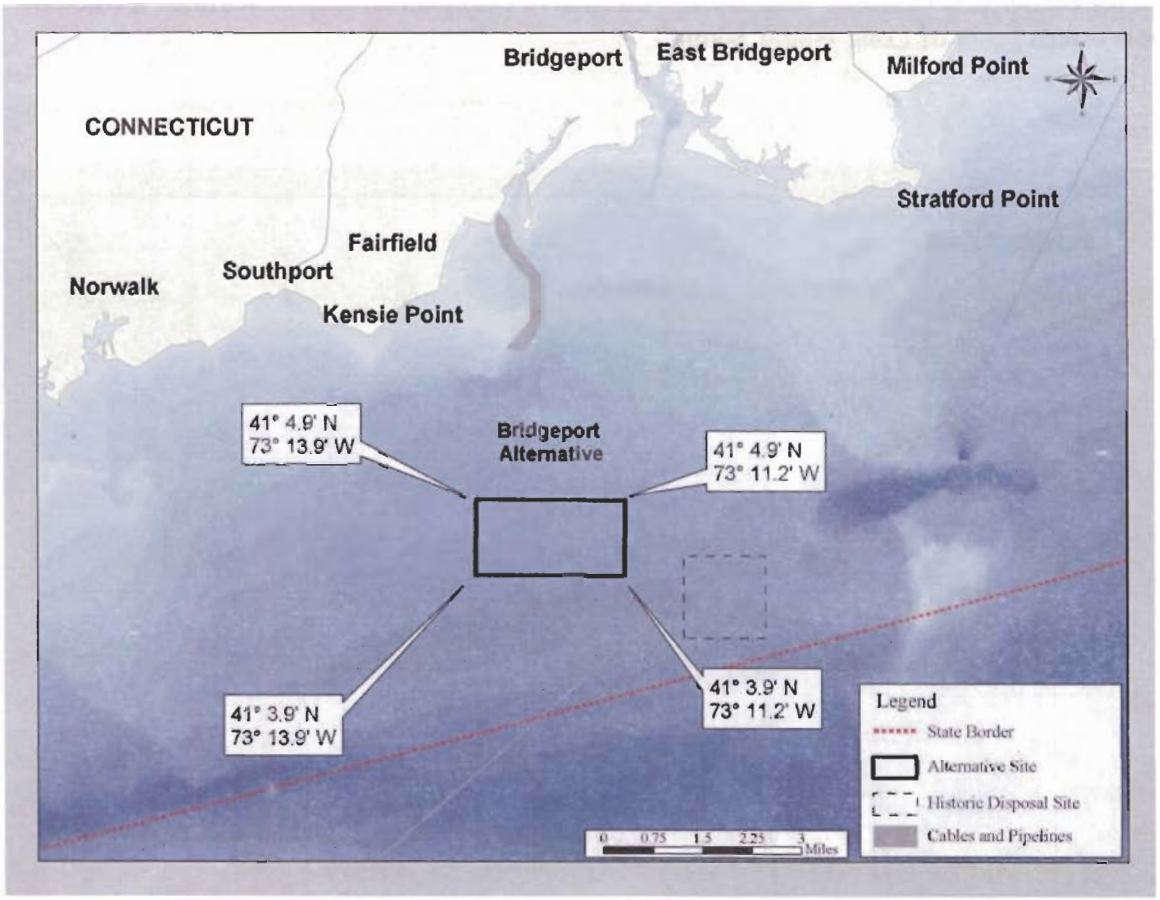

Figure 4-3. Bridgeport Alternative

4.1.4 Milford Alternative

The Milford Alternative is located approximately 2.8 nautical miles (5.2 kilometers) southeast of Stratford Point, Stratford, Connecticut and about 5 nautical miles (9.3 kilometers) south of Milford, CT. It is approximately 1.7 square nautical miles (3 square kilometers) in size and is centered at 41°7.1'N, 73°2.1'W (NAD 83) (see Figure 4-4 for corner coordinates). The Milford Alternative occupies an area of seafloor located in the central basin of Long Island Sound.

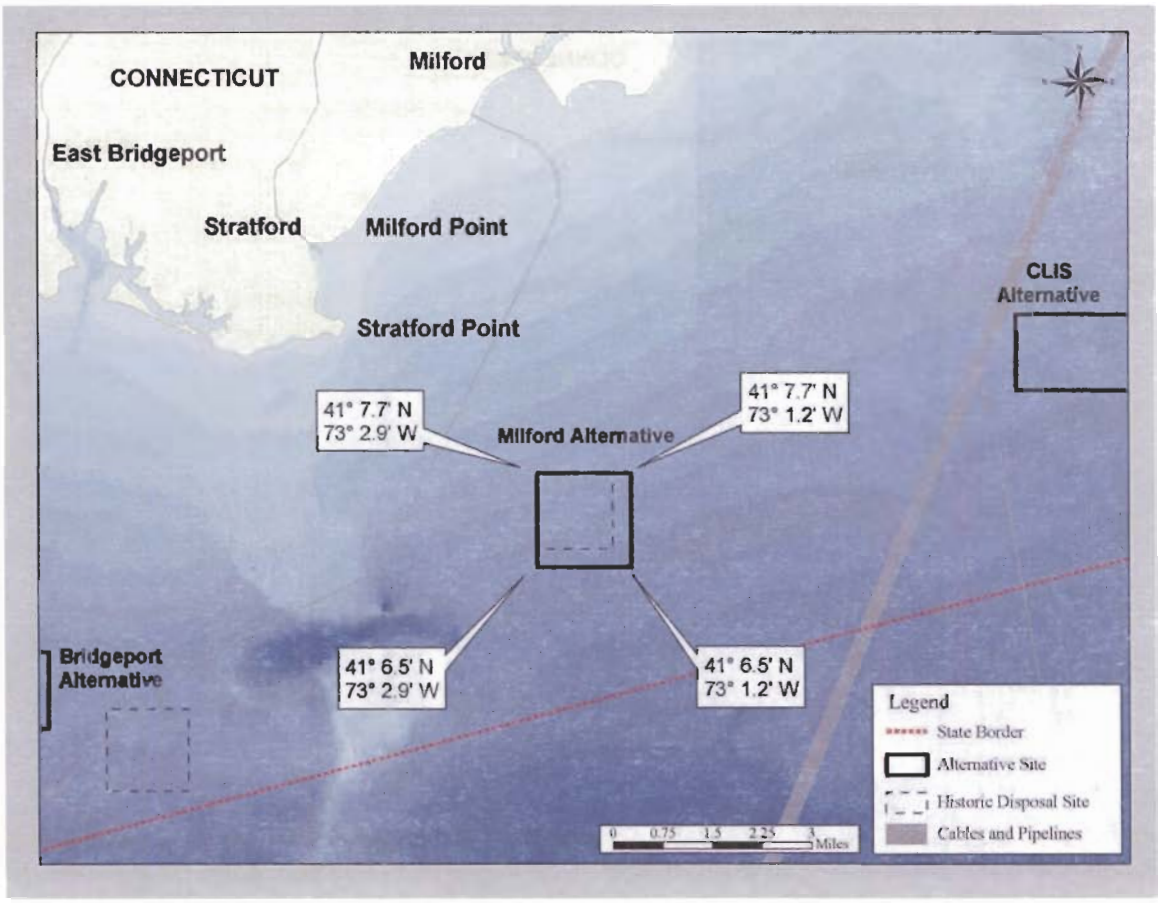

Figure 4-4. Milford Alternative

4.1.5 Central Long Island Sound Alternative

The CLIS Alternative is located approximately 5.6 nautical miles (10.4 kilometers) due south of South End Point, East Haven, Connecticut. It is approximately 2 square nautical miles (2 by 1 nautical miles; 3.7 by 1.9 kilometers) in size and is centered at 41°8.9' N and 72°53.1'W (NAD83) (see Figure 4-5 for corner coordinates). The Alternative occupies an area of seafloor located in the central basin of Long Island Sound.

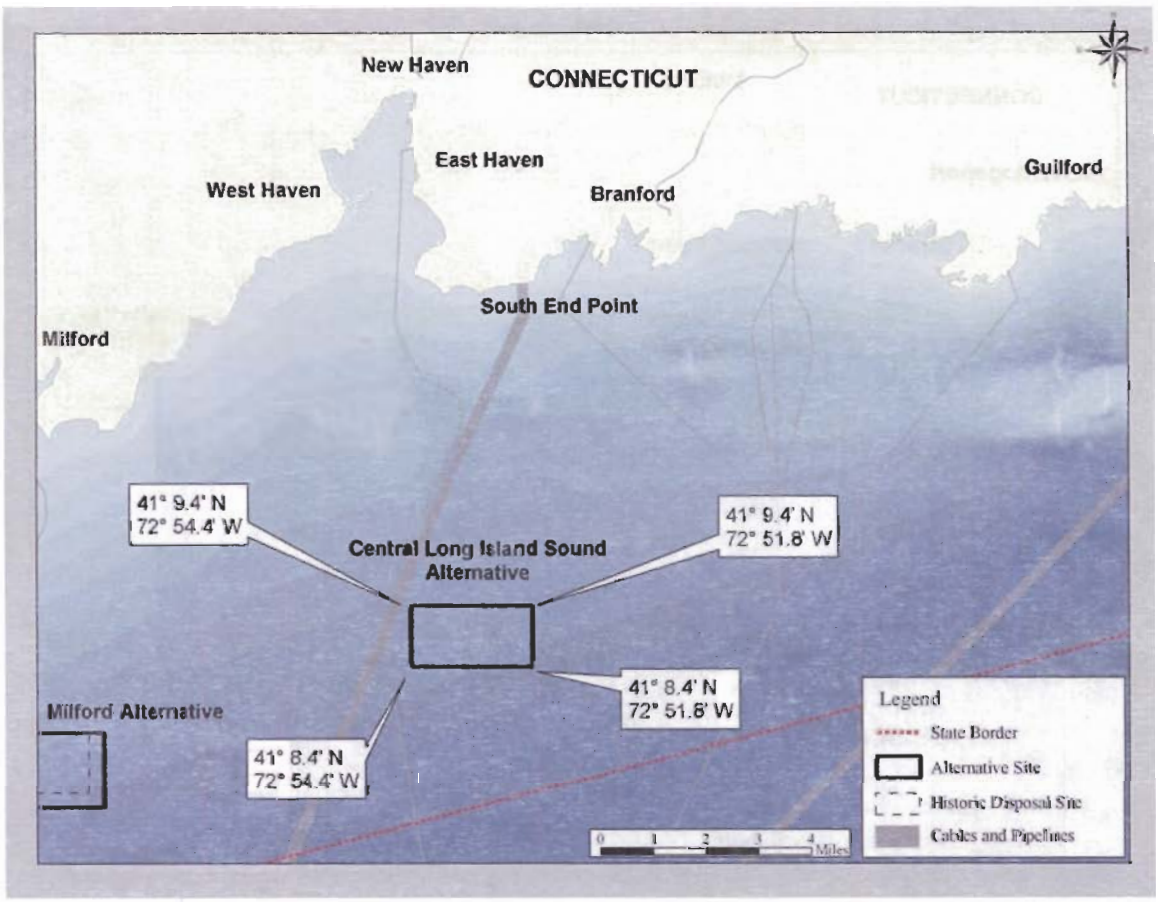

Figure 4-5. Central Long Island Sound Alternative

4.2 Bathymetry (Water Depth)

The following sections describe the bathymetry of Long Island Sound in general and specifically for the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS. This evaluation is based on general data available for Long Island Sound (Knebel and Poppe, 2000) as well as site-specific bathymetric surveys conducted in support of this DEIS (see Appendix I).

4.2.1 Long Island Sound

The general bathymetry of Long Island Sound is shown in Figure 4-6 (USGS, 2002). Within the ZSF, the bottom topography is characterized by three areas of broad, relatively flat seafloor separated by the Stratford and Norwalk shoal complexes. The Stratford and Norwalk shoal complexes are oriented in a north-south direction and have irregular topography and high relief. The seafloor in the western and central basins of Long Island Sound slopes towards an east-west trending axial depression with depths ranging from 100 to 200 feet (30 to 60 meters). The axial depression is deepest and narrowest where it cuts across the shoal complexes (Knebel and Poppe, 2000). In the eastern basin of Long Island Sound, the bottom topography is irregular and has a high degree of relief.

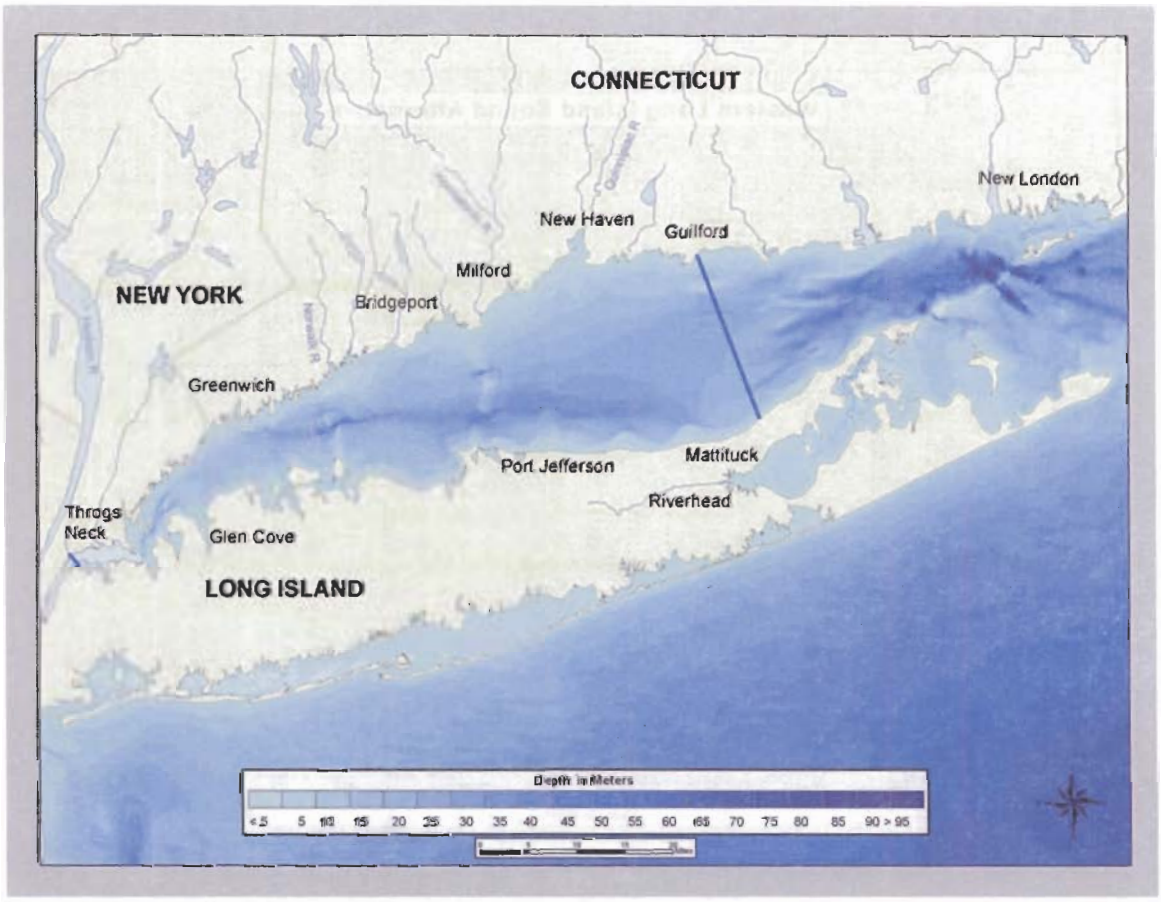

Figure 4-6. Bathymetry of Long Island Sound

4.2.2 Western Long Island Sound Alternative

The seafloor at the WLIS Alternative 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 79 to 89 feet (24 and 27 meters) in the northwest and northeast corners, respectively, down to 98 feet (30 meters) along the southern boundary, with the 118-foot (36 meter) deep cut of the axial depression occupying one quarter of the area of the site in the southern half. Distinct disposal mounds from past dredged material disposal activities are present with peaks as high as 89 feet (27 meters) deep, including some in the axial depression. A bathymetric map of the WLIS site is presented in Figure 4-7 (USGS, 2002). The resolution of Figure 4-7 does not distinguish individual disposal mounds.

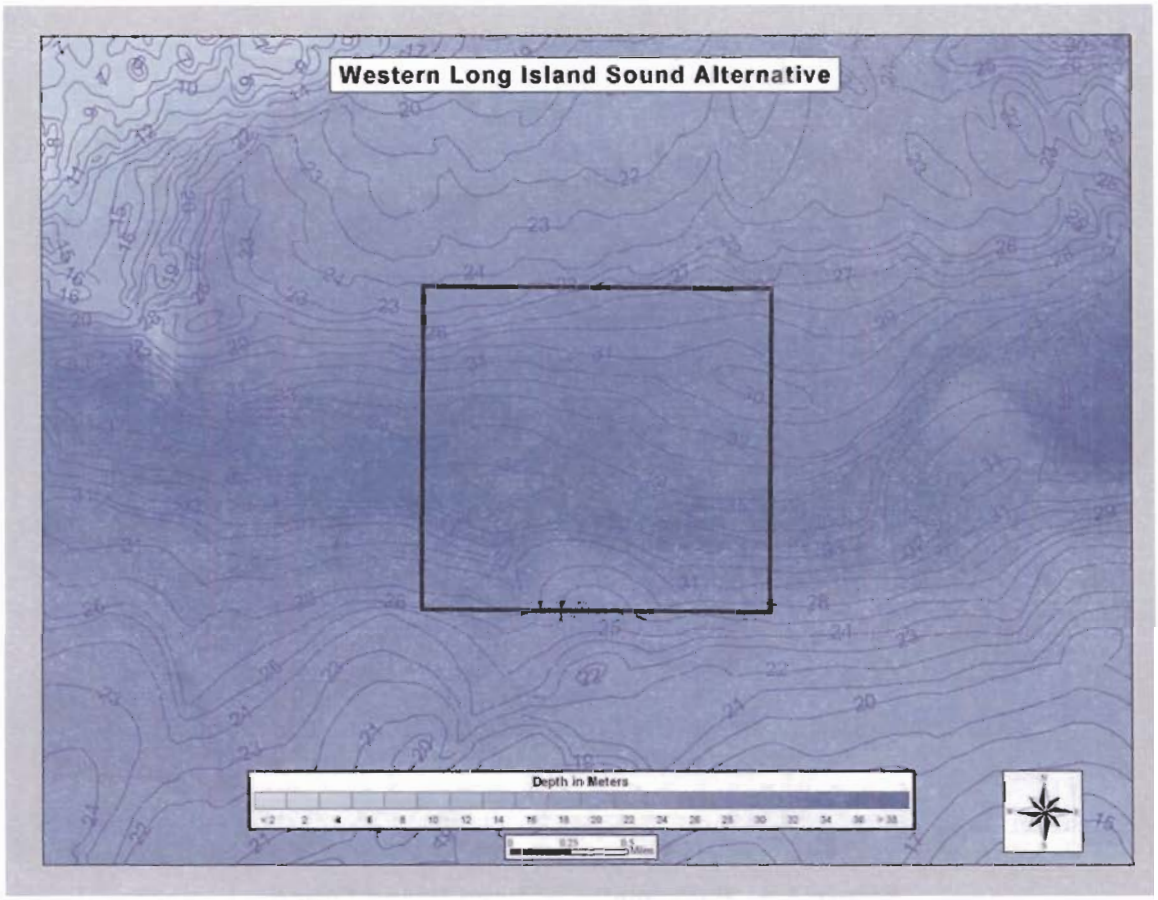

Figure 4-7. Bathymetry at the Western Long Island Sound Alternative

4.2.3 Bridgeport Alternative

The bottom at the Bridgeport Alternative slopes gently downward from north to south, and ranges in depth from about 60 feet (18.3 meters) to 68 feet (20.7 meters). Bathymetric, archaeological, and geomorphological surveys were conducted at the Bridgeport Alternative in August/September 2002. The full report (USACE, 2003i) is provided in Appendix I. The central part of the site appears to shoal gently, possibly reflecting historical dredged material deposition though no distinct mounds were found. A bathymetric map of the Bridgeport site is presented in Figure 4-8 (USGS, 2002; USACE, 2003i).

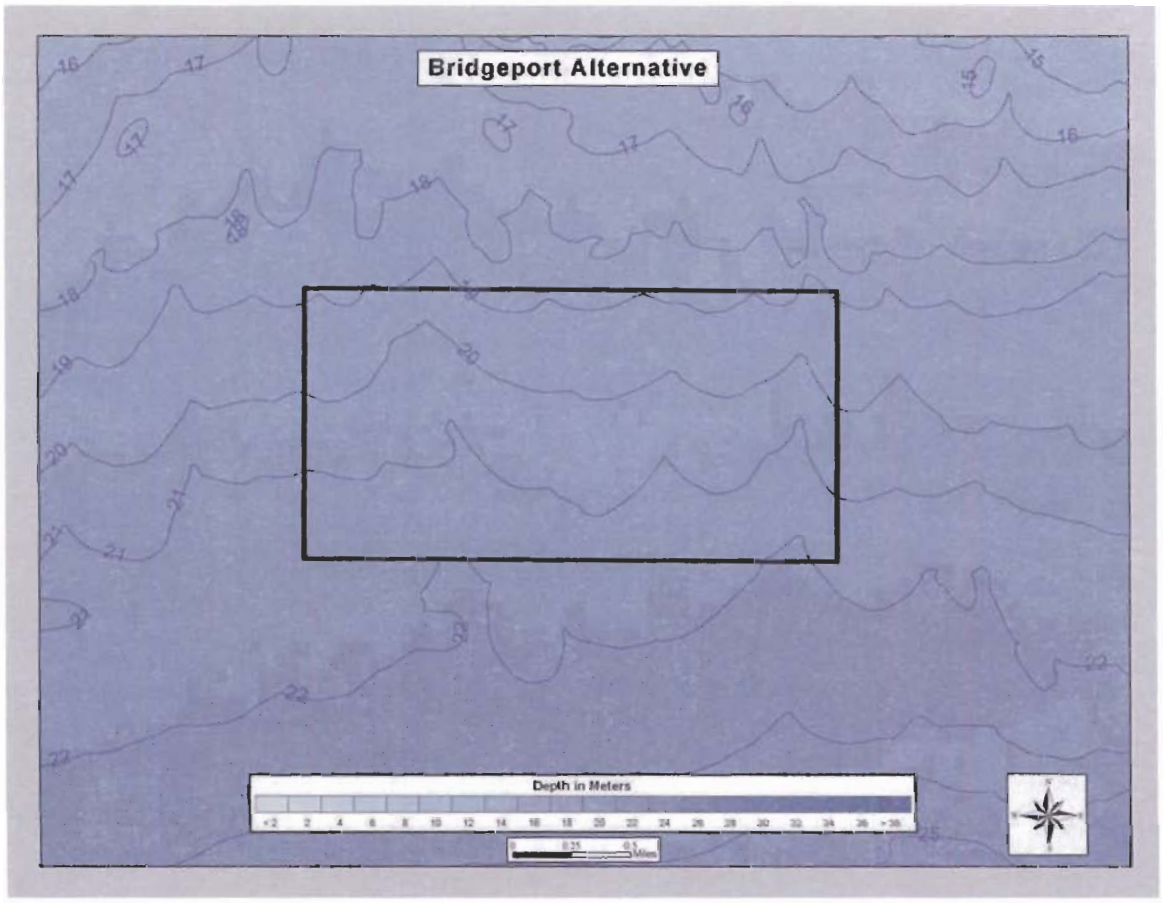

Figure 4-8. Bathymetry at the Bridgeport Alternative

4.2.4 Milford Alternative

The seafloor in the Milford Alternative is generally flat with a downward slope from northwest to southeast with depths ranging from 52.5 feet (16 meters) in the northwest corner to 75 feet (23 meters) in the southeast corner. Bathymetric, archaeological, and geomorphological surveys were conducted at the Milford site in August/September 2002. The full report (USACE, 2003i) is provided in Appendix I. No disposal mounds were discernable at the Milford Alternative. A bathymetric map of the Milford Alternative is presented in Figure 4-9 (USGS, 2002; USACE, 2003i).

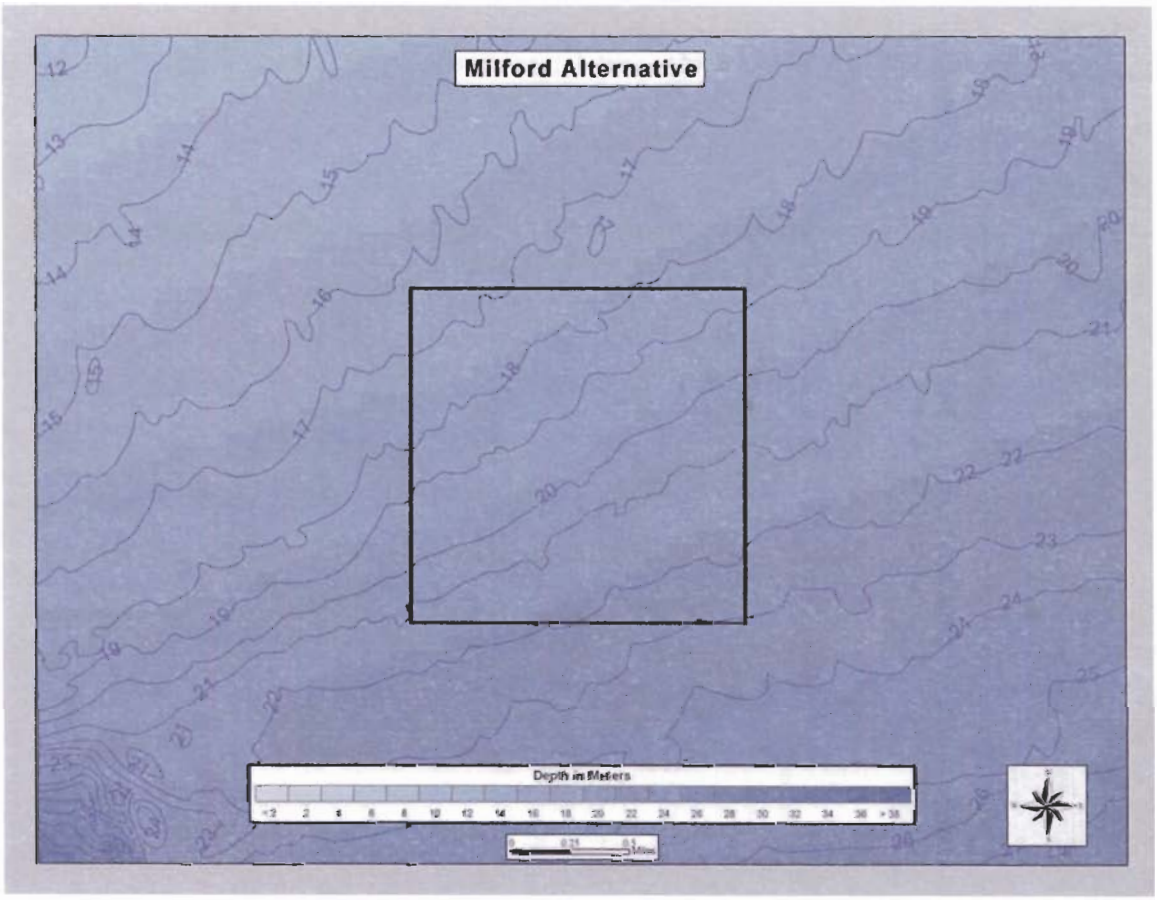

Figure 4-9. Bathymetry of the Milford Alternative

4.2.5 Central Long Island Sound Alternative

The seafloor at the CLIS Alternative slopes from a depth of 59 feet (18 meters) at the northwest corner to 74 feet (22.5 meters) in the southeast corner, with distinct disposal mounds from past dredged material disposal activities as high as 46 feet (14 meters) deep. A bathymetric map of the CLIS Alternative is presented in Figure 4-10 (USGS, 2002). The resolution of Figure 4-10 does not distinguish individual disposal mounds.

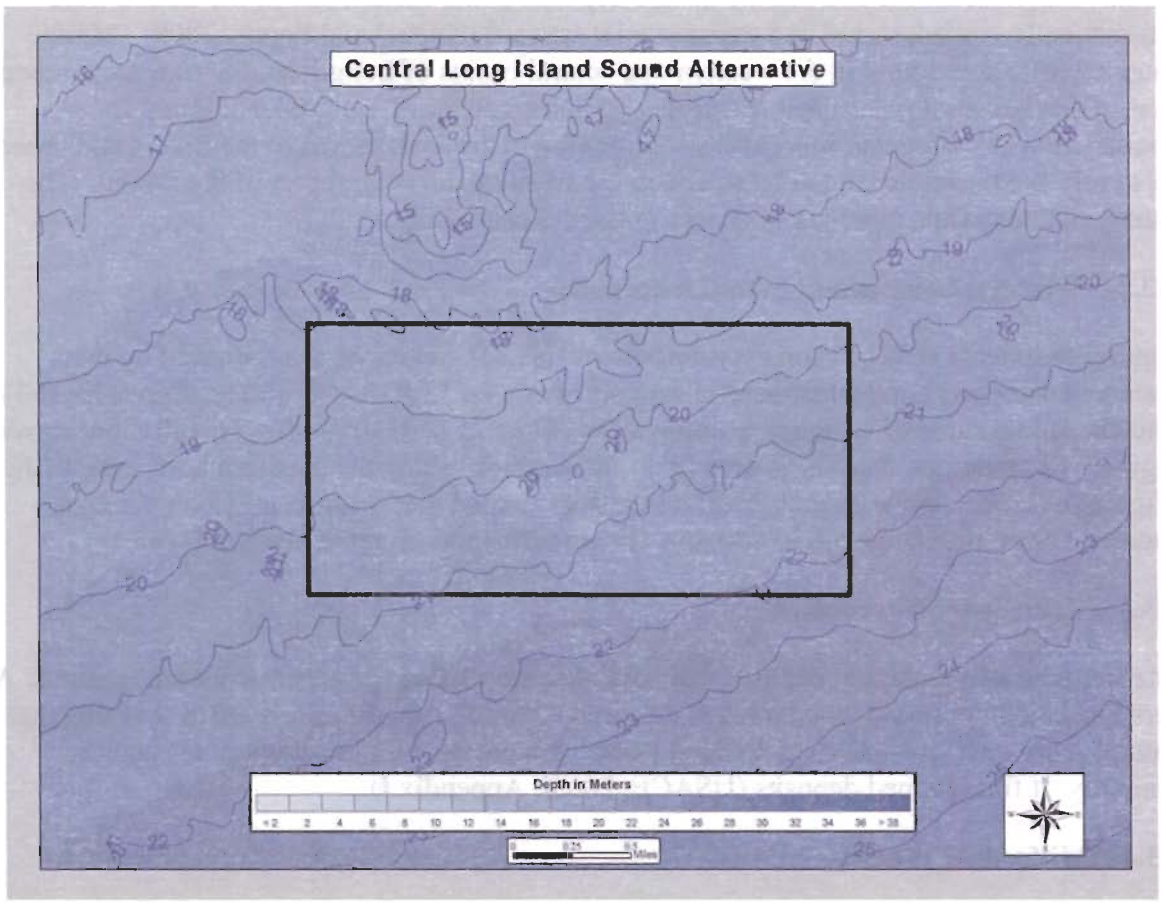

Figure 4-10. Bathymetry of the Central Long Island Sound Alternative

4.3 Geological Setting and Geomorphology

The following sections describe the geological setting and geomorphology of Long Island Sound in general and specifically for the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS. The sound-wide summary is based on the available literature including reviews by Knebel and Poppe (2000), Gordon (1980) and Poppe *et al.* (2000) while the site-specific discussion relies on these sources as well as the results of field surveys conducted in support of this DEIS (see Appendices F, G, and I).

4.3.1 Long Island Sound

Long Island Sound was formed relatively recently in geologic history during the Quaternary Period, which was dominated by glaciation, glacial retreat and marine submergence (Knebel and Poppe, 2000; Gordon, 1980). During the Pleistocene Period, ice sheets advanced over Long Island Sound, depositing glacial drift. As the last ice sheet receded, a recessional moraine was deposited on the north shore of Long Island. This moraine was the dam for an extensive glacial lake, Lake Connecticut (Knebel and Poppe, 2000). Erosion of a spillway at its eastern end about 15,500 years ago drained the lake, exposing the lake bed (Poppe *et al.*, 2000). Sea level began to rise about 15,000 years ago, submerging the Long Island Sound basin. Glaciolacustrine and marine deltaic deposits at the eastern end of the Sound were subsequently eroded, sorted and transported westward (Knebel and Poppe, 2000). Marine mud deposits now found in the western and central basins of Long Island Sound accumulated during this 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 shoals are submarine outcrops of coarse-grained glacial drift.

4.3.2 Western Long Island Sound Alternative

Natural sediments at WLIS consist primarily of fine silt and clays, as confirmed by the results of sampling conducted there in support of this DEIS (USACE 2002g; 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 WLIS (Figure 4-7). Bokuniewicz and Gordon (1980) estimated that the area in which WLIS is situated has accumulated 200 to 400 $g/m^2/yr$ of sediment during the last 8,000 years.

4.3.3 Bridgeport Alternative

The site is in a fine-grained depositional area indicative of a generally low current regime. A geomorphological survey conducted at the site in 2002 in support of this DEIS revealed that natural sediments and historical dredged material deposits at the Bridgeport site consist primarily of fine-grained deposits (USACE, 2003i; Appendix I).

4.3.4 Milford Alternative

Natural sediments at Milford consist primarily of fine grained deposits. The site is characterized as being a fine-grained depositional area indicative of a generally low current regime. A geomorphological survey conducted at the site in 2002 in support of this DEIS revealed that little or no evidence of dredged material disposal was found at the site (USACE, 2003i; Appendix I).

4.3.5 Central Long Island Sound Alternative

The bottom sediments at the CLIS 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 this DEIS

(USACE 2002g; Appendix H-1). The site is in an area of sediment accumulation which is indicative of a generally low current regime. Bokuniewicz and Gordon (1980) estimated that the area in which CLIS is situated has accumulated 200 to 600 g/m^2/yr of sediment during the last 8,000 years.

4.4 Meteorology

Meteorological data to evaluate conditions in Long Island Sound were obtained from NOAA (http://www.ndbc.noaa.gov/climate.phtml). The modeling efforts for the DEIS focused on these data because they provide information on long-term trends. In addition, a study sponsored by the Corps and EPA in 2001 in support of this DEIS provided information relative to the alternative sites (USACE, 2001g; Appendix G-1). USACE (2001g) combined an analysis of data from previous studies and a field data collection program in the spring of 2001. The results of the USACE (2001g) evaluation were 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 U.S., with hot summers and cold, stormy winters. Large ranges of offshore air temperature are observed both daily and annually (Figure 4-11). The average precipitation is about 40 inches (102 centimeters) per year, distributed evenly across the seasons. Fog in Long Island Sound is not common, but occurs most frequently during the late winter and spring seasons when a warm moist southerly flow of air passes over cold ocean water.

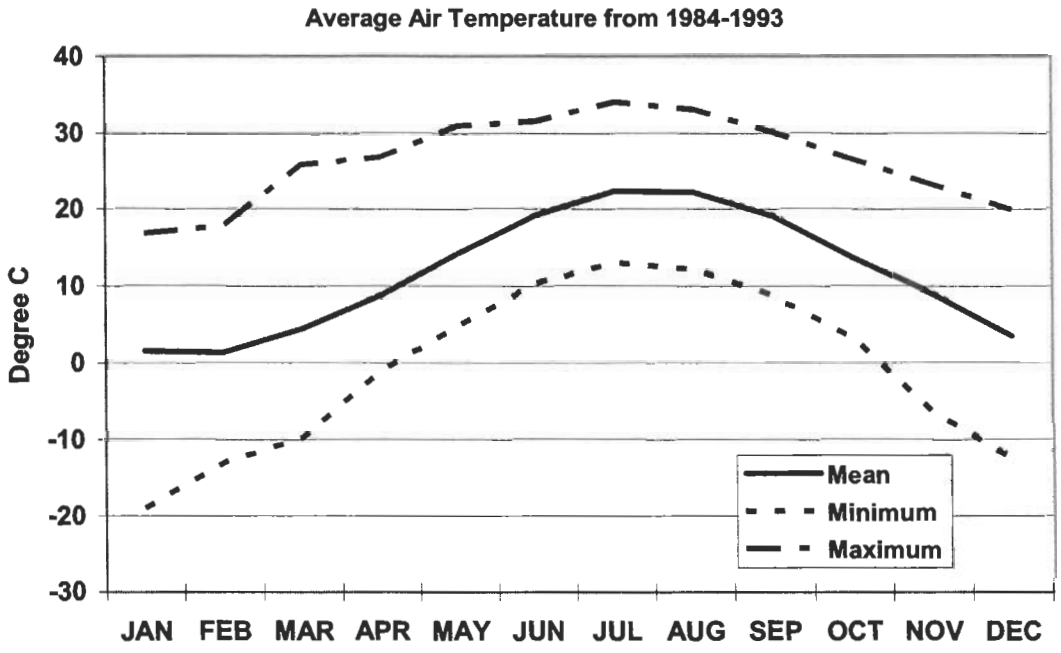

Figure 4-11. Average Air Temperature at Buoy ALSN6 (40°N, 73.8°W)

Source: http://www.ndbc.noaa.gov/climate.phtml

Average wind speeds measured from 1984 through 1993 at an offshore weather buoy south of Long Island (40.5°N, 73.8°W) ranged from about 11.5 knots (21.3 kilometers/hour) in July to about 16.5 knots (30.6 kilometers/hour) in December (see Figure 4-12). Prevailing winds are from the south and southwest in the summer, and from the north and northwest in the winter (see Figure 4-13). Occasional two- to three-day winter storms from the northeast ("northeasters") can produce severe offshore conditions with high winds, cold rain, and steep seas.

Long-term wind measurements from four stations around Long Island Sound were analyzed to characterize the effect of wind on bottom currents (USACE, 2001g). 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 percent of the time (USACE, 2001g). Table 4-1 and Table 4-2 (USACE 2001g; see Appendix G-1) present the long-term percent exceedences for winds from the west and east. For reference, a 0.05 percent exceedence corresponds to approximately 8 hr in 2 years. The effects of winds on the generation of waves are addressed in Section 4.5.1.

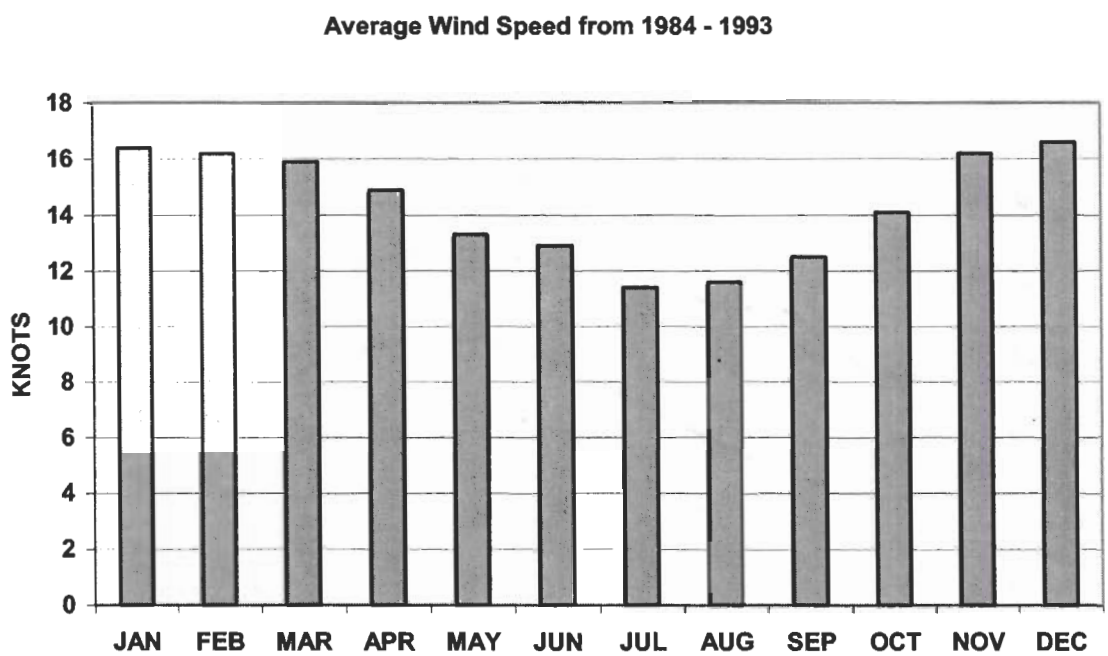

Figure 4-12. Average Wind Speed at Buoy ALSN6 (40.5°N, 73.8°W)

Source: http://www.ndbc.noaa.gov/climate.phtml

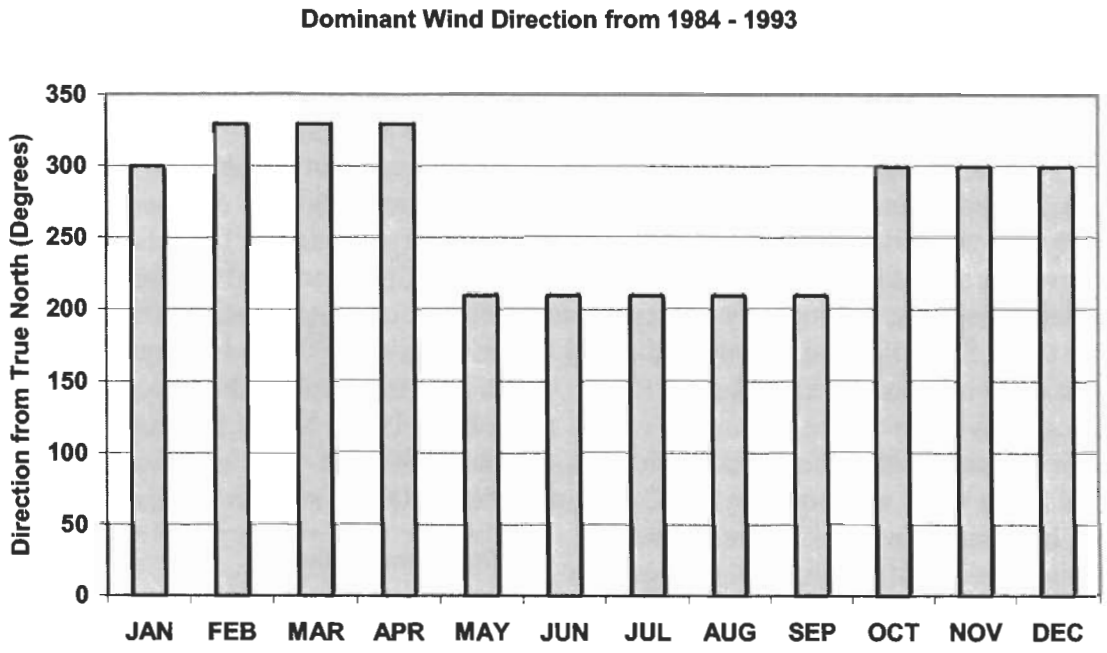

Figure 4-13. Prevailing Wind Direction at Buoy ALSN6 (40.5°N, 73.8°W)

Source: http://www.ndbc.noaa.gov/climate.phtml

Table 4-1. Long-term Percent Exceedence for West Winds

Location	No. of Years Evaluated	>5 m/s (>9.7 knots)	>10 m/s (>19.4 knots)	>15 m/s (>29.2 knots)	>20 m/s (>38.9 knots)
Groton	31	12%	0.4%	0.01%	<0.005%
Block Island	27	19%	1.5%	0.04%	<0.005%
Brookhaven	29	25%	1.7%	0.07%	<0.005%
Buzzards Bay	12	32%	7.0%	1.05%	0.05%

Source: USACE 2001g; Appendix G-1

Table 4-2. Long-term Percent Exceedence for East Winds

Location	No. of Years Evaluated	>5 m/s (>9.7 knots)	>10 m/s (>19.4 knots)	>15 m/s (>29.2 knots)	>20 m/s (>38.9 knots)
Groton	31	5%	0.2%	0.01%	0.003%
Block Island	27	5%	0.3%	0.01%	0.002%
Brookhaven	29	6%	0.4%	0.03%	0.001%
Buzzards Bay	12	11%	1.9%	0.28%	0.034%

Source: USACE 2001g; Appendix G-1

4.5 Physical Oceanography

This section describes the physical oceanography (current, waves, and density structure) of Long Island Sound in general and specifically for the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS. Information about the physical oceanography of Long Island Sound and the proposed alternative sites, as it relates to dredged material stability and transport, was derived primarily from two large studies of Long Island Sound. The first was an extensive study (the Long Island Sound Environmental Studies Program) of the benthic habitats, sedimentary processes, and transport of contaminated sediments carried out by the U.S. Geological Survey in the mid 1990s. This study formed the basis of the evaluation conducted by Signell *et al.* (2000) which presents much of the regional physical oceanography review here, relying on results of the Long Island Sound Environmental Studies Program and earlier work by the USGS in the 1980s and other investigators. The second was a study sponsored by the Corps and EPA in 2001 in support of this DEIS from which information relative to the alternative sites was derived (USACE, 2001g; Appendix G-1). That study combined an analysis of data from previous studies and a major field data collection program in the spring of 2001.

4.5.1 Long Island Sound

The transport, dispersion, and eventual fate of sediment in the marine environment depend upon the physical characteristics of the sediment and the structure 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. 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 receiving water, relative to the density of the sediment, influences how long the sediment remains in the water column. In this section, historical data are used to characterize these parameters for the study area.

Currents. Currents in Long Island Sound in the vicinity of the alternative sites are, as with the Sound system as a whole, driven by three distinct processes, tides, density and wind,

Sediment 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 disposal, 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 disposed in Long Island Sound consists of very fine sand to silt and clay. Low concentrations (2 to 5 percent 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).

Once deposited, current and wave energy affect the transport and dispersion of dredged material. The deep basins of western and central Long Island Sound are covered with fine-grained deposits and have recorded net accumulation rates ranging from 0.26 to 1.3 millimeters (0.01 to 0.05 inches) per month (Kim and Bokuniewicz, 1991). These areas have low current-induced energy regimes, with tidal currents between 0.5 to 0.8 feet (15 to 25 centimeters)/second; weak wind-driven currents (<0.13 feet [4 centimeters] per second), density-driven currents (<0.13 feet [4 centimeters] per second) and tide-induced residual currents (<0.07 feet [2 centimeters] per second); and little or no wave energy except during very large storms (Signell *et al.*, 2000). The finest fraction of sediments may be deposited and then resuspended, transported, dispersed, and redeposited many times before ultimately being incorporated into permanent sediment deposits (SAIC, 1994).

which interact to fashion the overall circulation of the Sound. Tidal currents are the dominant source of water movement in Long Island Sound and the rise and fall of the tide in the North Atlantic 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 structure of the tidal current in the Sound is complicated by the shape of the Sound and its complex bathymetry. 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. Peak surface tidal currents through the Race are typically 3.9 feet/second (120 centimeters/second) and can exceed 5.2 feet/second (160 centimeters/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 feet/second (20 to 30 centimeters/ second). Because of a resonant effect of the semidiurnal (twice daily) tide, the tidal range increases from 2.6 feet (0.8 meters) in the eastern portion of the Sound to 7 feet (2.1 meters) in the west (Ianniello, 1981).

Bottom tidal currents are strongest in the eastern region of Long Island Sound, with peak bottom velocities of 2 to 2.3 feet/second (60 to 70 centimeters/second) during spring tides, but weaken toward western Long Island Sound to 0.6 to 0.7 feet/second (18 to 21 centimeters /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 feet/second [2 centimeters/second]) throughout the western and central basins (Signell *et al.*, 2000).

Waves. Orbital (to-and-fro) wave motions are present under all surface waves. They vary with wave height and are strongest near the surface and weaken 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, but do not transport the sediments. However, once mixed into the water column by waves, particles may be transported by any net current flow.

Table 4-3 shows wave height and period calculated for various wind conditions (storms of different return periods – a 10-year storm corresponds to a percent frequency of occurrence of approximately 0.02 percent) at alternative sites in Long Island Sound, based on historical wind data for the period 1985 to 1994 and 1997 to 2001. Storms with a return period of 10 years may generate waves ranging from 10 to 11 feet (3 to 3.4 meters) with periods of 6 to 7 seconds. Because Long Island Sound is almost completely surrounded by land, waves in the Sound are generated locally and are limited by the maximum distance winds can blow over open water (fetch). As seen in Table 4-3, WLIS has the highest wave heights. This is because WLIS has the longest fetch from the east. 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 deep as those beneath fully developed waves.

Table 4-3. Estimated Wave Height and Period for the Alternatives for Storms from the Northeast having Various Return Periods

Return Period (years)	WLIS		Bridgeport		Milford		CLIS	
	Wave Height (feet)[1]	Peak Wave Period (second)	Wave Height (feet)	Peak Wave Period (second)	Wave Height (feet)	Peak Wave Period (second)	Wave Height (feet)	Peak Wave Period (second)
1	8.39	5.72	7.99	5.55	7.64	5.40	7.25	5.24
2	9.25	6.01	8.82	5.83	8.46	5.68	8.04	5.50
5	10.35	6.36	9.90	6.18	9.51	6.02	9.06	5.83
10	11.17	6.62	10.71	6.43	10.30	6.26	9.83	6.07
20	11.97	6.87	11.50	6.67	11.09	6.50	10.60	6.30
50	13.02	7.18	12.53	6.97	12.11	6.79	11.60	6.59
100	13.79	7.40	13.30	7.19	12.87	7.01	12.35	6.80

[1]For meters, multiply by 0.305.

Density Structure and Salinity. Long Island Sound, like all estuaries, has salinity gradients resulting from the mixing of freshwater from rivers and streams with salt water from the Atlantic Ocean. The narrow East River on Long Island Sound's western end and the Race on the Sound's eastern end limit the exchange of Sound water with Atlantic Ocean water. Rivers and streams drain the adjacent watersheds and supply freshwater inflow into the Sound. Annual freshwater input to Long Island Sound is greater than 14 million acre-feet per year (560 cubic meters/second), comprising about 35 percent of its volume (Parker and O'Reilly, 1999; NYSDEC and CTDEP, 2000). The major sources of freshwater, sediments, and inorganic nutrients, along the Connecticut shoreline are the Connecticut River (72 percent of fresh water) followed by the Housatonic River (12 percent), and the Thames River (9 percent). The Connecticut and Thames Rivers, which discharge east of the Mattituck Sill, appear to have little influence on the salinity in the western and central basins of the Sound. The salinity in the western-most Sound is more heavily influenced by the flow from the East River and the Hudson Raritan Estuary (Riley, 1956; Hardy, 1972), which can contribute freshwater input equal to the sum of the Connecticut rivers (Salztman, 1980). The major source of saline water is in the east where salty Block Island Sound water enters Long Island Sound (salinities in Block Island Sound average 34.5 practical salinity units (psu) [USACE, 1998]). The mixing of Block Island Sound water with Long Island Sound water results in salinities in the eastern Long Island Sound of approximately 30 psu, the highest in Long Island Sound.

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 move the whole water mass up and down the estuary with the flood and ebb tides. 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 mixing and movement 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. Although salinities measured in Long Island Sound range from 23 to 33 psu, the eastern end of the Sound has been found to be consistently 5 to 6 psu more saline than the western end (Kim and Bokuniewicz, 1991). The change in salinity is generally more abrupt within 20 kilometers (12 miles) of either end of the Sound and is more gradual through the central part of the Sound.

While salinity stratification generally 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. Warming of the Sound's surface waters begins in April and by June strong thermal stratification develops. During the summer months, stratification with typically 3 to 5°C (37 to 41 °F) top to bottom temperature difference throughout most of the Sound has been observed (Signell *et al.*, 2000). In August or 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.

Longitudinal salinity and associated density gradients through Long Island Sound are present for much of the year, maintaining an estuarine circulation with a net eastward surface flow and net westward bottom flow (Wilson, 1976). Examining data from a series of current meter moorings located in the Sound, Gordon and Pillbeam (1975) estimated average westward near bottom currents of approximately 0.2 to 0.3 feet/second (5 to 10 centimeters/ second). For the western and central basins in particular, weak bottom flows of 0.07 to 0.13 feet/second (2 to 4 centimeters/second) have been estimated, increasing to 0.2 to 0.3 feet/second (6 to 8 centimeters/second) in the axial depression (Signell *et al.*, 2000).

Wind Stress. 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 driving currents that are generally weaker than tidal currents, wind-stress 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 – conditions ideal for the resuspension and transport of bottom sediments.

The predominant wind stress in Long Island Sound is from the southwest directed just northward of the long axis of the Sound. Wind data from Ambrose Light in the New York Bight shows that southwesterly winds of at least 21 knots (10.8 meters/second) occur about 8 percent of the time throughout the year and during the winter southwesterly winds of at least 27 knots (13.9 meters/second) occur about 5 percent of the time. 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 Long Island 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 and eastern areas, this deep bottom flow is quite weak. During strong west wind events (*i.e.,* winds 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 extratropical storms, result in an eastward bottom current response, opposite the westward density-driven flow, serving to weaken the westward density-driven bottom flow.

Near-bottom currents alone rarely have enough energy to initiate the resuspension and transport of bottom sediment. When waves, however, are large enough and long enough to impart energy to the bottom, 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.

4.5.2 Western Long Island Sound Alternative

Currents. Throughout Long Island Sound tidal currents are dominant running east-southeast and west-northwest parallel to the long axis of the Sound. Average peak ebb and peak flood currents run 20 to 30 centimeters/second (0.7 to 1 feet/second) (depth-averaged), with the spring tides 20 to 40 percent stronger. Tidal ellipse parameters for surface, middle, near-bottom, and bottom currents measured in WLIS in the spring of 2001 are presented in Table 4-4 (USACE, 2001g). The dominate flow direction is nearly east-west and the narrow ellipses indicate that there was little flow normal to the dominant flow direction. Amplitude decreases with depth and near-bottom amplitude is less than 20 centimeters/second (0.7 feet/second). Seventy to ninety percent of the current variance during the 2-month spring deployment period was due to the tide with nearly 90 percent of the current variation in the x-direction because of tidal forcing at the bottom.

Table 4-4. Tidal Ellipse Parameters for Bottom, Near-bottom, Middle and Surface Currents Measured in WLIS, Spring 2001

Layer	Distance from Bottom (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Inclination (deg)	Phase (deg)	% Vx Tidal Variance	% Vy Tidal Variance
Surface	31.1	25.9	0.6	8.9	125.2	71.5	34.6
Middle	16.1	26.5	1.3	357.5	113.9	78.8	25.1
Near-Bottom	2.1	19.1	4.3	353.2	96.1	76.1	55.3
Bottom	~1.0	14.2	3.4	358.4	50.6	89.3	52.1

Source: USACE 2001g; Appendix G-1

While currents throughout Long Island Sound are continuously driven by the rise and fall of the tide, they are also intermittently driven by strong, steady wind events and by the density effect of freshwater inflows. The year-long current meter deployment reported by Fredriksson and 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 20 to 30 centimeters/second (0.7 to 1 feet/second), flows directed to the west-southwest run as high as 40 to 45 centimeters/second (1.3 to 1.5 feet/second) for 2 percent of the time and 35 to 40 centimeters/second (1.1 to 1.3 feet/second) for 5 percent of the time, with flows as high as 50 to 55 centimeters/second (1.6 to 1.8 feet/second) recorded on occasion. These results are consistent with the USACE (2001g; Appendix G-1) 2-month measurement from the spring of 2001 of 42 centimeters/second (1.4 feet/second) peak near-bottom current (2 meters [6.6 feet] above the bottom) and also with a month-long current meter deployment inside the boundaries of WLIS completed in January 1982 under the DAMOS program (Morton *et al.*, 1982). A current meter deployed in that study 1.5 meters (4.9 feet) above the bottom recorded a peak flood event of 45 centimeters/second (1.5 feet/second) associated with winds in excess of 30 knots (15.4 meters/second). Fredriksson and Dragos (1996) and Morton *et al.*, (1982) reported a net west-southwestward flow (long-term mean) of 1.5 to 5.5 centimeters/second (0.05 to 0.18 feet/second) indicative of the density driven estuarine circulation.

Waves. The wind fetch at WLIS 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 WLIS. The 2-month record of waves made in the spring of 2001 at a station within WLIS during a survey conducted in support of this DEIS (USACE 2001g; Appendix G-1) recorded 6.5-foot (2-meter) high waves (significant wave height) with 4 to 6 second periods associated with a 10 meter/second (19 knot) wind event (winds from the east). Near bottom peak orbital wave velocities measured at a 118-foot (36-meter) depth in the axial depression reached only 2 centimeters/second (0.07 feet/second). This survey, however, represents a short record of potential wave

activity. Therefore, a 12-year record of wind data from the Buzzards Bay Tower[1] was analyzed for the period July 1985 to February 1994 and May 1997 to March 2001 to develop wind climatology for the region (see also Tables 4-1 and 4-2). 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. The results for WLIS are presented in Table 4-5.

Table 4-5. Wave Height and Period at the WLIS Alternative for Storms of Various Return Periods Estimated from Wind Data

	Wind Direction (Degrees from True North)									
	0°		45°		90°		135°		180°	
Return Period (years)	Wave Height (ft)[1]	Peak Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	4.64	4.17	7.19	5.27	8.39	5.72	6.68	5.09	3.17	3.50
2	5.06	4.34	7.86	5.50	9.25	6.01	7.33	5.33	3.45	3.65
5	5.61	4.56	8.73	5.80	10.35	6.36	8.17	5.62	3.82	3.83
10	6.03	4.71	9.38	6.01	11.17	6.62	8.80	5.83	4.11	3.96
20	6.45	4.86	10.03	6.21	11.97	6.87	9.42	6.04	4.40	4.09
50	7.02	5.06	10.87	6.47	13.02	7.18	10.24	6.30	4.78	4.25
100	7.45	5.20	11.50	6.66	13.79	7.40	10.85	6.49	5.07	4.37

	Wind Direction (Degrees from True North)					
	225°		270°		315°	
Return Period (years)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	4.96	4.22	4.15	3.89	3.03	3.35
2	5.35	4.37	4.46	4.02	3.24	3.45
5	5.87	4.55	4.86	4.18	3.52	3.58
10	6.26	4.69	5.17	4.29	3.74	3.68
20	6.66	4.82	5.48	4.41	3.96	3.78
50	7.20	5.00	5.89	4.56	4.25	3.90
100	7.60	5.12	6.21	4.66	4.47	3.99

[1]Wave heights are reported as significant wave height which is the average of the one-third highest waves.

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 southwest in spring and summer. The data show a northeast storm with a return period of 2 years will generate waves of 9 feet (2.8 meters) with a 6 second period over the WLIS Alternative. Storms with a return period of 10 years will generate 11-foot (3.4-meter) waves with a 6.6 second period over the site. The short period relative to wave height is indicative

[1] Data from the Buzzards Bay Tower were used to represent Long Island Sound because it is the nearest regional marine station. Much stronger differences exist between land-based wind measurements and marine-based measurements than between marine-based measurements from across the region. In addition, the Buzzards Bay Tower has the longest record of the existing stations.

of locally-generated, fetch-limited waves. The waves reported in USACE 2001g (Appendix G-1), with a peak wave height of 6.5 feet (2 meters), represent storms that can be expected several times a year.

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 feet (30 meters)(the average depth of the WLIS 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 10 and 20 centimeters/second (0.3 to 0.7 feet/second), respectively. Velocities of this magnitude are not sufficient to cause appreciable erosion (Bokuniewicz and Gordon, 1980). Model estimates indicate that bottom orbital velocities of 35 centimeters/second (1.1 feet/second) are required to mobilize 1 millimeter (0.04 inches) of non-cohesive sediments (Appendix G-3).

4.5.3 Bridgeport Alternative

Currents. There are no long-term current measurements available from within the Bridgeport Alternative; however, short-term measurements are available from the vicinity of the site. Specifically, a month-long current record generated by the State University of New York (SUNY) at Stony Brook, Marine Sciences Research Center during the summer of 1988 at a station approximately 1.7 nautical miles (3.2 kilometers) to the east of the Bridgeport Alternative was analyzed (SUNY, unpublished data). Tidal ellipse parameters for surface, middle, and near-bottom currents based on these data are presented in Table 4-6. The dominant flow directions recorded were east-southeast and west-northwest with the narrow ellipses indicating little flow normal to the dominant flow direction. Amplitude decreased with depth with the near-bottom amplitude recorded at less than 16 centimeters/second (0.5 feet/second). Based on these data, 70 to 85 percent of the current variance during the 1-month summer deployment period was due to the tide. Spring tides and non-tidal flow produced a maximum current during the measurement period of 70 centimeters/second (2.3 feet/second) at the surface and 41 centimeters/second (1.3 feet/second) near-bottom.

Summertime current measurements reveal little about the non-tidal currents associated with fall and winter storm wind stress and spring density flows. Therefore, long-term measurements at other locations in the western basin must be evaluated to provide an indication of the magnitude of these effects. The year-long current meter deployment (between WLIS and Bridgeport) reported by Fredriksson and 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 with the density gradients. While near-bottom peak ebb and flood tides run from 20 to 30 centimeters/second (0.7 to 1 feet/second), flows directed to the west-southwest run as high as 40 to 45 centimeters/second (1.3 to 1.5 feet/second) for 2 percent of the time and 35 to 40 centimeters/second (1.1 to 1.3 feet/second) for 5 percent of the time with flows as high as 50 to 55 centimeters/second (1.6 to 1.8 feet/second) recorded on occasion. Fredriksson and Dragos (1996) also observed a net west-southwestward flow (long-term mean) of 1.5 to 5.5 centimeters/second (0.05 to 0.18 feet/second) indicative of the density driven estuarine circulation.

Table 4-6. Tidal Ellipse Parameters for Near-bottom, Middle and Surface Currents Measured Approximately 1.7 Nautical Miles East of the Bridgeport Alternative, Summer 1988

Layer	Distance from Bottom (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Inclination (deg)	Phase (deg)	% Vx Tidal Variance	% Vy Tidal Variance
Surface	14.3	33.2	3.3	80.8	222.2	84.4	44.0
Middle	7.6	16.9	0.4	83.4	203.2	77.5	38.1
Near-Bottom	3.0	15.2	1.0	92.0	194.8	72.2	16.6

Source: SUNY, unpublished data

Waves. The wind fetch at Bridgeport is limited by the semi-enclosed nature of Long Island Sound, which limits the wave heights that can be developed at the site as discussed for WLIS. However, the potential effect of waves must be taken into account despite the limited fetch due to the potential winds from storms (see Section 4.5.2). No wave measurements are available at or near the Bridgeport Alternative. A 12-year record of wind data from the Buzzards Bay Tower (see Section 4.5.2) was used to calculate wave height and period for various wind conditions experienced in the Sound using a simple fetch and duration wave model. The results are presented in Table 4-7.

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 southwest in spring and summer. The data show a northeast storm with a return period of 2 years will generate waves of 8.8 feet (2.6 meters) with a 5.8 second period over the Bridgeport Alternative. Storms with a return period of 10 years will generate 11-foot (3.4-meter) waves with a 6.4 second period over the site. The short period relative to wave height is indicative of locally-generated, fetch-limited waves.

Sedimentary suspension and transport. The oscillatory motions beneath such steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 64 feet (19.5 meters), 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 28 to 45 centimeters/second (0.9 to 1.5 feet/second). Ten-year storm velocities of 45 centimeters/second (1.5 feet/second) are sufficient to cause erosion of non-cohesive silt and fine sands (Bokuniewicz and Gordon, 1980). Even 2-year storm velocities of 28 centimeters/second (0.9 feet/second) when combined with strong wind-driven or tidal currents may be sufficient to cause erosion (Bokuniewicz and Gordon, 1980).

Table 4-7. Wave Height and Period at the Bridgeport Alternative for Storms of Various Return Periods Estimated from Wind Data

	Wind Direction (Degrees from True North)									
	0°		45°		90°		135°		180°	
Return Period (years)	Wave Height (ft)[1]	Peak Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	4.78	4.23	6.94	5.15	7.99	5.55	6.43	4.97	4.97	4.24
2	5.21	4.40	7.60	5.38	8.82	5.83	7.07	5.20	5.40	4.41
5	5.78	4.61	8.46	5.66	9.90	6.18	7.89	5.49	5.96	4.61
10	6.21	4.77	9.10	5.87	10.71	6.43	8.51	5.70	6.39	4.76
20	6.65	4.92	9.74	6.07	11.50	6.67	9.13	5.90	6.83	4.91
50	7.23	5.12	10.58	6.33	12.53	6.97	9.93	6.15	7.41	5.09
100	7.67	5.26	11.20	6.52	13.30	7.19	10.54	6.34	7.85	5.23

	Wind Direction (Degrees from True North)					
	225°		270°		315°	
Return Period (years)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	5.49	4.46	4.90	4.21	3.03	3.35
2	5.92	4.61	5.25	4.35	3.24	3.46
5	6.48	4.81	5.73	4.52	3.52	3.59
10	6.91	4.95	6.09	4.64	3.74	3.69
20	7.35	5.09	6.45	4.77	3.95	3.78
50	7.92	5.27	6.93	4.93	4.24	3.91
100	8.36	5.41	7.30	5.05	4.47	4.00

[1]Wave heights are reported as significant wave height which is the average of the one-third highest waves.

4.5.4 Milford Alternative

Currents. In the absence of long-term current meter measurements from within the Milford Alternative, short-term measurements available from near the site were evaluated. Specifically, a month-long current record generated by the SUNY Marine Sciences Research Center during the summer of 1988 at two stations located approximately 6 nautical miles (11.3 kilometers) to the northeast and 9.5 nautical miles (18 kilometers) to the west of the Milford Alternative, respectively, were analyzed (SUNY, unpublished data). These two stations are each located in approximately the same water depth and at approximately the same distance from the Connecticut coast. Tidal ellipse parameters for both stations for surface, middle, and near-bottom currents are presented in Table 4-8. Based on this information, the dominant flow direction is east-southeast and west-northwest and the narrow ellipses indicate that there was little flow normal to the dominant flow direction. Amplitude decreases with depth and near-bottom amplitude is less than 16 centimeters/second (0.5 feet/second). The major axis, minor axis, and inclination of the tidal ellipses are nearly the same at the two stations for similar depths as expected given their relative locations. This clearly indicates the validity of using these tidal ellipse parameters for the Milford

Alternative given its location between the two stations. Seventy to ninety percent of the current variance during the summer deployment period was due to the tide. Spring tides and/or non-tidal flow produced a maximum current during the measurement period of 48 centimeters/second (1.6 feet/second) at the surface and 34 centimeters/second (1.1 feet/second) near-bottom.

Table 4-8. Tidal Ellipse Parameters for Near-bottom, Middle and Surface Currents Measured Near the Milford Alternative, Summer 1988

Layer	Distance from Bottom (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Inclination (deg)	Phase (deg)	% Vx Tidal Variance	% Vy Tidal Variance
Station 4N located 6 nautical miles (11.3 kilometers) northeast of the Milford Alternative 8/10/88-9/788							
Surface	10.0	26.7	1.8	77.0	211.9	92.5	66.4
Near-Bottom	4.0	18.5	1.6	80.4	246.6	91.5	52.8
Station 3NC located 9.5 nautical miles (18 kilometers) west of the Milford Alternative 7/14/88-8/10/88							
Surface	14.3	33.2	3.3	80.8	222.2	84.4	44.0
Middle	7.6	16.9	0.4	83.4	203.2	77.5	38.1
Near-Bottom	3.0	15.2	1.0	92.0	194.8	72.2	16.6

Source: SUNY, unpublished data

As discussed for Bridgeport, summertime measurements are not good indicators of fall and winter storm wind stress or spring density flows, therefore, long-term measurements from nearby locations in the western basin. As discussed earlier, the year-long current meter deployment (located between WLIS and Bridgeport) reported by Fredriksson and 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 with the density gradients. Flows directed to the west-southwest run as high as 40 to 45 centimeters/second (1.3 to 1.5 feet/second) for 2 percent of the time and 35 to 40 centimeters/second (1.1 to 1.3 feet/second) for 5 percent of the time with flows as high as 50 to 55 centimeters/second (1.6 to 1.8 feet/second) recorded on occasion (Fredriksson and Dragos, 1996). These are consistent with the maximum near-bottom currents of 34 and 41 centimeters/second (1.1 to 1.3 feet/second) measured during summer at the two SUNY stations near Milford.

Waves. The wind fetch at the Milford Alternative is limited by the semi-enclosed nature of Long Island Sound which limits the wave heights that can be developed at the site. This is particularly true for winds from the north and northwest. Considering that winter storms can generate powerful winds from the northeast, however, the potential effect of waves must be taken into account despite the limited fetch. No wave measurements are available at or near the Milford Alternative. Therefore, a 12-year record of data from the Buzzards Bay Tower was analyzed as described for WLIS (Section 4.5.2). Table 4-9 presents the wave height and period developed for Milford from the Buzzards Bay Tower data.

Table 4-9. Wave Height and Period at the Milford Alternative for Storms of Various Return Periods Estimated from Wind Data

	Wind Direction (Degrees from True North)									
	0°		45°		90°		135°		180°	
Return Period (years)	Wave Height (ft)[1]	Peak Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	4.58	4.12	6.60	5.00	7.64	5.40	6.62	5.01	5.28	4.42
2	4.99	4.29	7.23	5.22	8.46	5.68	7.28	5.24	5.73	4.59
5	5.54	4.50	8.06	5.50	9.51	6.02	8.13	5.52	6.32	4.80
10	5.96	4.65	8.68	5.71	10.30	6.26	8.78	5.73	6.77	4.96
20	6.38	4.80	9.30	5.90	11.09	6.50	9.42	5.93	7.22	5.11
50	6.95	4.99	10.12	6.15	12.11	6.79	10.26	6.19	7.82	5.30
100	7.38	5.13	10.74	6.33	12.87	7.01	10.89	6.37	8.28	5.45

	Wind Direction (Degrees from True North)					
	225°		270°		315°	
Return Period (years)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	6.64	4.95	5.81	4.63	4.00	3.86
2	7.14	5.12	6.23	4.78	4.28	3.98
5	7.80	5.34	6.77	4.96	4.65	4.13
10	8.29	5.50	7.18	5.10	4.93	4.24
20	8.79	5.65	7.60	5.24	5.21	4.35
50	9.45	5.85	8.15	5.41	5.59	4.49
100	9.94	5.99	8.56	5.54	5.88	4.60

[1]Wave heights are reported as significant wave height which is the average of the one-third highest waves.

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 southwest in spring and summer. The data show a northeast storm with a return period of 2 years will generate waves of 8.5 feet (2.6 meters) with a 5.7 second period over the Milford Alternative. Storms with a return period of 10 years will generate 10-foot (3.1-meter) waves with a 6.3 second period over the site. The short period relative to wave height is indicative of locally generated, fetch-limited waves.

Sedimentary suspension and transport. The oscillatory motions beneath such steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 61 feet (18.5 meters), 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 27 to 44 centimeters/second (0.9 to 1.4 feet/second). Ten-year storm velocities of 44 centimeters/second (1.4 feet/second) are sufficient to cause erosion of non-cohesive silts and fine sands (Bokuniewicz and Gordon, 1980). Even 2-year storm velocities of 27 centimeters/second (0.9 feet/second) when combined with strong wind-driven or tidal currents may be sufficient to cause erosion (Bokuniewicz and Gordon, 1980).

4.5.5 Central Long Island Sound Alternative

Currents. No long-term current meter measurements have been made within or in the immediate vicinity of the CLIS Alternative, however, short-term measurements were collected in support of this DEIS (USACE, 2001g; Appendix G-1). Throughout the central basin of Long Island Sound basin, tidal currents running east and west are dominant. Average peak ebb and peak flood currents run 20 to 30 centimeters/second (0.7 to 1 feet/ second) (depth-averaged) with the spring tides about 20 to 40 percent stronger. Tidal ellipse parameters for surface, middle, and bottom currents measured in CLIS in the spring 2001 are presented in Table 4-10 (USACE, 2001g; Appendix G-1). The dominant flow direction is nearly east-west and the narrow ellipses indicate that there was little flow normal to the dominant flow direction. Amplitude decreases with depth and near-bottom amplitude is less than 25 centimeters/second (0.8 feet/second). Fifty to 95 percent of the current variance during the 2-month spring deployment period was due to the tide with 96 percent of the current variation in the x-direction due to tidal forcing at the bottom.

Table 4-10. Tidal Ellipse Parameters for Bottom, Near-Bottom, Middle and Surface Currents Measured at the CLIS Alternative, Spring 2001

Layer	Dist. Bottom (m)	Major Amplitude (cm/s)	Minor Amplitude (cm/s)	Inclination (deg)	Phase (deg)	% Vx Tidal Variance	% Vy Tidal Variance
Surface	20.1	26.3	2.3	355.0	122.3	51.3	28.9
Middle	10.1	31.9	0.0	352.0	102.9	83.8	51.0
Near-Bottom	2.1	24.1	3.1	351.6	93.4	84.9	52.1
Bottom	~1.0	14.2	2.4	342.9	40.5	96.0	68.6

Source: USACE 2001g; Appendix G-1

Tidal currents are intermittently supplanted by currents caused by strong, steady wind events and by the density effect of freshwater inflows. The 2-month current meter deployment, observed a peak near-bottom flood event of 45 centimeters/second (1.5 feet/second) associated with winds in excess of 30 knots (15 meters/second). Also observed was a net west-southwestward flow (long-term mean) of approximately 2.5 centimeters/second (0.08 feet/second) indicative of the density driven estuarine circulation.

Waves. The wind fetch at CLIS is limited by the semi-enclosed nature of Long Island Sound which limits the wave heights that can be developed 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 (northeasters), the potential effect of waves must be take into account despite the limited fetch. Few wave measurements are available at or near CLIS. A 2-month record of waves made in the spring of 2001 at a station within CLIS (Appendix G-1) recorded 5-foot (1.5-meter) high waves (significant wave height) with 4 to 6 second periods associated with a 10 meters/second (19 knot) wind event (winds from the east). Near bottom peak orbital wave velocities measured at 69-foot (21-meter) depth reached approximately 8 centimeters/second (0.3 feet/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 WLIS (Section 4.5.2). The results for CLIS are presented in Table 4-11.

Table 4-11. Wave Height and Period at the CLIS Alternative for Storms of Various Return Periods Estimated from Wind Data

	Wind Direction (Degrees from True North)									
	0°		45°		90°		135°		180°	
Return Period (years)	Wave Height (ft)[1]	Peak Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	3.49	3.58	5.99	4.75	7.25	5.24	6.29	4.86	5.31	4.41
2	3.81	3.73	6.57	4.97	8.04	5.50	6.92	5.09	5.76	4.58
5	4.24	3.91	7.34	5.24	9.06	5.83	7.74	5.36	6.36	4.79
10	4.57	4.04	7.92	5.43	9.83	6.07	8.36	5.57	6.82	4.95
20	4.90	4.17	8.50	5.62	10.60	6.30	8.99	5.76	7.28	5.10
50	5.35	4.34	9.27	5.86	11.60	6.59	9.81	6.01	7.88	5.29
100	5.69	4.46	9.85	6.04	12.35	6.80	10.42	6.19	8.35	5.43

	Wind Direction (Degrees from True North)					
	225°		270°		315°	
Return Period (years)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)	Wave Height (ft)	Wave Period (sec)
1	6.05	4.70	6.10	4.74	4.49	4.09
2	6.52	4.87	6.53	4.89	4.80	4.21
5	7.13	5.07	7.10	5.08	5.21	4.37
10	7.59	5.23	7.53	5.22	5.52	4.49
20	8.06	5.37	7.96	5.36	5.83	4.61
50	8.67	5.56	8.53	5.54	6.25	4.75
100	9.14	5.70	8.96	5.67	6.57	4.86

[1]Wave heights are reported as significant wave height which is the average of the one-third highest waves.

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 southwest in spring and summer. The data show a northeast storm with a return period of 2 years will generate waves of 8.0 feet (2.4 meters) with a 5.5 second period over the CLIS Alternative. Storms with a return period of 10 years will generate 10-foot (3.0 meter) 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 Appendix G-1, with a peak wave height of 5 feet (1.5 meters), represent storms that can be expected several times a year.

Sedimentary suspension and transport. The oscillatory motions beneath such steep waves do not penetrate as deeply as those beneath fully developed waves. For a representative average depth of 68 feet (21 meters), 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 17 to 31 centimeters/second (0.6 to 1 feet/second). Velocities of this magnitude are not sufficient to cause significant erosion (Bokuniewicz and Gordon, 1980). Model estimates indicate that bottom orbital velocities of 35 centimeters/second (1.1 feet/ second) are required to mobilize 1 millimeter (0.04 inches) non-cohesive sediments (Appendix G-3; USACE, 2003e).

4.5.6 Physical Oceanography Summary

Based on the analysis presented above, there is essentially no difference in the average speed of tidal currents among the four alternative sites. Similarly, there is little difference among the sites in the significant wave heights calculated for 2- and 10-year storms, 8 to 9 feet (2.4 to 2.7 meters) and 10 to 11 feet (3 to 3.4 meters), respectively. Thus, there are no important differences in these parameters among the sites. However, when the calculated wave heights are linked with the average water depth at each site, the potential for sediment resuspension does differ among the alternative sites. The near-bottom orbital velocities generated by 10-year storms would be sufficient to cause erosion of non-cohesive silt and fine sands at the Bridgeport and Milford Alternative sites because of the shallow depths there. Additionally, near-bottom orbital velocities generated by 2-year storms would be sufficient, when combined with wind-driven or tidal currents to cause erosion at these sites. Neither storm category generates near-bottom orbital velocities at WLIS or CLIS that would be sufficient to cause sediment erosion.

4.6 Sediment Quality

The following sections describe the sediment quality (grain size, total organic carbon, metals, organic contaminants, and sediment toxicity) of Long Island Sound in general (Section 4.6.1) and specifically for the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS (Section 4.6.2). These aspects of sediment quality can impact the aquatic habitats available to benthic and fish communities. Information for the sediment quality of Long Island Sound was based on several sound-wide studies identified in the literature (*e.g.*, Knebel and Poppe, 2000; Mecray and Buchholtz ten Brink, 2000).

Current sediment quality conditions at all four alternative sites were assessed through the collection of surface sediment samples in February and July 2000 (WLIS and CLIS), July 2001 (CLIS) and July 2002 (Bridgeport and Milford) for physical, chemical, and toxicological evaluation, as well as for characterization of benthic community structure (USACE, 2001e and USACE, 2002d; Appendix F). These surveys were sponsored by the Corps and EPA in support of this DEIS. Table 4-12 provides a summary of the sampling and analysis programs conducted at the four alternative sites and the sampling locations are

Station Types Defined in Site-specific Surveys

Historic: a station from an area within the Alternative that received dredged material prior to the onset of testing requirements in 1979.
Active: a station from within the area of the Alternative that accepts dredged material deemed suitable for open-water disposal.
Reference: a station located in a remote area that, by its position, should not reflect any discernable impacts from the disposal of dredged material at a particular site. These sites were intended to represent ambient conditions.
Farfield: a station positioned outside of the Alternative boundaries and in alignment with the predominant east-west current regime to assess whether contaminants have migrated offsite.

Table 4-12. Summary of Recent Sediment Surveys Conducted at the Four Long Island Sound Alternative Sites

	WLIS	Bridgeport	Milford	CLIS
Sediment Characterization Studies				
Survey Date(s)	February, July 2000	July 2002	July 2002	February, July 2000; July 2001
Station Types and ID[1]				
Active	MD1	None	None	N93
Historical	EB1	BP10, BP14, BP23, BP-A1[2], BP-A2[2], BP-A3[2]	MF06, MF29, MF-A2[2], MF-A3[2]	N74, FVP
Farfield	E5H, W5H	None	MF04[3], MF-A1[2,3]	1KW, 2KW
Reference	STH	BPR1	MFR1	REF
Total Number of Samples	30	12	12	45
Sample Size	0.04 m^2 (0.4ft^2) modified van Veen grab	0.04 m^2 (0.4ft^2) modified van Veen grab	0.04 m^2 (0.4ft^2) modified van Veen grab	0.04 m^2 (0.4ft^2) modified van Veen grab
Data Type	Grain size, TOC, Chemistry, Infaunal Abundance, Species, Toxicity Bioassays	Grain size, TOC, Chemistry, Infaunal Abundance, Species, Toxicity Bioassays	Grain size, TOC, Chemistry, Infaunal Abundance, Species, Toxicity Bioassays	Grain size, TOC, Chemistry, Infaunal Abundance, Species, Toxicity Bioassays
Study Citation	USACE, 2001e, 2002g Appendix H-1; F-1	USACE, 2002d; 2003f Appendix F-2; H-2	USACE, 2002d; 2003f Appendix F-2; H-2	USACE, 2001e, 2002g Appendix H-1; F-1
Sediment Profile Image Studies				
Survey Date(s)	July 1996	July 2002	July 2002	September 1999
Site Stations	4	29	29	5
Reference Stations	3	3	3	3
Study Citation	SAIC, 1998	USACE, 2002f Appendix F-7	USACE, 2002f Appendix F-7	SAIC, 2002a

[1] See Figures 4-14 and 4-15 for sampling locations.
[2] Sample evaluated for additional metals chemistry only.
[3] Samples were collected outside the current boundary of the alternative site.

depicted in Figures 4-14 and 4-15. Complete sediment chemistry and toxicity test results are reported in Appendix F. For WLIS and CLIS, data were available for several station types including historic, active, reference, and farfield (see text box). Data available for Bridgeport and Milford included samples collected from within the site boundaries and at reference stations.

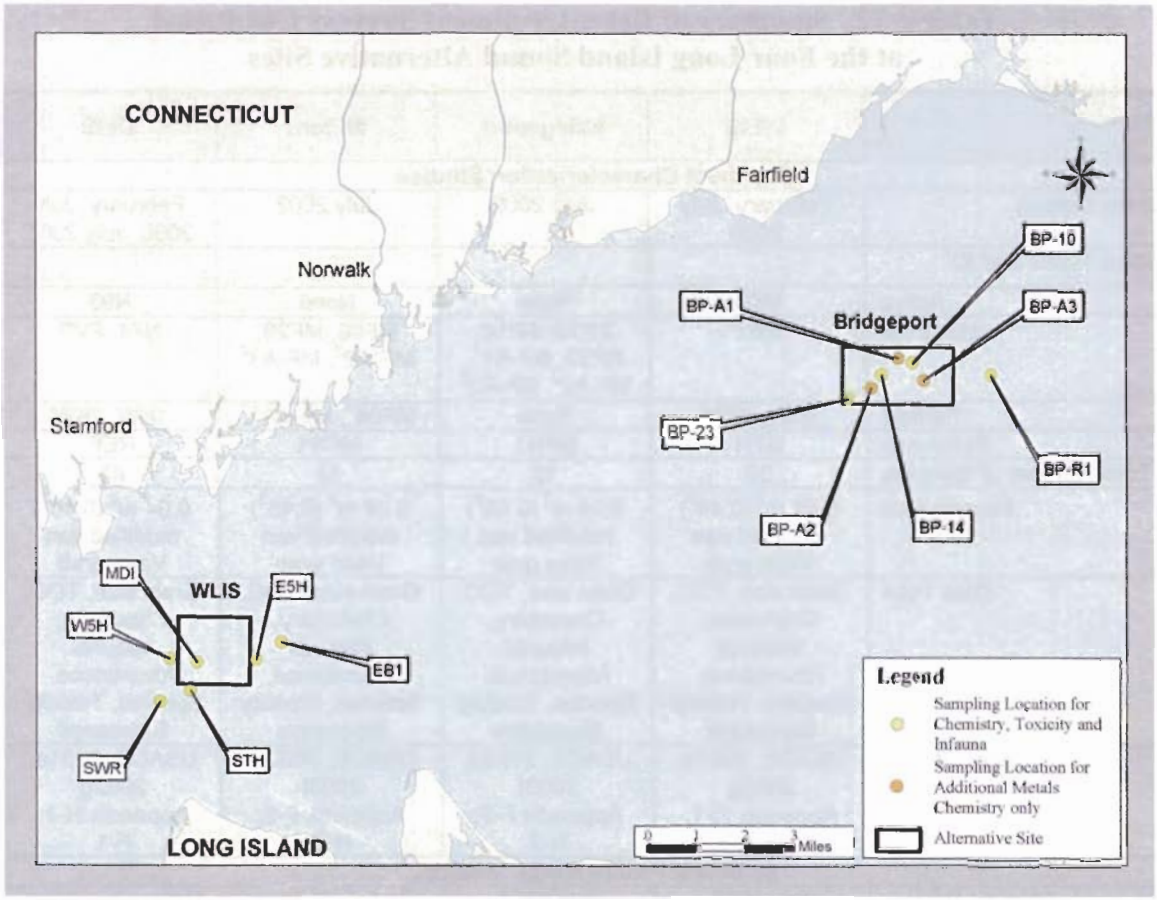

Figure 4-14. Sediment Sampling Locations for Surveys Conducted in Support of the DEIS: WLIS and Bridgeport

Source: USACE, 2001e; USACE, 2002d; Appendix F

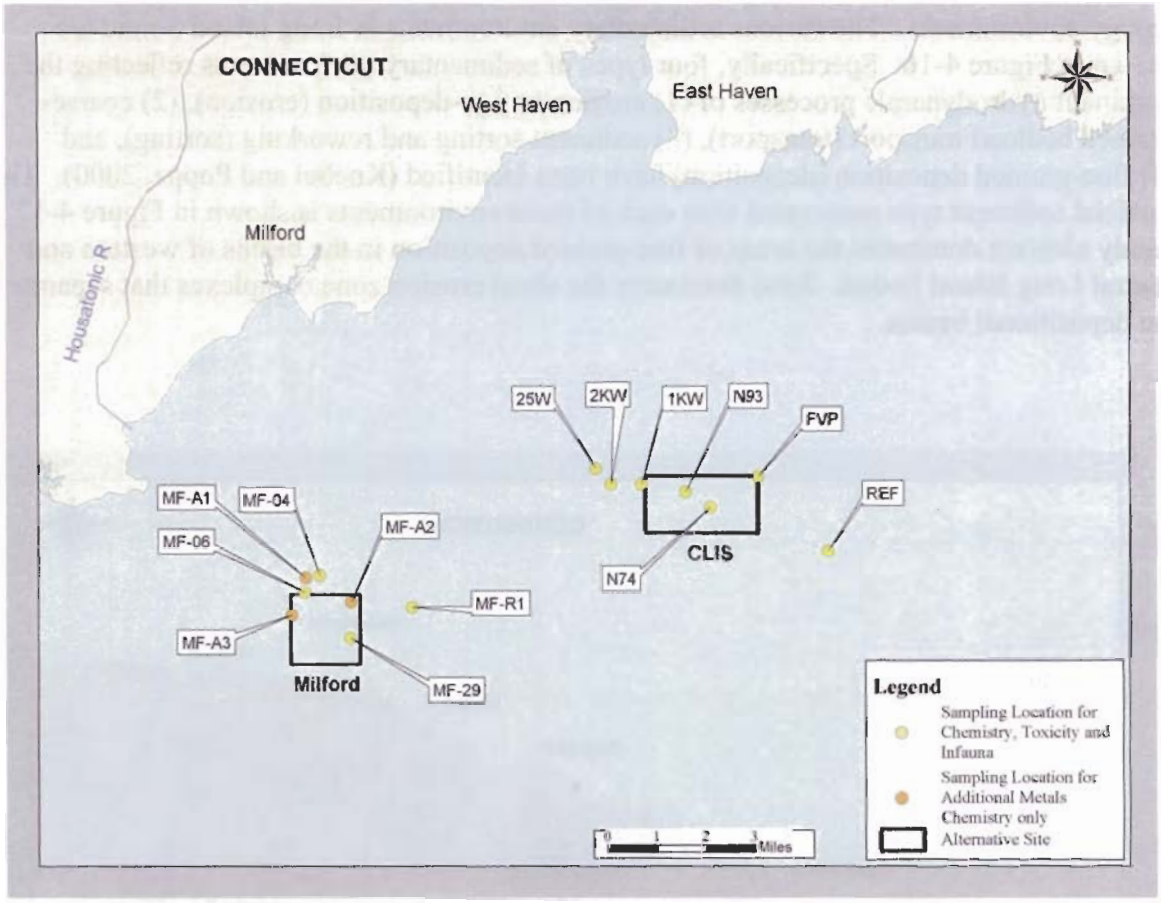

Figure 4-15. Sediment Sampling Locations for Surveys Conducted in Support of the DEIS: Milford and CLIS

Source: USACE, 2001e; USACE, 2002d; Appendix F

4.6.1 Long Island Sound

Long Island Sound, particularly at its west end, is located in a densely populated and industrialized area of the northeast. Contaminants may be released to the Sound from numerous point and non-point sources, including wastewater and water treatment plants, industrial facilities, stormwater runoff from urban areas, agricultural runoff, and atmospheric inputs (Wolfe *et al.*, 1991). Although improvements in industrial practices in the past 25 years have in many cases reduced the load of contaminants to Long Island Sound, some residual historical contamination remains, particularly in industrialized harbors and nearshore areas.

Grain size and total organic carbon. Grain size and total organic carbon are important physical characteristics of the sediment environment. These factors play a large role in the suitability of the sediment as habitat for benthic organisms, and may control the fate, transport, and uptake of contaminants. Sediment grain size is related to the hydrodynamic environment in which the sediments are found, with coarser-grained deposits found in nearshore and higher-energy environments and finer-grained deposits found in deeper, lower

energy environments. The various sedimentary environments in Long Island Sound are shown in Figure 4-16. Specifically, four types of sedimentary environments reflecting the dominant hydrodynamic processes of (1) erosion or non-deposition (erosion), (2) coarse-grained bedload transport (transport), (3) sediment sorting and reworking (sorting), and (4) fine-grained deposition (deposition) have been identified (Knebel and Poppe, 2000). The surficial sediment type associated with each of these environments is shown in Figure 4-17. Sandy clay/silt dominates the areas of fine-grained deposition in the basins of western and central Long Island Sound. Sand dominates the shoal erosion zone complexes that separate the depositional basins.

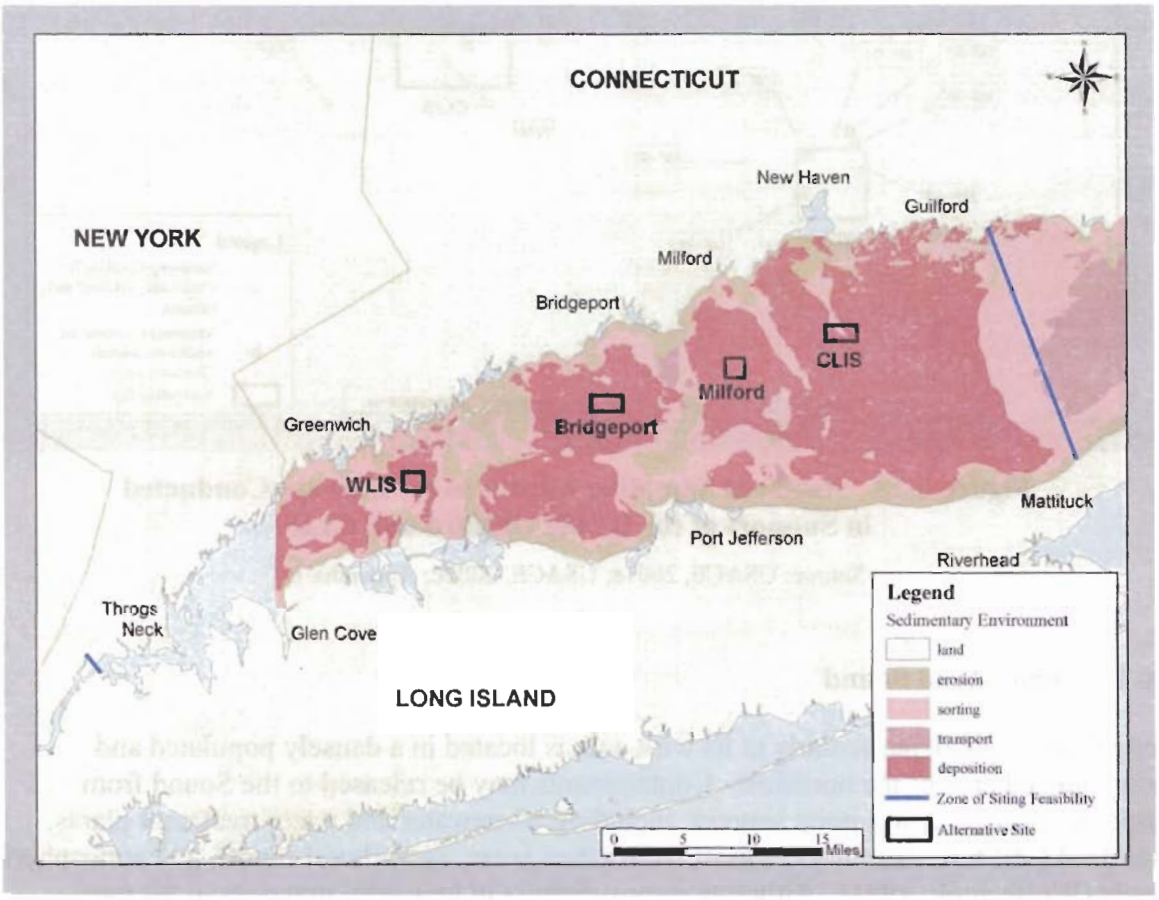

Figure 4-16. Sedimentary Environments throughout Western and Central Long Island Sound

Source: Knebel and Poppe, 2000

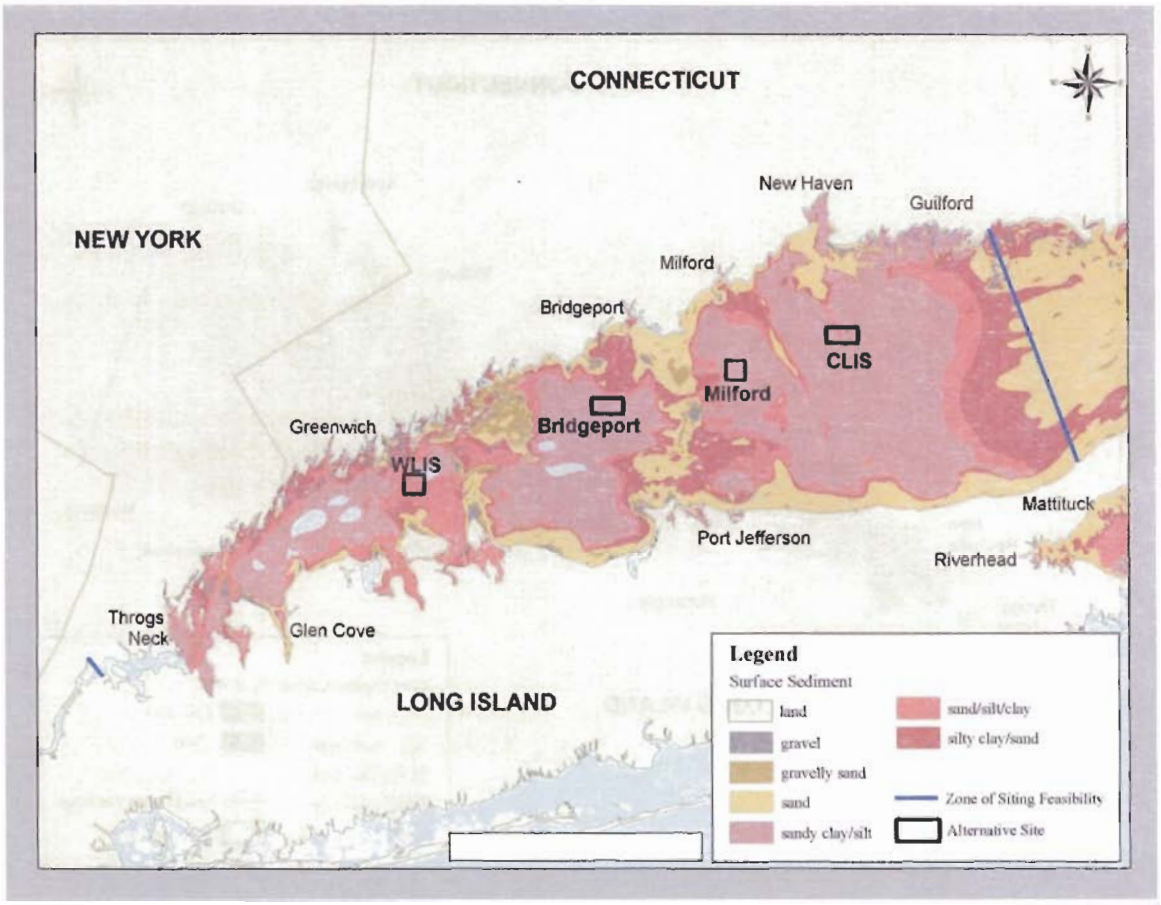

Figure 4-17. Distribution of Major Sediment Grain Size Characteristics in Surficial Sediments of Long Island Sound

Source: Poppe *et al.*, 2000

Total organic carbon (TOC) is a measure of the total amount of organic material in sediment. TOC content influences many physical, chemical, and biological processes, including the availability of sediment contaminants to marine organisms. The amount of total organic carbon (TOC) in Long Island Sound sediments increases with decreasing grain size, with an average of more than 1.9 percent dry weight in sandy clay/silt and less than 0.4 percent in sand (Poppe *et al.*, 2000). The distribution of TOC in Long Island Sound sediments is shown in Figure 4-18. In general, TOC content increases towards the west and from the shallow margins to the deeper parts of the Long Island Sound basin (Poppe *et al.*, 2000).

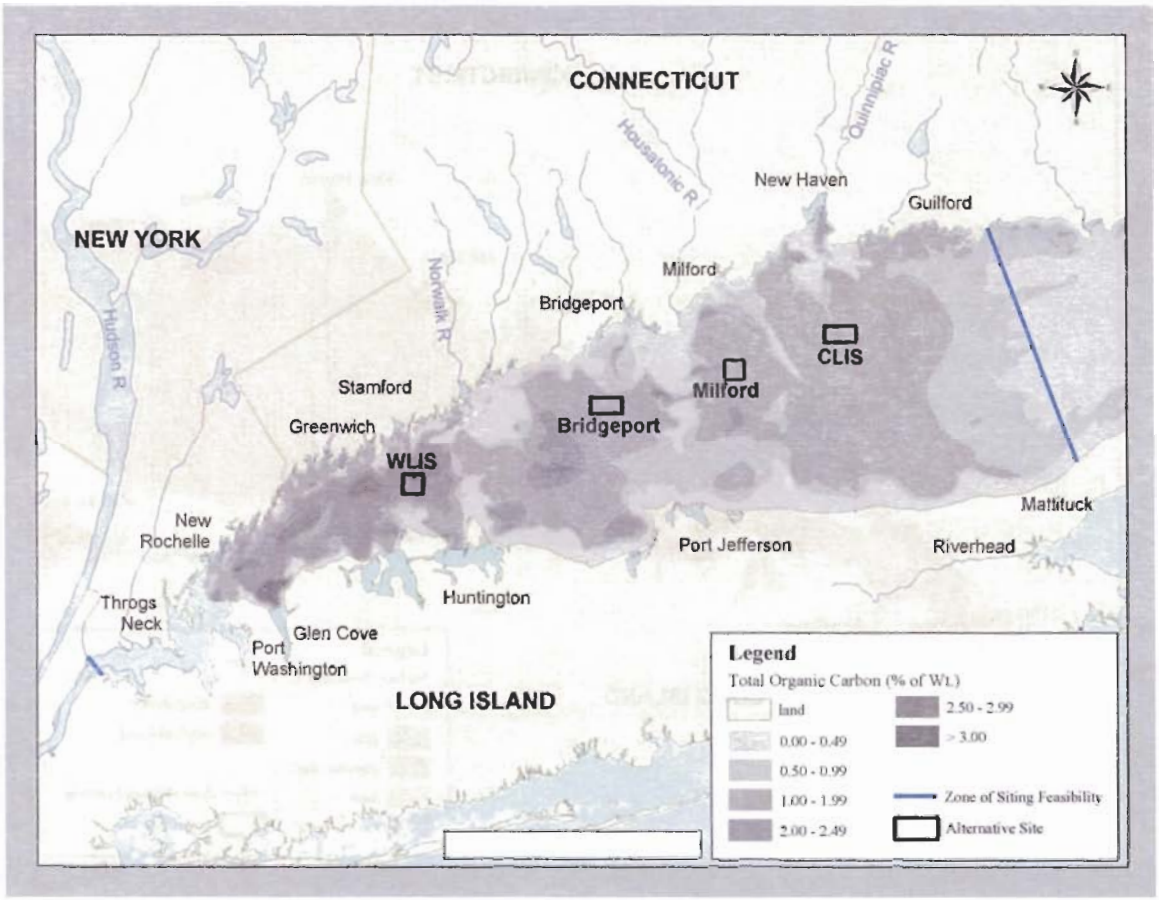

Figure 4-18. Distribution of Total Organic Carbon in Long Island Sound

Source: Poppe *et al.*, 2000

Metals. Regional studies of metals in Long Island Sound sediments have found that in general, concentrations increase from eastern Long Island Sound to western Long Island Sound (*e.g.*, Brownawell *et al.*, 1991; Mecray and Buchholtz ten Brink, 2000). Concentrations of many metals are positively correlated with total organic carbon content and percent fines. Ratios of metals to percent fines were found to be uniform in the depositional basins of the Sound (Mecray and Buchholtz ten Brink, 2000). Therefore, most differences in metal concentrations can be attributed to sediment properties, although higher than average levels of metals are found in some of the urbanized harbors and tributaries in western Long Island Sound and the Connecticut shore (Brownawell *et al.*, 1991).

Table 4-13 presents the average concentrations for selected metals in Long Island Sound sediments, as well as average concentrations specific to depositional environments within Long Island Sound. To evaluate the potential for impacts associated with these sediments, Effects Range-Low (ER-L) and Effects Range–Median (ER-M) effects values (Long *et al.*, 1995) are provided for comparison. ER-L values represent concentrations below which adverse biological effects rarely occur, and ER-M values represent concentrations above

Table 4-13. Average Metals Concentrations (mg/kg dry weight) in Long Island Sound Sediments[1]

	Silver	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
ER-L[2]	1.0	1.2	81	34	0.15	20.9	46.7	150
ER-M[2]	3.7	9.6	370	270	0.71	51.6	218	410
Long Island Sound average	0.27	0.16	67.9	**39.1**	0.12	**24.8**	36.1	103
Long Island Sound depositional environment average	0.44	0.25	**93.3**	**59.5**	**0.18**	**32.2**	**47.7**	146

Bold values exceed the ER-L.
[1] Source: Mecray and Buchholtz ten Brink, 2000
[2] Ecological effects values derived by Long *et al.*, 1995

which biological effects frequently occur. Chromium, copper, mercury, nickel, and lead concentrations exceed the ER-L in sediments found in fine-grained, depositional environments.

Concentrations of lead, copper, zinc, and mercury in Long Island Sound have been found to be higher in the upper approximate 30 centimeters (12 inches) of sediment than at depth, reflecting the effects of industrialization (Cochran *et al.*, 1991; Varekamp *et al.*, 2000). Mercury concentrations decline in the upper 10 to 15 centimeters (4 to 6 inches) of sediment, apparently the result of a reduction in mercury sources in recent decades (Varekamp *et al.*, 2000).

Organic contaminants. Few data are available on the distribution of organic contaminants in Long Island Sound. Regional data have been collected by the National Oceanic and Atmospheric Administration as part of the National Status and Trends (NS&T) Program; although these data are concentrated in nearshore areas and may not accurately represent the fine-grained depositional basins in western and central Long Island Sound. Average concentrations of organic contaminants in these near-shore sediment samples collected by the NS&T program are summarized in Table 4-14. On average, the NS&T data indicate that concentrations of the most common organic contaminants close to shore exceed ER-Ls, however, only PCBs exceed the ER-M. When comparing the ER-Ls and ER-Ms, however, it is important to note that the benchmarks were derived using sediments with a TOC content of approximately 1 percent. The higher TOC content observed in most Long Island Sound sediments may reduce the bioavailability of many organic compounds. NS&T studies indicate that organic contaminant concentrations tend to be higher in western Long Island Sound relative to eastern Long Island Sound (Turgeon and O'Connor, 1991).

Table 4-14. Average Concentrations of Organic Contaminants (µg/kg dry weight) in Long Island Sound Sediments

	% TOC	Total PCB	Low Molecular Weight PAH	High Molecular Weight PAH	Total tPAH	Total DDT
ER-L[1]	~1	22.7	552	1700	4022	1.58
ER-M[1]	~1	180	3160	9600	44792	46.1
Long Island Sound average[2]	3.34	**249**	**1307**	**5971**	**7814**	**36**
Long Island Sound average[3]	1.75	**108**	**747**	**3470**	2416	**5.61**

Bold values exceed the ER-L; Underlined values exceed the ER-M.
[1] Ecological effects values derived by Long *et al.*, 1995.
[2] Source: Brownawell *et al.*, 1991. Nearshore data collected by NOAA from 1986-1988 as part of NS&T Program. Areas sampled were comprised primarily of fine-grained sediments.
[3] Source: NOAA NS&T Benthic Surveillance Program; near-shore data collected from 1984-1991 (http://ccmaserver.nos.noaa.gov/NSandT/NSandTdata.html)

Sediment toxicity. To evaluate the potential toxicity of sediments to aquatic organisms, laboratory tests are often conducted in which representative organisms are exposed to sediments collected from the area under evaluation. A review of the literature indicated that only a few studies have been conducted with sediments from Long Island Sound to evaluate their potential toxicity, therefore, limited data sets are available to determine the sound-wide toxicity. The NS&T Program performed a regional survey of sediment toxicity in Long Island Sound based on samples collected in 1990 and 1991 (Wolfe *et al.*, 1994). Results of these whole-sediment assays, conducted using the tube-dwelling amphipod *Ampelisca abdita*, showed that sediment toxicity was widespread in the 20 coastal bays that were included in the study. However, with the exception of two samples collected near the CLIS Alternative, none of the sediment samples collected offshore in the Sound exhibited toxicity and all had survival rates of at least 82 percent of the reference sediment values. Based on these results, whole sediment toxicity appears to be primarily in nearshore areas of Long Island Sound. The general absence of toxicity in sediment samples collected offshore in Long Island Sound is supported by the results of testing conducted in support of this EIS. These site-specific data are described in more detail under the discussion of the specific alternatives (Section 4.6.2).

In addition to the whole-sediment toxicity tests described above, the U.S. Geological Survey recently conducted a sound-wide evaluation of sediment porewater toxicity using a sediment elutriate test that measures the effects of sediment porewater contaminants on sea urchin or clam egg fertilization and larval development (Buchholtz ten Brink *et al.*, 2002). The tests showed significant differences between stations from various locations, with an apparent correlation between concentrations of metals in sediment samples and toxic response. However, consistent with the results of the whole-sediment tests, there was little evidence of porewater toxicity in the open waters of the Sound.

4.6.2 Sediment Quality at the Alternative Sites

Sediment quality for the four alternative sites is evaluated using the data summarized in Table 4-12. A complete description of the surveys conducted and the results obtained is provided in Appendix F.

Grain size and total organic carbon. Average grain size and TOC values at the four alternative sites are summarized in Table 4-15. In general, these parameters were similar at all four sites, although sediments at WLIS and CLIS were more heterogeneous than Bridgeport and Milford.

Table 4-15. Average Grain Size and TOC Content for Sediment Samples from the Four Alternative Sites

Station Type	Average % fines	Average % TOC
WLIS Alternative[1]		
WLIS Active	52.5	1.5
WLIS Far Field	76.4	2.6
WLIS Historic	88.8	2.6
WLIS Reference	24.8	1.3
Bridgeport Alternative[2]		
Bridgeport Historic	86.2	1.8
Bridgeport Reference	92.4	1.9
Milford Alternative[2]		
Milford Historic	91.9	2.2
Milford Reference	98.0	2.0
CLIS Alternative[1]		
CLIS Active	81.8	2.2
CLIS Far Field	87.4	1.9
CLIS Historic	57.4	1.4
CLIS Reference	92.4	1.9

[1] Collected in February 2000 (USACE, 2001e; Appendix F-1).
[2] Collected in July 2002 (USACE, 2002d; Appendix F-2).

Metals. Metals concentrations in surface sediment samples collected from the four alternative sites are summarized in Table 4-16. In general metal concentrations at the four alternative sites tended to be higher than those reported for natural depositional environments within Long Island Sound as reported in the general studies (Table 4-16).

Table 4-16. Summary of Metals Concentrations (mg/kg dry weight) in Sediment Samples from the Four Alternative Sites

Station	Silver	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
ER-L[1]	1.0	1.2	81	34	0.15	20.9	46.7	150
ER-M[1]	3.7	9.6	370	270	0.71	51.6	218	410
Sound-wide Sediment Concentrations[2]								
LIS average	0.27	0.16	67.9	**39.1**	0.12	**24.8**	36.1	103
LIS depositional environment average	0.44	0.25	**93.3**	**59.5**	**0.18**	**32.2**	**47.7**	146
WLIS Alternative[3]								
WLIS Active	**0.97**	**0.60**	44.5	**63.5**	**0.79**	18.5	**49.4**	110
WLIS Far Field	**1.09**	**0.62**	68.8	**76.6**	**0.41**	**27.0**	**53.1**	**152**
WLIS Historic	**0.90**	**0.31**	68.6	**67.3**	**0.18**	**25.6**	44.6	**139**
WLIS Reference	0.36	0.20	27.2	**36.5**	**0.13**	12.9	24.1	**118**
Bridgeport Alternative[4]								
Bridgeport Historical	**0.58**	0.18	78.1	**63.9**	**0.22**	**34.4**	35.9	146
Bridgeport Reference	**0.63**	0.21	**84.4**	**71.6**	**0.24**	**36.4**	39.0	**156**
Milford Alternative[4]								
Milford Historical	**0.62**	0.19	**82.1**	**72.3**	**0.32**	**35.9**	38.0	**152**
Milford Reference	**0.52**	0.17	74.9	**50.2**	**0.20**	**36.0**	36.6	144
CLIS Alternative[3]								
CLIS Active	**1.33**	**0.58**	79.3	**75.8**	**0.20**	**23.2**	44.2	139
CLIS Far Field	**0.66**	**0.18**	62.4	**51.2**	**0.12**	**22.7**	33.7	108
CLIS Historic	**0.78**	**0.52**	62.6	**85.1**	**0.15**	17.4	28.9	92.3
CLIS Reference	**0.60**	0.13	52.8	**44.0**	0.11	**23.1**	29.0	107

Shaded values exceed the average background level for LIS depositional environments; Bold values exceed the ER-L; Underlined values exceed the ER-M.
[1] Ecological effects values derived by Long *et al.* (1995)
[2] Mecray and Buchholtz ten Brink (2000)
[3] Collected in February 2000 (USACE 2001e, Appendix F-1)
[4] Collected in July 2002 (USACE 2002d, Appendix F-2)

- At WLIS the average concentrations of six metals (copper, mercury, nickel, and lead, silver and zinc) exceeded the ER-L at one or more of the station types. The average mercury concentration in samples from the WLIS active station also slightly exceeded the ER-M. Average concentrations of six metals exceeded the average background concentration for the depositional environments of Long Island Sound (silver, cadmium, copper, mercury, lead, and zinc). In general, average contaminant concentrations are highest in the far field samples.
- At Bridgeport the average concentrations of five metals (copper, mercury, nickel, chromium, and zinc) exceeded the ER-L for at least one type of station. None exceeded the ER-M. Average concentrations of silver, copper, mercury, nickel, and zinc exceeded the average background concentration for depositional environments of Long Island

Sound for at least one type of station. In general, metals concentrations were higher at the reference locations than at the historical locations.

- At Milford the average concentrations of five metals (copper, mercury, nickel, chromium, and zinc) exceeded the ER-L for at least one type of station. None exceeded the ER-M. Average concentrations of silver, copper, mercury, nickel, and zinc exceeded the average background concentration for depositional environments of Long Island Sound for at least one type of station. In general, metals concentrations were higher in samples from the historical locations than from the reference locations.
- At CLIS the average concentrations of four metals (copper, nickel, silver, and mercury) exceeded the ER-L for at least one type of station. None exceeded the ER-M. Average concentrations of silver, cadmium, copper, and mercury exceeded the average background concentration for depositional environments of Long Island Sound for at least one type of station. In general, average contaminant concentrations were higher in the active area samples than in samples from historical, far field or reference locations.

Figures 4-19 through 4-22 present the concentrations of selected metals versus grain size (percent fines) for ambient samples collected throughout Long Island Sound (Mecray and Buchholtz ten Brink, 2000) and samples collected from the open-water alternative sites (Appendix F). These plots also illustrate the regional trend for a given metal. Metals concentrations in sediment tend to increase with increasing percent fines. Samples that fall above the regional trend (*i.e.*, samples appearing to be outliers in Figures 4-19 through 4-22) have a metal concentration that is higher than what would be expected from background sources only. Three metals (copper, mercury, and nickel) were selected for analysis because concentrations of these metals in samples from the open-water alternative sites commonly exceeded the ER-L (Table 4-16). Lead was also included because it is a contaminant of interest.

Based on these figures, the following trends were observed.

- At the WLIS Alternative, concentrations of metals in samples tend to follow the regional trend except for copper and lead in several of the coarser-grained samples (*i.e.,* less than 60 percent fines) and mercury in several samples. Mercury concentrations in these samples suggest contamination above the regional trend.
- At the Bridgeport Alternative, concentrations of all of these metals follow the regional trend.
- At the Milford Alternative, concentrations of copper, lead, mercury and nickel in samples generally follow the regional trend.
- At the CLIS Alternative, copper, mercury, nickel, and lead concentrations follow the regional trend except for copper in one sample from a historical station. This concentration of 219 mg/kg appears to represent residual contamination above the regional trend.

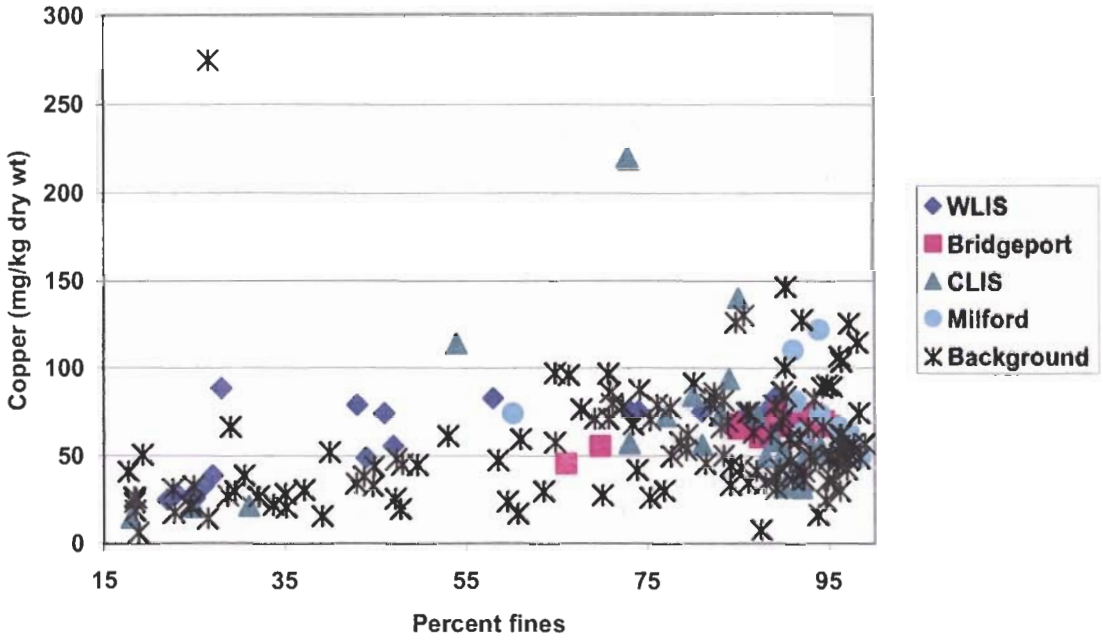

Figure 4-19. Sediment Copper Concentrations versus Percent Fines

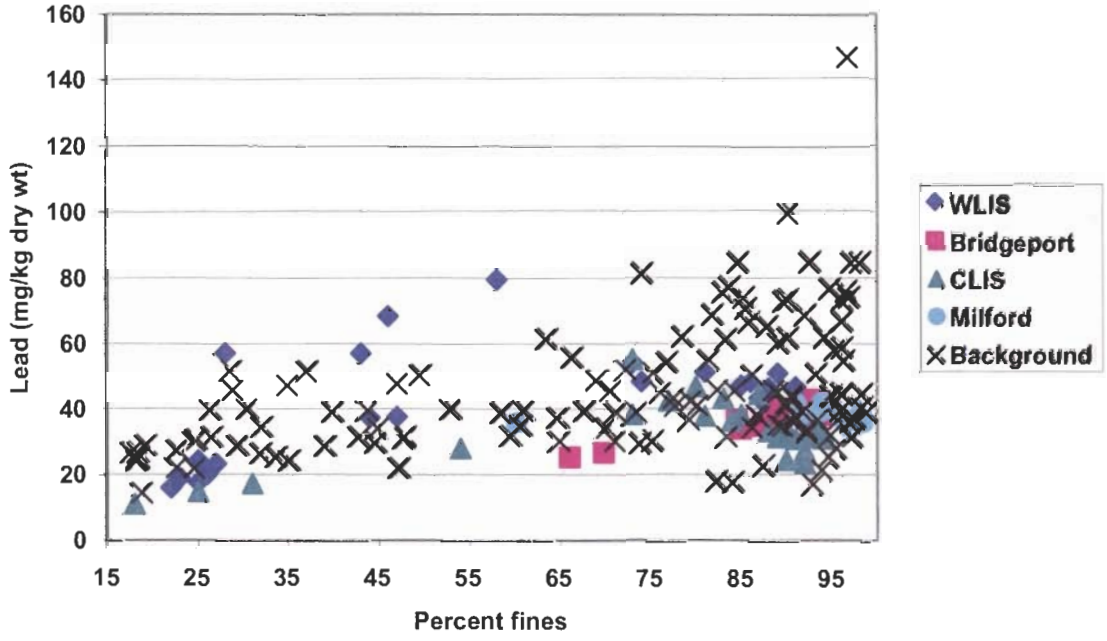

Figure 4-20. Sediment Lead Concentrations versus Percent Fines

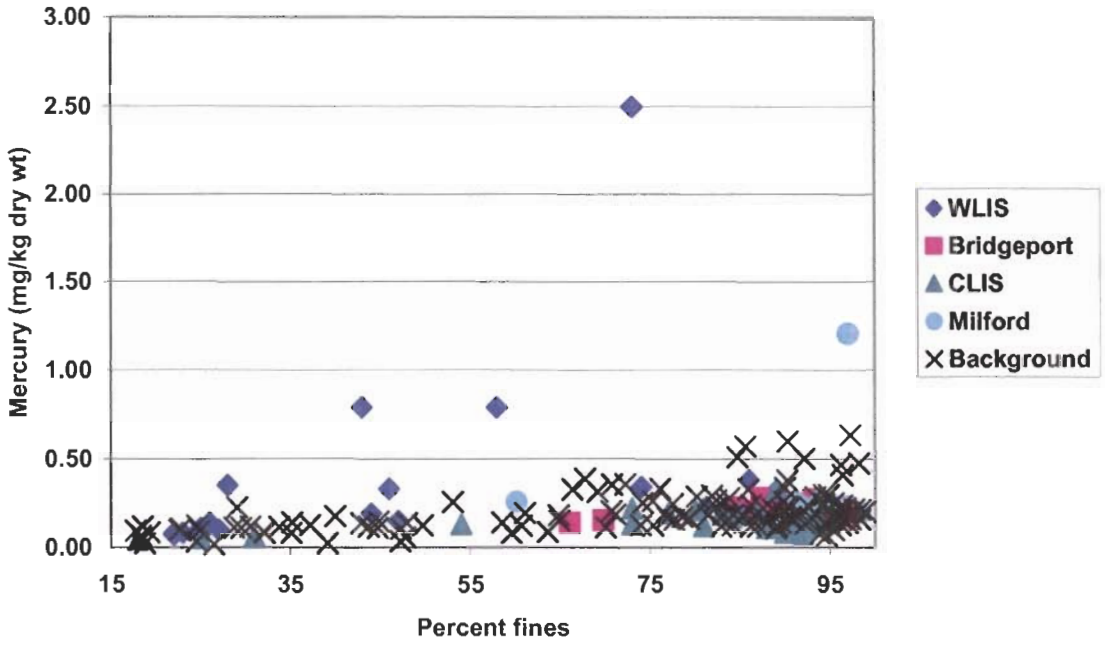

Figure 4-21. Sediment Mercury Concentrations versus Percent Fines

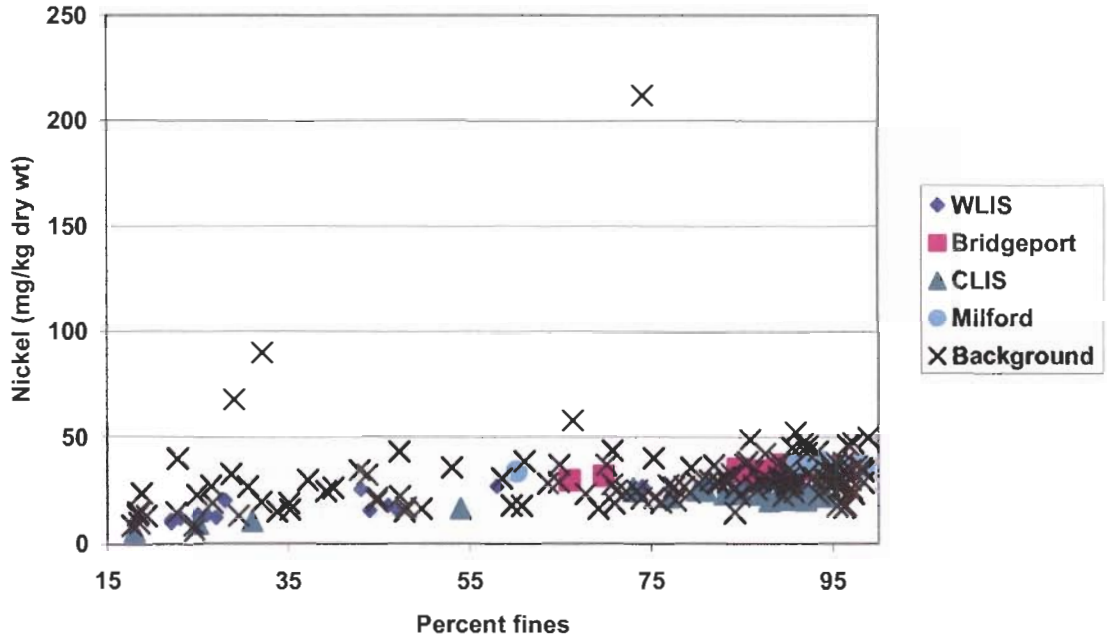

Figure 4-22. Sediment Nickel Concentrations versus Percent Fines

Acid volatile sulfide (AVS) and simultaneously extracted metal (SEM) concentrations in sediment samples collected in support of this DEIS from WLIS and CLIS in 2000 (USACE, 2001e; Appendix F-1) and Bridgeport and Milford in 2002 (USACE, 2002d; Appendix F-2) were measured to assess whether metals are likely to be bioavailable (*i.e.*, available for uptake by aquatic organisms). If AVS concentrations exceed SEM concentrations, then the metals are likely to be present in the sediment as insoluble sulfides and will not be available for uptake into aquatic life. The full analytical results for AVS/SEM data are provided in Appendix F. A summary is provided below[2].

- WLIS samples indicate that metals in sediment are not likely to be bioavailable to organisms at this site.
- Bridgeport samples indicate that sediment metals are not likely to be bioavailable with the exception of copper and zinc in one replicate sample from a historical station.
- Milford samples suggest that sediment metals are not likely to be bioavailable to organisms at this site.
- CLIS samples indicate that in general, metals in sediment are not likely to be bioavailable to organisms at this site.

Organic contaminants. The complete organic chemistry results from the surveys conducted in 2000 (USACE, 2001e) and 2002 (USACE, 2002d) are provided in Appendix F-1 and F-2, respectively. Sediments were analyzed for PAHs, PCBs, dioxins/furans, butyltins, pesticides, and radionuclides. Table 4-17 provides a summary of these chemical classes by providing the results for total PCBs, total PAHs, and total DDT. Total PCBs is the sum of 22 individual PCB congeners; the PAHs together represent 16 individual analytes grouped by molecular weight and combined; and total DDT represents the sum of three DDT compounds. Therefore, the trends observed in these summary values represent the majority of the numerous parameters evaluated. Additional discussion of parameters not summarized is provided below when important trends were noted (Table 4-17). As previously discussed, it should be noted that the sediment TOC content throughout Long Island Sound is generally higher than the 1 percent on which the ER-Ls and ER-Ms were based.

At the WLIS Alternative, average concentrations of total low and high molecular weight PAHs and total PCBs exceeded the ER-L at the active and farfield stations (Table 4-17; see Figure 4-14 for sample locations); total DDT also exceeded the ER-L in the samples from the active station. Average concentrations of total PCBs and total DDT exceeded the ER-L in the samples from the historic stations. Average concentrations of most organic contaminants in the reference site samples were less than the ER-Ls. A summary of the trends observed among the individual analytes at WLIS is provided below.

[2] AVS/SEM data for WLIS and CLIS are based on qualified data (see Appendix F-1)

Table 4-17. Summary of Organic Chemical Concentrations (µg/kg dry weight) in Sediment Samples from the Four Alternative Sites

	Low Molecular Weight PAH	High Molecular Weight PAH	Total PAH	Total PCB	Total DDT	2,3,7,8-TCDD[1]
ER-L[2]	552	1700	4022	22.7	1.58	—
ER-M[2]	3160	9600	44792	180	46.1	—
Long Island Sound Average[3]	747	3470	2416	108	5.61	—
WLIS Alternative[4]						
WLIS Active	**1008**	**3283**	3865	**69**	**4.6**	0.0009
WLIS Far Field	**698**	**2000**	2414	**83**	1.1	0.0035
WLIS Historic	382	1016	1255	**43**	**1.8**	0.0016
WLIS Reference	158	542	630	9	1.1	0.00051
Bridgeport Alternative[5]						
Bridgeport Historical	52	1398	1659	**31**	**2.8**	0.00053
Bridgeport Reference	58	1624	1926	**37**	**3.2**	0.0004
Milford Alternative[5]						
Milford Historical	78	**1914**	2307	**53**	**3.4**	0.0004
Milford Reference	44	1295	1527	**27**	**2.8**	0.00034
CLIS Alternative[4]						
CLIS Active	274	896	1036	**59**	0.40	0.00066
CLIS Far Field	203	624	748	7	ND	0.00021
CLIS Historic	298	855	1019	**95**	0.7	0.00053
CLIS Reference	202	674	783	16	0.8	0.00028

Shaded values exceed background levels; Bold values exceed the ER-L
[1] 2,3,7,8-TCDD is presented as a representative dioxin/furan
[2] Ecological effects values derived by Long *et al.*, 1995 using sediments containing 1 percent TOC
[3] NOAA NS&T Benthic Surveillance Program 1984-1991, (http://ccmaserver.nos.noaa.gov/NSandT/NSandTdata.html)
[4] Source: USACE 2001f; Appendix F-3
[5] Source: USACE 2003d; Appendix F-4

- Among the PAH analytes evaluated, 20 were detected at the WLIS Alternative (Appendix F). Analyte concentrations were lowest at the two reference stations (STH, SWR; Figure 4-14) and, with the exception of acenaphthylene and anthracene, were highest at the active station (MD1; Figure 4-14). The same pattern was observed when WLIS was compared to the other alternative sites. PAH concentrations were generally lower at the two WLIS reference stations and higher at the WLIS active station than at the other alternative sites.

- Among the 22 PCB congeners evaluated, most were not detected in at least one replicate from each station (Appendix F). As reflected by the total PCB values, the concentrations of individual congeners were generally highest at Farfield Station E5H and the active station. PCB concentrations were lowest at the reference stations (STH, SWR; Figure 4-14). PCB congener concentrations were higher at most WLIS stations than at Bridgeport and Milford stations.

- Pesticide concentrations at the six WLIS stations sampled in February 2000 were generally not detected (Appendix F). Two DDT compounds, 4,4'-DDD and 4,4'-DDE, were detected at all stations. Dieldrin was detected in one replicate from a farfield station (E5H; Figure 4-14) and in two replicates from the active station (MD1), but was not detected at the site. Gamma chlordane was detected in one replicate from the active station. Aldrin, endosulfan, endrin, and heptachlor were not detected in any sample.
- Butyltin concentrations were detected at all stations, but were much higher at the active station (average = 31 µg/kg) than elsewhere in the WLIS area (Appendix F). Butyltin (*i.e.*, TBT) concentrations were lowest at the two reference stations (average < 1.0 µg/kg).
- In general, concentrations of dioxin and furan congeners were not detected in sediments from WLIS. Concentrations of 2,3,7,8-TCDF were low, ranging from 0.00051 µg/kg at the reference station to 0.0016 µg/kg at the historic site (Table 4-17).
- Uranium 238 was detected in one replicate at WLIS Reference Station STH and Uranium 235 was present in two replicates at Reference Station SWR (Figure 4-14). Among the remaining stations, Uranium 234 and Uranium 238 were detected (Appendix F). Concentrations of all radionuclides were orders of magnitude below available sediment benchmarks indicating very low potential for adverse effects.

At the Bridgeport Alternative, concentrations for all analytes except total DDT and total PCBs were less than the ER-Ls. However, total PCB concentrations were much lower at Bridgeport than the Long Island Sound average value. Average concentrations of organic contaminants are higher in samples from the reference site samples than in the historical stations. A summary of the trends observed among the individual analytes at Bridgeport is provided below.

- All 23 PAH analytes were detected at all Bridgeport stations (Appendix F). Concentrations of most of these analytes were higher at the reference station than at the historical stations. PAH concentrations at the Bridgeport historical stations were generally lower than those at the Milford historical stations, but higher than those at most CLIS stations.
- Among the 22 PCB congeners evaluated, 21 were detected at the historical and reference stations. Concentrations for most congeners were slightly greater at the reference station than those at the historical stations. PCB concentrations at the Bridgeport stations were generally less than those at WLIS stations and less than those at CLIS Historical Station FVP and Milford Historical Station MF06 (Appendix F; see Figure 4-14 and 4-15 for sampling locations).
- The only pesticides detected at the Bridgeport Alternative were alpha-chlordane, dieldrin, and four DDT compounds (Appendix F).

- Concentrations of 2,3,7,8-TCDD ranged from 0.0004 µg/kg at the reference station to 0.00053 µg/kg within the Bridgeport Alternative. Most of the other dioxin/furan congeners were not detected.
- Due to the low concentrations reported for samples within Long Island Sound during the 2000 sampling event, no analyses for radionuclides were performed on samples collected from the Bridgeport Alternative site in July 2002.

At the Milford Alternative, total analyte concentrations, except higher molecular weight PAHs, total DDT, and total PCBs, were less than the ER-Ls. However, total PCB concentrations were much lower at Milford than the Long Island Sound average value. Average concentrations of organic contaminants are higher in samples from the historical stations than in the reference site samples.

- Among the 22 PCB congeners evaluated, 21 were detected at the historical and reference stations. Concentrations for most congeners were greater at one historical station (MF06; see Figure 4-15 for sampling locations) than those at the other Milford stations. PCB concentrations at the Milford stations were generally less than those at WLIS stations and less than those at CLIS Historical Station FVP (Appendix F).
- The only pesticides detected at Milford were alpha-chlordane, dieldrin, and four DDT compounds (Appendix F).
- Concentrations of 2,3,7,8-TCDD ranged from 0.00034 µg/kg at the reference station to 0.0004 µg/kg within the Milford Alternative. Most of the other dioxin /furan congeners were not detected.
- Due to the low concentrations reported for samples within Long Island Sound during the 2000 sampling event, no analyses for radionuclides were performed on samples collected from the Milford Alternative site in July 2002.

At the CLIS Alternative, concentrations of the most common organic contaminants were below the ER-Ls with the exception of total PCBs at the active and historic stations. Total analyte concentrations were generally higher at the historic or active stations than at the reference or farfield stations.

- Among the PAH analytes measured in the CLIS samples, 16 were detected (Appendix F). Analyte concentrations were lowest at the CLIS reference station (*i.e.*, REF; see Figure 4-15 for sampling locations) and one of the historic stations (N74). PAH concentrations generally were highest at one historic station (FVP) and at the active station (N93). PAH analyte concentrations were lower at CLIS than at most stations in the other three sites.
- Most of the 22 PCB congeners were not detected in at least one replicate from each station (Appendix F). As reflected by the total PCB values, the concentrations of individual congeners were generally highest at Historical Station FVP and the active station (N93). Those PCB congener concentrations detected were generally higher than at the other sites.

- Pesticides were generally not detected at the seven CLIS stations sampled in February 2000 (Appendix F). Two DDT compounds, 4,4'-DDD and 4,4'-DDE, were detected in all replicates from one historic station (FVP) and at the active station (N93). Dieldrin was detected in one replicate from Historical Station FVP and in one replicate from the active station (N93), but was not detected elsewhere at the site. Gamma chlordane was detected in one replicate from Station FVP (Figure 4-15). Aldrin, endosulfan, endrin, and heptachlor were not detected.
- Butyltin (*i.e.*, TBT) concentrations were detected at all stations, but were much higher at Active Station N93 (average = 5.0 µg/kg) and Historic Station FVP (average = 3.6 µg/kg) than elsewhere in the CLIS area (Appendix F). TBT concentrations were lowest at the reference station (average = 0.5 µg/kg).
- Dioxin and furan congeners were generally not detected. Concentrations of 2,3,7,8-TCDD ranged from 0.00021 µg/kg at the farfield station to 0.00066 µg/kg at the active station.
- Radionuclide concentrations were generally not detected; however, Uranium 238 was detected in at least one replicate at all CLIS stations. Uranium 234 was detected in at least one replicate from all stations except Historic Station FVP (Appendix F). Concentrations of both of these compounds were orders of magnitude below available sediment benchmarks indicating very low potential for adverse effects.

Sediment toxicity. The potential toxicity of sediment from the alternative sites and appropriate reference locations was evaluated by testing sediments collected from stations in February 2000 (USACE, 2000d; Appendix F-5) and July 2002 (USACE, 2002e; Appendix F-6). These samples were collected for physical, chemical, and toxicological evaluation, as well as for characterization of benthic community structure (Table 4-12). The potential toxicity was evaluated in two 10-day, whole sediment tests with the amphipod *Ampelisca abdita*. To determine sediment toxicity, mean amphipod survival associated with sediments from each alternative site was statistically and arithmetically compared to those associated with the appropriate reference sediment. Typically, to be classified as acutely toxic to *Ampelisca abdita*, survival in alternative site sediment must be statistically less than that in the reference sediment for that Alternative and also must differ from the reference by more than 20 percent (USEPA and USACE, 1991). Both toxicity test reports are provided in Appendix F.

- At the WLIS Alternative, the mean percent survival ranged from 96 to 100 percent (Table 4-18). Amphipod survival in the test sediments was not significantly different from that in the reference site samples (the difference in survival between test sediments and the reference sediment did not exceed 20 percent). Therefore, sediments at the active, historic, and far field stations at WLIS were not acutely toxic to *A. abdita*.
- At the Bridgeport Alternative, mean percent survival ranged from 88 to 94 percent (Table 4-18). Amphipod survival was significantly lower for two of the in-site sediments (BP-10 and BP-23; Figure 4-14) than that in the reference sediment; however, the difference in survival between these two stations and the reference did not exceed 20 percent. Therefore, the Bridgeport in-site sediment was not acutely toxic to *A. abdita*.

Table 4-18. Mean and Standard Deviation (sd) Survival in the 10-day Solid-Phase *Ampelisca abdita* Acute Toxicity Tests, Long Island Sound Alternative Sites, March 2000 and August 2002

Station IDs	Percent Survival		Survival Statistically Different from Reference? [1]	Absolute Difference from Reference (%)
	Mean	sd		
Sediment Toxicity Results for WLIS and CLIS, March 2000 (Appendix F-5)				
WLIS Alternative				
Reference (STH)	98	3	NA	NA
EFH	96	2	No	–2
W5H	98	3	No	0
EBI	98	3	No	0
MDI[3]	100	–	No	+2
CLIS Alternative				
Reference (REF)	97	3	NA	NA
1KW	98	3	No	+1
2KW	98	3	No	+1
FVP	94	5	No	–3
N74	100	–	No	+3
N93	98	4	No	+1
Sediment Toxicity Results for Bridgeport and Milford, August 2002 (Appendix F-6)				
Bridgeport Alternative				
Reference (BP-R1)	99	2	NA	NA
BP-10	89	9	Yes	–10
BP-14	94	4	No	–5
BP-23	88	6	Yes	–11
Milford Alternative				
Reference (MF-R1)	91	7	NA	NA
MF-04	87	16	No	–4
MF-06	84	16	No	–7
MF-29	86	10	No	–5

[1] Alternative site sediments were compared only to their site-specific reference sediment.
Source: USACE 2000d; USACE 2002e; Appendix F-5 and F-6

- At the Milford Alternative, mean percent survival ranged from 84 to 87 percent (Table 4-18). Amphipod survival in any in-site sediment was not significantly different from that in the reference sediment (the difference in survival between test sediments and the reference sediment did not exceed 20 percent). Therefore, the Milford in-site sediment was not acutely toxic to *A. abdita*.
- At the CLIS Alternative, the mean percent survival ranged from 94 to 100 percent (Table 4-18). Amphipod survival in the test sediments was not significantly different from that in the reference site samples (the difference in survival between test sediments and the

reference sediment did not exceed 20 percent). Therefore, sediments at the active, historic, and far field sites at CLIS were not acutely toxic to *A. abdita*.

Sediment quality triad analyses. The concept of using various types of data in the evaluation of benthic communities relative to pollution was formalized in 1985 with the first publication of the Sediment Quality Triad (SQT) (Chapman, 2000). The SQT used benthic community structure data in conjunction with sediment chemistry and toxicity data to evaluate sediments in Puget Sound, Washington (Long and Chapman, 1985). Among the concepts established by the early SQT works was the usefulness of relating values for individual parameters from test stations to those from a clean reference station. This "ratio-to-reference" (RTR) approach generates a dimensionless number that eliminates the problems associated with comparing values of widely varying magnitudes (Chapman, 2000). The SQT analysis provides a coherent way to incorporate a variety of data into an assessment of possible pollution effects, and its real utility resides in the notion that there is no single best method of implementing it (Chapman, 2000).

Two surveys conducted in support of the Long Island Sound EIS study supplied the data required to perform the SQT analysis (Appendix F-3 and F-4). Sediments were collected from the WLIS and CLIS Alternative sites in February 2000 and from the Bridgeport and Milford Alternative sites in August 2002 (Table 4-12). Shortly after the benthic community, sediment chemistry, and toxicity data generated by each survey were available for analysis, SQT analyses were performed. The RTR values generated during the analyses were used to produce triaxial plots to allow visual comparison of three data types for each station. Both SQT reports, which contain the specific RTR calculations for each site, are provided in Appendix F.

A summary of the SQT analyses for each site is provided here; the full reports are presented in Appendix F-3 and F-4.

- At the WLIS Alternative, the infauna and toxicity RTR values were either close to or equal to 1.0 and the chemistry RTR values were above 1.0 for all stations (Figure 4-23).
- At the Bridgeport Alternative, the chemistry, infauna, and toxicity RTR values were close to 1.0 (Figure 4-24). The chemistry RTR values for the three in-site stations were less than 1.0, indicating that the chemistry concentrations were generally lower in-site than at the reference station.
- At the Milford Alternative, the infauna and toxicity RTR values were either close to or equal to 1.0 and the chemistry RTR values were close to 1.0 for all stations except MF06, which had an RTR value of 1.9 (Figure 4-25).
- At the CLIS Alternative, the infauna and toxicity RTR values were either close to or equal to 1.0 and the chemistry RTR values were above 1.0 for the active (N93) and historic (FVP) stations (Figure 4-26). The chemistry RTR value for the farfield (1KW) station was 1.1.

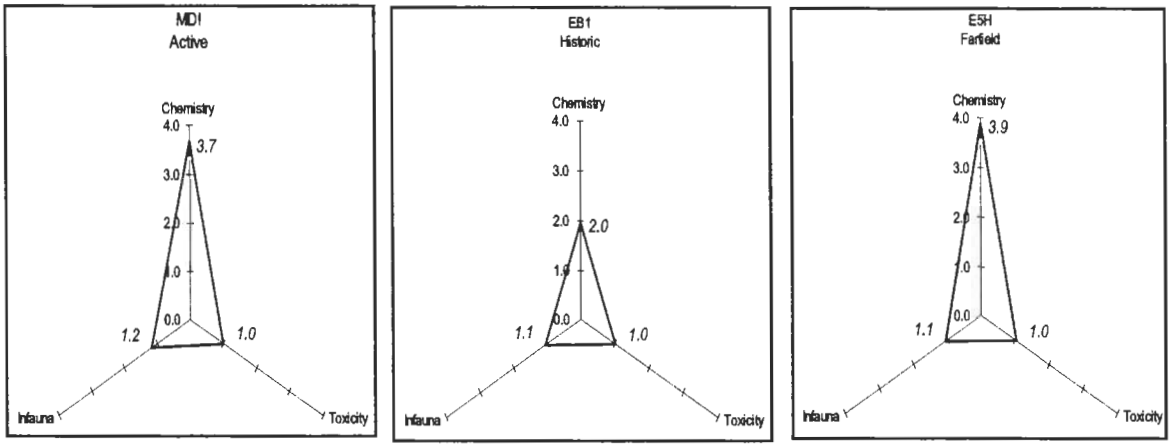

Figure 4-23. Triaxial Plots for the WLIS Alternative Site based on the RTR Approach, February 2000

Source: USACE, 2001f; Appendix F-3

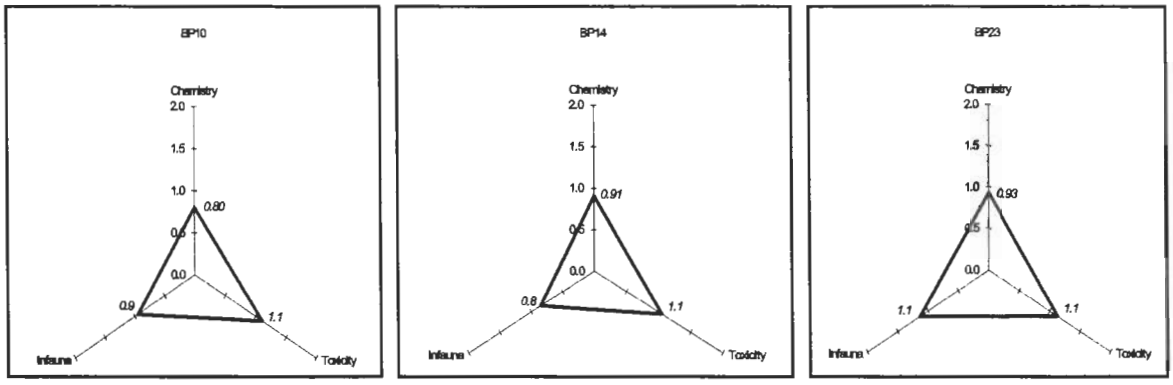

Figure 4-24. Triaxial Plots for the Bridgeport Alternative Site based on the RTR Approach, July 2002

Source: USACE, 2003d; Appendix F-4

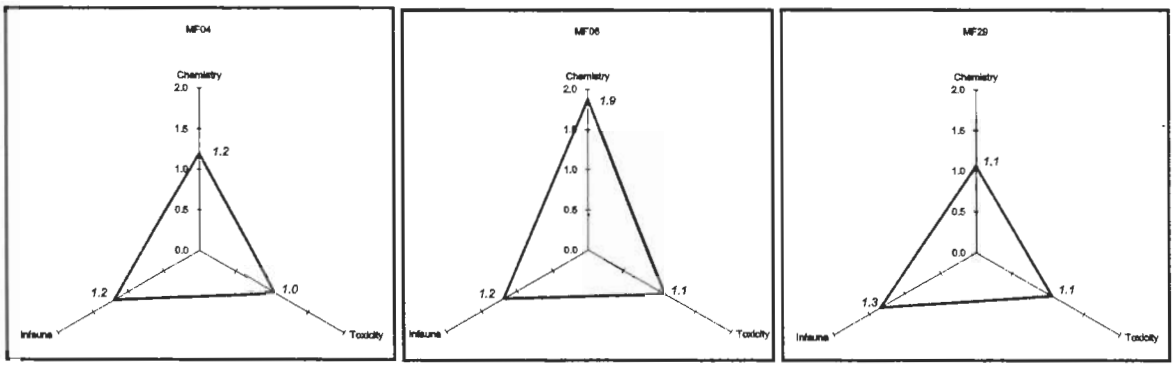

Figure 4-25. Triaxial Plots for the Milford Alternative Site based on the RTR Approach, July 2002

Source: USACE, 2003d; Appendix F-4

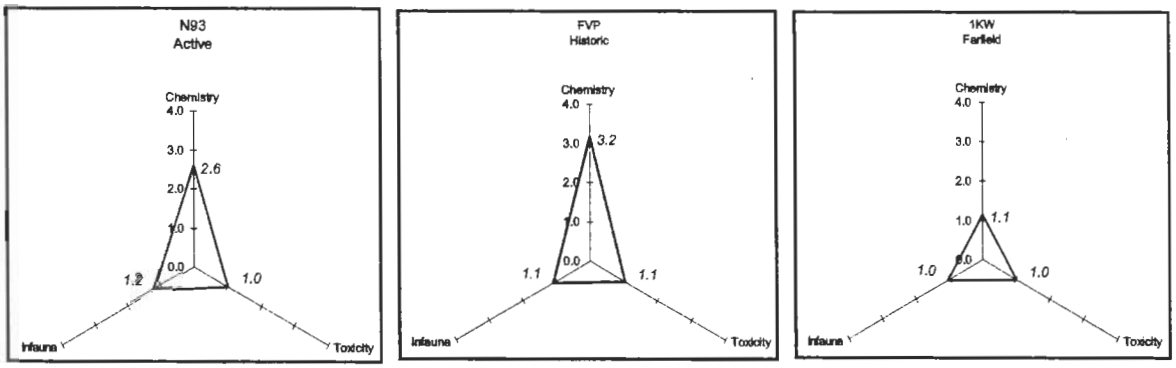

Figure 4-26. Triaxial Plots for the CLIS Alternative Site based on the RTR Approach, February 2000

Source: USACE, 2001f; Appendix F-3

RTR values should only be used to make comparisons within each site. The RTR values evaluate the relationship between site stations and their respective reference station. For example, one cannot compare the chemistry RTR value for WLIS Farfield Station E5H (3.9) to the RTR values for CLIS Farfield Station 1KW (1.1) to say that the chemistry is "worse" at the WLIS station than it is at the CLIS station. To make such a statement, the actual chemistry data need to be compared. In general, the SQT suggests the alternative sites are similar to their reference with respect to the infaunal communities and with toxicity. Sediment chemistry is typically higher at the Alternatives, with the exception of Bridgeport.

4.6.3 Sediment Quality Summary

Sediment chemistry summary. Sediment grain-size regimes and TOC contents were very similar among the alternative sites, although sediments at the two alternative sites used most recently were more variable than at the historic alternative sites. Sediments were predominantly fine-grained and indicative of depositional environments. Sedimentary concentrations of five or six metals at each alternative site exceed ER-L values. Metals concentrations among the alternative sites were similar and often exceed Long Island Sound background values. Organic contaminant concentrations generally were highest at WLIS and lowest at CLIS. Among the six organic analyte groups listed in Table 4-17, the ER-L values for four were exceeded at the WLIS active and farfield stations. Total PCB and total DDT concentrations at Bridgeport and Milford exceeded the ER-L values for those groups. At CLIS, only the total PCB concentrations at the active and historic stations exceeded the ER-L value.

Sediment toxicity summary. The recent studies conducted in support of this DEIS (USACE, 2000d; USACE, 2002e) showed that sediments from the alternative sites were not acutely toxic to the tube-dwelling amphipod *Ampelisca abdita*. These results are consistent with the Sound-wide studies conducted by the NS&T (Wolfe *et al.*, 1994), which indicated that most toxicity in Long Island Sound was associated with near-shore areas. The Sound-wide study conducted in 1991 (Wolfe *et al.*, 1994) included three stations from within the CLIS boundaries and provides an interesting comparison to more recent data. Absolute toxicity (*i.e.,* uncorrected for survival in the reference sediment) to *A. abdita* was 65, 74, and 76 percent for sediments from these three stations. These absolute toxicity values were much lower than those obtained for sediments collected in 2000 from CLIS in-site stations, which ranged from 94 to 100 percent.

A Sound-wide porewater test conducted with sea urchins also concluded that most toxicity is associated with near-shore areas (Buchholz ten Brink *et al.*, 2002).

Sediment quality triad summary. The SQT analysis does not provide the necessary information to allow the four alternative sites to be distinguished. The use of the RTR values only allows the in-site stations to be compared to the selected reference station. The critical assumption implicit in the use of the RTR is that the reference condition represents the undisturbed background condition. This assumption may not always be valid. As described in the triad summary for Bridgeport, the chemistry RTR values for the in-site stations were less than 1.0. This could be interpreted to imply that the chemistry at those stations was very good because the values were lower than the background values. However, during the triad

analyses, it was determined that the chemistry values for all stations at the Bridgeport site were actually higher than those for samples from the WLIS reference station. Had RTR values been calculated for that comparison, the Bridgeport in site and reference station values would have been greater than 1.0. In general, the analysis indicates that the Alternatives are comparable to their reference sites with respect to the benthic community composition and toxicity.

4.7 Water Quality

The following sections describe the water quality (temperature, turbidity, nutrients, dissolved oxygen, pathogens, and toxic contaminants) of Long Island Sound in general and specifically for the four alternative sites analyzed in this DEIS: WLIS, Bridgeport, Milford, and CLIS. In general, limited site-specific water quality information was available for the four alternative sites (USACE, 1998); therefore, this evaluation relies on information collected during several Sound-wide studies (HydroQual, 1996; NYSDEC and CTDEP, 2000).

4.7.1 Long Island Sound

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 included closure of approximately 25 percent of shellfishing beds in New York state waters and closure of bathing beaches because of high bacteria counts, eutrophication (reduction of dissolved oxygen) 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 (Wolfe *et al.,* 1991). This concern 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. EPA sponsored the largest of these studies, the Long Island Sound Study (LISS), 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 the Long Island Sound was approved in September 1994. While loadings of contaminants to Long Island Sound have been reduced dramatically since the early 1970s, Long Island Sound is still considered an impaired water body. Key water quality issues identified by the LISS include low dissolved oxygen, toxic contamination, pathogens, floating debris, and the health of living organisms of the Sound (USEPA, 1998).

Temperature. Long Island Sound experiences one of the widest annual temperature ranges of any body of marine water (USACE, 1998). During more than 18 months of LISS surveys in 1988 and 1989, temperatures ranged from under 2°C (36 °F) in the central Sound in March 1989 to greater than 24 °C (75°F) in August 1989 (HydroQual, 1996). However, temperatures tend to be quite uniform vertically and horizontally in the spring. In the summer and fall, temperatures tend to increase 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 (constant temperature surface to 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 LISS surveys showed a typical temperature gradient of 3 to 5 °C (37 to 41 °F) 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 an important consideration in the development of low oxygen conditions in Long Island Sound bottom waters in the summer months.

Turbidity. Organic and inorganic particulate matter present in the water column are measured as total suspended solids (TSS) in milligrams of solids per liter of water (mg/L). 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 (USEPA, 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 fish food. Thus, turbidity plays an important role in the behavior of phytoplankton in Long Island Sound. Direct or indirect measures of turbidity are most often made in the spring and summer, the most productive seasons in Long Island Sound.

In Long Island Sound, field measurements of water transparency have most often been measured 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 following 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 LISS 1988 to 1989 field study found that 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 10 to 15 feet [3 to 4.5 meters]; HydroQual, 1996). For western Long Island Sound, O'Shea and 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, the LISS found extinction coefficients consistently at 0.4 per meter, which corresponds to a euphotic zone depth of about 36 feet (11 meters) (HydroQual, 1996).

Nutrients. Nutrients include the organic and inorganic forms of nitrogen, phosphorus, and silica, which exist in aquatic environments primarily in dissolved or particulate form. In Long Island Sound, nitrogen is the primary limiting nutrient for algal growth (that is, if this nutrient is absent, plant growth is reduced). Nutrients have been measured in Long Island Sound for over 50 years. Since the mid-1980s, the LISS has measured nutrients more or less continuously throughout the Sound (HydroQual, 1996; USEPA, 1998). The significant sources of nitrogen to Long Island Sound include: municipal and industrial wastewater treatment plants, combined sewer overflows, nonpoint sources (runoff from land use

activities), and atmospheric deposition directly to water surfaces (NYSDEC and CTDEP, 2000). A summary of nitrogen loading to Long Island Sound is presented in Table 4-19.

The LISS 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 and concentrations diminished 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 and 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 and Taylor (2001) observed no systematic vertical gradients in nitrogen species.

Table 4-19. Summary of In-basin Total Nitrogen Loading (tons per year), as Delivered to Long Island Sound (attenuation considered) from all Source Types

Zone	Nonpoint Sources				Point Sources			Total Load[3]
	Pre-Colonial	Terrestrial	Atmospheric	Total[1]	WWTP	CSO	Total[2]	
1	991.3	256.1	604.7	1852.1	1242.6	0.0	1242.6	3094.7
2	1158.6	479.5	835.1	2473.2	2805.0	0.0	2805.0	5278.2
3	408.0	235.5	355.7	999.2	2103.3	0.0	2103.3	3102.5
4	808.2	305.7	538.0	1651.9	1668.6	0.0	1668.6	3320.5
5	179.1	121.2	174.3	474.6	947.9	0.0	947.9	1422.5
6	195.9	146.8	202.2	544.9	1108.0	0.0	1108.0	1652.9
7	43.5	68.7	77.3	189.5	837.0	0.0	837.0	1026.5
8	N/A	N/A	N/A	N/A	17502.0	578.5	18080.5	18080.5
9	N/A	N/A	N/A	N/A	9103.0	314.1	94171.1	9417.1
10	81.9	84.2	108.6	274.7	484.0	0.0	484.0	758.7
11-west	104.0	133.5	155.2	392.7	191.0	0.0	191.0	583.7
11-east	9.1	11.6	13.5	34.2	13.9	0.0	13.9	48.1
12	1785.8	0.0	3699.2	5485.0	0.0	0.0	0.0	5485.0
Total	5765.4	1842.8	6763.8	14372.0	38006.3	892.6	38898.9	53270.9

[1]The sum of Pre-Colonial, Terrestrial, and Atmospheric nitrogen delivered from the watershed
[2]The sum of Wastewater Treatment Plants (WWTP) and Combined Sewer Overflows (CSO)
[3]The sum of Nonpoint Sources and Point Sources of total nitrogen
Source: NYSDEC and CTDEP, 2000.

The LISS 1989 to 1999 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 the 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 reaching a minimum in early spring (HydroQual, 1996).

The LISS measured both dissolved and particulate silica. Dissolved silica is an important nutrient required by unicellular plants such as diatoms, whereas particulate silica is generally in a form not available for immediate algal uptake. Again, the highest concentrations of 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 phytoplankton.

Dissolved oxygen. Dissolved oxygen (DO) is an important gauge of water quality and 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 (USEPA, 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 (72 °F), 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). LISS has defined the onset of hypoxia as 3 mg/L (USEPA, 1990).

State Dissolved Oxygen 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, 2002a; 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, 2002a; NYSDEC, 1999).

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 when consumed by bacteria in bottom waters depletes or removes oxygen. 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 (SOD) (*i.e.,* the biological and chemical processes that use oxygen in sediments) once the bottom water DO has begun to be depleted. That is, SOD is dependent upon water column DO concentrations and does not exacerbate hypoxic events (Welsh and 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 (USEPA, 1998). Natural variations in weather and physical factors have affected the size of the hypoxic area, the duration of the event, and how low the DO concentrations have fallen. Generally, hypoxia events have spanned a period of 40 to 80 days (USEPA, 1998). The occurrences can start as early as mid-June and can end mid to late September (Figure 4-27). Hypoxia steadily develops through the summer as bacteria consume the supply of phytodetritus (*i.e.*, debris from dead phytoplankton) descending to bottom waters and propagates from near the East River in an easterly direction reaching well into the central basin of the Sound. DO is restored to bottom waters by the fall turnover (USEPA, 1998; Anderson and Taylor, 2001). More recent events have been less severe as illustrated for the summer of 2000 in Figure 4-28. It is important to note that hypoxic events occur during the summer months, while dredging and disposal events occur during the fall and winter.

Maximum Area and Duration of Hypoxia

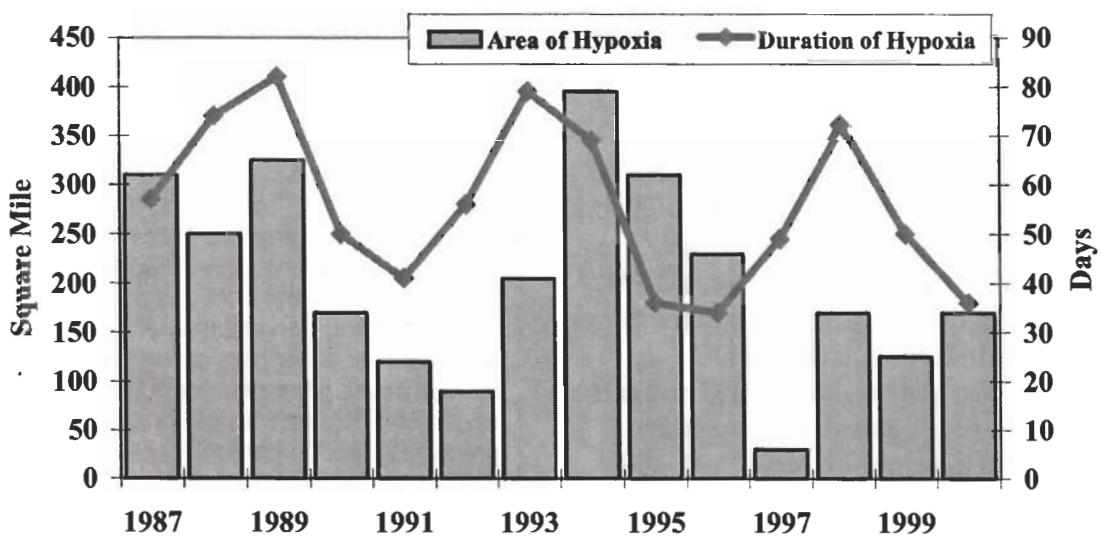

Figure 4-27. Dissolved Oxygen Levels in Long Island Sound

Source: USEPA, 2001

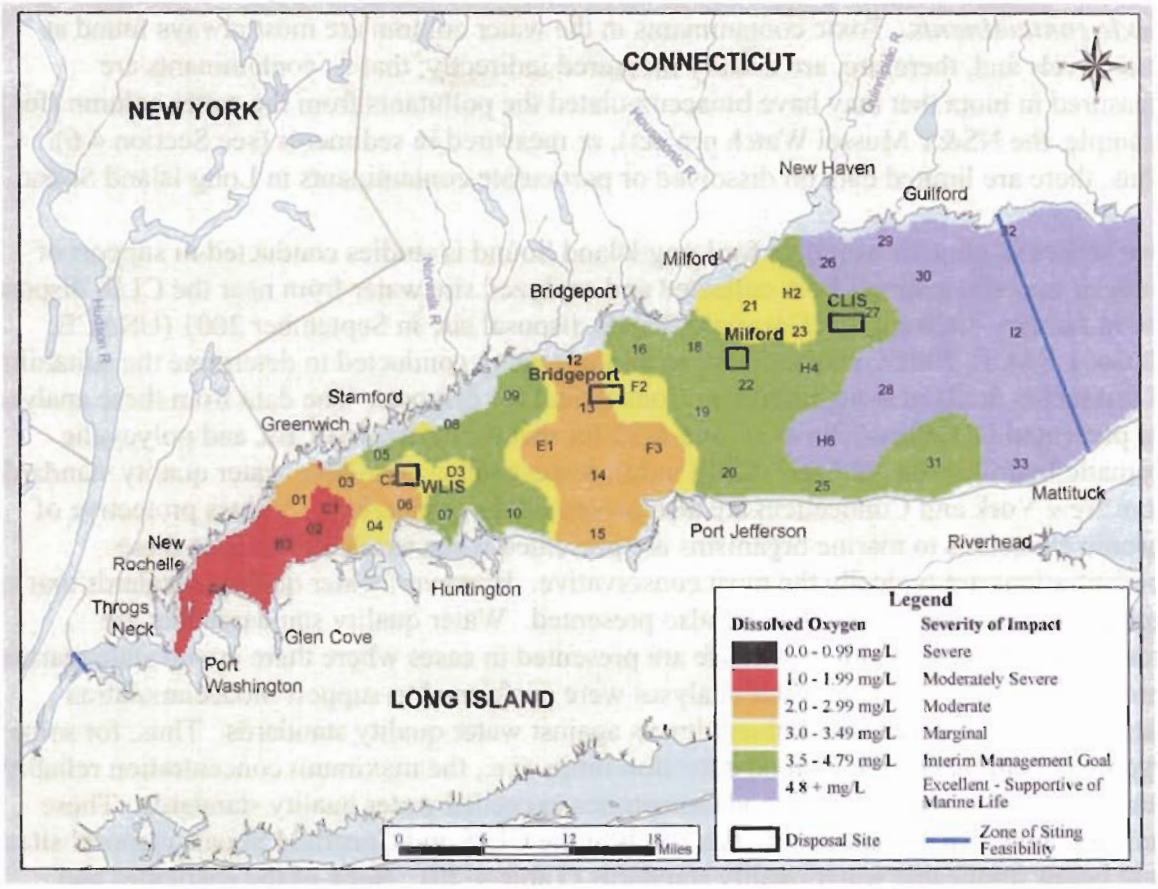

Figure 4-28. Dissolved Oxygen in Long Island Sound Bottom Waters, July 2000

Source: http://www.dep.state.ct.us/wtr/lis/monitoring/summer00.htm

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 combined sewer overflows, 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 (USEPA, 1990b). There are no practical tests for pathogens in the environment, and coliform bacteria (*i.e.*, total coliform bacteria, fecal coliform bacteria) are often used as surrogates. The sources of fecal coliform bacteria to Long Island Sound in 1986 included urban runoff (47.3 percent), rivers and upstream sources (51.7 percent), and sewage treatment plants (1.0 percent; USEPA, 1990b). The open waters of Long Island Sound are not often tested for coliform 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) showed no significant increasing or decreasing trends in the number of pathogen-related beach closure days from 1993 through 2000 (USEPA, 2001).

Toxic contaminants. Toxic contaminants in the water column are most always found at trace levels and, therefore, are usually measured indirectly; that is, contaminants are measured in biota that may have bioaccumulated the pollutants from the water column (for example, the NS&T Mussel Watch project), or measured in sediments (see Section 4.6). Thus, there are limited data on dissolved or particulate contaminants in Long Island Sound.

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 CLIS disposal site in January 2000 and the Cornfield Shoals disposal site in September 2001 (USACE, 2002o; USACE, 2002n; respectively) as part of testing conducted to determine the suitability of sediments dredged from harbors in Connecticut for disposal. The data from these analyses are presented in Tables 4-20, 4-21, and 4-22 for metals, pesticide/PCBs, and polycyclic aromatic hydrocarbons (PAHs) (CLIS only), respectively. Available water quality standards from New York and Connecticut are also presented for comparison. Values protective of chronic exposures to marine organisms are presented when available because these concentrations are typically the most conservative. However, water quality standards that are protective of marine aquatic life are also presented. Water quality standards that are protective of human health or wildlife are presented in cases where there are no state marine chronic standards. The site water analyses were performed to support bioaccumulation testing and not to determine ambient levels against water quality standards. Thus, for some organic contaminants, the method detection limits (*i.e.*, the maximum concentration reliably quantified by the analytical method) sometimes exceeded water quality standards. These analyses show that all ambient metals levels at the CLIS and Cornfield Shoals disposal sites were below applicable water quality standards (Table 4-20). None of the pesticides and PCBs evaluated were detected with the exception of endosulfan sulfate at CLIS and methoxychlor at Cornfield Shoals. However, measured concentrations of these compounds were below applicable water quality standards (Table 4-21). Similarly, low molecular weight PAHs (*i.e.*, the 2 and 3-ring PAHs, which exhibit some water solubility), were detected at CLIS 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 (Table 4-22).

4.7.2 Western Long Island Sound Alternative

The water quality conditions of Long Island Sound, including general spatial and temporal trends, are presented in Section 4.7.1. None of the water quality studies cited in Section 4.7.1 included water quality information specific to WLIS. However, based on its location in the western basin near the eastern narrows, some general conclusions of the water quality at WLIS can be drawn. The average annual salinity is expected to be lower than those at the other sites located farther to the east and water temperatures in the summer and fall are expected to be higher. Salinity in August 1988 ranged from 27.5 to 28.5 psu in August 1988 and ranged from 25 to 27.5 psu in February 1989. Temperatures in August 1988 ranged from 19 to 25 °C (66 to 77 °F). In February 1989 water temperature was a relatively constant 2.5 °C (36.5 °F). The water clarity in the summer months at WLIS is lower than the other sites (K_c ranged from approximately 0.7 to 0.9 in August 1988). Hypoxia at WLIS is expected to be more significant compared to the other sites. Based on analysis of the general trends documented for Long Island Sound (HydroQual, 1996), hypoxic conditions in the

Table 4-20. Metals Concentrations in Water from the Central Long Island Sound and Cornfield Shoals Disposal Sites

Parameter	CLIS Disposal Site[1] µg/L	Cornfield Shoals Disposal Site[2] µg/L	State Water Quality Standards	
			CTDEP WQS[3] µg/L	NYSDEC WQS[4] µg/L
Arsenic	1.65	1.13	36	63
Cadmium	0.044	0.031	9.3	7.7
Chromium	0.31	0.33	50[5]	54[5]
Copper	1.48	0.9	3.1	---
Mercury	0.0012	0.0009	0.94	0.0026[6]
Nickel	0.66	0.55	8.2	8.2
Lead	0.16	0.15	8.1	8
Zinc	1.65	1.59	81	66

[1] Whole water samples, mean of triplicate analyses (USACE, 2002o)
[2] Whole water sample, single sample (USACE 2002n)
[3] CTDEP, 2002a. Values presented are the chronic marine aquatic life values (A[C]) unless otherwise indicated.
[4] NYSDEC 1999. Values presented are the chronic marine aquatic life values (A[C]) unless otherwise indicated.
[5] Value presented is for Hexavalent chromium
[6] Criteria presented is for protection of wildlife (w)

waters of WLIS are expected to arrive earlier in the season, be more severe, and last longer than in the waters further east (Figure 4-28). The increased significance of hypoxia in the vicinity of the WLIS Alternative results from higher levels of nutrients (primarily nitrogen) that are found in waters in the western Long Island Sound compared to the central and eastern Long Island Sound basins as well as the more restricted circulation and flushing in the western portion of the Sound. Concentrations of metals and organic chemicals have not been measured in the waters at WLIS; however, assumptions can be made based on the measured sediment quality and the known distribution of contaminant sources to the Sound. As discussed in Section 4.6, sediment concentrations were generally consistent throughout the Sound, but were somewhat elevated in the western basin. It is likely that water quality would follow a similar pattern. However, it is important to note that the chemicals most often elevated in the sediments of the western basin (*e.g.*, PCBs) are not very water soluble and are not likely to be present in water at detectable levels. Therefore, water concentrations of most contaminants at WLIS are not expected to differ significantly from those measured at CLIS.

Table 4-21. Concentrations of Pesticides and PCBs Analyzed in Water at the Central Long Island Sound and Cornfield Shoals Disposal Sites

Parameter	CLIS Disposal Site[1] µg/L	Cornfield Shoals Disposal Site[2] µg/L	State Water Quality Standards	
			CTDEP WQS[3] µg/L	NYSDEC WQS[4] µg/L
4,4 DDD	<0.0015	<0.0015	---	0.00001[5,6]
4,4 DDE	<0.0015	<0.0015	---	0.00001[5,6]
4,4 DDT	<0.0015	<0.0015	0.001	0.00001[5,6]
Aldrin	<0.0015	<0.0015	0.00013[7]	0.001
a-BHC	<0.0015	<0.0015	0.0039[7]	0.002[6]
b-BHC	<0.0015	<0.0015	0.014[7]	0.007[6]
d-BHC	<0.0015	<0.0015	---	0.008[6]
g-BHC	<0.0015	<0.0015	0.019[7]	0.008[6]
a Chlordane	<0.0015	<0.0015	0.004	0.00002[8]
g-Chlordane	<0.0015	<0.0015	---	---
Dieldrin	<0.0015	<0.0015	0.0019	0.0000006[6]
Endosulfan I	<0.0015	<0.0015	0.0087	0.001
Endosulfan II	<0.0015	<0.0015	0.0087	---
Endosulfan sulfate	0.00186	<0.0015	110[7]	---
Endrin	<0.0015	<0.0015	0.0023	---
Endrin aldehyde	<0.0015	<0.0015	0.76[7]	---
Endrin Ketone	<0.0015	<0.0015	---	---
Heptachlor	<0.0015	<0.0015	0.0036	---
Heptachlor epoxide	<0.0015	<0.0015	0.0036	---
Methoxychlor	0.00655	0.0045	---	---
Toxaphene	<0.02	<0.02	0.0002	---
			---	---
Total PCB	<0.0015[10]	<0.0015[10]	0.03	---

[1] Whole water samples, mean of duplicate analysis (USACE, 2002o)
[2] Whole water samples, mean of triplicate analysis (USACE, 2002n)
[3] CTDEP, 2002a. Values presented are the chronic marine aquatic life values (A[C]) unless otherwise indicated
[4] NYSDEC, 1999. Values presented are the chronic marine aquatic life values (A[C]) unless otherwise indicated
[5] Criteria presented is for the sum of DDT compounds
[6] Criteria presented is the H(FC) = Health (Fish consumption)
[7] Criteria presented is the HH = Human health water and organisms
[8] Criteria presented is the H(WS) = Wildlife
[9] Criteria presented is the W = Wildlife
[10] Total PCBs defined as the sum of the PCB congeners

Table 4-22. Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs) in Water at the Central Long Island Sound Disposal Site

Parameter	CLIS Disposal Site[1] µg/L	CTDEP WQS[2] µg/L
Naphthalene	0.007	677
2-Methylnaphthalene	0.003	---
1-Methylnaphthalene	0.002	---
2,6-Dimethylnaphthalene	0.002	---
Biphenyl	0.001	---
Acenaphthylene	0.002	4.37
Acenaphthene	<0.01	2.7
Fluorene	0.0009	4.37
Phenanthrene	0.002	4.37
Anthracene	<0.01	0.44
1-Methylphenanthrene	<0.01	---
Fluoranthene	0.001	1.01
Pyrene	0.001	4.37
Benzo(a)anthracene	<0.01	0.044
Chrysene	<0.01	0.44
Benzo(b)fluoranthene	<0.01	0.044
Benzo(k)fluoranthene	<0.01	0.044
Benzo(e)pyrene	0.0008	---
Benzo(a)pyrene	<0.01	0.0044
Perylene	<0.01	---
Indeno(1,2,3-c,d)pyrene	<0.01	0.044
Dibenz(a,h)anthracene	<0.01	0.009
Benzo(g,h,i)perylene	<0.01	0.44

[1] Whole water sample, single sample (USACE, 2002o)

[2] CTDEP 2002a. Criteria presented are the HH = Human health water and organisms. NYSDEC has no water quality standards for these compounds.

4.7.3 Bridgeport Alternative

Based on its location in the western Sound, the Bridgeport Alternative is expected to exhibit similar water quality conditions as WLIS; however, site-specific data is not available. The average annual salinity is expected to be lower than those sites farther to the east and water temperatures in the summer and fall are expected to be higher. Based on general water quality trends in the Sound water clarity in the summer months at the Bridgeport Alternative are expected to be lower than the CLIS and Milford Alternatives and hypoxia is expected to be more significant, as noted for WLIS. Similarly, hypoxic conditions in the waters of the western basin are expected to arrive earlier in the season, be more severe, and last longer than in the waters further east (Figures 4-28). The significance of hypoxia at the Bridgeport Alternative results from higher levels of nutrients (primarily nitrogen) that are found in waters in the western Long Island Sound compared to the central and eastern Long Island Sound basins. As discussed for WLIS, the levels of toxic contaminants at the Bridgeport Alternative have not been measured but are expected to be similar to the low levels found at CLIS and Cornfield Shoals, meeting water quality standards for all listed parameters.

4.7.4 Milford Alternative

The water quality conditions of Long Island Sound, including general spatial and temporal trends, are presented in Section 4.7.1. None of the water quality studies cited in Section 4.7.1 included water quality information specific to the Milford Alternative. However, based on its location in the central Long Island Sound basin, the Milford Alternative is expected to exhibit water quality conditions similar to those found at CLIS. The average annual salinity is expected to be higher than those sites farther to the west and water temperatures in the summer and fall are expected to be slightly lower. The impact of freshwater flow from the Housatonic River on salinity at the site (located approximately 3 nautical miles [5.5 kilometers] from its mouth) is expected to be minimal, with the possible exception of high flow spring runoff conditions, when the salinity in the nearshore surface waters would be expected to be lowered by dilution. The water clarity in the summer months at the Milford Alternative will be similar to CLIS and will be higher than at the WLIS or Bridgeport Alternatives. Hypoxia at Milford is also expected to be similar to CLIS and less significant than at WLIS or Bridgeport. Based on the general trends documented for Long Island Sound, hypoxic conditions in the waters of CLIS are not expected annually and, if they do arise, the hypoxia will arrive later in the season, be less severe, and be briefer than in the waters farther west (Figures 4-28). The lower significance of hypoxia at the Milford Alternative results from generally lower levels of nutrients (primarily nitrogen) that are found in waters in the central Long Island Sound basin compared to the western Long Island Sound basin. As discussed for the other alternative sites, the levels of toxic contaminants at Milford have not been measured in water but are expected to be similar to those found at CLIS due to the proximity of the two sites and the similarity in sediment concentrations; that is, levels of contaminants are expected to be low and meet water quality standards for all listed parameters.

4.7.5 Central Long Island Sound Alternative

The levels of toxic contaminants in water at CLIS were measured and were found to be low, meeting water quality standards for all listed parameters (Section 4.7.1). The water quality conditions of Long Island Sound, including general spatial and temporal trends, are presented in Section 4.7.1. In the summer months, water clarity is expected to be higher at CLIS than in the western basin. With the exception of toxic contaminants, none of the water quality data cited in Section 4.7.1 were specific to CLIS. However, based on its location in the central Long Island Sound basin, CLIS is expected to exhibit similar water quality conditions to the Sound, in general. The average annual salinity is expected to be higher than those sites farther to the west and water temperatures in the summer and fall are expected to be slightly lower. The water clarity in the summer months at CLIS will be higher than at the WLIS or Bridgeport Alternatives and hypoxia is expected to be less significant. Based on the general trends documented for Long Island Sound, hypoxic conditions in the waters of CLIS are not expected annually and, if they do arise, the hypoxia will arrive later in the season, be less severe, and be briefer than in the waters farther west (Figures 4-28). The lower significance of hypoxia at CLIS results from generally lower levels of nutrients (primarily nitrogen) that are found in waters in the central Long Island Sound basin compared to the western Long Island Sound basin.

4.7.6 Water Quality Summary

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 the severity of hypoxia is expected to be greatest at WLIS, least at CLIS, and intermediate at Bridgeport and Milford. The levels of toxic contaminants at WLIS, Bridgeport, and Milford have not been measured but are expected to be similar to the low levels found at CLIS and Cornfield Shoals, meeting water quality standards for all listed parameters; however, assumptions can be made, based on the measured sediment quality and the known distribution of contaminant sources to the Sound. Therefore, water contaminant levels do not allow the four alternative sites to be distinguished.

4.8 Plankton

Plankton are small, free-floating, or weakly swimming organisms that drift through the water column. Despite their small size and short life spans, plankton form the base of most of the ocean's food chains and have key ecosystem roles in the distribution, transfer, and recycling of nutrients and minerals. Early studies of plankton in Long Island Sound were conducted as part of general oceanographic studies and included evaluation of various aspects of the phytoplankton (Riley and Conover, 1967) and zooplankton (Deevey, 1956). However, most of the recent studies have focused on detailed studies of various aspects for certain species or groups of species rather than on general descriptions of community structure patterns Sound-wide or in specific parts of the Sound. Because there have been no recent studies of plankton community structure within the vicinity of the four alternative sites evaluated in this DEIS, the following discussion focuses on general aspects of the Sound-wide community as they apply to the alternative sites.

4.8.1 Long Island Sound

In general, the plankton community in Long Island Sound appears to be consistent with that expected for the mid to north Atlantic (Capriulo and Carpenter, 1983; Peterson, 1983; Anderson and 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 late spring, but increased freshwater runoff and increasing water temperatures cause buoyant, warmer water to become layered over more dense, colder water during the summer and early fall. This stratification may result in seasonal changes in the distribution and abundance of the plankton community.

The plankton are divided into two major groups, phytoplankton, and zooplankton. The phytoplankton community, consisting of unicellular plants such as diatoms and dinoflagellates, is the major contributor to primary production in the sea. The zooplankton community, comprised of microscopic animals, not only includes primary consumers of phytoplankton, but also consumers of other zooplankton. Zooplankters include animals that spend their entire life span in the plankton community (holoplankton) and some that are part of the planktonic community for only specific life stages (meroplankton). For example, the meroplankton includes the larval forms of many species of invertebrates and fish. Important zooplankton include unicellular (Foraminifera, Radiolaria) and multicellular animals (copepods). A discussion of each of these major groups within Long Island Sound is provided below.

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 greater than that removed by cell death and grazing. Diatoms characterize the spring (January or February) bloom, dinoflagellates comprise the summer (June and July) bloom, and diatoms again typify the fall (September and October) bloom (Capriulo and Carpenter, 1983).

Phytoplankters are typically evenly distributed throughout the water column before the onset of seasonal stratification discussed above and 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. Occasional summer blooms may occur if increased tidal mixing during new moon phases (Peterson, 1983) or disturbance of bottom waters by storms (Anderson and Taylor, 2001) break down the stratification barrier and release nutrients into the photic zone (zone within which light penetrates and photosynthesis occurs).

The size of phytoplankton cells varies in relation to stratification. Before stratification occurs, 80 to 90 percent of the phytoplankton biomass consists of cells greater than 10 micrometer (μm) while during the stratified period cells smaller than 10 micrometer constitute up to 98 percent of the biomass (Peterson and Kimmerer,1994).

About 2 percent of the approximately 4,100 known phytoplankton species are capable of causing harmful algal blooms (HABs) such as red or brown tides (Smayda, 1997). HABs have generally increased in prevalence since the 1980s (Anderson and Garrison, 1997) and are of concern because of the devastating effects they can have on other marine organisms and humans. Red tides are relatively infrequent in Long Island Sound and tend to be limited to isolated embayments (Anderson and Garrison, 1997). One of the species causing HABs in the waters around parts of Long Island is the very small bacterium *Aureococcus anophagefferens*, blooms of which are termed brown tides. Brown tides caused by this species can have serious effects on the ecosystems in which they occur by reducing light levels available to other plants such as eelgrass (*Zostera marina*) and severely reducing growth and causing high mortalities in bivalves such as mussels (*Mytilus edulis*) and bay scallops (*Argopecten irradians*) (Bricelj and Lonsdale, 1997). Although not directly toxic to fish, brown tides may indirectly affect larval fish feeding by reducing visibility, and may interrupt migration and other behavior. Brown tides caused by *Aureococcus anophagefferens* have been reported from Narragansett Bay to Long Island (Peconic Bay and bays along the south shore), and as far south as New Jersey, but have not yet occurred in Long Island Sound, although the bacterium has been found in small numbers (Bricelj and Lonsdale, 1997; Greenfield and Lonsdale, 2002). The specific causes of brown tides and conditions for their development are poorly understood (Gobler and Sañudo-Wilhelmy, 2001). Gobler and Sañudo-Wilhelmy (2001) found that high groundwater flows stimulated multispecies blooms resulting in increased organic nitrogen levels and, therefore, greater populations of *Aureococcus;* brown tides developed as flows decreased. Later, Gobler *et al.* (2002) also showed that organic nutrient levels and grazing by microzooplankton may help stimulate brown tides. Grazing by microzooplankton (protozoans, see below) was higher on other phytoplankters than it was on *Aureococcus*. Thus, Gobler *et al.* (2002) concluded that brown tides were accentuated by high organic nutrient inputs coupled with increased grazing on potential competitors.

Zooplankton. The structure of zooplankton communities in Long Island Sound is strongly influenced by the seasonal stratification of the water column. The predominant species are holoplankton and vary according to season. For example, boreal copepods have over-lapping distributions in the water column before stratification occurs, but afterwards are restricted to specific zones (Peterson, 1983). After stratification, *Acartia hudsonica* is found in the upper 5 meters (16 feet) of the water column, *Temora longicornis* at about 5 to 15 meter (16 to 49 feet), and *Pseudocalanus* species at about 15 to 20 meters (49 to 66 feet). With the onset of stratification, the size of the predominant phytoplankters changes from large to small diatoms, which effectively stops egg production by *T. longicornis* (Peterson, 1983; Peterson and Kimmerer, 1994).

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. 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 17 °C [63 °F] in bottom waters and to 20 °C [68 °F] in surface waters) by one primarily consisting of three other copepod species: *Acartia tonsa*, *Oithona similes*, and *Paracalanus crassirostris* (Peterson, 1985). All three of these species occur in the Sound throughout the year, but are not abundant during the winter and early spring. That only two of the six species respond to the spring phytoplankton bloom implies that the summer species may not be able to produce eggs at the colder temperatures characterizing the early spring waters. Control of copepod egg production by phytoplankton abundance is probably the main factor structuring these assemblages although predators such as burrowing sea anemones (*e.g., Ceriantheopsis*) and the sand lance (*Ammodytes*) no doubt have some influence (Peterson, 1985). Predation by ctenophores, such as *Mnemiopsis leidyi*, is also known to affect copepod populations (Kremer, 1979), including those in Long Island Sound (Carlson, 1978).

Smaller animals are also an important component of the overall zooplankton community in the Sound. Capriulo and Carpenter (1980, 1983) studied the abundance and feeding biology of micro-zooplankton in Long Island Sound. Micro-zooplankton are defined as those animals smaller than 202 micrometers, but larger than 35 micrometers. These are primarily protozoans such as tintinnids. Capriulo and Carpenter (1983) found 28 species of tintinnids in the Sound, and that the highest diversity occurred from September to April. Tintinnid abundances ranged from 268 to 12,600 individuals/Liter, with the highest numbers occurring in July and August. Occasionally rotifers were 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.

4.8.2 Alternative Disposal Sites

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 description of a 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 determinant of the community structure is the seasonal stratification of the water column, it is assumed that the general description would apply to conditions at each of the alternative sites. For example, Capriulo *et al.* (2002) found little difference between the zooplankton communities offshore of Milford, Connecticut and those offshore of Stamford, Connecticut. Thus, it is assumed that the plankton community at each of the alternative sites is similar to that described for the Sound in general, and the primary factor controlling fluctuations in these populations is the seasonal stratification of the water column.

4.9 Benthic Invertebrates

The benthic community refers to those invertebrate organisms (*e.g.*, shellfish, worms) that live on or within the bottom substrate. Benthic invertebrates represent an important biological community that interacts closely not only with other communities in the overlying water (Steimle *et al.*, 1994) but also with the physical environment. Benthic communities are particularly useful for evaluating the effects of physical disturbances because they are relatively immobile, providing a site-specific measure of impacts. In addition, many benthic community constituents are very sensitive to anthropogenic impacts (Thomas, 1993; Conlan, 1994). Particularly important as an indicator is the health and diversity of the infaunal community, typically defined as the organisms inhabiting the sediment from its surface to a depth of about 10 centimeters (4 inches). The infauna community is typically studied by using a grab sampler to collect a discrete portion of the sediment, typically a 0.1 square meter (1.1 square feet) or 0.04 square meter (0.4 square feet) section of the bottom. The sediment collected is evaluated to determine the number and type of organisms present. Abundance calculations are extrapolated to numbers per square meter by dividing the number of organisms in the sample by the surface area sampled (see the text box for an explanation of the ecological metrics used in the evaluations). This section focuses primarily on the infaunal benthic community. In addition, commercially and recreationally important shellfish (*e.g.*, clams, molluscs, lobster) are discussed in Section 4.11.

Information about the general condition of the Long Island Sound benthos was derived primarily from several key studies conducted in the 1950s, 1970s, and 1980s. Sanders (1956) studied the benthos at eight locations in the central Sound. From 1972 to 1978 Reid *et al.* (1979) conducted a much more extensive study of the Sound involving 142 stations. Pellegrino and Hubbard (1983) studied the benthos at 413 stations located in Connecticut state waters. A subset of their data was later reanalyzed by Zajac (1998) and Zajac *et al.* (2000).

Information about the benthic communities at the four alternative sites evaluated in this DEIS was derived primarily from several field studies sponsored by the Corps and EPA in the late 1990s and early 2000s in support of the Long Island Sound EIS (Table 4-12; Figures 4-14 and 4-15). Two approaches were used to evaluate benthic habitats sediment characterization studies and sediment profile imagery (SPI) surveys (see text box). Sediment characterization studies were used to provide information on sediment chemistry, sediment toxicity, and infaunal community structure as described in Section 4.6. The results of the sediment characterization studies conducted at the WLIS and CLIS Alternative sites in February and July 2000 and July 2001 were presented in USACE (2002g) and are included here as Appendix H-1. Stations sampled at WLIS included one active station located within the site, one reference station, and three supplementary stations located outside the site boundaries (Table 4-12). At CLIS, three stations from within the site, one reference stations, and two supplementary stations located outside the site boundaries were sampled (Table 4-12). In July 2002, a sediment characterization study was conducted at the Bridgeport and Milford Alternative sites. At each alternative site, three in-site stations and one reference station were sampled (Table 4-12). The results of this study were presented in USACE (2003f) and are included here in Appendix H-2. SPI surveys were also conducted at each site in late July

Ecological Parameters Used to Characterize Infaunal Communities

The analysis of a benthic sample begins with the identification and counting of 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 should be 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 can not 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 tropical communities. Maximum values for southern New England communities are generally <5.0.

Sander's 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 displayed graphically 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 and evenness 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. Samples with higher evenness will have steeper curves than those with lower evenness.

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.

2002 (USACE, 2002f; Appendix F-7). In July 1996, SPIs were taken at four stations within the WLIS site and at three stations in nearby reference areas (SAIC, 1998). In addition, five SPI stations within the CLIS site and three in a nearby reference location were also evaluated in September 1999 (SAIC, 2002a).

4.9.1 Long Island Sound

Benthic habitats in Long Island Sound can be categorized into several general geophysical regions, separated by significant bathymetric features (Knebel and Poppe, 2000; Zajac *et al.,* 2000). The Narrows is the westernmost region of the Sound encompassing the area from the East River to the Norwalk Shoal Complex (Figure 4-1). Benthic habitats in The Narrows are heterogeneous (Zajac *et al.,* 2000) and predominantly show evidence of sediment sorting and reworking and are typically coarse textured (Knebel and Poppe, 2000). The eastern portion of The Narrows contains a discrete area just west of the Norwalk Shoal Complex that has been characterized as depositional (Knebel and Poppe, 2000). The WLIS Alternative is located within this area. Separated by the Norwalk Shoal Complex to the west and the Stratford Shoal Complex to the east, the western basin of the Sound is an area of relatively flat sea floor that consists largely of depositional habitat (Knebel and Poppe, 2000; Zajac *et al.,* 2000). The Bridgeport Alternative occupies a portion of the depositional basin just west of the Stratford Shoal Complex (Figure 4-16).

The expansive central basin, which contains the CLIS and Milford Alternative, occupies the portion of the Sound east of the Stratford Shoal Complex to the Mattituck Sill. Benthic habitats in this basin are primarily depositional areas interrupted occasionally by north-south extending bands of sediment extending from the Connecticut shore (Knebel and Poppe, 2000; Zajac *et al.,* 2000). The Milford Alternative, located in the depositional area just east of the Stratford Shoal Complex and the CLIS Alternative, are near the sediment-sorting zone that extends southward from New Haven (Figure 4-16).

Although scientific study of the soft-bottom benthic communities in Long Island Sound began almost 50 years ago (Sanders, 1956) there have been few large-scale, community-level studies of benthic habitats in the Sound (Zajac, 1998). Many of the studies of the Sound's benthic fauna have focused on infaunal community dynamics in relatively small portions of the Sound (*e.g.,* McCall, 1977 and 1978; Rhoads *et al.,* 1978; Yingst and Rhoads, 1978; Rhoads and Boyer, 1982), particularly within the central Sound area.

Sanders' (1956) short-term studies at eight locations in the central Sound area led to the development of many important concepts about the relationships between infaunal animals and their sedimentary environment. One important community association that Sanders described was that of a polychaete worm (*Nephtys incisa*) and two deposit-feeding clams (*Yoldia limatula* and *Nucula annulata*), which were abundant in sediments having a fine-grained component greater than 25 percent.

Interpretation of Sediment Profile Imagery

Sediment profile images (SPI) are photographs of a vertical section of the sea floor captured via the deployment of a 35-millimeter camera housed on top of a wedge-shaped prism that penetrates several centimeters into the bottom sediments. The prism has a clear faceplate at the front with a mirror placed at a 45° angle at the back to reflect the image from the faceplate to the camera lens above. The prism has an internal strobe to provide illumination for the image. This wedge assembly is mounted on a moveable carriage within a stainless steel frame. The use of sediment profile imagery is a common technique for evaluating unconsolidated benthic habitats. It was pioneered in the early 1970s. One of the purposes of the approach is to provide photographic documentation of the relationship between infaunal organisms and their sedimentary habitat. When interpreting SPI, there are several specific features that are particularly useful in evaluating the quality of the habitat.

Sediment Grain Size — determined by comparison of site-specific images with a set of standard images for which mean grain size has been determined in the laboratory. The sediment type descriptors follow the Udden-Wentworth size class system (*e.g.*, clay, sand, gravel). Data are reported as phi units, which indicate approximate particle size and typically range from 4 (fine) to less than –1 (coarse).

Apparent Color Redox Potential Discontinuity (RPD) Layer — an estimation of the depth of the boundary between oxidized and anoxic sediments. It is called the apparent RPD because it is a visual estimate based on differences in the reflectivity or color of oxidized and anoxic sediments and is not an actual measurement of the RPD depth, which must be made with an Eh electrode. The depth of the RPD in the sediment increases as the amount of sediment movement by infaunal organisms (called bioturbation) increases thereby carrying oxygen to greater depths in the sediment. Habitats considered to be of good quality have relatively deep (greater than 2 centimeters) RPD layers.

Infaunal Community Successional Stage — based on the hypothesis that after a disturbance, infaunal organisms will recolonize a habitat in a predictable sequence leading from the early colonizing stage to the final climax community. The community is classified as Stage I if it is comprised primarily of dense assemblages of small polychaete worms that move into an area soon after disturbance. Stage II is the transitional stage between the colonizing and climax communities and consists of tube-dwelling amphipods such as *Ampelisca* spp. Stage III represents the mature, climax community comprised of polychaete worms (*e.g.*, maldanid worms) that feed in deeper parts of the sediment and deposit waste material near the sediment surface. In practice, analysis often detects the presence of more than one stage in an image with the resulting data being classified as Stage I on III or Stage II on III.

Gas Voids — occur when organic materials are decomposed. Methane and other gases are produced and create gas-filled voids in the sediment. Voids are recognizable in SPI images because of their irregular shapes and reflection of the strobe light.

Organism-Sediment Index (OSI)—a summary statistic calculated from four SPI parameters: the apparent RPD depth, the community successional stage, the presence/absence of methane gas voids, and the presence/absence of low dissolved oxygen conditions. The index was developed in the 1980s to map disturbance gradients in estuarine habitats. OSI values range from –10 to +11, with higher values indicating better habitat quality. An OSI value of 6 is generally used to indicate whether or not a community has recently experienced some type of disturbance, with values less than 6 indicating the influence of disturbance.

An extensive survey of the benthos in the Sound undertaken in 1972 included 142 stations, of which about 100 were located in the western and central basins (Reid, 1979; Reid *et al.*, 1979). A subset of the stations were re-sampled in 1973 and then annually from 1975 through 1978. Based on the initial 1972 survey, three main infaunal assemblages were defined. A shallow-water, sandy-sediment based group occurred on a narrow strip of sea floor along the southern margin of the Sound and was characterized by the polychaete worms *Nephtys picta* and *Aricidea catherinae*, the clams *Spisula solidissima* and *Tellina agilis*, and the amphipod *Ampelisca vadorum*. A muddy assemblage comprised of the polychaete worms *Nephtys incisa*, *Mediomastus ambiseta*, and *Polydora cornuta* (then known as *P. ligni*), the clams *Nucula annulata* and *Yoldia limatula*, and the amphipod *Ampelisca abdita* occupied a considerable expanse of the flat sea floor in the western and central basins. The third group was a transitional shallow-water fauna occupying sandy muds primarily along the Connecticut shore comprised of the polychaetes *Polydora cornuta*, *Streblospio benedicti*, and *Tharyx acutus*, the clams *Tellina agilis* and *Ensis directus*, and the amphipods *Ampelisca abdita* and *A. vadorum*.

The description of the continued presence of the muddy assemblage highlights the persistence of an assemblage first described by Sanders almost 20 years earlier and one that still persists today (Appendix H-1). Absent from Reid's list of predominant mud assemblage taxa was the polychaete worm now known as *Levinsenia gracilis* (formerly known as *Paraonis gracilis*), which has been recorded among the numerically dominant species in more recent studies of portions of the muddy communities in the Sound (Appendix H-1 and H-2). The absence of *L. gracilis* from the earlier studies may be partly explained by the difference in sieve size used (1.0-millimeter [0.04 inch] mesh) compared to that used in more recent studies (0.5-millimeter [0.02 inch] mesh). *L. gracilis* is a fairly small, thin worm, reaching a length of about 25 millimeters (1 inch), but only 0.5 millimeter (0.02 inches) in width (Gosner, 1971), therefore, it may have been poorly retained on the larger mesh sieves.

Another major survey of the benthic communities in the Sound was conducted as part of the Connecticut Coastal Energy Impact Program (Pellegrino and Hubbard, 1983), conceived to evaluate the potential impact of energy-related environmental incidents (Zajac, 1998). The study sampled the benthos at 413 stations throughout Long Island Sound, many of which were located in the western half of the Sound, but within Connecticut state waters. As previously reported (Reid, 1979; Reid *et al.*, 1979), the primary communities of the western and central regions of the Sound were characterized primarily by *Nephtys incisa* and *Nucula annulata*, but also included another small clam *Mulinia lateralis*. The occurrence of *M. lateralis* as a predominant member of these regions is noteworthy because it is considered an opportunistic species (Williams *et al.*, 1986) and its populations are often very transient in the Sound (Levinton, 1970). Reid (1979) recorded a substantial reduction in the occurrence and density of the species during 1973 through 1978. Michael (1975) reported that *M. lateralis* was one of the predominant species at the New Haven Dredged Material site in the central Sound in the summer of 1972, but was virtually absent from a nearby control site. *M. lateralis* was found during the recent surveys at the four alternative sites, but also occurred at fairly low densities (Appendix H-1 and H-2).

Zajac (1998) and Zajac *et al.* (2000) examined variation within the infaunal communities of the Sound at various spatial scales by reanalyzing a subset (the 35 most abundant species) of the data from Pellegrino and Hubbard (1983). From a Sound-wide perspective, the reanalysis of the older data showed that the benthic communities inhabiting the Sound were highly variable and could be grouped into more than a dozen assemblages. Pertinent to this DEIS, eight assemblages were found in the western and central Sound (Zajac, 1998; Zajac *et al.,* 2000), many of them similar to those reported in the previous studies. Zajac *et al.* (2000) concluded that the benthic communities in Long Island Sound are limited in their extent by the particular adaptations of the species limiting them to the various hydrographic and sediment regimes encountered. For example, bathymetric elevations, such as the Stratford and Norwalk Shoal Complexes, create distinct boundaries between communities in the western basin.

Temporal Aspects of Long Island Sound Benthic Communities. Few studies of the benthic communities of Long Island Sound have incorporated a significant temporal component into their design. Most studies have been conducted over one or two years with only one or two samplings within each year. However, there are some patterns that can be recognized by examining the many studies that have been conducted in the Sound over the last five decades. For example, there is evidence that the benthic community of Long Island Sound has experienced significant fluctuations at various points. Reid (1979) observed that between 1972 and 1973 the benthos comprising each of the predominant groups described underwent a substantial decrease in abundance and numbers of species. For example, the total infaunal abundance in April 1973 was only about 14 percent of what it was the previous summer and the number of species per sample was about half its previous value. These abundance and species numbers remained somewhat low through 1977, but did show slight increases in 1978, the last year of the study. Reid (1979) attributed these observations to erosion of benthic habitats.

However, in a separate study, McCall (1977) observed that certain organisms, particularly those with long-lived larvae that feed on other organisms in the plankton community, did not repopulate the benthos between those two years. McCall (1977) offered two possible explanations for the recruitment failure. First, there were several storms during the winter of 1972 to 1973 strong enough to impact the bottom, therefore, it is possible that sediment resuspension during these storms interrupted feeding by adult suspension feeders who then produced fewer larvae. The other alternative is that there was unusually high larval mortality within the plankton community between those years. Zajac and Whitlatch (1988 and 1989) described changes in the abundance of the polychaete *Nephtys incisa* during studies conducted at the CLIS Alternative in the early 1980s. These fluctuations not only occurred in relation to numbers estimated in the 1950s, but also reflected short-term decreases between 1982 and 1983. Zajac and Whitlatch attributed such fluctuations in populations of *Nephtys* to occasional recruitment failure.

Changes in predominant members of the benthic community are also detectable by examining the data sets accumulated over the years. A prime example is that of the small clam *Mulinia lateralis*. *M. lateralis* has been present in samples from most, if not all, of the benthic surveys conducted in Long Island Sound since the 1950s. Sanders (1956) reported

the species' presence, but it was not abundant. As mentioned earlier, *Mulinia* was a predominant taxon among samples collected in the 1970s and 1980s. It was one of the species that experienced the sharp reduction in abundance between 1972 and 1973 (Reid, 1979), but yet was once again predominant during the survey of Pellegrino and Hubbard (1983). *M. lateralis* was still present during surveys conducted at the four alternative sites during 2000 to 2002, but was not abundant (Appendix H-1 and H-2).

Despite these periodic fluctuations, perhaps the most notable feature of the benthic community in Long Island Sound is that although many kinds of sampling gear and approaches have been used, there are some very consistent and distinctive faunal assemblages inhabiting the Sound's benthos. Foremost among these is the *Nephtys-Nucula-Yoldia* assemblage initially described by Sanders (1956). This assemblage persisted in its general form through the 1970s and 1980s (McCall, 1977 and 1978; Reid, 1979; Pellegrino and Hubbard, 1983) although at times the species varied in their numerical contribution to it. More recent studies have indicated that the community was still in evidence in the western and central basins although its role was diminished (Appendix H-1 and H-2). Thus, soft-bottom (particularly muddy) communities within the western and central regions of Long Island Sound appear to have distinctive persistent features upon which periodic change in response to important environmental factors is layered.

4.9.2 Western Long Island Sound Alternative

WLIS, which is west of the Norwalk Shoals Complex, is located in one of the depositional basins in western Long Island Sound (Knebel and Poppe, 2000). However, the WLIS Alternative is surrounded by many areas of sediment sorting and reworking. SPI images taken in 1996 indicated that the sediments at WLIS were predominantly fine-grained (>4 phi) (Table 4-23; SAIC, 1998). Three of the stations (EB1, E5H, and W5H) included in the sediment characterization survey conducted in February and July 2000 at WLIS (Table 4-12; Figure 4-14; Appendix H-1) had primarily fine sediments, ranging from 70 to 89 percent fines in February and 84 to 94 percent fines in July. Two stations were sandier. The active station (MD1, at which dredged material was recently deposited) was 46 percent sand in February and 31 percent sand in July. The sand fraction at the WLIS reference station, STH, was 70 percent in February and 55 percent in July. Station STH was located south of the alternative (Figure 4-14) and may have been near the area of sediment sorting and reworking, which is comprised of fine sand or fine sand and mud, identified by Knebel and Poppe (2000). Each of the five stations sampled had a higher percentage of fine sediment in July than in February. TOC content varied considerably among the WLIS stations, ranging from low at the sandier stations (1.1 to 1.5 percent) to moderate at the mud stations (2.5 to 3.1 percent).

SPI data were obtained from four stations within the WLIS Alternative and from three nearby reference stations. Analyses of the SPI data generally indicated that habitat quality in the WLIS Alternative and the reference area was highly variable. Primary evidence for this conclusion was the high variability in the average OSI values calculated for the site, ranging

Table 4-23. Comparison of the Biological Characteristics of the WLIS Alternative

	Alternative[1]	Reference[2]
SPI Features (July 1996)[3]		
Grain Size (phi)	>4	>4, 4–3
Prism Penetration (cm)	11–19	8–14
Dominant Processes	Biological/Physical	Biological/Physical
RPD Depth (cm)	0.4–4.9	1.6–2.7
Successional Stage	I, III	I, III
OSI	−1–10.5	3.5–9.0
Infaunal Community Features (February, July 2000)[4]		
Average Abundance (/sample)	910 (~23,000/m2)	1,002 (~25,000/m2)
Average Species (/sample)	36	45
Average Diversity (H')	3.6	3.9
Average Evenness (J')	0.7	0.7
Five Most Abundant Taxa[5]	*Nucula annulata* *Mediomastus ambiseta* *Ampharete finmarchica* *Macoma tenta* *Tharyx sp. 1B*	*Nucula annulata* *Ampharete finmarchica* *Mediomastus ambiseta* *Macoma tenta* *Tharyx sp. 1B*

[1] Four SPI stations; range of values shown.
[2] Three SPI stations; range of values shown.
[3] Source: SAIC, 1998
[4] Source: USACE 2002g; Appendix H-1
[5] In order of decreasing abundance.

from −1 to 10.5, and the reference stations, ranging from 3.5 to 9.0 (Table 4-23; SAIC, 1998). Contributing to the variable OSI values were the variability in the depth of the RPD layer, the infaunal successional stage (primarily Stage III), and the presence of early-colonizing (Stage I) infauna.

The infaunal communities found within the WLIS Alternative and its nearby reference site during the recent sediment characterization surveys conducted in support of this DEIS were very similar (Appendix H-1). 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 4-23). The average numbers of species found in the disposal and reference site samples were 36 and 45, respectively. These sets of relatively high values were reflected in the moderately high Shannon-Wiener diversity (*H'*) values calculated for the WLIS samples (Table 4-23). Rarefaction analysis, which uses data from each sample to estimate the number of species expected for samples of various sizes (Sanders, 1968; Hurlbert 1971), of WLIS samples (with replicates for each station pooled or summed) showed that species diversity among the active, farfield, and historical stations sampled in July 2000 were very similar, whereas that calculated for the reference station was slightly higher (Figure 4-29). Evenness values were moderately high in the alternative and at the reference station (0.7)(Table 4-23).

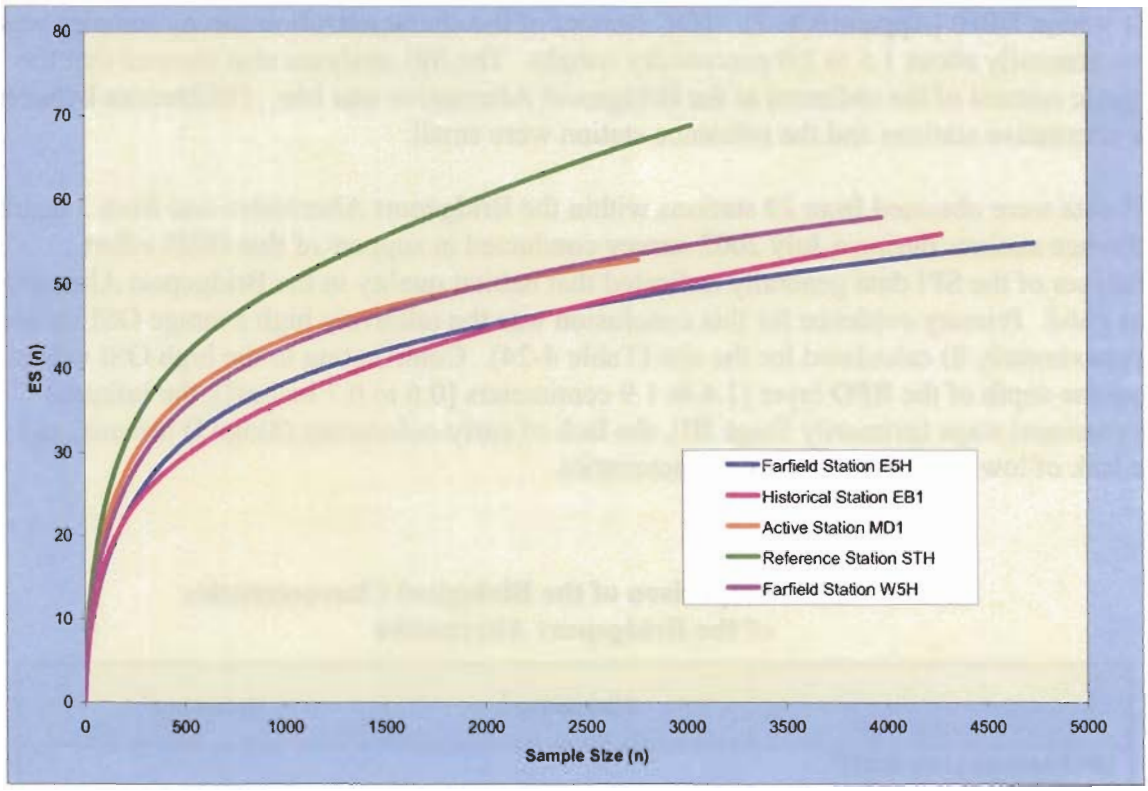

Figure 4-29. Rarefaction Curves for Pooled Samples Collected in July 2000 from the WLIS Alternative Area Showing the Number of Expected Species (ES) for a Given Sample Size

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 WLIS samples (Table 4-23). Together they accounted for about 49 percent of the fauna identified from the Alternative in July 2000 (Appendix H-1). The density of *N. annulata* among all WLIS 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 (this species is one that has not yet been described in the formal scientific literature; its taxonomic status is presently being studied).

4.9.3 Bridgeport Alternative

The Bridgeport Alternative is located west of the Stratford Shoal Complex in the broad depositional basin that comprises much of the western part of Long Island Sound (Knebel and Poppe, 2000). Typical depositional sediments are found in the Bridgeport Alternative. SPI images collected in July 2002 indicated that the sediments are fine-sand-silt-clay (4.5 to 5.5 phi) and contained no evidence of coarse sediment (USACE, 2002f; Appendix F-7). The samples collected during the recent sediment characterization surveys conducted in support of this DEIS (Table 4-12, Figure 4-14) also showed a predominance of fine-grained (silt+clay) sediments in the site, but did reveal some sandy sediments (up to 34 percent) at in-

site station BP10 (Appendix F-7). TOC content of the characterization survey samples was low, generally about 1.5 to 2.0 percent dry weight. The SPI analyses also showed that the organic content of the sediment at the Bridgeport Alternative was low. Differences between the alternative stations and the reference station were small.

SPI data were obtained from 29 stations within the Bridgeport Alternative and from 3 nearby reference stations during a July 2002 survey conducted in support of this DEIS effort. Analyses of the SPI data generally indicated that habitat quality in the Bridgeport Alternative was good. Primary evidence for this conclusion was the relatively high average OSI values (approximately 8) calculated for the site (Table 4-24). Contributing to the high OSI values were the depth of the RPD layer (1.6 to 1.9 centimeters [0.6 to 0.7 inches]), the infaunal successional stage (primarily Stage III), the lack of early-colonizing (Stage I) infauna, and the lack of low dissolved oxygen characteristics.

Table 4-24. Comparison of the Biological Characteristics of the Bridgeport Alternative

	Alternative[1]	Reference[2]
SPI Features (July 2002)[3]		
Grain Size (phi)	4.5–5.5	4.5–5.5
Prism Penetration (cm)	16	19
Dominant Processes	Biological; Biological/Physical	Biological; Biological/Physical
RPD Depth (cm)	1.8	1.6
Successional Stage	III; II-III	III
OSI	7.9	7.7
Infaunal Community Features (July 2002)[4]		
Average Abundance (/sample)	350–497 (~9,000–12,000/m2)	448 (~11,000/m2)
Average Species (/sample)	20–25	17
Average Diversity (H')	2.3–2.8	2.3
Average Evenness (J')	0.5–0.6	0.6
Five Most Abundant Taxa[5]	*Levinsenia gracilis* *Nephtys incisa* *Mediomastus ambiseta* *Cossura sp. 1* *Oligochaeta*	*Levinsenia gracilis* *Mediomastus ambiseta* *Nephtys incisa* *Cossura sp. 1* *Oligochaeta*

[1] Twenty-nine SPI stations; range or average of values shown
[2] Three SPI stations; range or average of values shown
[3] Source: USACE 2002f; Appendix F-7
[4] Source: USACE 2003f; Appendix H-2
[5] In order of decreasing abundance

The infaunal communities found within the Bridgeport Alternative and its nearby reference area during the July 2002 sediment characterization survey were very similar (USACE, 2003f; Appendix H-2). The numbers of infaunal animals within each area in July 2002 were moderately low, with about 9,000 to 12,000 individuals per square meter found within the alternative and about 11,000 individuals per square meter occurring within the reference area (Table 4-24). The average numbers of species found in the Bridgeport Alternative and reference site samples were 20 to 25 and 17, respectively. The resulting Shannon-Wiener diversity (H') values calculated for the Bridgeport Alternative samples were low, ranging from 2.3 to 2.8 (Table 4-24). Diversity at the reference station was also low (2.3). Rarefaction analysis showed that species diversity among the three Bridgeport sediment stations was very similar and all were more diverse than the Bridgeport reference station (Figure 4-30). Evenness values were moderate in the alternative and at the reference station (0.5–0.6; Table 4-24).

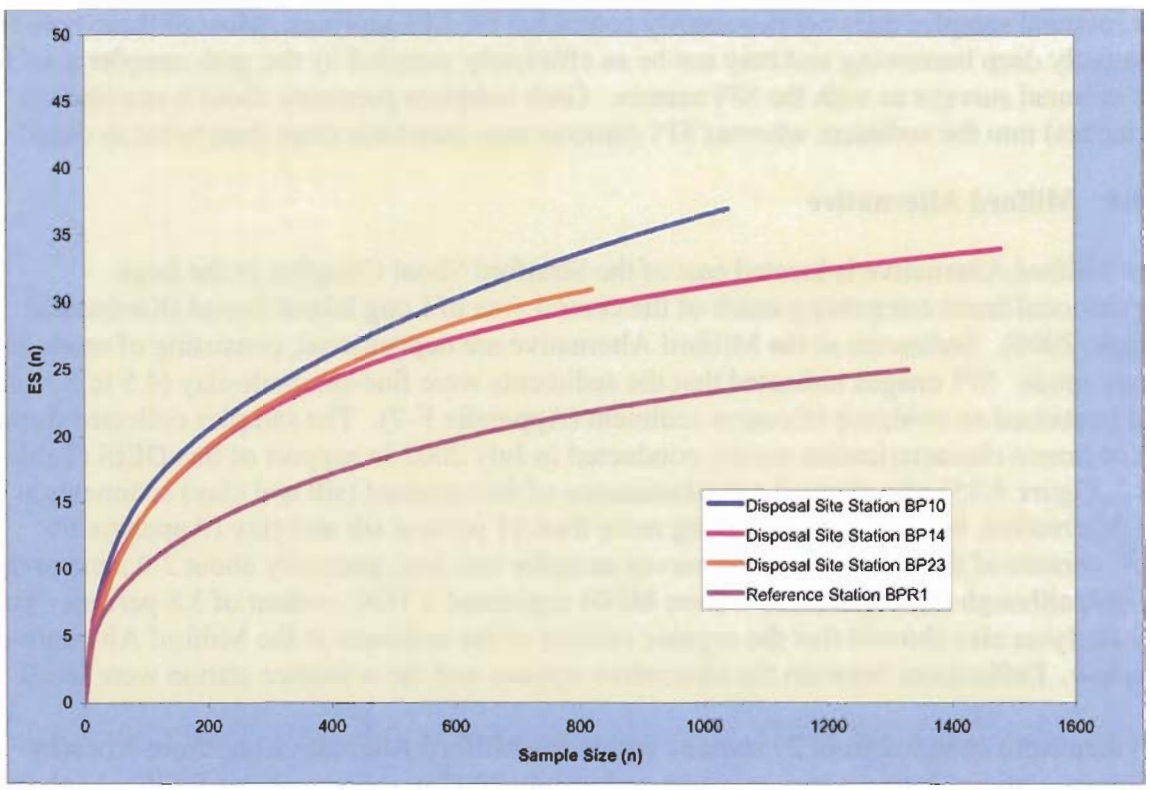

Figure 4-30. Rarefaction Curves for Pooled Samples Collected in July 2002 from the Bridgeport Alternative Area Showing the Number of Expected Species (ES) for a Given Sample Size

Five taxa characterized the infaunal communities at the Bridgeport Alternative (Table 4-24). A small surface deposit-feeding worm *Levinsenia gracilis* was the most abundant species at the site, accounting for about 51 percent of the infauna collected there and occurring at a density of almost 4,900 individuals per square meter. Three other polychaete worms, *Nephtys incisa*, *Mediomastus ambiseta*, and *Cossura* sp. 1, and oligochaete worms were the

next four most abundant taxa. Together these five taxa accounted for about 86 percent of the fauna collected from the Bridgeport Alternative in July 2002 (Appendix H-2). The small clam *Nucula annulata*, which was the predominant species at WLIS in July 2000, was the sixth most abundant species among the Bridgeport samples, but was relatively low in abundance, occurring at about 177 individuals per square meter.

The SPI analyses characterized the habitats at the Bridgeport Alternative as good and characterized the infaunal community as belonging to successional Stage III (Appendix F-7). The analysis identified taxa such as maldanid polychaete worms, large tube-dwelling chaetopterids worms, and large burrowing cerianthid sea anemones as primary examples of Stage III taxa. However, the infaunal samples do not show a preponderance of these taxa. Examples of all did occur among the Bridgeport Alternative samples, but none was particularly abundant as only two of those taxa, *Spiochaetopterus oculatus* (a chaetopterids worm) and *Cerianthiopsis americanus* (a burrowing anemone) occurred among the most abundant 20 taxa at the Alternative. The relatively small numbers of Stage III taxa among the infaunal samples does not necessarily contradict the SPI analyses. Most of these taxa are relatively deep burrowing and may not be as efficiently sampled by the grab sampler used for the infaunal surveys as with the SPI camera. Grab samplers penetrate about 8 centimeters (3 inches) into the sediment whereas SPI cameras may penetrate more than twice as deep.

4.9.4 Milford Alternative

The Milford Alternative is located east of the Stratford Shoal Complex in the large depositional basin comprising much of the central area of Long Island Sound (Knebel and Poppe, 2000). Sediments at the Milford Alternative are depositional, consisting of muds and sandy muds. SPI images indicated that the sediments were fine-sand-silt-clay (4.5 to 5.5 phi) and contained no evidence of coarse sediment (Appendix F-7). The samples collected during the sediment characterization survey conducted in July 2002 in support of this DEIS (Table 4-12, Figure 4-15) also showed a predominance of fine-grained (silt and clay) sediments at the Alternative, with all stations having more than 91 percent silt and clay (Appendix F). TOC content of the characterization survey samples was low, generally about 2.0 percent dry weight, although one replicate at station MF04 registered a TOC content of 3.8 percent. The SPI analyses also showed that the organic content of the sediment at the Milford Alternative was low. Differences between the alternative stations and the reference station were small.

SPI data were obtained from 29 stations within the Milford Alternative and from 3 nearby reference stations during a survey conducted in July 2002 in support of this DEIS. Analyses of the SPI data generally indicated that habitat quality in the Milford Alternative was good. Primary evidence for this conclusion was the relatively high average OSI values (~7) calculated for the site (Table 4-25, Appendix F-7). Contributing to the high OSI values were the depth of the RPD layer (1.2 to 1.3 centimeters [0.47 to 0.51 inches]), the infaunal successional stage (primarily Stage III), the lack of early-colonizing (Stage I) infauna, and the lack of low dissolved oxygen characteristics.

The infaunal communities found within the Milford Alternative and its nearby reference area were very similar (Appendix H-2). In July 2002 there were about 10,000 to 14,000 individuals per square meter found within the alternative and about

Table 4-25. Comparison of the Biological Characteristics of the Milford Alternative

	Alternative [1]	Reference [2]
SPI Features (July 2002)[3]		
Grain Size (phi)	4.5–5.5	4.5–5.5
Prism Penetration (cm)	14	15
Dominant Processes	Biological; Biological/Physical; Physical	Biological; Biological/Physical
RPD Depth (cm)	1.2	1.3
Successional Stage	III	III
OSI	7.1	7.0
Infaunal Community Features (July 2002)[4]		
Average Abundance (/sample)	402–566 (~10,000–14,000/m2)	568 (~14,000/m2)
Average Species (/sample)	19–21	30
Average Diversity (H′)	2.2–2.4	2.8
Average Evenness (J′)	0.5–0.6	0.6
Five Most Abundant Taxa[5]	*Levinsenia gracilis* *Cossura sp. 1* *Nephtys incisa* *Mediomastus ambiseta* *Oligochaeta*	*Levinsenia gracilis* *Nephtys incisa* *Mediomastus ambiseta* *Cossura sp. 1* *Pseudopotamilla reniformis*

[1] Twenty-nine SPI stations; range or average of values shown
[2] Three SPI stations; range or average of values shown
[3] Source: USACE 2002f; Appendix F-7
[4] Source: USACE 2003f; Appendix H-2
[5] In order of decreasing abundance

14,000 individuals per square meter occurring within the reference area (Table 4-25). The average numbers of species found in the alternative and reference site samples were 19 to 21 and 30, respectively. The resulting Shannon-Wiener diversity (H′) values calculated for the Milford Alternative samples were low, ranging from 2.2 to 2.4 (Table 4-25). Diversity at the reference station was also low (2.8). Rarefaction analysis showed that species diversity among the three alternative stations was very similar and all were less diverse than the Milford reference station (Figure 4-31). Evenness values were moderate in the site and at the reference station (0.5–0.6; Table 4-25).

The characteristic taxa of the infaunal communities at the Milford Alternative were the same five that were characterized at the Bridgeport Alternative (Table 4-25). The polychaete worm *Levinsenia gracilis* was the most abundant species at the alternative, accounting for about 53 percent of the infauna collected there and occurring at a density of almost 6,900 individuals per square meter. Three other polychaete worms, *Nephtys incisa*, *Mediomastus ambiseta*, and *Cossura sp. 1*, and oligochaete worms were the next four most abundant taxa. Together these five taxa accounted for about 86 percent of the fauna collected from the Milford Alternative in July 2002 (Appendix H-2). The small clam *Nucula annulata*, which was the predominant species at WLIS in July 2000, was the ninth most abundant species among the Milford samples, but was low in abundance, occurring at about 150 individuals per square meter.

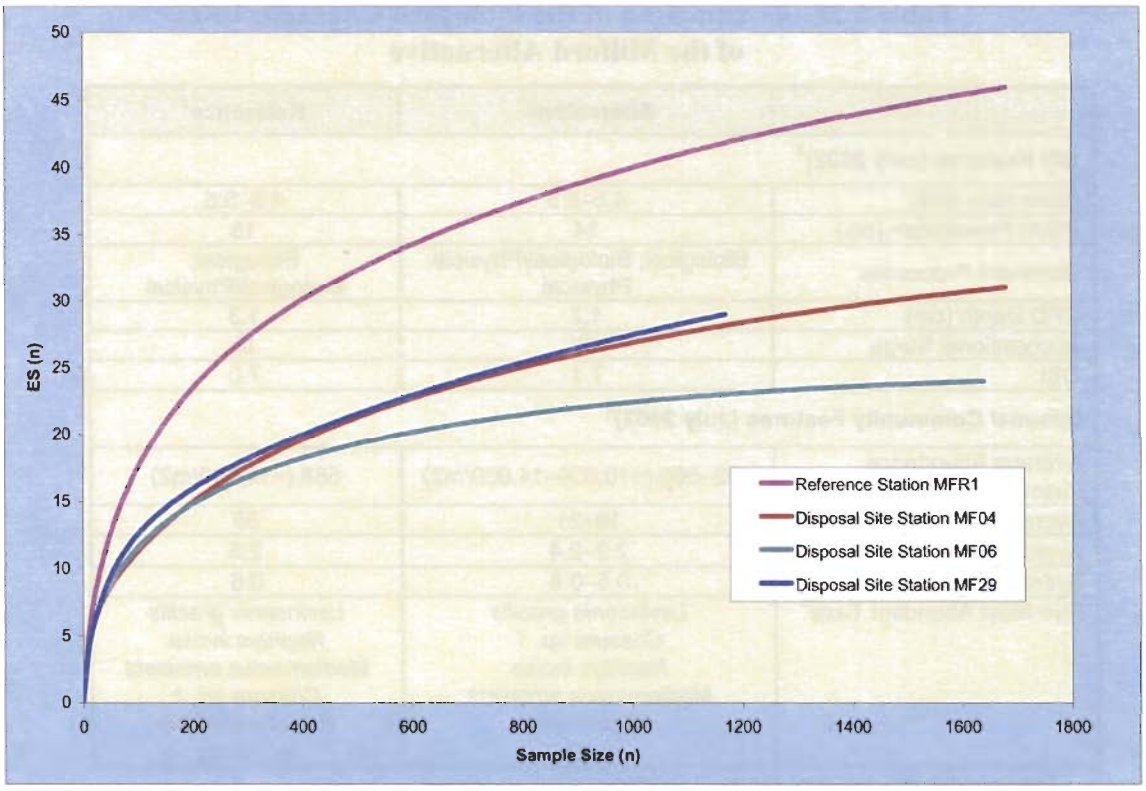

Figure 4-31. Rarefaction Curves for Pooled Samples Collected in July 2002 from the Milford Alternative Area Showing the Number of Expected Species (ES) for a Given Sample Size

The SPI analyses characterized the Milford Alternative as having good habitat quality with a Stage III infaunal community (Appendix F-7). The Stage III community members were not well-represented among the Milford Alternative infaunal samples because they were not efficiently sampled by the small 0.04-square meter (0.4 square feet) grab sampler used there (see Section 4.10.3).

4.9.5 Central Long Island Sound Alternative

CLIS is located in the eastern portion of the large depositional basin comprising much of the central area of Long Island Sound (Knebel and Poppe, 2000). Sediments at the CLIS Alternative are depositional, that is, composed primarily of fine-grained materials. Five of the stations included in the 2000 sediment characterization survey at CLIS (Table 4-12, Figure 4-15) had fine sediments, ranging from 82 to 91 percent fines in February and 83 to 92 percent fines in July (Appendix H-1). One historic station (N74) was sandy in February (68 percent), but was muddy the following July (76 percent fines) and in July 2001 (72 percent fines). TOC content among the CLIS stations ranged from 0.2 to 0.5 percent at the sandier stations sampled in July 2001 to 2.1 percent at a muddy station (FVP) sampled in July 2000.

SPI data were obtained in September 1999 from five disposal mounds within CLIS and from three nearby reference stations. The areas sampled within the alternative were selected to represent various post-disposal conditions, thereby allowing evaluation of the recolonization process at the alternative. Analyses of the SPI data (Table 4-26) showed that the benthic habitats within and near the alternative were generally as expected given the time since each mound received dredged material (SAIC, 2002a). Values for some of the SPI parameters were actually better than they were for a survey conducted in 1997 (SAIC, 2002a). For example, average OSI values calculated for the 1999 survey were higher than they were for the 1997 survey. This reflects a generally deeper RPD layer and a greater abundance of Stage III organisms in 1999. At least part of the difference between the two surveys could be related to effects of each year's respective hypoxia event. Both surveys were conducted at about the same time of year. However, the 1997 hypoxia event started later in the year than the 1999 event and it lasted well into September, and bottom oxygen concentrations were still relatively low when the survey was conducted. Conversely, the 1999 hypoxia event ended before the SPI survey and bottom oxygen levels had rebounded to levels not thought to affect benthic animals (SAIC, 2002a). Therefore, the benthic habitats measured during 1997 probably were still experiencing the impacts of that year's hypoxic event, whereas those evaluated during the 1999 were not (SAIC, 2002a). Analyses of the SPI data generally indicated that habitat quality in the CLIS Alternative was reasonably good. Primary evidence for this conclusion was the relatively high average OSI values (>6) calculated for the alternative (Table 4-26, SAIC 2002a). Contributing to the high OSI values were the depth of the RPD layer (>2.2 centimeters [0.9 inch]), the infaunal successional stage (primarily Stage I on III and Stage III), the lack of early-colonizing (Stage I) infauna, and the lack of low dissolved oxygen characteristics.

The infaunal communities found within CLIS and its nearby reference area during the sediment characterization surveys conducted in 2000 and 2001 shared several features (Appendix H-1). 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 4-26). The average numbers of species found in the alternative and reference site samples were 29 to 36 and 27, respectively. 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 CLIS and reference samples were moderate, ranging from 3.0 to 3.6 (Table 4-26). Rarefaction analysis showed that species diversity among most of the alternative stations was very similar (Figure 4-32). 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 (0.6–0.7; Table 4-26).

Table 4-26. Comparison of the Biological Characteristics of the CLIS Alternative

	Alternative[1]	Reference [2]
SPI Features (September 1999)[3]		
Grain Size (phi)	>4, 3–2	>4
Prism Penetration (cm)	13–16	15
Dominant Processes	Biological/Physical	Biological/Physical
RPD Depth (cm)	2.2–3.4	3.3
Successional Stage	I on III; III	I on III; III
OSI	6.2–9.2	8.7
Infaunal Community Features (July 2000, 2001)[4]		
Average Abundance (/sample)	413–682 (~10,000–17,000/m2)	640 (~16,000/m2)
Average Species (/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[5]	*Levinsenia gracilis* *Nucula annulata* *Ampharete finmarchica* *Tharyx sp. 1B* *Mediomastus ambiseta*	*Levinsenia gracilis* *Nephtys incisa* *Nucula annulata* *Tharyx sp. 1B* *Sigambra tentaculata*

[1]Five SPI stations; range or average of values shown
[2]Three SPI stations; range or average of values shown
[3] Source: SAIC 2002a
[4] Source: USACE 2002g; Appendix H-1
[5] In order of decreasing abundance

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 4-26). 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 percent of the identified infaunal animals (Appendix H-1). 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 percent of the identified animals (Appendix H-1). Similar marked changes in abundance between the two years has been noticed previously for other infaunal animals in Long Island Sound (McCall, 1978).

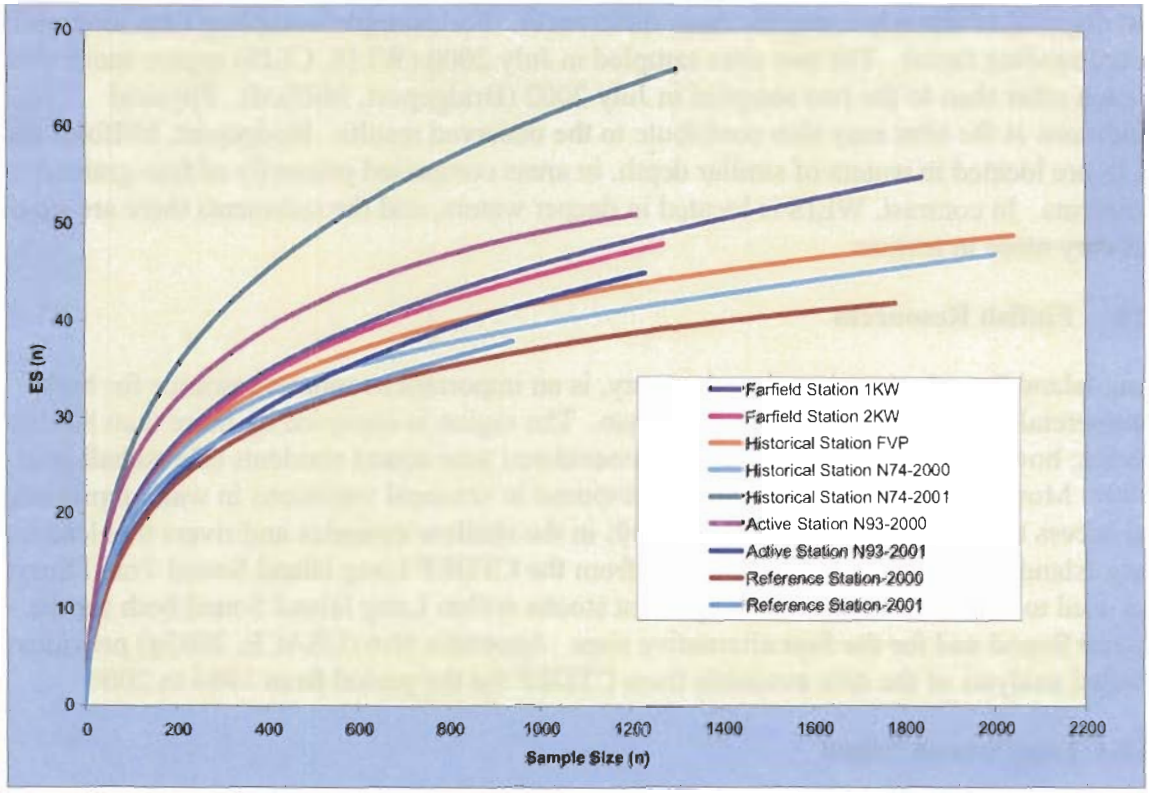

Figure 4-32. Rarefaction Curves for Pooled Samples Collected in July 2000 and July 2001 from the CLIS Alternative Area Showing the Number of Expected Species (ES) for a Given Sample Size

4.9.6 Benthic Invertebrates Summary

Overall, the infaunal communities found at all four alternative sites were similar, although the number of species per sample, species diversity, and infaunal abundance were higher at WLIS and CLIS. In addition, the predominant species present at WLIS were more similar to CLIS than to those at Bridgeport or Milford. However, based on the SPI analyses, the benthic habitats at Bridgeport, Milford and CLIS were generally very similar to each other. The general habitat quality at these alternative sites was determined to be typical of the area and the OSI values, RPD depths, and the successional stage of the communities all showed little effects of disturbance, such as that from disposal activity. In contrast, the SPI analyses at WLIS showed that some in-site and reference stations had very good habitat quality, whereas others had very poor habitats. Some stations at WLIS showed signs of recent disturbance as indicated by very low OSI and RPD values and the presence of Stage I pioneering communities.

Disposal activities have occurred more recently at WLIS and CLIS, providing a possible explanation for the similarity in species diversity and abundance observed at those alternatives. However, there are other confounding factors that make it difficult to conclude

that disposal is the only cause for these differences. For example, sampling time may also be a confounding factor. The two sites sampled in July 2000 (WLIS, CLIS) appear more similar to each other than to the two sampled in July 2002 (Bridgeport, Milford). Physical conditions at the sites may also contribute to the observed results. Bridgeport, Milford, and CLIS are located in waters of similar depth, in areas comprised primarily of fine-grained sediments. In contrast, WLIS is located in deeper waters, and the sediments there are sandier and vary more in texture.

4.10 Finfish Resources

Long Island Sound, a semi-enclosed estuary, is an important economic resource for both commercial and recreational/sport fisherman. The region is occupied by more than 83 fish species; however, only a few of them are considered year-round residents (Gottschall *et al.*, 2000). Most migrate through the area in response to seasonal variations in water temperature and access to spawning and nursery grounds in the shallow estuaries and rivers that lead into Long Island Sound. Trawl data available from the CTDEP Long Island Sound Trawl Survey was used to evaluate the status of important stocks within Long Island Sound both for the general Sound and for the four alternative sites. Appendix H-6 (USACE, 2003g) provides a detailed analysis of the data available from CTDEP for the period from 1984 to 2000.

4.10.1 Long Island Sound

There are numerous finfish habitat types present within Long Island Sound, ranging from deep mud to shallow sand. For the purpose of the evaluation, the CTDEP Long Island Sound Trawl Survey divided Long Island Sound into 18 habitat areas (Figure 4-33; Table 4-27). For example, the western basin of Long Island Sound is divided into seven habitat areas for analysis: Habitat Areas 1, 2, 3, 15, 16, 17, and 18 (Figure 4-33). This part of the Sound contains two small basins separated by a shallow water area known as Cable and Anchor Reef. Habitat Area 2 is a deep mud area within the larger of these two basins and Habitat Area 15 is a deep mud area located within the smaller, more western basin. Habitat Areas 1 and 17 are shallow-water mud areas that lie adjacent to mud areas with greater depth. Habitat Areas 3 and 18 are shallow-water transitional areas along the Long Island shore. Habitat Area 16 is a deep-water transitional area that spans the Cable and Anchor Reef.

Similarly, the central basin is divided into eight habitat areas: Habitat Areas 4, 5, 6, 7, 8, 9, 10, and 11. Habitat Areas 7, 9, and part of 11 are in a deep part of Long Island Sound and the sediment shifts from mud to transitional to sand along the west-east axis of the Sound (Figure 4-33). To the north, a series of nearshore shallow habitats shift from mud to transitional to mud and back to transitional along the same axis. These habitats (Habitat Areas 4, 5, 6, and 8) are more likely to be affected by nearshore, estuarine processes, and the urban impact of New Haven Harbor. Habitat Area 10 lies along the shallow transitional shoreline of Long Island near Mattituck.

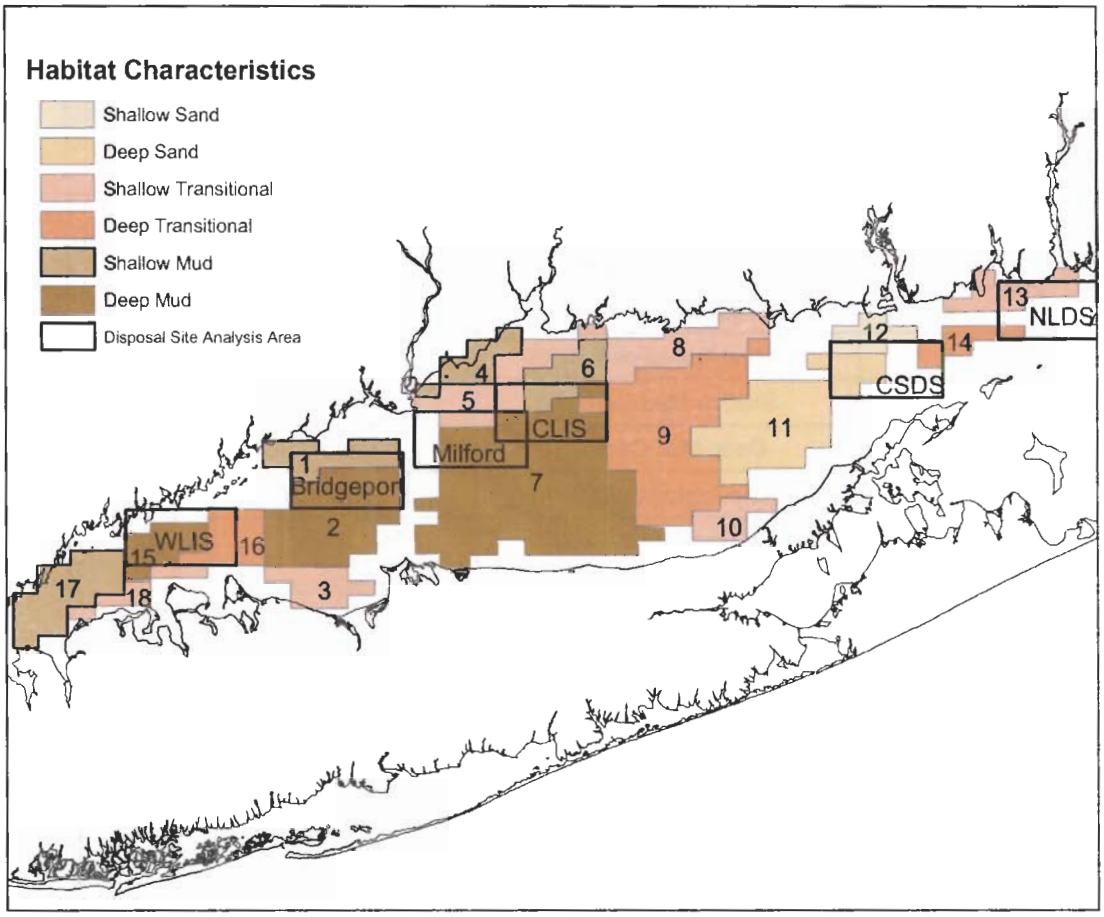

Figure 4-33. Location of CTDEP Habitat Areas and Their Characteristics

Source: USACE, 2003g; Appendix H-6

In addition to the CTDEP habitat areas defined in Table 4-27 and Figure 4-33, disposal site analysis areas were identified for the purpose of this EIS. Disposal site analysis areas are defined as 6 by 3 nautical mile (11 by 5.5 kilometer) rectangles surrounding each alternative site (Figure 4-33 and Appendix H-6). The size of these areas was selected to ensure sufficient sample size relevance to disposal area, and to capture the scope of fish movement. The rectangles were elongated east-west to account for the prevailing tidal currents at each site. Trawl data is generally not collected by CTDEP within current disposal sites (1 to 2 square nautical miles [1.9 to 3.7 square kilometers]) to avoid potential interference between bottom trawls and dredged material so it was not possible to evaluate data collected directly from all of the alternative sites. The results from these analysis areas, therefore, represent standardized seasonal estimates of fish abundance over a seventeen-year period in the region surrounding each alternative. In the case of existing disposal sites, this data represents a comparative record of seasonal fish abundance near disposal activity during disposal and recovery periods. These active areas were compared to adjacent habitat areas similar to the

Table 4-27. Habitat Types Defined by the CTDEP Long Island Sound Trawl Survey

Habitat Area	Name	Sediment Type	Depth (meters)[1]
1	Shallow Mud West	Mud	<18
2	Deep Mud Western Basin	Mud	>18
3	Shallow Transitional Sand West	Transitional and Sand	<18
4	Shallow Mud North	Mud	<18
5	Shallow Transitional North	Transitional	<18
6	Shallow Mud Central	Mud	<18
7	Deep Mud Central	Mud	>18
8	Shallow Transitional Central	Transitional	<18
9	Deep Transitional Central	Transitional	>18
10	Shallow Transitional South	Transitional	<18
11	Deep Sand East	Sand	>18
12	Shallow Sand North	Sand	<18
13	Shallow Transitional East	Transitional	<18
14	Deep Transitional East	Transitional	>18
15	Deep Mud West	Mud	>18
16	Deep Transitional West	Transitional	>18
17	Shallow Mud West	Mud	<18
18	Shallow Transitional West	Transitional	<18

[1] 18 meters = 59 feet

disposal sites but remote from disposal activities. This approach cannot identify direct impacts from disposal (burial), or exclude factors such as hypoxia, commercial fishing, or recreational fishing. However, if impacts due to disposal are spatially persistent and sufficient to affect fish abundance (positively or negatively) in the region immediately surrounding disposal sites, this comparative analysis would identify those species most affected. The analysis areas also provide an assessment of the relative abundance of species present around each alternative at the beginning (fall) and end (spring) of disposal activities.

Overview of Finfish Abundance and Distribution. The abundance and distribution of finfish resources in Long Island Sound show several general patterns, based on analysis of CTDEP trawl survey data. A more detailed discussion of potentially vulnerable fish species is included in Section 5.5.5. The western and central basins of the Sound consistently have higher abundance of finfish than the eastern basin (Figures 4-34 and 4-35; USACE, 2003g; Appendix H-6). In particular, the shallow mud and transitional substrates adjacent to these basins have the highest average catch per unit effort (CPUE) in the Sound. The central basin contained sampling stations with the highest species richness, particularly in transitional and

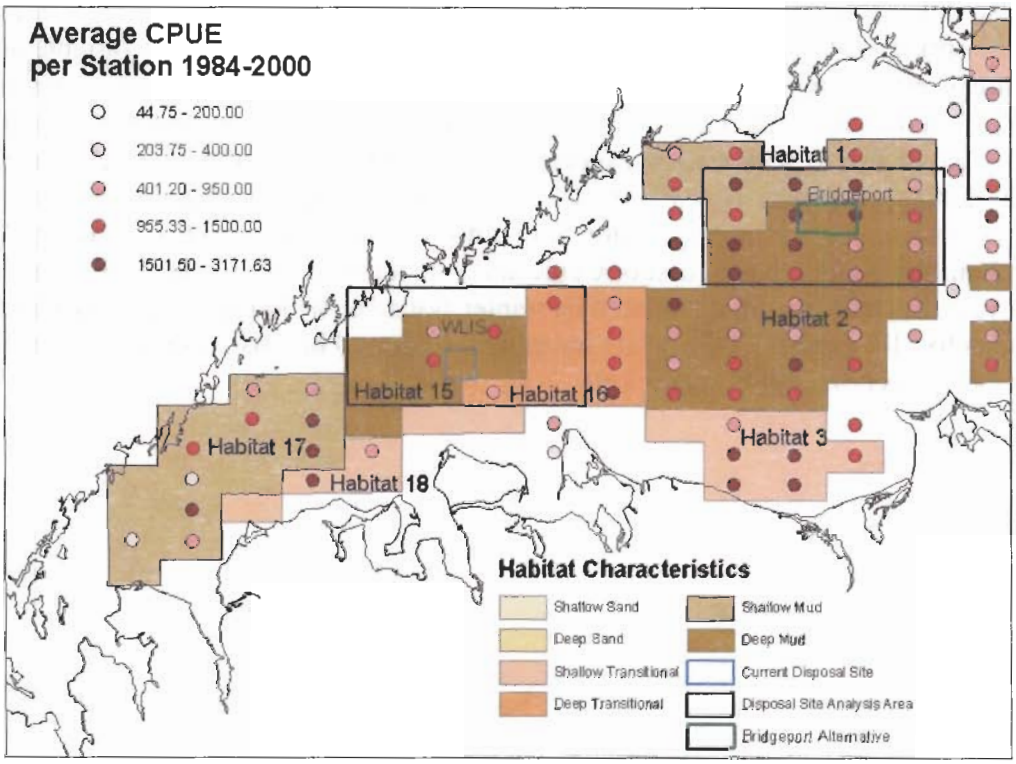

Figure 4-34. Average Catch per Unit Effort for WLIS, 1984 to 2000

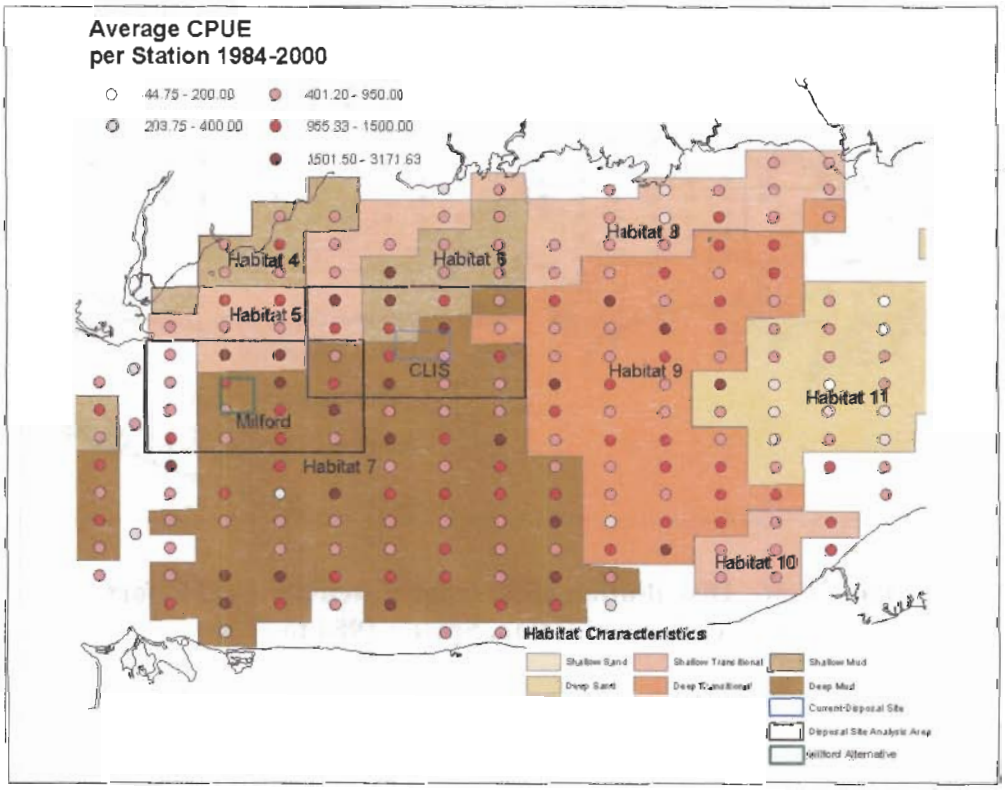

Figure 4-35. Average Catch per Unit Effort for CLIS, 1984 to 2000

muddy habitats, although this richness (and that at other sites) was observed to decrease during the spring (note: there are no winter surveys). Richness was far less variable between habitat areas and the only notable pattern was decreased richness in the eastern basin (see data presented in Gottschall *et al.*, 2000). Trawl surveys conducted in the spring months had a higher yield of fish in deep waters, especially at the eastern edge of the western basin (USACE, 2003g; Appendix H-6; Figure 4-36). Fall trawl surveys yielded higher average numbers of fish at every sampling station than did spring surveys, with the highest numbers coming from the western basin, east of Cable and Anchor Reef (Appendix H-6; Figure 4-37). Typically, spring trawls were dominated by winter flounder, windowpane flounder and scup (see Appendix H-6 Figure 3.1-8), while butterfish, scup, and bluefish dominated the fall surveys (see Appendix H-6 Figure 3.1-9).

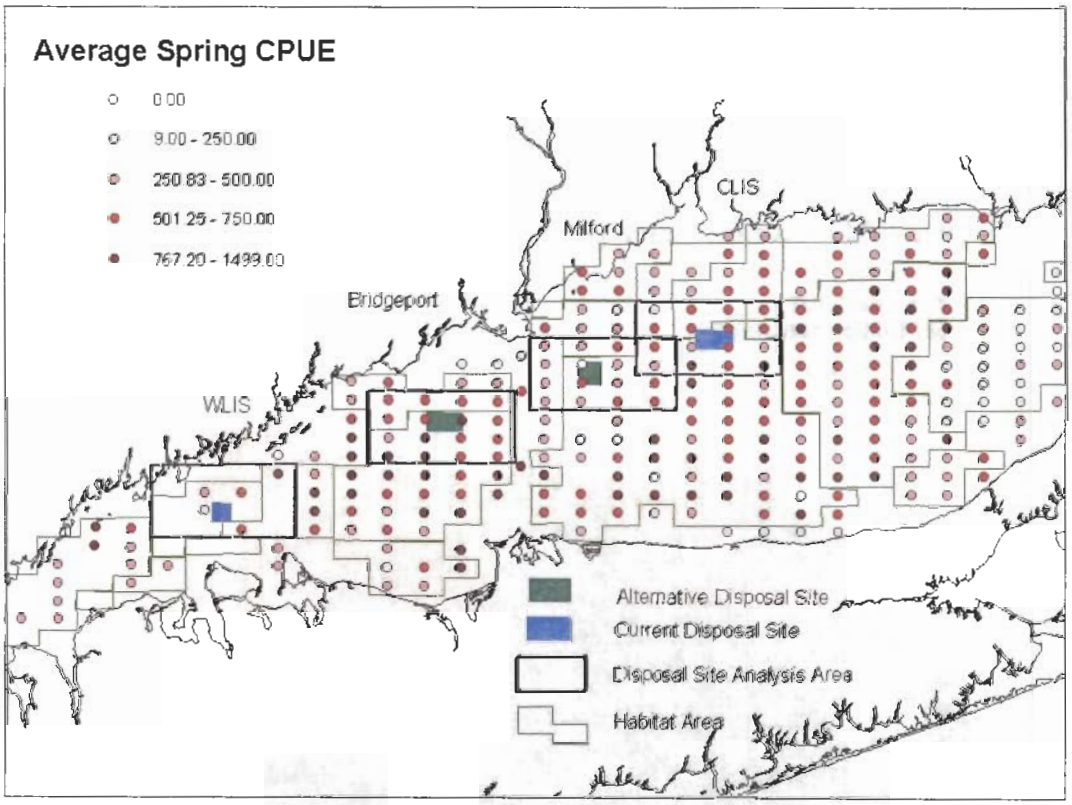

Figure 4-36. Distribution of Average Catch per Unit Effort for Each Trawl Station, Spring 1984 to 2000

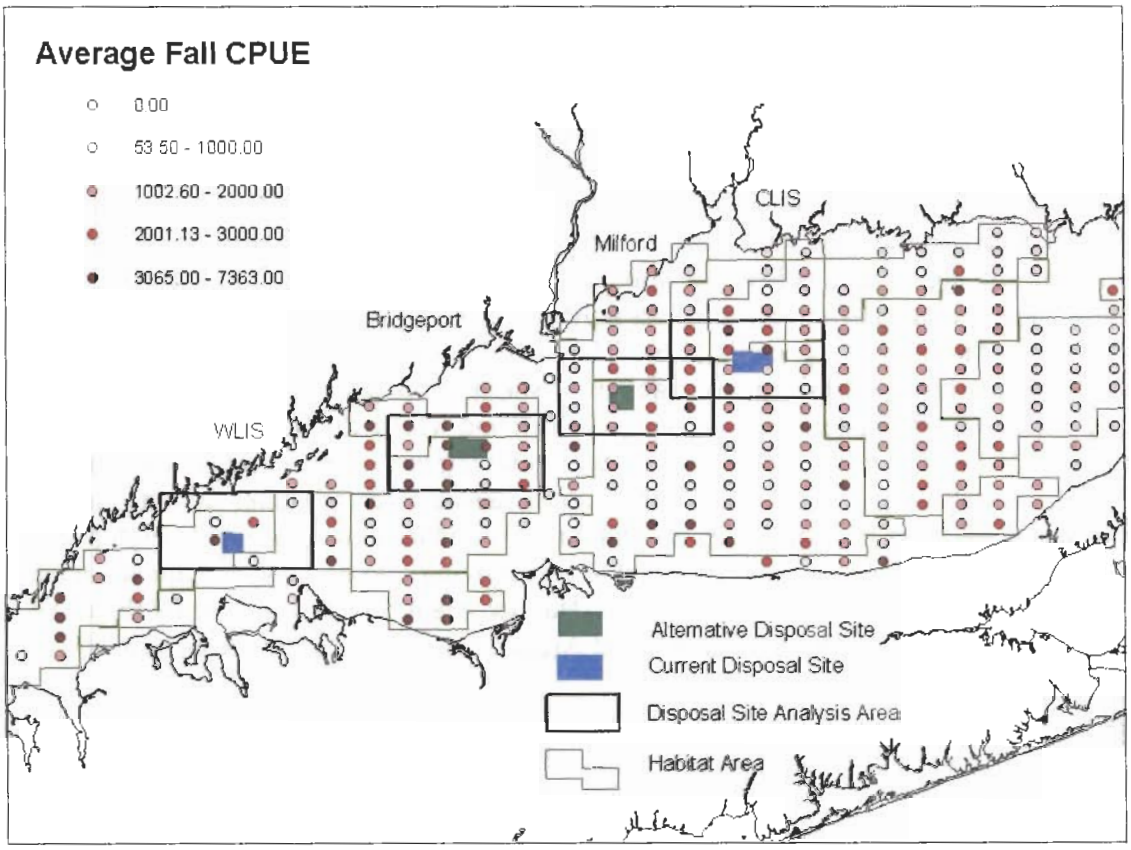

Figure 4-37. Distribution of Average Catch per Unit Effort for Each Trawl Station Fall, 1984 to 2000

The western basin of Long Island Sound has been sparsely sampled by the CTDEP trawl survey due to the very high density of fixed lobster gear in this region of Long Island Sound prior to 2000 (Appendix H-6). In addition to the density of fixed gear, there are areas of rough or rocky bottom that make trawling on straight transects difficult. The catastrophic collapse of the western Long Island Sound lobster fishery in 1999 spurred state agencies to increase efforts to evaluate the lobster resource and as a component of this effort, the CTDEP Fisheries Division added additional trawl stations in the far western Sound beginning in 2000. This single year sampling of abundance and richness of finfish species for that area provides some indication of the resources in this area that might be affected by disposal activities. It is also supported by the longer time series of stations adjacent to those added in 2000.

The western basin had high CPUE for both spring and fall. Habitat Area 3 had the highest CPUE in the fall, and Habitat Areas 2 and 1 ranked second and fifth, respectively (Appendix H-6). These high values were due to particularly high collections of butterfish and scup in western Long Island Sound (Appendix H-6). Habitat Areas 1 and 2 had slightly above average catches in spring sampling, mostly due to large collections of winter flounder and windowpane flounder (Appendix H-6). Westernmost areas of this basin had more patchy results. Although fall averages for Habitat Areas 15 through 18 were comparatively high,

these results are based on a small number of tows in which one or two large tows can dominate the average (Appendix H-6).

The central basin of Long Island Sound represents the largest area of the Sound and is relatively unrestricted for research trawling. By far the largest number of samples in the CTDEP survey are from this region (Appendix H-6). Central Long Island Sound has high CPUE in nearshore habitats with more moderate catches in the deeper basin and relatively low spring catches in the shallow transitional habitats (Habitat Areas 5, 8, and 10). The shallow mud habitat (Habitat Area 6) just north of the CLIS Alternative, had the third highest fall CPUE in the survey (Appendix H-6). This was due to high catches of butterfish in this area (Appendix H-6). The deep mud habitat (7) south of the alternative also had high fall and spring catches due to butterfish and scup in the fall and winter flounder in the spring (Appendix H-6). The CPUE fell off in the basin moving east over the transitional and sand habitats (Habitat Areas 9 and 11) apart from an increased catch of winter flounder and windowpane flounder in spring over Habitat Area 9. Richness was also quite high and stable in this region with a steady drop from west to east moving into the sandier habitats in fall and a sharper drop from shallow nearshore areas (Habitat Areas 5 and 6) to deep (Habitat Areas 7, 9, and 11) and more eastern areas (Habitat Areas 8 and 10) in spring (Appendix H-6).

Although abundance, as measured by CPUE, increased substantially during the survey period, all of the recent increase is in fall catch (Appendix H-6). Spring catch has remained remarkably even, between an average of 360 and 746 individuals per tow per year. In contrast, fall catch has increased over an order of magnitude from a low of 426 in 1987 to a high of 4296 in 1999. Species richness (number of species caught per tow) has ranged between 9 and 14.5 species per tow with no distinct trend from 1984 to 2000 (Appendix H-6).

Seasonal Patterns. Richards (1963) and Gottschall *et al.* (2000) provide descriptions of seasonal patterns observed among commercial and recreational finfish species in Long Island Sound. For example, spring is characterized by warming water temperatures and migration of finfish species into the Sound. Demersal species (finfish that have an affinity to the seafloor) generally dominate all habitats at this time and are particularly abundant on mud habitats in April and May (Gottschall *et al.,* 2000). The top six finfish species in CPUE in spring include four demersal species (winter flounder, scup, windowpane flounder, and little skate) and two pelagic (fish that have an affinity for the water column) species (Atlantic herring and silver hake). Most of the variation in average spring CPUE over the survey period can be accounted for by variations in abundance of winter flounder, scup, and windowpane flounder (Appendix H-6). Both winter flounder and windowpane flounder have declined in abundance since 1990, with increases in scup helping to keep average CPUE fairly constant (compare Appendix H-6 Figure 3.2-1 and 3.2-3).

Fall months in Long Island Sound are characterized by cooling water temperatures and migration of many species out of the Sound. Overall, catch is much higher and dominated by pelagic species that are caught more frequently over mud and transitional habitats than sand (Gottschall *et al.,* 2000). The top five finfish species in CPUE in the fall included three pelagic species (butterfish, bluefish, and weakfish) and two demersal species (scup and windowpane flounder). In addition, the two common invertebrate species, American lobster

and long-finned squid, provide as much as one-fifth of the average CPUE in some years. The overall increase in fall CPUE since 1987 can be accounted for by large increases in the catch of butterfish and more recently scup and weakfish (Appendix H-6). Windowpane flounder have declined in abundance since 1989 leaving scup as the only demersal species caught in large numbers in fall trawls.

Food, Habitat, and Distribution of Finfish Species in Long Island Sound. Table 4-28 summarizes the location and habits of the predominant finfish species captured in the CTDEP Long Island Sound Trawl Survey, including their preferred prey, the habitat type in which they were typically found during the surveys, and their common abundance and distribution within the open waters of the Sound. Finfish were grouped in the table by habitat categories, distinguishing those that are typically found in sandy or muddy, or hard substrate habitats from those that are found within a variety of habitat areas. Information on seasonal distribution is also included. This is important for evaluating the need for dredging windows. Dredging windows allow dredging and disposal activities to occur only during specified times of the year to minimize the impact to sensitive life stages. Many marine fish and invertebrates are present in the Sound during sensitive life history stages (*i.e.*, egg and larval stages) when they have more potential to be impacted by dredging and disposal operations.

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act of 1996 (Magnuson-Stevens Act), the sustainability of the nation's fishery resources must be protected through the conservation of "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (62 F.R. 66551). This statute mandates that Essential Fish Habitat (EFH) be designated for managed species in U.S. waters. It also calls for the conservation and enhancement of habitat necessary for the managed species to carry out their life cycles (NOAA, 2003a). The overall goal of this amendment is to ensure that EFH is not adversely impacted by fishing or other human activities, including dredged material disposal, and to further the enhancement of these habitats, thereby protecting both ecosystem health and the fisheries industries. The Magnuson-Stevens Act requires consultation among NMFS and Federal agencies in achieving these goals. To comply with this mandate, the EFH designated in Long Island Sound is taken into consideration during the evaluation of impacts (see Chapter 5).

A study conducted by the Corps in 2001 identified 27 species throughout Long Island Sound with EFH designation for one or more life stages (*i.e.*, adult, juvenile, larvae, or eggs) (USACE, 2001h; see Appendix H-3 for the full report). Of these 27 species, 10 are noted as being relevant to the western and central regions of the Sound (*i.e.*, Long Island Sound EFH squares 19, 20, 21, and 31)[3]. The 10 species are:

- Red Hake (*Urophycis chuss);*
- Silver Hake (*Merluccius bilinearis*);

[3] Although included in Appendix H-3, the Atlantic sturgeon is not identified by NOAA (1999) as an EFH species in Long Island Sound and was therefore not included in this list.

Table 4-28. Food, Habitat, and Distribution of the Predominant Finfish Species Present in Long Island Sound

Fish Species	General Prey Characterization	Prey Habitat	LIS Seasonal Distribution	LIS Abundance and Distribution	LIS Essential Fish Habitat?
Multi-Habitat Fish					
American Shad (*Alosa sapidissima*)	Benthic invertebrates (*e.g.*, crustaceans) small fish, fish eggs, variety of zooplankton	Water column	Most common in June	Shallow water. Typically found along the CT coast rather than in open waters of the Sound. Spawn over freshwater, gravel or mud substrates.	No
Atlantic Cod (*Gadus morhua*)	Fish, benthic invertebrates (*e.g.*, clams, crabs, mussels, polycheates, echinoderms)	Sand, gravel, water column	Rare in LIS	Rare in LIS	N/A
Fourspot Flounder (*Paralichthys oblongus*)	Benthic invertebrates (*e.g.*, arthropods, molluscs, shrimp, crabs) and fish	Near-bottom water column	Most abundant in spring	Found in all habitats, but prefers muddy sediments.	No
Red Hake (*Urophycis chuss*)	Benthic invertebrates (*e.g.*, shrimp, worms, crabs), zooplankton (copepods), fish	Sand, mud	Most common in spring and fall	Typically found along the coastlines. Prefer muddy sediments but can be found in sandy areas as well.	All life stages
Silver Hake (*Merluccius bilinearis*)	Fish, benthic invertebrates, squid	Sand, water column	Adults were most abundant in April and May. Juveniles were most abundant in the summer and fall.	Highest catches are within the LIS disposal areas and on Stratford Shoal.	Adults
Windowpane Flounder (*Scophthalmus aquosus*)	Plankton (planktonic shrimp), benthic invertebrates (*e.g.*, epibenthic shrimp)	Sandy environments	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.	All life stages

(Table Continued)

Table 4-28. Food, Habitat, and Distribution of the Predominant Finfish Species Present in Long Island Sound (continued)

Fish Species	General Prey Characterization	Prey Habitat	LIS Seasonal Distribution	LIS Abundance and Distribution	LIS Essential Fish Habitat?
Winter Flounder (*Pseudopleuronectes americanus*)	Benthic invertebrates (small crabs, worms, bivalves)	Mud and sand	More abundant in open water in spring than in fall.	Highest spring catches were in Central Basin over mud and transitional sediments. Highest fall catches were in shallow areas of the Western and central Basins.	All life stages
Sandy Habitat Fish					
Hogchoker (*Trinectes maculatus*)	Benthic invertebrates (crustaceans, polycheates, shrimp)	Sand, mud	Most abundant in spring.	Uniformly dispersed in Western and Central Basins, never deeper than 88 feet (31 meters). High early summer abundance along Long Island shoreline between Shoreham and Eaton's Neck. In July, high catches moved to CT shoreline.	No
Northern Searobin (*Prionotus carolinus*)	Benthic invertebrates (crabs, worms, epibenthic shrimp), fish	Mud, sand, water column	Slightly more abundant in spring.	Most abundant along the Mattituck Sill in sandy and transitional habitats as well as in deep waters of the Western Basin.	No
Scup (*Stenotomus chrysops*)	Benthic invertebrates (crustaceans, worms, molluscs), vegetable debris	Sand, rock	Most abundant during spring and fall, with adults dominating catches in April-June and juveniles dominating in fall.	Generally found over transitional or sandy bottoms in depths > 60 feet (18 meters). Largest numbers occur south of Milford, CT, around the mouth of the Thames River, and in Niantic Bay.	All life stages
Smooth Dogfish (*Mustelus canis*)	Benthic invertebrates (decapod crustaceans, bivalves), squid, fish	Sand	Abundance is higher in the fall than in the spring	In fall, greatest numbers are recorded in deep Eastern Basin areas as well as in shallower areas of the Western and central Basins. In spring, species prefers transitional habitats in Western and Central Basins.	No
Striped Searobin (*Pronotus evolans*)	Benthic invertebrates (crabs, epibenthic shrimp)	Mud, sand	Abundance is higher in fall than in spring.	Primarily found in Western and Central Basins.	No

(Table Continued)

Table 4-28. Food, Habitat, and Distribution of the Predominant Finfish Species Present in Long Island Sound (continued)

Fish Species	General Prey Characterization	Prey Habitat	LIS Seasonal Distribution	LIS Abundance and Distribution	LIS Essential Fish Habitat?
Summer Flounder (*Paralicthys denatus*)	Benthic invertebrates (rock crabs, shrimp, bivalves, polycheate worms), fish (esp. scup), squid	Sand, near-bottom water column	Juveniles--most abundant in spring and fall, with numbers dropping off in summer	Abundant along CT shoreline between Guilford and New Haven, as well as near the mouth of the CT River, in Niantic Bay, and near Mattituck, NY	Juveniles in Central Basin; larvae, juvenile and adults in Western Basin
Muddy Habitat Fish					
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)	Benthic invertebrates, gastropods, shrimp, sand lance	Mud, transitional sediments	Most abundant during September and October	Greatest numbers found in Central Basin in > 88 feet (31 meters) of water. Large numbers found in the Eastern Basin esp. around the mouth of the CT River in < 30 feet (11 meters) of water.	No
Fourbeard Rockling (*Enchelyopuss cimbrius*)	Bivalves (esp. *Yoldia* sp.), polychaetes, decapod crustaceans	Mud, sand	Seasonal distribution not very varied, although slightly more caught in spring compared to fall	Typically caught in deep muddy or transitional habitats in the Western Basin	No
Hard Substrate Habitat Fish					
Black Sea Bass (*Centropristis striata*)	Benthic invertebrates (crabs, mussels), squid	Sand, water column, rocky and transitional sediments	Greatest abundances reported between April and June	Generally found in shallow, nearshore areas in the Central Basin	Juveniles
Cunner (*Tautogolabrus adspersus*)	Benthic invertebrates (mussels, worms, epibenthic shrimp)	Rocks, sand	Very few individuals caught in fall	Majority of catches occur in Western basin in shallow mud/deep transitional habitats	No
Tautog (*Tautoga onitis*)	Benthic invertebrates (mussels, crabs, sand dollars)	Rocks, sand	Most tautog are caught in spring. Overall abundance peaks in May-July, drops off, then peaks again in early fall.	Abundance peaked along CT shoreline between New Haven and Norwalk, north of Hempstead, NY, and off of Eaton's Neck, CT.	No

(Table Continued)

Table 4-28. Food, Habitat, and Distribution of the Predominant Finfish Species Present in Long Island Sound (continued)

Fish Species	General Prey Characterization	Prey Habitat	LIS Seasonal Distribution	LIS Abundance and Distribution	LIS Essential Fish Habitat?
Pelagic Habitat Fish					
Alewife (*Alosa pseudoharengus*)	Fish, polychaete (cyclopoid copepods, cladocerans)	Water column, sandy bottoms	Most abundant in April, usually in > 60 feet (18 meters) of water	Mouths of Norwalk and Saugatuck Rivers were important habitats. Typically found over muddy, sandy, or transitional sediments	No
Atlantic Herring (*Clupea harengus*)	Plankton (copepods), euphasids, pterodpods	Water column, sandy bottoms	Most abundant in spring.	Particularly abundant in shallow areas of Western and central basins	Juvenile and adults
Atlantic Mackerel (*Scomber scombrus*)	Plankton (copepods, amphipods), shrimp, pelagic molluscs (squid)	Water column	Greatest numbers caught in April and June	Not abundant in Long Island Sound	All life stages
Atlantic Menhaden (*Brevoortia tyrannus*)	Zooplankton, phytoplankton, diatoms	Water column	Largest abundances caught between April and September	During summer months, largest numbers are caught near New Haven Harbor in < 90 feet (27 meters) of water. In fall, the largest numbers are caught along the shoreline between Norwalk and Guilford, CT.	No
Bluefish (*Pomatomus saltatrix*)	Fish, shrimp, squid, benthic invertebrates (crabs, annelid worms), squid, shrimp	Water column, sandy bottoms, rocky and transitional sediments	Most frequently caught between July and October. No bluefish were caught during winter months	Numbers peak on CT side of LIS in midsummer and throughout entire Sound in September	Juveniles and adults
Butterfish (*Peprilus tracantus*)	Plankton (copepods), small fish, benthic invertebrates (polycheate worms, amphipods, crabs, bivalves)	Water column, sandy bottoms	Most abundant in early fall	In early fall, found in large numbers around Stratford Shoal and within CLIS	No

(Table Continued)

Table 4-28. Food, Habitat, and Distribution of the Predominant Finfish Species Present in Long Island Sound (continued)

Fish Species	General Prey Characterization	Prey Habitat	LIS Seasonal Distribution	LIS Abundance and Distribution	LIS Essential Fish Habitat?
Striped Bass (*Morone saxatilis*)	Fish, shrimp, squid, benthic invertebrates (crabs, clams)	Water column, rocky and transitional sediments	Most common in May and November, with abundances dropping in summer	Commonly found along CT shorelines (esp. near mouths of CT and Housatonic Rivers) and Long Island shorelines (usually in <60 feet (18 meters) of water)	No
Weakfish (*Cynoscion regalis*)	Fish, shrimp, squid, benthic invertebrates (crabs, clams)	Water column, rocky and transitional sediments	Most abundant in fall	In spring, adults are commonly found along Mattituck Sill and both CT and NY coastlines. In fall, the central basin coastline of Long Island has the greatest abundance.	No

Sources: Buckley, 1989; CSRL, 2002; Cohen *et al.*, 1990; Derre, 1999; Fay *et al.*, 1983; Gilbert, 1989; Grimes *et al.*, 1989; Kelly and Moring, 1986; Langton and Bowman, 1981; Langton and Bowman, 1980; Mercer, 1989a; Mercer, 1989b; Olivier *et al.*, 1989; Rogers and Van Den Avyle, 1989; Steimle *et al.*, 1999; Steimle and Shaheen, 1999; Stone and Jessop, 1994; USACE, 2001h; USACE, 2003g; USEPA, 1997; Weiss-Glanz *et al.*, 1986.
N/A – not available

- Windowpane Flounder (*Scophthalmus aquosus*);
- Winter Flounder (*Pleuronectes americanus*);
- Scup (*Stenotomus chrysops*);
- Summer Flounder (*Paralicthys denatus*);
- Black Sea Bass (*Centropristis striata*);
- Atlantic Herring (*Clupea harengus*);
- Atlantic Mackerel (*Scomber scombrus*);
- Bluefish (*Peprilus tracantus*).

A summary of EFH designation is provided in Table 4-28 and a more detailed discussion is provided in Appendix H-3 (USACE, 2001h).

Evaluation of Potential Environmental Stressors. The presence of macrophage aggregates (MAs) in the spleens of fish is a potential indication of effects associated with chemical exposure and other environmental stressors. MAs are a sublethal immune response to environmental stressors. It has been demonstrated that the number of MAs in fish spleen, liver and kidney varies depending on the size, nutritional status and health of the species involved (Agius, 1979, 1980; Agius and Roberts, 1981). In addition, there is evidence that the abundance of MAs may be related to chemical contamination (Bucke *et al.*, 1984; Fournie *et al.*, 2001). For example, Fournie *et al.* (2001) concluded that higher densities of MAs may be linked to high concentrations of sediment contaminants.

Macrophage aggregate data for spleens of winter flounder from Long Island Sound were available from the EPA Narragansett-ORD Laboratory (see Section 4.13 and Figure 4-38 for a description of sampling locations). Abundance of MAs was rated based on the percentage of the total area of a tissue section occupied by the MAs (Table 4-29). These percentages were compared to available data from other areas with varying degrees of known environmental stress (*e.g.*, low stress areas such as Georges Bank, Martha's Vineyard versus high stress areas such as East Cape Cod Bay) to develop a numerical rating system to classify the sites as healthy or stressed. For example, an MA abundance of less than 1 percent of the total area of spleen tissue section is typically associated with areas of low environmental stress and was, therefore, assumed to represent a fish population that is generally healthy and exposed to limited stress. Individual samples were assigned a rating of <1 as indicated in Table 4-29. Samples in which the MAs represented at least 1 percent but less than 5 percent of the total area of spleen tissue section were assigned a rating of >1 and can be considered to be under low to moderate stress from disease or environmental degradation. A "+" after the number indicates those tissue sections in which the MA abundance was approaching the high end of the 1 to 5 percent range. Spleen tissue sections in which MAs represented at least 5 percent or greater of the total area of the tissue section were assigned a rating of 5, and are assumed to be associated with high stress from disease or environmental degradation. A rating "5+" indicates sections with values well beyond 5 percent. To derive a numerical rating for each site, the scores applied to each

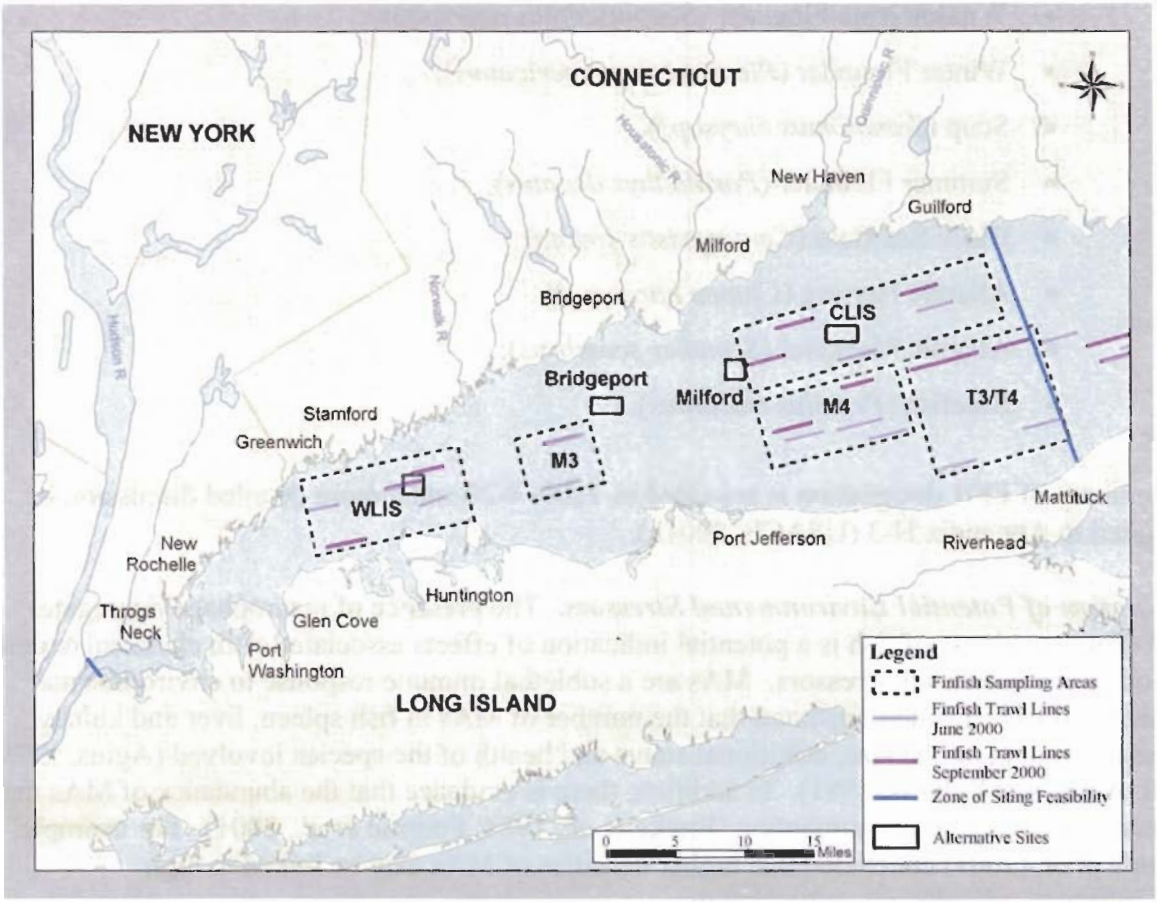

Figure 4-38. Finfish Sampling Locations, June and September, 2000
Source: USACE, 2000f, Appendix H-4

individual sample were assigned a relative numerical value (*i.e.*, 0.8 for <1, 1.2 for >1, 1.4 for >1+, 4.8 for <5, and 5.2 for >5, 5.4 for >5+) and the numerical values averaged.

Based on this analysis, most individual samples were rated as being indicative of generally healthy fish (*i.e.*, <1). However, there were several fish, particularly from the vicinity of the CLIS Alternative, and Strata M4, with individual ratings of 5 or 5+, resulting in average site ratings that indicating low to moderate stress at most locations. MA abundances in the central basin of Long Island Sound may be higher than in the western basin, however, a direct comparison is difficult because fewer samples were collected at the WLIS Alternative and Strata M3. No distinct differences were observed between the alternative sites and the other areas of the Sound evaluated.

Table 4-29. Ratings of Macrophage Aggregates (MAs) in Spleens of Winter Flounder Collected at Representative Areas in Long Island Sound[1]

Site	EPA Sample Number	Individual Sample Rating	Sample 'Score'	Average Site Score	Health Indication
Central Basin					
CLIS Alternative	15495	>1	1.2	1.64	Moderate Stress
	15598	>1	1.2		
	15599	<1	0.8		
	15600	<1	0.8		
	15601	<1	0.8		
	15602	<1	0.8		
	15603	<1	0.8		
	15604	>1	1.2		
	15776	>5	5.2		
	15777	>5+	5.4		
	15778	>1+	1.4		
	15779	>1	1.2		
	15780	<1	0.8		
	15781	>1	1.2		
	15801	<1	0.8		
	15802	>5	5.2		
	15803	>1	1.2		
	15804	<1	0.8		
	15805	<1	0.8		
	15807	>1	1.2		
STRATA M4	15823	<1	0.8	1.94	Moderate to high stress
	15824	>5	5.2		
	15825	>5	5.2		
	15826	<1	0.8		
	15827	<1	0.8		
	15845	>1	1.2		
	15846	<1	0.8		
	15847	<1	0.8		
	15848	>5	5.2		
	15849	<1	0.8		
	15850	<1	0.8		
	15851	<1	0.8		
	15852	<1	0.8		
	15853	>1	1.2		
	15854	>1	1.2		
	15862	>1	1.2		
	15863	<1	0.8		
	15864	<1	0.8		
	15865	>1	1.2		
	15866	>5	5.2		
	15867	>5	5.2		

Table 4-29. Ratings of Macrophage Aggregates (MAs) in Spleens of Winter Flounder Collected at Representative Areas in Long Island Sound[1], continued

Site	EPA Sample Number	Individual Sample Rating	Sample 'Score'	Average Site Score	Health Indication
STRATA T4/T3	15707	<1	0.8	1.44	Moderate Stress
	15708	<1	0.8		
	15709	<1	0.8		
	15710	<1	0.8		
	15711	>1	1.2		
	15712	<1	0.8		
	15713	<1	0.8		
	15714	<1	0.8		
	15715	<1	0.8		
	15731	>5	5.2		
	15732	<1	0.8		
	15733	>5	5.2		
	15734	>1	1.2		
	15735	>1+	1.4		
	15736	<1	0.8		
	15737	<1	0.8		
Western Basin					
STRATA M3	15883	>5	5.2	2.07	Moderate to high stress
	15884	<1	0.8		
	15885	<1	0.8		
	15923	<1	0.8		
	15924	>5+	5.4		
	15925	<1	0.8		
	15926	>1	1.2		
	15927	>1	1.2		
	15964	>1	1.2		
	15928	>5	5.2		
	15929	>1+	1.4		
	15930	<1	0.8		
WLIS	16073	>1	1.2	1.09	Low to moderate stress
	16074	>1	1.2		
	16075	<1	0.8		
	16076	<1	0.8		
	16077	<1	0.8		
	16095	>1+	1.4		
	16114	>1+	1.4		

[1] <1 indicates MAs represent less than 1% of total area of tissue section; >1 indicates MAs represent at least 1% but less than 5% (+ indicates high end of 1% to 5% range); >5% indicates MAs represent at least 5% of the total area of the tissue section (+ indicates values extending well beyond 5%). Numbers in parenthesis are mean numerical ratings based on assignment of: <1 = 0.8; >1 = 1.2; >1+ = 1.5; >5 = 5.2; >5+ = 5.5.
[2] See Figure 4-38 for sampling locations

As previously discussed, MA abundance has been linked with a variety of potential environmental stressors including disease, water quality, and the presence of chemical contamination. The available data indicate that one or more of these stressors may be affecting fish within Long Island Sound, resulting in a low to moderate stress throughout the western and central basins. In general, sediment and tissue concentrations of most organic and inorganic chemicals are relatively low (see Sections 4.x and 4.x) throughout the Sound, so it is not clear whether a correlation can be made between MA abundance and contaminant levels. One possible explanation for the observed MA abundance may be low oxygen concentrations (*i.e.*, hypoxia). As discussed in Section 4.7, hypoxia has been identified as an issue of concern throughout the Sound and, therefore, may be a potential explanation for the observed evidence of 'stress' indicated by the MA abundances.

4.10.2 Western Long Island Sound Alternative

The WLIS Alternative disposal site analysis area contains five sampling stations that were trawled fifteen times in total between 1984 and 2000 (eleven of these trawls occurred in 2000). Due to the limited number of tows conducted at WLIS, caution must be used in comparing trawl data from these tows with those from the other disposal site analysis areas, which typically represent over 150 tows during this sampling period. The data collected from the WLIS Alternative disposal site analysis area can only be considered representative of a single sampling year (2000) but the surrounding habitat areas provide a more complete perspective.

The habitat types found in this disposal site analysis area are deep mud, deep transitional sediments, and, where the area's boundary approaches the Connecticut shoreline, shallow sand. Of the 15 total trawls over the sixteen survey years, the average CPUE for the spring trawls within the vicinity of the WLIS Alternative disposal site analysis area was the highest (890) of all four alternative sites while the average fall CPUE (1,486) was the lowest (Table 4-30). The seasonal average of the 1984 to 2000 surveys was 1,188. The species richness in the WLIS Alternative analysis area was 12.46 in the fall and 12.25 in the spring (Table 4-30). The 2000 trawl surveys are used here as examples of the species that typically dominate the WLIS Alternative analysis area. Winter flounder, windowpane flounder, and scup dominated the catch in the alternative disposal site analysis area during the spring 2000 trawl survey, these three species range widely showing little fidelity for specific locations. The fall 2000 trawl survey found scup and weakfish to be the species with the highest catch numbers. The fall and spring species composition found within the WLIS Alternative analysis area is highly comparable to that found in surrounding habitat areas (areas 15, 16, 17, 18) which include data collected from 72 tows from 1984 to 2000 and provide a more comprehensive assessment of fish resources in the area surrounding WLIS.

Table 4-30. Alternative Dredged Material Site Specific CPUE and Species Richness

	WLIS[1]	Bridgeport	Milford	CLIS
CPUE				
Spring	890	694	476	588
Fall	1486	2693	1856	1982
Seasonal Average	1188	1693	1166	1285
Species Richness				
Spring	12.3	12.65	13.6	14.3
Fall	12.5	12.14	13	13.7

Source: USACE, 2003g; Appendix H-6
[1] The calculation of WLIS values used data derived from 15 tows; the calculation of values for the remaining Alternatives used data from over 100 tows.

4.10.3 Bridgeport Alternative

The Bridgeport Alternative is located in the western basin of Long Island Sound, slightly east of the WLIS Alternative. In total, there are sixteen trawling stations located within the boundaries of the Bridgeport Alternative disposal site analysis area and there are two stations located partially within the alternative itself, one bisecting the eastern border and one bisecting the western border.

Between 1984 and 2000, the Bridgeport Alternative disposal site analysis area received a total of 171 tows at the 16 trawling stations. The average CPUE for the 1984 to 2000 fall trawls was 2,693 (the highest CPUE of any of the four alternative sites) while the average CPUE for spring trawls was 694, giving a seasonal average CPUE for the Bridgeport Alternative analysis area of 1,693 over the 16 survey years (Table 4-30). The average species richness per tow was 12.14 in the spring and 12.65 in the fall (Table 4-30). The high fall CPUE in the Bridgeport Alternative disposal site analysis area has been primarily due to butterfish. The spring CPUE of 694 was not as remarkable as the fall figure, although it was slightly above the average. The 2000 trawl surveys are used here as examples of the species that typically dominate the Bridgeport Alternative disposal site analysis area. Other species caught in large numbers in the fall of 2000 included scup, long-finned squid, and bluefish, although butterfish was indisputably the dominant catch. The spring 2000 catch was dominated by windowpane and winter flounder. None of the species noted are considered residents of this area. According to the CPUE results, the Bridgeport Alternative disposal site analysis area (and the enclosed Bridgeport Alternative) lies within one of the most productive regions of Long Island Sound (Appendix H-6).

4.10.4 Milford Alternative

The Milford Alternative is located in the central basin of Long Island Sound, just south of Milford, Connecticut. In total, there are sixteen trawling stations located within the boundaries of the Milford Alternative disposal site analysis area and there are two stations located partially within the alternative itself, one in the northwest corner and one in the southwest corner.

Between 1984 and 2000, the Milford Alternative analysis area received a total of 137 tows at the 16 trawling stations. The average CPUE for all the fall trawls was 1,856 while the CPUE for all the spring trawls was 476 (the lowest of the four alternative areas), giving a seasonal average CPUE for the Milford Alternative analysis area of 1,166 (Table 4-30). The average species richness per tow was 12.99 in the spring and 13.56 in the fall, which was exceeded only by the richness detected within the CLIS Alternative disposal site analysis area (Table 4-30). The 2000 trawl surveys are used here as examples of the species that typically dominate the Milford Alternative disposal site analysis area. Fall trawls in 2000 in the Milford Alternative disposal site analysis area were dominated by scup and butterfish, while winter and windowpane flounder dominated the 2000 spring trawls (Appendix H-6).

4.10.5 Central Long Island Sound Alternative

A total of 155 tows were made in the CLIS Alternative analysis area between 1984 and 2000. The nearshore areas yielded the highest CPUEs recorded in central Long Island Sound, with the deep mid-basin areas producing the next highest CPUEs (the CLIS site is located in this deeper area). For the 1984 to 2000 fall trawls, the average CPUE at the CLIS Alternative analysis area was 1,982. The average spring CPUE recorded proved to be relatively low at 588, giving a seasonal average over the sixteen years of 1,285 (Table 4-30). Nevertheless, species richness at CLIS was the highest of the four alternative areas with 13.72 in the fall and 14.25 in the spring (Table 4-30). The trawl survey analysis found that the species diversity detected at stations near the analysis area was almost identical to that detected inside the alternative. (Appendix H-6) The 2000 trawl surveys are used here as examples of the species that typically dominate the CLIS Alternative analysis area. The spring 2000 trawls were dominated primarily by winter and windowpane flounder, while the fall 2000 trawls were dominated by scup and butterfish.

4.10.6 Finfish Summary

Species richness in the trawl samples collected from the four alternative sites analysis areas were very similar (about 12 to 14 species per trawl) and do not provide much distinction among alternative sites. However, trawl richness potentially showed an increasing trend from west to east (Table 4-30). The average CPUE estimates showed that the Bridgeport Alternative is situated in one of the most productive areas in the Sound while CLIS was the second most productive. The WLIS Alternative showed high spring, but low fall productivity in 2000. Milford, which had the lowest spring CPUE and the second lowest fall CPUE, is likely in the least productive area evaluated in the ZSF.

4.11 Commercial and Recreational Shellfish Resources

Section 4-9 described the key characteristics of the general benthic community. However, certain species of shellfish also comprise one of the key commercial and recreational fishery resources in nearshore areas of Long Island Sound. A summary of the distribution of these species is provided in this section for both the general Sound and for the specific alternative sites evaluated based primarily on the results of CTDEP trawl surveys described in Section 4.10 and in Appendix H-6. Data from benthic grab samples collected for the benthic characterization studies conducted in support of this DEIS (USACE, 2002g; USACE, 2003f; Appendices H-1 and H-2) were used to evaluate populations of shellfish not collected in the trawls.

4.11.1 Long Island Sound

Important bivalve mollusc resources include the bay scallop (*Argopecten irradians*), eastern oyster (*Crassostrea virginica*), Northern Quahog/hard clam (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), and surfclam (*Spisula solidissima*). The bay scallop is primarily found in the eastern part of Long Island Sound, outside the boundaries of the ZSF and will not be discussed further. With the exception of lobster and longfin squid, commercially and recreationally important shellfish resources of Long Island Sound occur near shore.

Table 4-31 summarizes the location and habits of the Long Island Sound shellfish species that could be present in or near the alternative sites, including their preferred prey, habitat type in which they are typically found, and their common abundance and distribution within the Sound. Additional information is provided below for the American lobster which is perhaps the most significant shellfish species occurring at the alternative sites.

American Lobster. The American lobster (*Homarus americanus*) occurs from Cape Hatteras to Labrador and is found in habitats ranging from shallow coastal waters to subtidal areas with depths of up to 2,300 feet (700 meters) (Idoine, 2000). According to Idoine (2000), lobsters live primarily in rocky areas of coastal waters, but may be abundant in muddy areas in which they can burrow. Small lobsters in coastal waters do not travel long distances, although larger individuals may do so. Offshore, lobster populations are usually found near submarine canyons at the edge of the continental shelf. In contrast to inshore lobsters, those living offshore often migrate considerably, traveling as far as 186 miles (300 kilometers).

The lobster fishery is one of the most important commercial fishing activities along the northeast coast of the United States. Lobsters comprising the catch are typically very close to the minimum allowable size, thus the fishery is very dependent on younger, smaller individuals.

In Long Island Sound, the fishing pressure on the lobster is tremendous. The Long Island Sound fishery is believed to capture 90 percent of the lobsters larger than the legal limit each year (Landers *et al.,* 2001). That statistic, coupled with the observations that lobster abundance generally increased through the 1990s (until 1999; see discussion of episodic lobster mortality) and that fishing efforts have increased, make it unusual that the fishery has persisted (Landers *et al.,* 2001). This persistence may be related to increased reproduction by small female lobsters. Landers *et al.* (2001) found that the abdomen width:carapace length (aw:cl) ratio of females lobsters increased during the 1990s. Because abdomen width is related to reproduction, the increase in aw:cl ration means that lobsters are reproducing at smaller lengths. Because the legal size limit (3 ¼ inch shell length) for lobsters has not changed, it is likely that more of the smaller lobsters (*i.e.,* those below the legal size limit) are reproducing now than in the past (Landers *et al.*, 2001). This earlier reproduction may enable Long Island Sound lobster populations to recover relatively quickly from the heavy fishing pressures.

Table 4-31. Food, Habitat, and Distribution of the Predominant Shellfish Species Present in Long Island Sound

Species	Habitat	Preferred Food	Distribution in LIS
American Lobster (*Homarus americanus)*	Rocky coastal areas; muddy habitats for burrowing; offshore canyons	Fish, crustaceans, echinoderms, polychaetes	Abundant in western and central basins of LIS especially west of Bridgeport alternative site.
Longfin Squid (*Loligo pealeii)*	Primarily pelagic	Fish, crustaceans, squid larvae	Most common throughout the Sound in the summer and fall. Higher abundances in eastern basin of LIS during migrations. High abundances in western basin during summer.
Eastern Oyster (*Crassostrea virginica*)	Attached to natural or artificial hard substrates	Filter feed for phytoplankton, zooplankton, bacteria, detritus	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.
Northern Quahog/ Hard Clam (*Mercenaria mercenaria)*	Sandy or muddy sediments	Filter feed for phytoplankton, zooplankton, bacteria, detritus	CT waters: Occur up to 4 kilometers (2.1 nautical miles) offshore and in water less than 15 meters (49 feet) 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)*	Prefer multi-habitats, including clay, mud, sand, and gravel	Filter feed for phytoplankton, zooplankton, bacteria, detritus	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.
Surfclam (*Spisula solidissima)*	Shallow, subtidal areas with coarse sediments	Filter feed for phytoplankton, zooplankton, bacteria, detritus	CT waters: no abundance data NY waters: Occur in medium abundance along north shore of Long Island.

Female lobsters mate after molting and carry the fertilized eggs under the abdomen until the larvae hatch about eight months later. Eggs hatch in late spring or early summer and the planktonic larvae pass through four developmental stages before metamorphosing into postlarvae and settling to the bottom (Idoine, 2000). Lobsters require five to eight years to attain legal size in Long Island Sound.

Lobsters feed on a variety of foods including fish and other benthic invertebrates including crabs, sea stars, worms, and sea urchins. Predators primarily include fish and predation is likely more intense on juvenile stages than on mature adults.

Distribution in Long Island Sound. Based on the CTDEP data (Appendix H-6) lobsters, which were most abundant on muddy substrates, occurred Sound-wide in all seasons during the study period (*i.e.,* 1984 to 2000). Plots of the catch data indicated that the lobster catch was particularly high in the western Sound area west of the Bridgeport Alternative. Lobster trawl data from WLIS are only available for a small number of tows, primarily from 2000 (after lobster mortality episode, see below). The central basin also yielded relatively high numbers of lobsters. One interesting result of the analyses was that the trawl data did not show the precipitous decline in lobsters shown elsewhere in the western Sound in 1999 (see below). The reason for the apparent differences in the perceptions about the status of the lobster population could be related to the differences in catch characteristics between the lobster pots, for which the decline was best documented and the trawls (Appendix H-6). Trawls may imply higher abundance because in some instances, although lobsters aren't entering the pots they are caught by a trawl being dragged along a flat bottom.

Episodic Lobster Mortality in Long Island Sound. During the last decade, episodes of lobster mortality have occurred occasionally in Long Island Sound. Limited fall mortality often occurs annually as a result of high water temperatures and/or low dissolved oxygen concentrations (CTDEP, 2000). However, CTDEP described several unusual mortality events that occurred in the 1990s. For example, in 1990 to 1991, unusually high lobster mortality was found to result from a bacterial infection called gaffkemia, which is also known as wasting disease or red-tail disease. Gaffkemia contributed to high lobster mortality again in 1993. Beginning in the fall of 1997 and culminating in 1999, a major episode of increasing fall lobster mortality occurred in the Sound. The major mortality event during this episode began in the late summer and early fall of 1999. The early reports of dead or dying lobsters came from fishers in the western Sound, but were soon followed by similar reports from the central Sound. The western region of the Sound was likely affected in 1998 and 1999, whereas the central Sound was only affected in 1999 when the die-off was most severe and affected most of the Sound. The 1999 mortality event was catastrophic to the Long Island Sound lobster fishery, especially in the western Sound where landings were at least 90 percent lower than 1998 landings. The U.S. Secretary of Commerce declared the commercial lobster fishery in Long Island Sound a failure in January 2000 (CTDEP, 2000).

The CTDEP joined with the New York Department of Environmental Conservation to investigate these mortalities. Interviews with lobster fishers and commercial dealers, water quality studies, lobster pathological studies, and analyses of various fisheries data (trawl catches, landings, and catch-per-unit-effort) were used in an attempt to determine the cause and extent of the problem. Based on these data sources, CTDEP (2000) concluded that there was no evidence of a single major contributing factor to the population decline and recommended that additional sampling and testing be conducted. The CTDEP report stated that University of Connecticut scientists had found that the dead lobsters were infested by a small one-celled parasite, paramoeba. The parasite is known to infest lobsters' nervous systems, destroying nerve tissue, causing death within 24 hours (USEPA, 2000b). In a later study of lobster health lead by

University of Connecticut scientists, no evidence of pathological infections other than that of the paramoeba were found and suggested that the mortality event was a result of paramoebiasis, a natural disease (French *et al.,* 2001).

Longfin Squid. The longfin squid (*Loligo pealeii*) is a highly mobile pelagic macroinvertebrate that occurs in the northwestern Atlantic from Newfoundland to the Gulf of Venezuela, but is found in commercially important abundances from Cape Hatteras to Georges Bank (Cargnelli *et al.*, 1999). Populations of the longfin squid living north of Cape Hatteras undertake seasonal migrations, probably in response to changing water temperatures (Hatfield and Cadrin, 2002). During the annual migrations, squid move offshore in late autumn and inshore in spring and early summer. As inshore waters begin to warm, squid move shoreward and populations become concentrated in inshore waters such as Long Island Sound during the summer. These inshore waters are important nursery areas as eggs are laid on the benthic substrates in late spring and early summer. Upon hatching, the pelagic larvae live near the surface of inshore waters. Subadults migrate offshore in fall (Hatfield and Cadrin, 2002).

Distribution in Long Island Sound. Seasonal migration patterns explain the distribution and temporal variability of the longfin squid in Long Island Sound. The primary avenue connecting Long Island Sound to offshore continental shelf regions is through the Sound's eastern ocean passage. Therefore, squid would be expected to be higher in abundance in the eastern Sound during migration periods, with significant numbers occurring in the western Sound in summer. Analyses of trawl data collected from 1984 to 2000 by the CTDEP (Appendix H-6) showed that squid were more common in Long Island Sound in summer and fall than in winter and spring (Cargnelli *et al.*, 1999, Gottschall *et al.*, 2000). Cargnelli *et al.* reported that juveniles were the most abundant stage in May, but were the least abundant stage in winter. Hatfield and Cadrin (2002) described Long Island Sound as a persistent spawning area for Longfin squid from May to July.

Eastern Oyster. The eastern oyster (*Crassostrea virginica*) ranges from the Gulf of the St. Lawrence to the Gulf of Mexico. Oysters filter feed on planktonic organisms. Oyster farming constitutes a very important industry in Connecticut with current annual sales of $60 million, representing an annual harvest of more than 700,000 bushels (CTDAG, 2002). Oyster farmers use several culture methods to raise oysters on leased parcels of the Sound floor off Connecticut. The farming method requires that the oysters be grown in relatively shallow waters close to shore. In New York, oysters are found in low to medium abundances close to shore. The fishery occurs in relatively shallow waters as mechanical means can not be used to harvest oysters. The New York fishery is much smaller than that in Connecticut. Eastern oysters were not found at any of the alternative sites during the recent sediment characterization surveys conducted in support of this DEIS (Appendix H-1, Appendix H-2).

Clams. The Northern Quahog/hard clam (*Mercenaria mercenaria*), softshell clam (*Mya arenaria*), and surfclam (*Spisula solidissima*) are three species discussed briefly here because all occur in soft-bottom habitats and their possible presence in the alternative sites should be considered. Some of the biological characteristics of the species are listed in Table 4-31. The primary fishery areas for these clams are shallow waters.

4.11.2 Western Long Island Sound Alternative

The motile shellfish resources at the WLIS Alternative were evaluated by using the trawl data collected from 1984 to 2000 (with the majority of samples from 2000) (Appendix H-6) and the recent benthic characterization study performed in support of this DEIS (Appendix H-1).

The WLIS Alternative analysis area had relatively more lobsters than either the Milford or CLIS Alternative analysis areas in the year 2000. The 2000 trawl data showed that the average CPUE for WLIS was 116 lobsters in the fall and about 110 in the spring.

Longfin squid were less abundant at WLIS than at the other alternative sites. About 42 squid per tow were recorded at WLIS in the fall and only 1 squid per tow in the spring.

Based on benthic characterization surveys conducted in support of this DEIS, none of the commercially harvested clam species, or the eastern oyster, occurred in benthic samples collected at the WLIS site during recent benthic characterization studies and there is no evidence of substantial populations there.

4.11.3 Bridgeport Alternative

The motile shellfish resources at the Bridgeport Alternative were evaluated by using the trawl data collected from 1984 to 2000 (Appendix H-6) and the recent benthic characterization study performed in support of this DEIS (Appendix H-2).

The site-specific analyses of the 1984 to 2000 trawl data determined that lobsters were more numerous at the Bridgeport Alternative analysis area than elsewhere in the Sound. Tows from the Bridgeport Alternative analysis area averaged 207 lobsters in the fall and 171 lobsters in the spring.

Longfin squid were slightly more abundant at the Bridgeport Alternative than at the Milford or CLIS Alternatives. In general, there were about 210 squid per tow in the fall and 2 squid per tow in the spring.

Based on the benthic characterization survey conducted in support of this DEIS, none of the commercially harvested clam species, or the eastern oyster, occurred in benthic samples collected at the Bridgeport Alternative and there is no evidence of substantial populations there.

4.11.4 Milford Alternative

The motile shellfish resources at the Milford Alternative were evaluated by using the trawl data collected from 1984 to 2000 (Appendix H-6) and the recent benthic characterization study performed in support of this DEIS (Appendix H-2).

The site-specific analyses of the 1984 to 2000 trawl data determined that lobsters were less abundant at the Milford Alternative analysis area than at the other alternative sites, although similar to CLIS. Tows from the Milford Alternative analysis area contained about 70 lobsters in the fall and 34 lobsters in the spring.

Longfin squid were slightly less abundant at the Milford Alternative than at the Bridgeport and CLIS Alternatives, but substantially more than WLIS. In the fall, about 179 squid per tow were recorded and about 10 squid per tow in the spring.

Based on the benthic characterization survey conducted in support of this DEIS, none of the commercially harvested clam species, or the eastern oyster, occurred in benthic samples collected at the Milford Alternative and there is no evidence of substantial populations there.

4.11.5 Central Long Island Sound Alternative

The motile shellfish resources at the CLIS Alternative were evaluated by using the trawl data collected from 1984 to 2000 (Appendix H-6) and the recent benthic characterization study performed in support of this DEIS (Appendix H-1).

The site-specific analyses of the 1984 to 2000 trawl data determined that lobsters were slightly more abundant at CLIS than at the Milford Alternative analysis area, but were less abundant than at the WLIS or Bridgeport Alternative sites. Tows from the CLIS Alternative analysis area averaged 82 lobsters in the fall and 40 in the spring. However, tows in parts of CLIS contained an average of 137 lobsters per tow (averaged over all years of data).

Longfin squid were slightly more abundant at the CLIS Alternative than at the Milford Alternative. There were about 195 squid per tow in the fall and 19 squid per tow in the spring.

Based on the benthic characterization surveys conducted in support of this DEIS, the hard clam is the only commercially harvested mollusk species occurring at the CLIS Alternative. The data evaluated provided no evidence that there is a substantial population of this species at CLIS.

4.11.6 Shellfish Summary

Only two of the shellfish species considered in this section, lobster and longfin squid, are of sufficient abundance at the alternative sites to be considered in the evaluation. Lobsters, which have considerable commercial value in Long Island Sound, were most abundant at Bridgeport and WLIS and least abundant at CLIS and Milford. Abundances of longfin squid in the fall were similar among Bridgeport (which had the highest number), CLIS, and Milford. Squid were less abundant at WLIS. These data indicate that the Bridgeport Alternative site probably has the best shellfish resource among the alternative sites. Milford may have the lowest shellfish resource value at present because the site had the lowest lobster abundances and the next to lowest squid abundances among the sites.

4.12 Birds, Marine Mammals, Reptiles, and Endangered and Threatened Species

In addition to the fish and aquatic invertebrates discussed above, there are a number of other ecological species that may be affected by disposal activities. Due to their mobility, information on the use of the alternative sites by birds, mammals, and reptiles is not available, therefore this evaluation focused on identifying species relevant to Long Island Sound and determining the likelihood that they will frequent the offshore areas associated with the alternative sites. To ensure compliance with NEPA, CWA Section 404, MPRSA Criteria 228.6(a)(2), and the

Endangered Species Act, a list of birds, mammals, reptiles, and endangered and threatened species with ties to Long Island Sound (including the shoreline) was developed based on information obtained from CTDEP, the Federation of New York State Bird Clubs, NYSDEC, the Audubon Society, NMFS, Mystic Aquarium, and USFWS, as well as relevant literature and internet sources. A summary of the information collected for each species identified is listed in the sections below.

4.12.1 Marine and Coastal Birds

The coast of the Atlantic Ocean supports a large number of resident and migratory marine and coastal birds (MMS, 1991). Dozens of marine and coastal birds migrate through Long Island Sound annually as noted by the states of Connecticut and New York during winter waterfowl surveys and breeding bird surveys and at other times of the year by local Audubon Societies (personal communication, Mr. Min Wong, CTDEP; Mr. Ronald Bourque, Federation of New York State Bird Clubs, January 2003). Based on the sources described, the following birds were identified as occurring within Long Island Sound.

Long Island Sound

Birds commonly known to inhabit the coastal or pelagic Long Island Sound area are listed in Table 4-32. Included in this table are the type of habitats each bird frequents and the season during which it is typically present in the Long Island Sound area, as well as the likelihood that it would visit open-water areas like the alternative sites. Birds listed in the table as "rarely" to use the offshore or open-water areas may be seen resting in open-water areas on a rare occasion, but, based on the consideration of their preferred habitat and foraging behavior, do not rely on the area for food or nesting sources. These birds would only use the open-water area as a temporary stopping point during their travels. Other birds in the table have been listed as "occasional." These birds are known to look for food sources in deeper waters including parts of Long Island Sound, thus may be seen anywhere within Long Island Sound.

In addition to the birds listed in Table 4-32, Connecticut and New York record and monitor birds that are on either federal or state endangered or threatened species lists. Endangered and Threatened species are listed and discussed in Section 4.12.3.

Waterfowl. The preferred habitat of waterfowl includes coastal ocean waters, bays, sounds, estuaries, lagoons, and tidal wetlands (Alsop, 2001). Waterfowl, like shorebirds, are migratory and breed within inland regions. However, the foraging habitats of some of these species may lead them to deeper waters such as those found in Long Island Sound. Dabbling ducks, such as mallards, widgeons, and pintails, feed in shallow subtidal and intertidal areas and would not be observed in deeper water. In contrast, diving ducks, such as scaup and canvasbacks, dive to about 20 feet (6 meters) or more to feed on smaller bivalves, other invertebrates, fish, and plants. Sea ducks, such as scoters and eiders, may feed at much deeper depths, some at well over 100 feet (30 meters).

Table 4-32. Coastal and Pelagic Bird Species Found in Long Island Sound[1]

Bird Species	Preferred Habitat	Seasonal Presence	Use of offshore, open-water areas
WATERFOWL			
Dabbling Ducks			
Mallard (*Anas platyrhynchos*) *^	Bays	Resident	None
American Black duck (*Anas rubripes*) *^	Bays, estuaries, rivers	Resident	None
Gadwall (*Anas strepera*) *^	Marshes	Resident	None
Northern pintail (*Anas acuta*)	Salt bays	Summer	Rarely
American wigeon (*Anas americana*) ^	Bays, coastal marshes	Winter	Rarely
Eurasian wigeon (*Anas penelope*)*	Shallow coastal estuaries, sheltered bays	Winter	Rarely
Northern shoveler (*Anas clypeata*)	Salt bays	Summer	Rarely
Wood duck (*Aix sponsa*)	Marshes	Summer	None
Green-winged teal (*Anas crecca*)	Salt bays	Winter	Rarely
Diving Ducks			
Canvasback (*Aythya valisineria*) ^	Salt bays, estuaries	Winter	Rarely
Redhead (*Aythya americana*)	Salt bays, estuaries	Winter	Rarely
Ring-neck duck (*Aythya collaris*)	Bays	Winter	Rarely
Greater scaup (*Aythya marila*) *^	Bays, estuaries	Winter	Occasional
Lesser scaup (*Aythya affinis*) *^	Bays, estuaries	Winter	Occasional
Ruddy duck (*Oxyura jamaicensis*) ^	Salt bays, rocky and sandy seashore	Winter	Rarely
Tufted duck (*Aythya fuligula*)*	Shallow coastal bays, estuaries	Winter	Rarely
Sea Ducks			
Common eider (*Somateria mollissima*)	Rocky coasts, shoals	Winter	Rarely
King eider (*Somateria spectablilis*)	Coasts, ocean	Winter	Occasional
Harlequin duck (*Histrionicus histrionicus*)	Rocky coastal waters	Winter	Rarely
Surf scoter (*Melanitta perspicillata*) ^	Ocean surf, salt bays	Winter	Rarely
Black scoter (*Melanitta nigra*)	Seacoast, ocean	Winter	Occasional
White-winged scoter (*Melanitta deglandi*)	Salt bays, ocean	Winter	Occasional
Red-breasted merganser (*Mergus serrator*) *^	Coastal bays, rocky and sandy seashore	Winter	Rarely
Hooded merganser (*Lophodytes cucullatus*)	Rivers	Winter	None
Common merganser (*Mergus merganser*) *^	Coastal bays, rocky and sandy seashore	Winter	None
Long-tailed duck (*Clangula hyemalis*) *^	Rocky and sandy seashore, ocean	Winter	Occasional
Bufflehead (*Bucephala albeola*) *^	Rivers	Winter	Rarely
Common goldeneye (*Bucephala clangula*) *^	Rocky coasts	Winter	Rarely
Barrow's goldeneye (*Bucephala islandica*)*	Open bays, estuaries	Winter	Rarely
Oldsquaw (*Clangula hyemalis*)	Open ocean, often far from shore	Winter	Occasional
Other Waterfowl Species			
Mute swan (*Cygnus olor*) *^	Coastal lagoons, salt bays	Resident	Rarely
Brant (*Branta bernicla*) *	Rocky and sandy seashore, estuaries	Winter	Rarely
Canada goose (*Branta canadensis*) *^	Bays	Resident	Rarely
Snow goose (*Chen caerulescens*)	Bays, marshes	Winter	Rarely
Red-throated loon (*Gavia stellata*)	Rocky and sandy seashore, bays, estuaries, oceans	Winter	Rarely
Horned grebe (*Podiceps auritus*)	Coastal waters, rocky and sandy seashore	Winter	Rarely

(Table Continued)

Table 4-32. Coastal and Pelagic Bird Species Found in Long Island Sound[1] (continued)

Bird Species	Preferred Habitat	Seasonal Presence	Use of offshore, open-water areas
Red-necked grebe (*Podiceps grisegena*)	Salt water, rocky and sandy seashore	Winter	Rarely
Double-crested cormorant (*Phalacrocorax auritus*)	Coast, bays, rocky and sandy seashore, rocky cliffs	Resident	Rarely
Great cormorant (*Phalacrocorax carbo*)	Coastal, rocky and sandy seashore	Winter	Rarely
American coot (*Fulica americana*)	Bays	Resident	Rarely
SEABIRDS AND GULLS			
Northern Gannet (*Morus bassanus*)	Open-water, offshore	Spring	Occasional
Black-headed Gull (*Larus ridibundus*)	Coastal waters, shallow estuaries	Winter	Rarely
Herring Gull (*Larus argentatus*)	Coastal waters, offshore waters	Resident	Occasional
Ring-billed Gull (*Larus delawarensis*)	Coastal waters, estuaries	Winter	Rarely
Great Black-backed Gull (*Larus marinus*)	Coastal waters, offshore waters	Resident	Occasional
Iceland Gull (*Larus glaucoides*)	Coastal waters, estuaries, offshore waters	Winter	Occasional
Bonaparte's Gull (*Larus philadelphia*)	Coastal waters, estuaries, offshore waters	Winter	Occasional
SHOREBIRDS			
Greater Yellowlegs (*Tringa melanoleuca*)	Mudflats, estuaries, open beaches	Winter	None
Lesser Yellowlegs (*Tringa flavipes*)	Mudflats, estuaries, open beaches	Winter	None
Willet (*Catoptrophorus semipalmatus*)	Mudflats, beaches, salt marshes	Resident	None
Black-bellied Plover (*Pluvialis squatarola*)	Mudflats, coastal beaches	Winter	None
Killdeer (*Charadrius vociferus*)	Mudflats, shores	Resident	None
American Oystercatcher (*Haematopus palliatus*)	Tidal flats, coastal beaches	Summer	None
Ruddy Turnstone (*Arenaria interpres*)	Beaches, mudflats, rocky shores	Winter	None
Sanderling (*Calidris alba*)	Outer beaches, tidal flats, rocky shores	Winter	None
Purple Sandpiper (*Calidris maritima*)	Rocky shores, jetties	Winter	None
Dunlin (*Calidris alpina*)	Tidal flats, beaches, muddy pools	Winter	None

[1] None of these birds are listed as threatened or endangered, See Table 4-34 for federally and regionally endangered species.
Sources: Alsop, 2001; Peterson, 1980; National Audubon Society, 2002; Sauer *et al.*, 2002; Kaufman, 1996
* Noted during the CTDEP's and Federation of New York State Bird Clubs Winter Waterfowl Survey 2003 in western Long Island Sound.
^ Noted during the CTDEP's and Federation of New York State Bird Clubs Midwinter Waterfowl Survey 2003 in eastern Long Island Sound.

Waterfowl that were recorded during the 2003 Connecticut and New York Winter Waterfowl Surveys in Long Island Sound, conducted by CTDEP and the Federation of New York State Bird Clubs, included: American Black duck (*Anas rubripes*), Canada goose (*Branta canadensis*), and Surf scoter (*Melanitta perspicillata*) (personal communication, Mr. Min Wong, CTDEP and Mr. Ronald Bourque, Federation of New York State Bird Clubs, January 2003). Greater scaup (*Aythya marila*) migrate from northwestern Canada and Alaska across the continent to wintering grounds along the coast between Cape Cod and Chesapeake Bay. Approximately 25 percent of the Atlantic flyway population of greater scaup winters in New York Harbor, especially in Raritan Bay/Sandy Hook Bay and western Long Island Sound.

Colonial Water Birds. The category of colonial waterbirds is a large one, comprising many coastal species including gulls, seabirds, wading birds, and cormorants. Colonial waterbirds are characterized by the colonies of nests that they build along the coast. Wading birds occur in all Atlantic coastal states, but prefer tidal creeks, ponds, marshes, and similar shallow water habitat

and therefore will not visit the deeper waters of Long Island Sound. While the Atlantic coast, including the study area, supports many species of seabirds, these birds typically do not spend much time near the shoreline or in enclosed estuaries, except when breeding and therefore are likely to be only occasional visitors to Long Island Sound. The gull family has several representatives commonly found in the Long Island Sound area and some of these tend toward occasional offshore foraging, potentially bringing them into the deeper waters of Long Island Sound. Finally, cormorants are diving birds, often found foraging offshore for fish; however, their unique feather physiology does not permit their venturing far from dry resting areas and, therefore, this species would not be frequently seen in the deeper waters of Long Island Sound.

Shorebirds. Shorebirds inhabit open beaches, title flats, and marshes. Although the majority of shore birds that occur along the Atlantic coast are migratory, they do not travel as far from land as pelagic birds (MMS, 1991). Shorebirds are either colonial or solitary in nesting habitat, and some species breed in upland areas.

Raptors. Raptors forage while in-flight and many species hunt for fish along the coast. The Northern harrier (*Circis cyaneus*), Osprey (*Pandion haliaetus*), Peregrine falcon (*Falco peregrinus*), and Bald eagle (*Haliaeetus leucocephalus*) are raptors that are listed as being expected in the Long Island Sound area (Alsop, 2001). These four species are protected under the Endangered Species Act and are further described in Table 4-34.

Summary of Birds at the Alternative Sites

Although the alternative sites evaluated are all located within deep water (greater than 50 feet [15 meters]) and are unlikely to support birds that prefer coastal regions (*i.e.*, Shorebirds), these sites could provide foraging habitat for diving ducks, sea ducks, and gulls, as well as resting opportunities for migratory species. Raptors such as the northern harrier (*Circis cyaneus*), osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus*), and bald eagle (*Haliaeetus leucocephalus*) may visit the alternative sites while foraging, but the potential is minimal.

4.12.2 Marine Mammals and Reptiles

Under the Marine Mammal Protection Act (MMPA) of 1972, the NMFS is responsible for protecting and managing marine mammals (*e.g.*, whales, porpoises, seals) and preventing the importation of their products. MMPA established a moratorium on the taking of marine mammals in U.S. waters and the high seas by U.S. citizens with a few exceptions (NOAA, 2003b). To ensure that marine mammals will not be harmed by potential use of open-water alternative sites, the presence of marine mammals has been reviewed in this DEIS.

Long Island Sound

As a semi-enclosed estuary, Long Island Sound provides limited habitat for most marine mammals and reptiles. However, there are several species that are frequent or occasional visitors to the Sound and that may forage in the vicinity of the alternative sites.

Harbor Porpoise. The harbor porpoise (*Phocoena phocoena*) is the smallest cetacean (maximum total length of 5 feet [1.5 meters]) in the western North Atlantic Ocean and 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. Harbor porpoises are typically observed alone or in groups of two to five individuals when in the open ocean. 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 (41 centimeters) long such as herring, capelin, sprat, and silver hake. Most of their food is found near the sea floor but they also forage in the water column. Calves often ingest small crustaceans during the early phases of weaning (Reeves *et al.*, 2002).

Long-finned pilot whale. The long-finned pilot whale (*Globicephala melas*) 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 feet (180 to 500 meters), although they can almost certainly forage deeper if necessary (Reeves *et al.*, 2002). There are at least 10,000 long-finned pilot whales in the western North Atlantic (Reeves *et al.*, 2002).

Pinnipeds. All pinnipeds found in Long Island Sound (harbor seal (*Phoca hispida*), gray seal (*Haliochoerus grypus*), harp seal (*Phoca groenlandica*), and hooded seal (*Cystophora cristata*)) are federally protected, but none are listed as endangered or threatened in the United States or Canada. The most common pinnipeds in the Long Island Sound area are the harbor and gray seals. Harbor seals have been reported in Long Island Sound year-round, with the highest abundance of animals occurring from November through May. Gray seals have also been sighted along the coast and are often sighted with harbor seals (Sadove and Cardinale, 1993). Gray seals have been observed feeding on cod when sighted along the coast. Harbor seals also have been observed feeding on cod, in addition to herring, mackerel, squid, flounder, green crabs, mussels, and whiting (Sadove and Cardinale, 1993). In 1994, it was estimated that 2,010 gray seals populated the areas of Muskeget Island and Monomoy, Massachusetts (NMFS, 1998). The range of these seals is limited primarily to near shore waters.

Reptiles. The only reptiles found in western and central Long Island Sound are the Kemp's ridley sea turtle (*Lepidochelys kempii*) Loggerhead sea turtle (*Caretta caretta*), Leatherback sea turtle (*Dermochelys coriacea*), Green sea turtle (*Chelonia mydas*), and Hawksbill sea turtle (*Eretmochelys imbricata*). All five of these turtles are protected under the Endangered Species Act. See Section 4.12.3 for a description of the turtles and their migratory patterns.

Summary of Marine Mammals and Reptiles at the Alternative Sites

Each of the four alternative sites is located two or more nautical miles (3.7 kilometers or more) from land in waters 15 meters (50 feet) or deeper, therefore each of the four alternative sites have the same findings for marine mammals and reptiles. Those findings are listed below.

Harbor porpoise, long-finned pilot whales, harbor seals, gray seals, harp seals, and hooded seals have been observed within Long Island Sound, although they are not expected to be frequent

residents of the areas surrounding the alternative sites. The harbor porpoise and seals are normally found in shallow waters of bays, estuaries, and harbors.

Long-finned pilot whales spend most of their time in waters greater than 600 feet (183 meters); therefore they are also not expected to frequent the area around the alternative sites.

The only reptiles found in Long Island Sound are five species of turtles listed on the Endangered and Threatened Species list. See Section 4.12.3 for more information on these species.

4.12.3 Endangered and Threatened Species

This section provides a summary of known endangered, threatened, and "special concern" species within the Long Island Sound region. 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 man, 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 because of the 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 2003). Endangered and threatened species are protected under the federal Endangered Species Act, 16 U.S.C. §§ 1531 *et seq*. and under state law while species listed as "special concern" are protected only by state law.

Long Island Sound

Endangered and Threatened Mammals. In general, whales and other marine mammals are not frequently observed in Long Island Sound, however, incidental sightings have resulted in the inclusion of several species on the endangered species list for Connecticut and New York (CTDEP, 2003; NYSDEC, 2003; USFWS, 2003). Table 4-33 lists the species on the federal endangered and threatened whale species list for Connecticut and New York. Pursuant to Section 7 of the Endangered Species Act, EPA requested input from NMFS on the identification of Threatened and Endangered Species in Long Island Sound. Based on information received, marine mammals are not expected to spend significant portions of time within the western and central basins of Long Island Sound, therefore no additional information has been provided.

Endangered and Threatened Reptiles. Sea turtles are the only endangered reptile species noted in the Long Island Sound area. Sea turtles are highly migratory and are often found throughout the world's oceans (NOAA, 1995). Pursuant to Section 7 of the Endangered Species Act, EPA requested input from NMFS, USFWS, CTDEP, and NYSDEC on the identification of Threatened and Endangered Species in Long Island Sound. Their assessment noted the five species of sea turtles as possibly being found in the waters of Long Island Sound.

Table 4-33. Endangered Marine Mammals and Turtles for Connecticut and New York

Species	Federal Status[1]	CT Status[2]	NY Status[3]
Humpback whale (*Megaptera novaeangliae*)	Endangered	Endangered	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered	Endangered	Endangered
Fin whale (*Balaenoptera musculus*)	Endangered	Endangered	Endangered
Right whale (*Eubalaena glacialis*)	Endangered	Endangered	Endangered
Kemp's ridley sea turtle (*Lepidochelys kempii*)	Endangered	Endangered	Endangered
Loggerhead sea turtle (*Caretta caretta*)	Threatened	Threatened	Threatened
Leatherback sea turtle (*Dermochelys coriacea*)	Endangered	Endangered	Endangered
Green sea turtle (*Chelonia mydas*)	Threatened	Threatened	Threatened
Hawksbill sea turtle (*Eretmochelys imbricata*)	Endangered	Endangered	Endangered

Source: [1]USFWS, 2003, [2]CTDEP, 2003; [3]NYSDEC, 2003;

Use of Long Island Sound by turtles appears related to the availability of prey, annual migration patterns, and age. The coastal waters of New York provide an important habitat for juvenile Kemp's 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 Long Island Sound is given below.

- The Kemp's Ridley sea turtle (*Lepidochelys kempii*) is the smallest of the sea turtles and the most endangered sea turtle in the world (NRC, 1990; Carr and 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 Long Island Sound are juveniles, averaging 25 to 30 centimeters (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 the Gardeners Bay (Sadove and Cardinale, 1993). In Long Island Sound, where crustaceans represent more than 80 percent of the diet, nearly all feeding takes place on or near the bottom in shallow water (Morreale and Standora, 1992; Morreale and Standora, 1993; Burke *et al.,* 1994). Young Ridley's consume several species of crabs, including spider crabs, lady crabs, and rock crabs (Morreale and Standora, 1992; Morreale and Standora, 1993).

- The loggerhead sea turtle (*Caretta caretta*) is listed as threatened throughout its range under the endangered species act (NMFS, 2002a). 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, 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 Long Island Sound; the second group is more oceanic, and is generally found along the south shore of Long Island and up to 40 miles (64 kilometers) offshore (Sadove and 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 and Cardinale, 1993). Abundance estimates of loggerheads along the U.S. Atlantic coast are difficult to make due to the short time turtles spend on the surface where they can be spotted from a plane or boat.

- The leatherback turtle (*Dermochelys coriacea*) 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 (150 to 170 centimeters) SLCL (straight line carapace length; large outstretched front flippers may span 270 centimeters [106 inches] in an adult) and a weight of 441 to 1,543 pounds (200 to 700 kilograms). Leatherbacks are more widely distributed as adults, as compared to other sea turtles, 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 (Friar *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 and 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 feet [400 meters], within an average of 197 feet [60 m]) 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.

- The green turtle (*Chelonia mydas*) is the largest of the hard-shelled sea turtles. Adult green turtles reach lengths of 36 to 43 inches (91 to 109 centimeters) SLCL and weights of up to 397 pounds (180 kilograms) (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 man on its eggs, erosion and fortification of nesting beaches, use of off-road vehicles on beaches, and on 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, the only species of sea turtle that is a strict herbivore as an adult, 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 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 New York or Massachusetts, 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.

- The hawksbill sea turtle (*Eretmochelys imbricata*) 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 (62 to 94 centimeters) SLCL and weigh about 176 pounds (80 kilograms) (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, hawksbill's occur along the Gulf of Mexico coast, especially in south Texas, along the Gulf and Atlantic coast of Florida, particularly around reefs of Palm Beach County and in the Florida Keys were the warm Gulf Stream comes close to shore, and Puerto Rico, particularly the islands of Mona, Culebra, and Vieques, and in the U.S. Virgin Islands. Hawksbill turtles are listed as endangered throughout their range worldwide. Their decline throughout their range 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 (20 to 25 centimeters) 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).

Endangered and Threatened Fish. The shortnose sturgeon (*Acipenser brevirostrum*) is listed as an endangered species in both the state of Connecticut (CTDEP, 2003) and New York (NYDEC, 2003) and is managed by NMFS under the Endangered Species Act. Shortnose sturgeon occur in the lower Connecticut River from the Holyoke Pool to Long Island Sound. Shortnose sturgeon spawn in fresh water from the end of March to the first week of May (CTDEP, 2003). 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 do not appear to make long-distance offshore migrations (NMFS, 2001e). It can be inferred that shortnose sturgeon utilizes portions of Long Island Sound since it is known to spawn in the Connecticut River. Shortnose sturgeon have not been observed in Long Island Sound during CTDEP trawls since 1984 (Appendix H-6).

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is listed as "threatened in inland waters" for the state of Connecticut (CTDEP, 2003). This designation means that the Atlantic sturgeon is not protected within the waters of Long Island Sound under the 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" (personal communication Tom Savoy, Connecticut Marine Fisheries Division). This proposal is still under consideration at this time.

Atlantic sturgeon is an anadromous species that lives up to 60 years, reaching lengths up to 14 feet (4 meters) and weighing over 800 pounds (363 kilograms) (NMFS, 2001f). Long Island

Sound may be an important feeding or resting area on-the-way to and from spawning areas in the Hudson River because all sizes of Atlantic sturgeon have been seen or captured in the Sound. Atlantic sturgeon were caught in all three basins of Long Island Sound but were mainly located in the vicinity of Falkner Island (Savoy and Pacileo, 2003). More detail about the life history and distribution of this species is found in Appendix H-3.

Endangered and Threatened Birds. Table 4-34 lists the Federal and state endangered and threatened coastal and marine birds and bird species of special concern that have been recorded in Connecticut or New York and may occur within the Long Island Sound region. As shown in the table, none of these species is expected to occur at the alternative sites due to their foraging and breeding requirements.

Table 4-34. Federal and State Endangered and Threatened Birds, and Birds of Special Concern in the Long Island Sound Area

	Classification	Season	Federal Status	CT State Status	NY State Status	Use of offshore, open-water areas
Black tern (*Chlidonias niger*)	Colonial waterbird	Spring – early fall	--	--	Endangered	None
Common tern (*Sterna hirundo*)	Colonial waterbird	Spring – early fall	--	--	Threatened	Occasional
Least tern (*Sterna antillum*)	Colonial waterbird	Spring – summer	--	Threatened	Threatened	Occasional
Roseate tern (*Sterna dougallii*)	Colonial waterbird	Spring – early fall	Endangered	Endangered	Endangered	Occasional
Great egret (*Ardea albus*)	Colonial waterbird	Summer	--	Threatened	--	None
Black rail (*Laterallus jamaicensis*)	Marsh	Spring – fall	--	Endangered	Endangered	None
Common Loon (*Gavia immer*)	Pelagic	Winter	--	--	Special Concern	Occasional
Pied-Billed Grebe (*Podilymbus podiceps*)	Pelagic	Permanent	--	Endangered	Threatened	None
Bald eagle (*Haliaeetus leucocephalus*)	Raptor	Winter	Threatened	Threatened	Threatened	None
Northern harrier (*Circis cyaneus*)	Raptor	Resident	--	Endangered	Threatened	None
Osprey (*Pandion haliaetus*)	Raptor	Spring and early-late fall	--	--	Special concern	None
Peregrine falcon (*Falco peregrinus*)	Raptor	Early fall		Endangered	Endangered	None
Piping plover (*Charadrius melodus*)	Shore	Spring – early fall	Threatened	Threatened	Threatened	None
Willet (*Catoptrophorus semipalmatus*)	Shore	Spring – early fall	--	Special concern	--	None

Source: NYSDEC Endangered Species List (www.dec.state.ny.us/website/dfwmr/wildlife/endspec/etsclist.html) 12/31/2002; CTDEP Wildlife Division Endangered and Threatened Species Series (http://dep.state.ct.us/burnatr/wildlife/learn/esfact.htm) 12/31/2002; USFWS, 2003, Alsop, 2001

Summary of Endangered and Threatened Species at the Alternative Sites

Each of the four alternative sites is located two or more nautical miles (3.7 kilometers or more) from land in waters 15 meters (50 feet) or deeper, therefore each of the four alternative sites have the same findings for the endangered and threatened species. Those findings are listed below.

Use of the alternative sites by whales and endangered birds would be on an incidental basis only. Although Atlantic sturgeon (threatened in inland waters) and Shortnose sturgeon (endangered) are listed on the Connecticut and New York (shortnose only) Endangered and Threatened species lists, the abundance of these species near the sites appears to be relatively low based on available information. In addition, these species are only present seasonally, from April to November. The incidental occurrence of a Kemp Ridley, Loggerhead, Leatherback, Green and Hawksbill sea turtle in the Long Island Sound area indicates that there is a slight chance that it may inhabit or travel through part of the alternative sites 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.

4.13 Contaminant Levels in Selected Species

As previously discussed, chemical contaminants are present in the sediments and surface waters of Long Island Sound (see Sections 4.7 and 4.8). These contaminants are available to aquatic receptors through a variety of pathways, including direct uptake (*e.g.,* bioconcentration or bioaccumulation) and through ingestion of contaminated prey. Once in the tissues of aquatic organisms, these chemicals can pose a health threat both to the organism directly and to other organisms (*e.g.*, upper trophic level species, humans) that consume them. This section provides a summary of contaminants in the tissues of representative organisms from Long Island Sound that either live in close association with the sediments or are likely to accumulate elevated tissue levels of these contaminants, such as benthic invertebrates and fish. An evaluation of Sound-wide tissue data is provided below, followed by consideration of information relative to the alternative sites evaluated.

While bioaccumulation of a contaminant by an organism may or may not result in detrimental impacts to the organism, it can be an indicator that a population of the same or similar organisms, or of higher trophic-level organisms that prey on the contaminated organisms, or both, may be potentially at risk of impact. Potential risks associated with the bioaccumulation of chemicals from sediments at each of the alternative sites were evaluated using an approach similar to that used by EPA for the purpose of screening dredged material proposed for ocean disposal as part of 40 CFR 228.10[4]. EPA applies this approach as a conservative screening tool to inform management decisions. A complete description of this approach as applied in the New

[4] EPA applies a tiered approach to evaluating dredged material for suitability for ocean disposal beginning with a chemical analysis of sediments focusing on a specific list of analytes, followed by various toxicity tests and finally a risk-based assessment of measured bioaccumulation. The risk-based assessment of bioaccumulation consists of three steps: 1) comparison of bioaccumulation test results to FDA Action/Tolerance Levels; 2) comparison to ecological reference effects levels available from FDA or the literature; and 3) evaluation of carcinogenic and non-carcinogenic risks to human health resulting from consumption of fish, lobster, and shellfish exposed through food chain transfers. Risk estimates are calculated using standard exposure equations and assumptions for the consumption of fish as outlined by USEPA (1989).

England region is available in the testing memos template used by EPA New England as part of the disposal application process (Appendix H-10).

Risks were evaluated using the tissue data available from the alternative disposal sites as described above and in Appendix H-10. Specifically, available tissue concentrations were compared to reference concentrations developed by FDA or from the literature to determine the potential for risks to ecological and human receptors. These reference levels represent concentrations in tissue that are believed to be safe to humans and/or aquatic organisms. It is assumed that concentrations below these levels will not be associated with adverse effects, while concentrations that exceed may result in impacts to health. In addition, carcinogenic and non-carcinogenic human health risks associated with the consumption of fish and shellfish were calculated. A more complete description of the methods used for the risk evaluation is provided in Appendix H-10.

The National Oceanic and Atmospheric Administration (NOAA) has conducted the most comprehensive studies of tissue concentrations within Long Island Sound as part of the National Status and Trends (NS&T) Mussel Watch and Benthic Surveillance Programs. The intent of these programs is to provide long-term monitoring data of contaminant levels for the purpose of detecting changes that are occurring in the environmental quality of estuarine and coastal waters. As part of the Benthic Surveillance Program (Harmon *et al.,* 1998), winter flounder have been collected periodically from four locations within the Sound (see "Benthic Surveillance sites" in Figure 4-39) since 1984 and analyzed (liver tissue only) for metals and a number of organic chemicals including PCBs, PAHs, and pesticides. Since 1986, mussels have been collected from nine additional locations (Figure 4-39) and analyzed for the same chemicals as part of the National Mussel Watch Program (O'Connor and Beliaeff, 1995). These data were used as the basis of the Sound-wide evaluation.

Tissue concentrations were measured Sound-wide to characterize bioaccumulation in Long Island Sound and the alternative sites in support of this DEIS (Appendix H-5). Contaminants evaluated included metals, PCB congeners, PAHs, chlorinated pesticides, butyltins, dioxin/furans, radionuclides, and lipids in fish, lobster, worm, and clam tissue. The parameters measured were a result of interagency coordination.

Finfish. Finfish collection was coordinated by Corps and EPA with the 2000 Long Island Sound Trawls Survey conducted by CTDEP (USACE, 2000f). As discussed in Section 4-11, CTDEP conducts trawls annually for the purpose of evaluating the fish populations within the Sound. Fish were collected from specific CTDEP trawls grouped around five areas representing various habitat types within the Sound (Figure 4-38). Fish collected from each of the five areas were combined by species into composite samples. A summary of the areas evaluated is provided below:

- Strata M4: This area is comprised of trawl stations located in mud strata deeper than 90 feet (27 meters) in the central region of Long Island Sound. This deep mud habitat is representative of habitat conditions in the south central Long Island Sound.

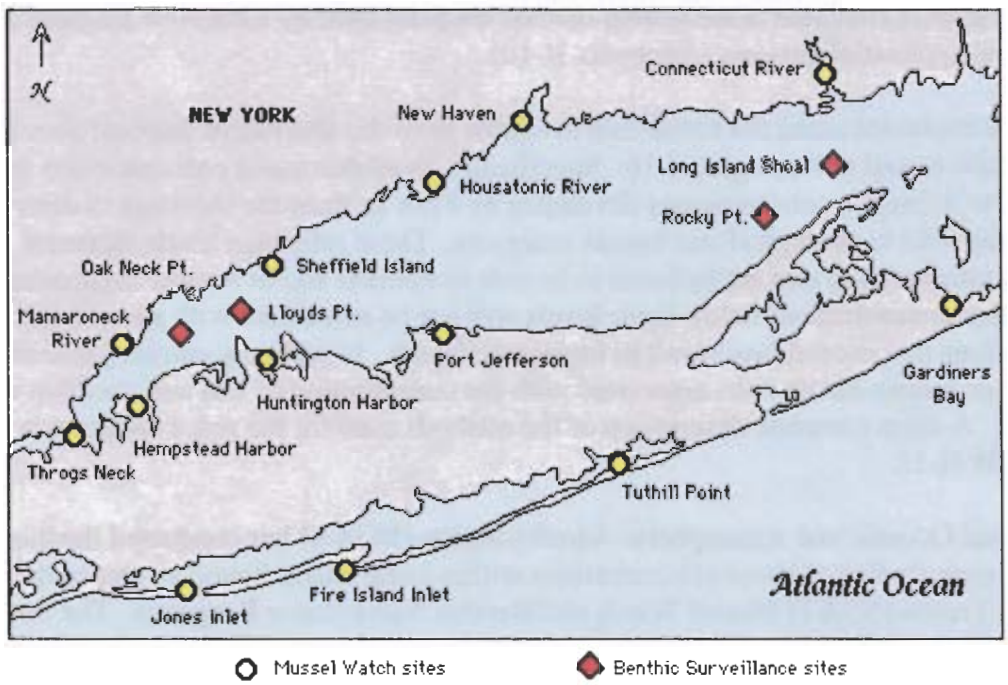

Figure 4-39. NOAA NS&T Sampling Sites for Mussels (*i.e.*, Mussel Watch sites) and Winter Flounder (*i.e.*, Benthic Surveillance sites) in Long Island Sound

Source: http://ccmaserver.nos.noaa.gov/NSandT/SitenoLIS.html

- Strata M3: This area is comprised of trawl stations representing mud strata at depths between 60 and 90 feet (18 to 27 meters) in an area between WLIS and Stratford Shoal at least one nautical mile from known historic dredged material disposal areas.
- Strata T4/T3: This area is comprised of trawl stations located in transitional (*i.e.*, mud to sand) areas with depths from 60 to 90 feet (18 to 27 meters) in the central region of Long Island Sound.
- WLIS: This area is comprised of trawl stations from areas representative of habitat in the vicinity of the WLIS Alternative (Figure 4-38) were combined. One station was located across the disposal site.
- CLIS: This area is comprised of trawl stations from areas representative of habitat in the vicinity of the CLIS Alternative.

Species composited from each area focused on the most common large demersal species available in June and September (*i.e.*, winter flounder, scup). Migratory top predators (*i.e.*, striped bass in June and bluefish in September) were also collected to evaluate bioaccumulation within Long Island Sound as a whole. Fillets from these four species were evaluated for each of the chemical parameters described above. In addition, liver and bone analyses were conducted on samples from winter flounder. Bone from winter flounder was analyzed for radionuclides. Winter flounder livers were also analyzed for the entire parameter list, in a subset of composite

samples. The fillet represents the edible portion of the fish, while the liver provides additional details about the potential for physiological effects on the individual fish. A detailed summary of these data is provided in Appendix H-5 and a more detailed description of the survey methods is provided in USACE (2000f).

Lobster. Lobster were collected in 2000 from within the WLIS Disposal Site and the CLIS Disposal Site as well as from three reference areas representing various habitat types within the Sound (Figure 4-40; USACE 2000g). In addition to evaluating the disposal sites, the sampling locations were selected to represent an east-west gradient across Long Island Sound. The metals and organic chemicals described above were evaluated in both muscle tissue (*i.e.*, "meat") and in the hepatopancreas, both of which represent edible portions of the lobster.

Benthic Invertebrates. Tissue concentrations were measured in clams (*Pitar morrhuana*) and worms (*Nephtys incisa*) collected from sampling locations within the CLIS Alternative and its reference station (see Table 4-12 for a list of stations). These tissues were analyzed for the same suite of metal and organic parameters, as well as the radionuclides (USACE 2002i; USACE 2002j; Appendix H-5).

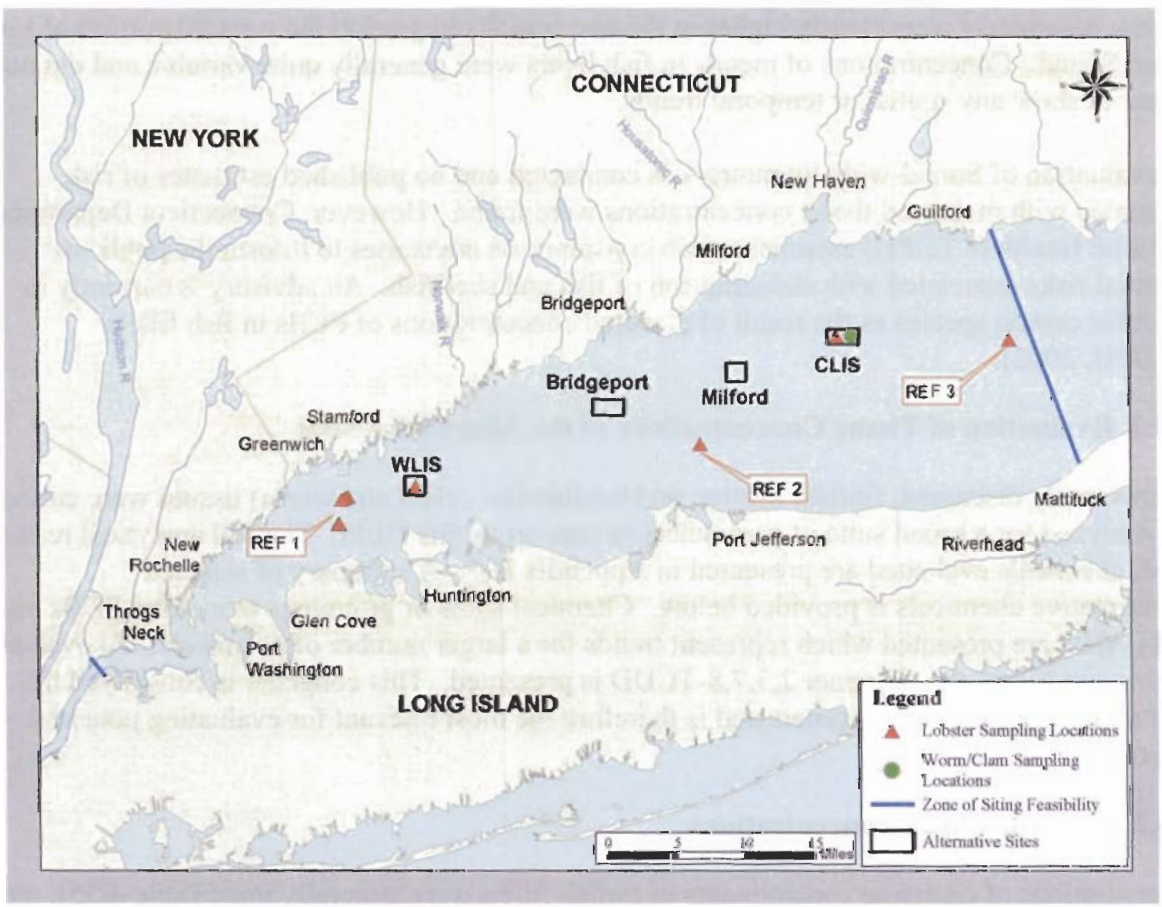

Figure 4-40. Benthic Tissue (Lobster, Clam, and Worm) Sampling Locations
Source: USACE, 2003f, Appendix H-2

4.13.1 Long Island Sound

In general, concentrations of most metals and organic chemicals in fish livers and mussel tissues from Long Island Sound are comparable to those reported nationwide, indicating that conditions in Long Island Sound are comparable to most other estuaries (Turgeon *et al.*, 1989; O'Connor and Beliaeff, 1995). However, some of the organic chemicals, most notably PCBs, tended to be near the higher end of the national range (Turgeon *et al.*, 1989).

Based on the NS&T mussel watch results, chemical concentrations in mussels from Long Island Sound have generally decreased since 1984 (O'Connor and Beliaeff, 1995), particularly in the western basin. However, results in some areas, such as near the Housatonic River and New Haven, have shown very little decrease in mussel tissue concentrations. Metals and PCB concentrations in mussels from the Housatonic River station are the highest found in the central and eastern portions of the Sound (O'Connor and Beliaeff, 1995). Overall, concentrations of both metals and organics tended to be higher in the most western portions of the Sound. With respect to analysis of winter flounder livers, temporal trends are difficult to discern given the short time period over which the data are available (*i.e.*, three or four years of data between 1984 and 1991 [O'Connor and Beliaeff, 1995]). Spatially, however, concentrations of the organic parameters were clearly higher in the two stations located in the western portion of Long Island Sound. Concentrations of metals in fish livers were generally quite variable and did not appear to show any spatial or temporal trends.

An evaluation of Sound-wide literature was conducted and no published estimates of risk associated with measured tissue concentrations were found. However, Connecticut Department of Public Health (CTDPH) establishes fish consumption advisories to inform the public of potential risks associated with consumption of fish and shellfish. An advisory is currently in effect for certain species as the result of elevated concentrations of PCBs in fish fillets (CTDPH, 2002).

4.13.2 Evaluation of Tissue Concentrations at the Alternative Sites

As previously discussed, finfish, lobster, and benthic (*i.e.*, clam and worm) tissues were collected and analyzed for a broad suite of parameters in support of this DEIS. The full analytical results for all chemicals evaluated are presented in Appendix H-5. A summary of selected representative chemicals is provided below. Chemical sums or groupings (*e.g.*, total PCBs and total PAHs) are presented which represent trends for a larger number of chemicals. To evaluate dioxins and furans the congener 2,3,7,8-TCDD is presented. This congener is considered the most toxic of the dioxin congeners and is therefore the most relevant for evaluating potential effects.

4.13.2.1 Finfish Tissue Concentrations

Concentrations of chemical contaminants in finfish fillets were generally low (Table 4-35). For winter flounder and scup, concentrations were generally consistent among species and highest at either Strata M3 or Strata M4. In general, organic compounds measured were higher in scup collected in September relative to June; however, winter flounder did not show substantial seasonal variation. Overall, the highest concentrations of organic contaminants were found in

Table 4-35. Summary of Finfish Fillet Concentrations[1]

Chemical	Winter Flounder				
Area	**WLIS[2]**	**Strata M3[2]**	**CLIS[2]**	**Strata M4[3]**	**Strata T4/T3[2]**
Lipid (%)	4.4	6.9	5.6	4.0	8.5
Organic Chemicals (µg/kg wet wt)					
Total PAH	2.0	5.3	1.6	1.2	1.8
Total PCB[5]	64.2	98.4	95.2	53.8	77.4
Total DDT	5.2	7.2	7.2	4.0	6.2
Dieldrin	0.83	0.83	0.90	0.41	0.78
Chlordane	1.30	1.36	1.22	0.76	0.96
Dioxin/Furan (ng/kg wet wt)					
2,3,7,8-TCDD	0.76 U	0.65 U	1.1 U	1.1 U	0.66 U
Metals (mg/kg wet wt)					
Arsenic	1.8	6.9	3.4	4.2	5.3
Cadmium	0.002	0.001 U	0.003	0.001 U	0.001 U
Chromium	0.16	0.15	0.16	0.05 U	0.05 U
Copper	0.18	0.10	0.18	0.10 U	0.14
Lead	0.006	0.17	0.011	0.014	0.068
Mercury	0.020	0.025	0.015	0.015	0.020
Nickel	0.023 U	0.033 U	0.026 U	0.026 U	0.026 U
Silver	0.001 U	0.002 U	0.001 U	0.003	0.002
Zinc	6.9	6.8	8.0	6.7	7.6
	Scup				
Lipid (%)	4.5	15.4	9.8	13.7	6.9
Organic Chemicals (µg/kg wet wt)					
Total PAH	1.8	2.8	2.3	3.8	1.8
Total PCB[5]	74.4	166.4	120.2	155.6	68.6
Total DDT	7.0	12.7	8.3	12.5	4.9
Dieldrin	0.99	2.91	2.10	2.83	0.57
Chlordane	0.83	0.76	0.58	0.94	0.46
Dioxin/Furan (ng/kg wet wt)					
2,3,7,8-TCDD	0.87 U	0.83 U	1.2 U	0.91 U	1.0 U
Metals (mg/kg wet wt)					
Arsenic	1.0	1.1	1.6	1.8	2.4
Cadmium	0.002	0.002	0.002	0.002	0.001
Chromium	0.19	0.093	0.051 U	0.051 U	0.076
Copper	0.38	0.44	0.32	0.51	0.35
Lead	0.003 U	0.075	0.005	0.041	0.003 U

(Table Continued)

Table 4-35. Summary of Finfish Fillet Concentrations[1] (continued)

Chemical	Scup				
Area	WLIS[2]	Strata M3[2]	CLIS[2]	Strata M4[3]	Strata T4/T3[2]
Mercury	0.060	0.088	0.063	0.055	0.041
Nickel	0.027 U	0.026 U	0.026 U	0.090	0.022 U
Silver	0.002	0.001 U	0.001 U	0.002	0.002
Zinc	5.3	5.9	5.7	6.1	5.0

Chemical	Bluefish			Striped Bass	
Area	CLIS[4]	Strata M3[4]		CLIS[4]	WLIS[4]
Lipid (%)	29.2	20.5		9.2	4.6
Organic Chemicals (µg/kg wet wt)					
Total PAH	6.3	4.4		3.4	10.4
Total PCB[5]	300	854		368	310
Total DDT	30.3	23.9		37.4	28.5
Dieldrin	7.1	7.5		3.5	1.2
Chlordane	4.1	3.2		1.9	1.5
Dioxin/Furan (ng/kg wet wt)					
2,3,7,8-TCDD	1.6 U	0.9 U		0.85 U	1.5 U
Metals (mg/kg wet wt)					
Arsenic	0.52	0.24		1.53	1.27
Cadmium	0.001 U	0.001 U		0.005	0.001 U
Chromium	0.211	0.051 U		0.051 U	0.195
Copper	0.43	0.38		0.50	0.46
Lead	0.003 U	0.003 U		0.003 U	0.003 U
Mercury	0.097	0.091		0.33	0.21
Nickel	0.032	0.030		0.025	0.016 U
Silver	0.001 U	0.003		0.001 U	0.003
Zinc	7.6	14.2		6.5	6.7

[1] Summarizes combined data from June and September 2000. See Appendix H-5 for full results of all analytes.
[2] Average based on 2 composite samples
[3] Average based on 3 composite samples
[4] Based on 1 composite sample
[5] For this analysis, Total PCBs are defined as two times the sum of the congeners.
U- Not detected

bluefish (at Strata M3), which is not surprising given their extremely high lipid content (*i.e.*, fatty tissue) relative to the other species. However, concentrations of organic chemicals in striped bass were also relatively high, compared to scup and winter flounder. Striped bass and bluefish are more migratory than winter flounder and scup, and may be exposed to chemical contaminants from areas outside of Long Island Sound. For all four species evaluated, many of the PAH compounds and individual dioxin congeners were below detection limits in most samples. Dioxin and furans were generally not detected in fillets, with the exception of a few of the less toxic, higher chlorinated compounds (*e.g.*, 2,3,7,8-TCDF, OCDD, HpCDD).

Metal concentrations exhibit different trends among species and locations than observed for the organic chemicals. Winter flounder had the highest arsenic concentrations among the species sampled and the lowest copper concentrations. Radionuclides were rarely detected in any of the tissue composites. Uranium 234 was detected in one winter flounder fillet from Strata T3/T4 (USACE, 2002h, Appendix H-5) at a concentration orders of magnitude below the relevant benchmarks. None of the metals showed a clear seasonal pattern.

Concentrations of the chlorinated organic compounds were much higher in the livers compared to the fillets due to the fact that these hydrophobic compounds tend to accumulate in the fatty tissue of the liver (Table 4-36). The highest concentrations of these compounds were found in livers from fish collected at Strata M3, similar to winter flounder muscle concentrations. Metals concentrations in general were higher in liver samples from winter flounder compared to muscle tissue with the exception of arsenic and mercury, which were found at levels near or below those found in the muscle. As reported for the other tissues, concentrations of radionuclides in bone were not detected in most samples.

4.13.2.2 Lobster Tissue Concentrations

Concentrations of chlorinated organic compounds and PAHs were low in lobster muscle (Table 4-37). In addition, there was no clear spatial trend and concentrations were similar at all locations. Concentrations of organic chemicals in lobster hepatopancreas, while approximately an order of magnitude higher than those in the lobster meat, followed a similar distribution. Metal concentrations in lobster hepatopancreas were somewhat more variable than organic chemical concentrations. The highest concentrations were generally found in lobster collected from within the CLIS disposal area, with the exception of lead, nickel, and zinc, which were highest at the WLIS reference location.

Radionuclides were below detection limits in most samples analyzed. Very low levels of Uranium 234 and 235 (*i.e.*, below 0.1 pCi/g) were detected in lobster muscle and hepatopancreas from one or more replicate samples at all the locations evaluated except REF 3. Dioxin and furans were generally not detected in the muscle tissue, with the exception of a few of the less toxic, higher chlorinated compounds (*e.g.*, 2,3,7,8-TCDF, OCDD, HpCDD). In hepatopancreas, dioxin concentrations were higher, with concentrations of 2,3,7,8-TCDD ranging from 1.54 to 4.25 ng/kg (Table 4-37).

Table 4-36. Summary of Winter Flounder Liver Concentrations

Chemical	WLIS[1]	Strata M3[1]	CLIS[1]	Strata M4[2]	Strata T4/T3[2]
Lipid (%)	30.1	47.6	65.0	49.8	61.5
Organics (µg/kg wet wt)					
Total PAH	64.0	31.6	20.8	29.0	39.8
Total PCB[3]	574	2518	962	706	1014
Total DDT	38.3	174	67.6	61.3	82.0
Dieldrin	3.9	17.9	14.0	5.0	9.1
Chlordane	12.0	25.7	12.0	8.4	11.4
Dioxin/Furan (ng/kg wet wt)					
2378 TCDD	n/a	2.7	1.5	1.2	2.4
Metals (mg/kg wet wt)					
Arsenic	1.81	2.61	3.25	3.49	3.33
Cadmium	0.073	0.021 U	0.058	0.021 U	0.021 U
Chromium	0.33	0.07	0.16	0.16	0.15
Copper	13.67	10.30	15.53	10.53	13.77
Lead	0.074	0.030	0.029 U	0.019	0.088
Mercury	0.024	0.018	0.018	0.014	0.026
Nickel	0.077	0.019	0.042	0.023	0.040
Silver	0.23	0.13	0.13	0.14	0.22
Zinc	47.8	34.0	44.5	31.3	37.4

n/a - not analyzed;
U – Not detected
[1] Average based on 2 composites
[2] Average based on 3 composites
[3] For this analysis, Total PCBs are defined as two times the sum of the congeners.

Table 4-37. Summary of Lobster Tissue Concentrations[1]

	Ref 1		WLIS		Ref 2		CLIS		Ref 3	
Chemical	**Muscle**	**Hepato-pancreas**	**Muscle**	**Hepato-pancreas**	**Muscle**	**Hepato-pancreas**	**Muscle**	**Hepato-pancreas**	**Muscle**	**Hepato-pancreas**
Organic Chemicals (µg/kg, wet wt)										
Total PAH	15.08	289	14.54	385	10.61	475	11.91	236	9.52	295
Total PCB[2]	23.38	1432	15.7	1848	9.32	1646	16.3	2062	14.78	1878
Total DDT	1.55	104	1.25	162	0.73	126	1.15	162	1.07	139
Dieldrin	0.67	7.4	1.10	15.8	0.48	14.0	0.89	10.7	0.54	12.3
Chlordane	0.13	3.70	0.14	3.50	0.1	6.00	0.1	2.60	0.1	3.87
Dioxin/Furan (ng/kg wet wt)										
2,3,7,8-TCDD	0.81 U	2.83	0.70 U	4.25	0.86 U	1.54	0.81 U	2.08	0.89 U	3.03
Metals (mg/kg, wet wt)										
Arsenic	3.58	6.98	3.06	6.36	5.04	6.91	5.71	14.41	6.32	10.95
Cadmium	0.03	6.30	0.02	5.36	0.02	6.76	0.03	14.42	0.03	9.83
Chromium	0.07 U	0.08	0.07 U	0.14 U	0.07 U	0.07	0.07 U	0.07	0.07 U	0.07
Copper	14.71	599	14.86	574	21.71	734	22.24	1010	18.33	934
Lead	0.02	0.126	0.06	0.136	0.01	0.093	0.01	0.072	0.01	0.036
Mercury	0.07	0.049	0.06	0.057	0.05	0.062	0.08	0.080	0.09	0.089
Nickel	0.06	0.74	0.06	0.81	0.06	0.46	0.06	0.78	0.05	0.60
Silver	0.37	20.96	0.32	14.78	0.41	14.88	0.54	25.84	0.36	15.52
Zinc	20.96	94.8	18.29	53.8	19.98	52.8	19.75	51.4	20.77	49.0

[1] Five composite samples averaged for all samples
[2] For this analysis, Total PCBs were defined as two times the sum of the congeners
U – Not detected

4.13.2.3 Clam and Worm Tissue Concentrations

Table 4-38 provides a summary of the average tissue concentrations in clams and worms collected from CLIS and its reference location during the 2000 field survey (USACE, 2002i; USACE, 2002j). The full analytical results are presented in Appendix H-5 (USACE, 2002i; USACE, 2002j). In general, concentrations of both organic chemicals and metals were similar. For example, 2,3,7,8-TCDD (and most of the other individual dioxin and furan congeners) was not detected in both species at any locations sampled. Metals concentrations in particular were very similar at both CLIS and its reference, with some chemicals (*e.g.*, cadmium, lead, mercury) higher at its reference location. Concentrations of organic chemicals were typically higher at CLIS than at its reference; however, concentrations in clams were very similar at both locations. Concentrations in worms, however, appeared to be higher in organisms collected from CLIS compared to its reference locations for some chemicals (*e.g.*, Total PAH, Total PCBs). Radionuclide concentrations were below detection levels in all samples evaluated.

Table 4-38. Summary of Clam (*Pitar morrhuana*) and Worm (*Nephtys incisa*) Tissue Concentrations

Chemical	CLIS[1]		CLIS Reference	
	Worm	Clam	Worm[2]	Clam[3]
Organic Chemicals (µg/kg, wet wt)				
Total PAH	78.17	54.03	24.88	42.42
Total PCB[4]	66.22	28.36	30.24	21.94
Total DDT	5.13	1.71	2.21	1.45
Dieldrin	0.38	0.15	0.30	0.20
Chlordane	0.57	0.29	0.18	0.27
Dioxin/Furan (ng/kg wet wt)				
2,3,7,8-TCDD	0.70 U	0.54 U	0.51 U	0.78 U
Metals (mg/kg, wet wt)				
Arsenic	3.64	1.05	0.03	1.07
Cadmium	0.14	0.17	4.01	0.14
Chromium	0.16	0.40	0.13	0.45
Copper	2.99	2.60	0.15	2.05
Lead	0.53	0.78	2.34	0.70
Mercury	0.01	0.01	0.37	0.01
Nickel	0.52	1.20	0.01	1.23
Silver	0.05	0.16	0.59	0.15
Zinc	19.68	15.95	18.29	14.30

[1] Average of six samples; 3 replicates each for stations FVP and N93
[2] Average of four replicate samples from the CLIS reference station
[3] Average of three replicate samples from the CLIS reference station
[4] For this analysis, Total PCBs were defined as two times the sum of the congeners.
U – Not detected

4.13.2.4 Human Health Risks

Table 4-39 shows the comparison of lobster and fish tissue concentrations to available FDA action/tolerance limits for human health. Measured chemical concentrations for all chemicals were approximately one to two orders (*i.e.,* 10 to 100 times) of magnitude below the applicable FDA limits. In addition to the comparison to FDA levels outlined in the EPA approach, Total PCB concentrations were also compared to threshold guidelines established by the CTDPH for the development of fish consumption advisories (Toal and Ginsberg, 1999). Most of the Total PCB concentrations were below those concentrations (*i.e.,* 0.1 ppm or 100 ppb) associated with recommendations for restricted consumption based on CTDPHs, risk-based approach for winter flounder and lobster. 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 fish consumption advisory; see Appendix H-10 for further discussion).

Similar results were noted based on the evaluation of carcinogenic and non-carcinogenic risk levels. As described in Appendix H-10, 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 non-carcinogenic hazard quotients less than 1 for most chemicals (hazard quotients greater than 1 implies risk). Risks associated with PCBs were the exception. Non-carcinogenic risks for Total PCBs were associated with hazard quotients greater than 1 for all species evaluated at all locations. Carcinogenic risks for PCBs were elevated for scup at Strata M4 and T3/T4.

Risks were also calculated based on fish and lobster tissue concentrations modeled from measured clam and worm data using trophic transfer assumptions (Appendix H-10). The conclusions based on risks associated with these estimated concentrations are comparable to those based on measured data; that is risks for consumption of fish and shellfish are low, with the exception of PCBs.

Based on these data, risks to human health associated with the consumption of fish and shellfish from Long Island Sound were determined to be low, typically falling below FDA reference levels and within EPA's acceptable risk ranges. The exception to this conclusion is risks associated with tissue concentrations of PCBs. However, this increased risk associated with ambient conditions in Long Island Sound and is currently managed through the issuance of fish consumption advisories such as that described for CTDPH. The advisory warns anglers of the potential risks associated with PCBs and recommends that consumption of certain fish species be limited to reduce exposure.

4.13.2.5 Ecological Risks

Table 4-40 presents a summary of the comparison of benthic invertebrate (*i.e.*, clams, worms, lobster) concentrations to available ecological effects values used by EPA New England to evaluate ecological risks associated with dredged material (see Appendix H-10). These values represent tissue concentrations determined to be safe to aquatic organisms. As described for the human health evaluation, risks to ecological receptors associated with elevated tissue

Table 4-39. Comparison of Lobster and Finfish Edible Tissue Concentrations (wet weight) to Human Health Action Levels (*i.e.*, FDA Action Levels)[1]

Station	Species	Total PCB (µg/kg)	Total DDT (µg/kg)	Total Chlordane (µg/kg)[2]	Aldrin (µg/kg)	Dieldrin (µg/kg)	Heptachlor (µg/kg)	Heptachlor Epoxide (µg/kg)	Mercury (mg/kg)
FDA Human Health Action Levels		2000	5000	300	300	300	300	300	1
CLIS	Winter Flounder	82 – 108	6 – 9	1.19 - 1.25	0.02 U	0.75 – 1.04	0.02 U	0.02 U	0.01 - 0.02
	Scup	72 – 168	5 -12	0.5 – 0.7	0.02 U	0.34 – 3.9	0.02 U	0.02 U	0.06 – 0.07
	Bluefish	300	30	4	0.02 U	7	0.02 U	0.02 U	0.10
	Striped Bass	368	37.4	1.90	0.02 U	3.5	0.02 U	0.02 U	0.33
	Lobster	14 - 20	0.9 – 1.2	0.06 – 0.1	0.03 U	0.3 – 0.9	0.04 U	0.02 U	0.17 – 0.33
Strata M3	Winter Flounder	84 – 250	6 – 8	1.16 – 1.56	0.02 U	0.71 – 0.94	0.02 U	0.02 U	0.02 - 0.03
	Scup	80 – 250	5 – 20	0.5 – 1.0	0.02 U	0.39 - 5	0.02 U	0.02 U	0.08 - 0.09
	Bluefish	854	24	3.2	0.02 U	7.5	0.02 U	0.02 U	0.09
	Lobster	7.8 - 10	0.6 – 0.9	0.09 – 0.1	0.02 U	0.4 – 0.6	0.02 U	0.02 U	0.04 – 0.06
WLIS	Winter Flounder	60 – 68	5.2	1.13 – 1.56	0.02 U	0.77 - 0.89	0.02 U	0.02 U	0.02
	Scup	60 - 88	5 - 9	0.55 – 1.12	0.02 U	0.44 – 1.54	0.02 U	0.02 U	0.03 - 0.09
	Striped Bass	308	28.5	1.55	0.02 U	1.19	0.02 U	0.02 U	0.21
	Lobster	12 - 32	1.1 - 2	0.1 – 0.2	0.02 U	0.6 – 1.6	0.02 U	0.02 U	0.05 – 0.08
Strata M4 and Strata T3/T4	Winter Flounder	44 - 86	3 - 7	0.7 – 1.1	0.02 U	0.3 –1.0	0.02 U	0.02 U	0.01 – 0.03
	Scup	32 – 228	3 - 7	0.5 - 1	0.02 U	0.2 –5.1	0.02 U	0.02 U	0.03 - 0.07
	Lobster	18 - 32	1.1 – 2.1	0.09 – 0.17	0.02 U	0.4 – 0.6	0.02 U	0.02 U	0.04 – 0.06

Shaded cells indicate that maximum values are greater than the minimum CTDPH consumption restriction level (*i.e.*, 100 µg/kg for Total PCBs) (Toal and Ginsberg, 1999).
[1] Half the Detection limit reported for those analytes that were not detected.
[2] Total chlordane is the sum of cis-Chlordane and trans-Nonachlor, as described in FDA (1989).
[3] Total PCBs defined as two times the sum of the congeners
U = Not detected

Table 4-40. Comparison of Benthic Tissue Concentrations to Ecological Effects Values[1]

Analyte	Ecological Effects Values[2]	Lobster				Clam		Worm	
		WLIS		CLIS		CLIS		CLIS	
		Average	Maximum	Average	Maximum	Average	Maximum	Average	Maximum
PAHs (ug/kg wet)									
Anthracene	3750	0.08	0.12	0.06	0.07	1.16	1.36	1.44	2.36
Benzo(a)pyrene	8000	1.38	2.04	0.87	1.32	3.94	4.61	6.22	9.30
Total PAH	10000[3]	14.54	18.61	11.91	14.55	54.03	74.13	78.17	118.05
Total PCBs (ug/kg wet)									
Total PCB	4000[4]	15.7	32.72	16.3	19.82	28.36	35.54	66.22	83.2
Pesticides (ug/kg wet)									
Aldrin	299	0.02 U	0.02 U	0.02 U	0.02 U	0.06	0.13 U	0.06	0.07
Chlordanes	64	0.10	0.13	0.10	0.12	0.29	0.32	0.57	1.26
Total DDT	3000[5]	1.25	2.13	1.15	1.25	1.71	1.94	5.13	6.37
Dieldrin	4.37	1.10	1.62	0.89	2.40	0.15	0.27	0.38	0.60
Endosulfans	2.85	0.11 U	0.11 U	0.11 U	0.11 U	0.33 U	0.39 U	0.32 U	0.38 U
Metals (mg/kg wet wt)									
Arsenic	12.6	3.06	4.37	5.71	6.95	1.05	1.16	3.64	4.45
Cadmium	3	0.02	0.04	0.03	0.04	0.17	0.21	0.14	0.22
Chromium	11.8	0.04	0.04	0.04	0.04	0.40	0.54	0.16	0.20
Copper	9.6	**14.86**	**17.82**	**22.24**	**25.58**	2.60	3.25	2.99	4.25
Lead	11.9	0.06	0.24	0.01	0.02	0.78	1.05	0.53	0.72
Mercury	0.2[6]	0.06	0.08	0.08	0.10	0.01	0.01	0.01	0.01
Nickel	3.8	0.06	0.09	0.06	0.08	1.20	1.31	0.52	0.63
Silver	1.5	0.32	0.41	0.54	0.66	0.16	0.18	0.05	0.07
Zinc	1517	18.29	24.14	19.75	24.60	15.95	18.14	19.68	20.91

Bolded values indicate exceedence of the ecological effects values
[1] Half the detection limit reported for those analytes not detected.
[2] The ecological effects values represent tissue concentrations that are believed to be "safe" for aquatic organisms. They are derived from the final chronic value of US EPA Water Quality Criteria (as suggested by Lee *et al.*, 1989) unless otherwise noted.
[3] Source: Widdows *et al.*, 1987
[4] Source: Hansen, 1974
[5] Source: Neufield and Pritchard, 1979
[6] Source: Friedmann *et al.*, 1996

concentrations appear to be very low. With the exception of copper in lobster tissue at WLIS and CLIS, all tissue concentrations were below the ecological effects values, indicating a very low potential for ecological effects to the species evaluated.

4.13.3 Summary

Based on data collected for NOAA's National Status and Trends Program, chemical contaminants in tissue from Long Island Sound are generally low and appear to be declining (Turgeon *et al.*, 1989; O'Conner and Beliaeff, 1995). Concentrations of most chemicals tended to be highest in the western basin. Contaminant concentrations in tissue collected in support of this DEIS were also low and showed little spatial variability across the areas evaluated. Site-specific tissue data were not available for the Bridgeport and Milford Alternatives. However, because aquatic organisms accumulate contaminants from sediments, tissue concentrations are often directly correlated to sediment concentrations. Sediment concentrations at the Bridgeport and Milford Alternatives are similar to those reported at CLIS and WLIS (see Section 4.7). Therefore, it is expected that trends in tissue concentrations would be similar to those found at WLIS and CLIS.

The risk-based approach employed by EPA New England for the evaluation of dredged material for ocean disposal, shows that potential risks to human health and ecological receptors associated with exposure to sediments at the alternative sites are low. All measured tissue concentrations were well below FDA limits for all chemicals with the exception of PCBs. In addition, carcinogenic and non-carcinogenic risk estimates were within the acceptable risk range. With the exception of copper, tissue concentrations were below ecological effect values.

4.14 Socioeconomic Environment

The following sections describe the socioeconomic environment (commercial and recreational fisheries, shipping and navigation, recreational activities and beaches, parks and natural areas, historic and archeological resources, and other human uses) of Long Island Sound. The socioeconomic resources were evaluated for the four alternative sites. Methods used to evaluate resources of the affected environment included a review of existing information and literature. For example, the evaluation of recreational and commercial fishing relied on data from NMFS such as commercial fish landings and the Northeast Region Marine Recreational Economics Survey (NMFS, 2002b) as well as recreational fisheries data from CTDEP (CTDEP, 1999). In addition, there were several studies conducted in support of this DEIS including:

- Appendix B: Dredging Needs of Navigation-Dependent Facilities (USACE, 2001b);
- Appendix E-1: Economic Significance of Navigation-Dependent Industries (USACE, 2001d);
- Appendix E-2: Analysis of Economic Impacts of No Action Alternative (USACE, 2003b);
- Appendix H-7: Lobster Survey, July 2000 (USACE 2000g);

- Appendix H-9: Fishing Questionnaire and Interview Interim Report (USACE, 2001i);
- Appendix I: Historic and Archaeological Resources (USACE, 2003i).

4.14.1 Commercial and Recreational Fisheries

Long Island Sound is located within a metropolitan region with more than 8 million inhabitants (Figure 4-41) (USEPA, 1990b). Commercial and recreational fisheries of Long Island Sound are valuable resources to the states of Connecticut and New York. Commercial fishing revenues in the region exceeded $10 million in 2001, while more than 1 million angling trips were recorded in 1997 (NMFS, 2003; CTDEP, 1999). Descriptions of the distribution and abundance of commercially and recreationally important fish and shellfish are presented in Sections 4.10 and 4.11. The following section presents information on commercial and recreational fishing practices and values.

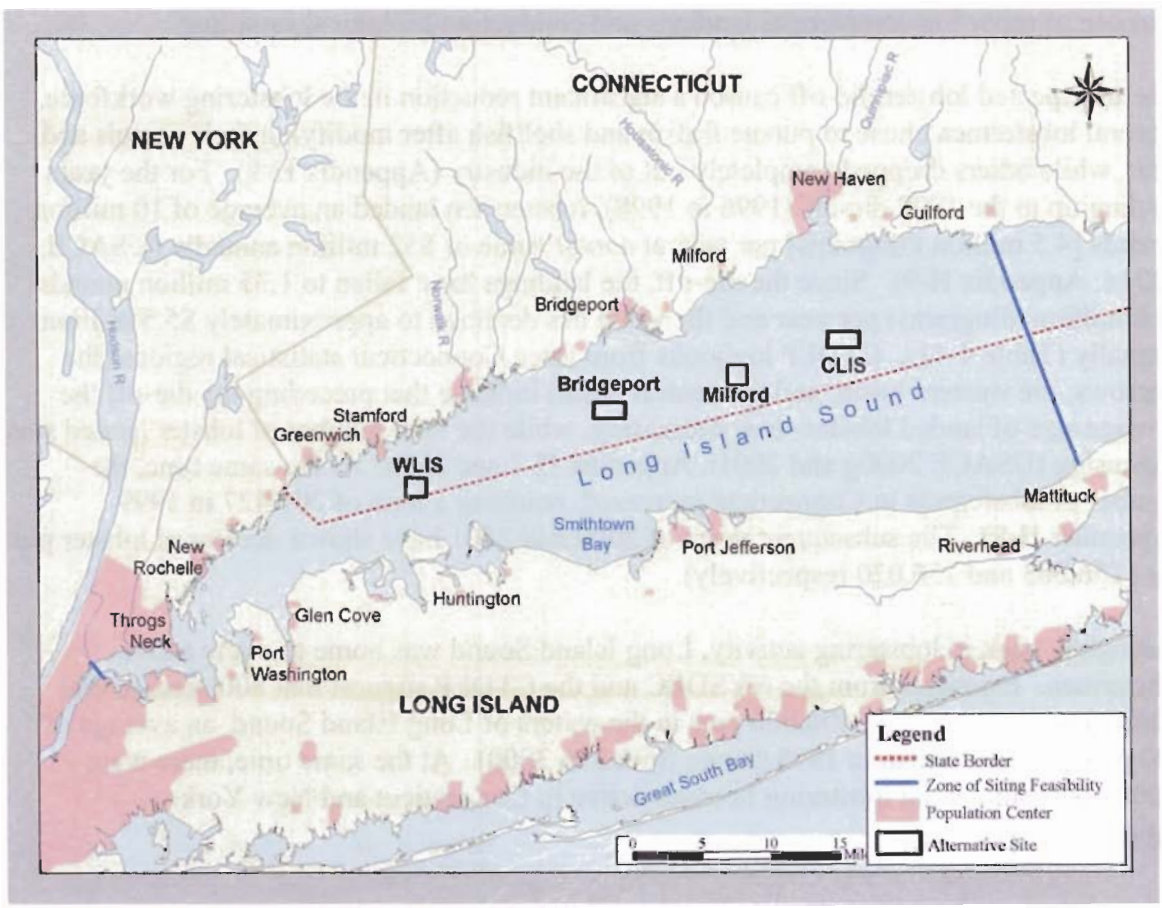

Figure 4- 41. Population Centers Surrounding Long Island Sound

Source: NOAA Chart 12300, 12363, 12354, 42 Edition.

Commercial Fisheries. Commercial fishing in Long Island Sound targets both finfish and shellfish (including bivalves and the American lobster *[Homarus americanus]*). Hard clams (*Mercenaria mercenaria*) and Eastern oyster (*Crassostrea virginica*) are the most actively fished commercial species in the region totaling more than 74 percent of total revenues in 2001 (NMFS, 2003). Shellfishing occurs in open water and aquaculture environments, with aquaculture taking place in beds off both the coasts of Connecticut and New York. Historically, the lobster fishery was a significant part of the shellfish industry in the Sound although, recently lobstering has decreased because of a die-off which began in 1998 (Section 4.11.1; Appendix H-6). Fin fishing also takes place throughout the Sound, although trawl fishing exists only at three central Long Island Sound locations because of the density of lobster pots throughout the Sound (Appendix H-8).

Table 4-41 shows the annual commercial fishing landings and values by species for Long Island Sound (included within NMFS Statistical Area 611) for 2001. Commercial fish landings are defined as quantities, in this case by weight, of fish and shellfish brought to shore and sold (NMFS, 2000). Statistical areas were established in the early 1970's for the purpose of reporting commercial landings and conducting biological sampling.

The unexpected lobster die-off caused a significant reduction in the lobstering workforce. Several lobstermen chose to pursue finfish and shellfish after modifying their vessels and gear, while others dropped completely out of the industry (Appendix H-9). For the years leading up to the 1999 die-off (1996 to 1998), lobstermen landed an average of 10 million pounds [4.5 million kilograms] per year at a total value of $32 million annually (USACE, 2001x; Appendix H-9). Since the die-off, the landings have fallen to 1.35 million pounds (0.6 million kilograms) per year and the value has declined to approximately $5.5 million annually (Table 4-41). CTDEP logbooks from three Connecticut statistical regions (the Narrows, the western basin, and the central basin) indicate that preceding the die-off the average size of landed lobsters was decreasing, while the total number of lobster landed was increasing (USACE 2000g and 2001i, Appendix H-7 and H-9). At the same time, the number of lobsterpots in Connecticut increased, reaching a high of 204,427 in 1999 (Appendix H-8). The subsequent years of 2000 and 2001 have shown decreased lobster pot use (156,003 and 156,020 respectively).

During the peak in lobstering activity, Long Island Sound was home to many active lobstermen. Estimates from the NYSDEC and the CTDEP suggest that 800 commercial lobsterman were working 400,000 pots in the waters of Long Island Sound, an average of 500 pots per lobsterman in 1998 (range from 1 to 3000). At the same time, there were 3,000 non-commercial lobstering licenses active in Connecticut and New York (Appendix H-9).

Table 4-41. Commercial Fishing Landings (Weight in Pounds) and Values (Dollars) by Species for NMFS Statistical Area 611 for 2001

Species Name	Weight (Lbs)	Value ($)	Species Name	Weight (Lbs)	Value ($)
Angler	5041	7733	Mackerel, Atlantic	5282	2382
Bass, Striped	418912	1044892	Mackerel, King	8	19
Bluefish	625851	186602	Mackerel, Span	2778	4746
Bonito	311	437	Menhaden	319497	37869
Butterfish	134595	86773	Mullets	564	193
Carp	164	29	Mussels	260	260
Catfish	27	9	Octopus	7	7
Clam, Razor	1,408	4,598	Other Fish	3773	427
Clam, Soft	72848	393762	Oysters	675557	5366781
Clam, Surf	134368	63160	Perch, White	21242	18246
Cobia	134	253	Periwinkles	278	810
Cod	1329	2506	Pout, Ocean	87	44
Conchs	46648	65560	Puffer, Northern	53	187
Crab, Blue	31	93	Quahog	4871429	20946242
Crab, Green	38467	51931	Quahog, Ocean	136960	83547
Crab, Hermit	453	228	Redfish	3	3
Crab, Horseshoe	31958	11505	Scallop, Bay	3,466	52,556
Crab, Jonah	22846	10519	Scallop, Sea	45	152
Crab, Nk	1645	964	Sculpins	650	65
Crab, Rock	678	84	Scup	335102	404555
Crevalle	74	55	Sea Bass, Black	25860	45719
Cunner	802	3548	Sea Raven	56	29
Dogfish Smooth	8743	3527	Sea Robins	7729	850
Dogfish Spiny	13958	3679	Shad, American	60070	43619
Dolphin Fish	24	34	Shad, Hickory	377	33
Drum, Red	35	18	Shark, Nk	37	11
Eel, American	1087	513	Shrimp (Mantis)	325	297
Eel, Conger	3720	3516	Shrimp (Penaeid)	111	143
Eel, Sand (Launce)	510	255	Silverside, Atlantic	3168	2149
Escolar	95	119	Skates	614469	101166
Flounder, Am. Plaice	1	1	Snapper, Red	48	108
Flounder, Sand-Dab	2576	870	Squid (Loligo)	53855	39484
Flounder, Summer	212339	497465	Tautog	38248	50396
Flounder, Winter	233593	179890	Toadfish, Oyster	33	100
Flounder, Witch	70	105	Tom Cod	5	1
Flounder, Yellowtail	4850	6126	Triggerfish	120	85
Gizzard Shad	151	12	Tuna (Nk)	276	690
Hake, Red	2633	721	Tuna, Albacore	42	53
Hake, Silver	4047	2233	Tuna, Big Eye	130	780
Hake, White	21	11	Tuna, Little	4968	834
Herring (Nk)	2506	563	Tuna, Skipjack	1	1
Herring, Atlantic	11355	2210	Tuna, Yellowfin	255	656
Herring, Blue Back	20	1	Weakfish, Squeteague	58495	60881
Lobster	1352837	5564059	Whiting, King	31	24
Total Commercial Weight (Lbs)	**10,639,511**		**Total Commercial Value ($)**		**35,468,369**

Source: NMFS, 2003.

In Long Island Sound, lobsters are found in deeper water from June through September and shallower water from November to March (Appendix H-8). Lobstermen have noted that lobsters seem to prefer dredged material disposal sites, possibly because of changes in topography and additional food sources, including worms and clams (Appendix H-8). The highest lobster catch rates have historically been observed in June, July, and August with a lesser peak in November and December (Appendix H-7 and H-9). Moderate activity is observed in January, February, and April, while March, May, September, and October are normally the least active (Appendix H-7 and H-9). Lobstermen generally consider the distance from home port and the location and abundance of lobsters when planning their fishing activities. On an average trip, commercial lobster vessels travel 2 to 10 miles (3 to 16 kilometers) from their point of origin (Appendix H-9).

Bivalves are harvested from aquaculture facilities and open-water sites. Northern Quahogs (also known as Hard clams) and eastern oysters are the two most heavily fished bivalve species, producing over $10 million in revenues in 2001 (Table 4-41). Oyster beds are located offshore of Port Chester, Oyster Bay, Huntington, and Port Jefferson, in New York, and offshore of most of Connecticut (USACE, 1991; USACE, 1981). Other bivalve beds have been harvested offshore between Manhasset and Huntington, Port Jefferson, and large areas near Mattituck, as well as, offshore between New Rochelle, New York and Guilford, Connecticut (USACE, 1981; 1982a, b).

Commercial shellfish harvesting is quite common along the shores of Long Island Sound, especially in Connecticut. The Connecticut Division of Aquaculture, which operates under the Connecticut Department of Agriculture, leases shellfish bed areas along the coast of Connecticut for commercial shellfishing of oysters and surf clams *(Spisula solidissima)*. In addition, the Connecticut Division of Aquaculture also participates in aquaculture enhancement activities of noncommercial bivalve beds. Other active species in the shellfish market include; conchs *(Busycon* sp.), periwinkles *(Littorina* sp.), and mussels *(Mytilus edulis)*. Mussels have been harvested offshore of Lloyd's Neck, Mt. Sinai, and Mattituck, New York (USACE, 1981). Molluscan shellfish and conch are harvested primarily by small boats in the bays and harbors of Long Island Sound (USACE, 1998). None of these sites is in the vicinity of the four alternative sites.

Commercial catches of finfish in Long Island Sound include windowpane flounder *(Scopththalmus aquosus)*, winter flounder *(Pseudopleuronectes americanus)*, red hake *(Urophycis chuss)*, cunner *(Tautogolabrus adspersus)*, skate *(Raja sp.)*, sea robin *(Prionotus sp.)*, silver hake *(Merluccius bilinearis)*, butterfish *(Peprilus triacanthus)* and scup *(Stenotomus chrysops)* (USACE, 1991; USACE, 1998). Commercial catch is defined as the total amount of fish brought onboard a vessel. Trawling activity has been observed east of Eaton's Neck, New York as well as at three specific locations near the CLIS Alternative (Figure 4-42). Commercial dragging is limited in the region due to the abundance of fixed gear such as lobster pots (USACE, 1991). Commercial fin fishing has historically occurred along both Connecticut and New York coasts and along a transect from the Housatonic River in Connecticut to Port Jefferson in New York (USACE, 1981). Information regarding lobster and shellfish locations can be found in Figure 4-42. The lobster information was obtained during meetings with local lobstermen in Bridgeport, Milford, and East Norwalk,

Connecticut, on August 26 and 27, 2002 (Appendix H-8). At this meeting, lobstermen rated areas within Long Island Sound with regard to lobstering success (*i.e.*, "good," "very good") as indicated in Figure 4-42. Shellfish information was collected from CTDEP and NYSDEC. This figure does not represent all areas fished throughout the region.

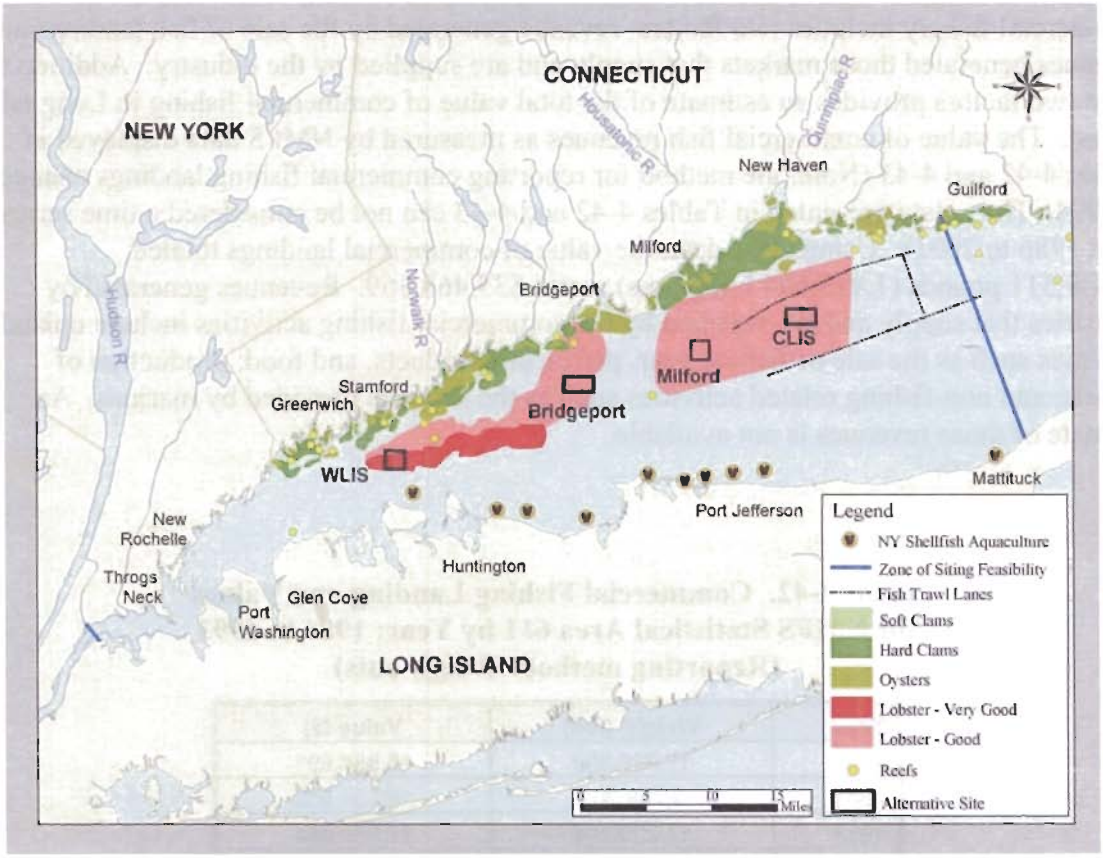

Figure 4-42. Examples of Commercial Fishing/Shellfishing Locations in Long Island Sound
Sources: Appendix H-8; CTDEP, 2002b; NYSDEC, 2002a

Active commercial shellfishing and fin fishing ports in Long Island Sound from west to east include, 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 Connecticut border, 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 (Appendix H-7 and H-9; USACE, 1998). In 1997, the most recent year of available data for fishing licenses, Connecticut had 364 vessels used by licensed fisherman for lobstering, of which 291 were registered to state residents (USACE, 1998). In 1997, the New York commercial fishing fleet was composed of approximately 20 trawlers/draggers, 122 lobster boats, and 4 shellfish dredges (USACE, 1998). Other

vessels, known as bay boats, gravies, or sharpies, numbered in the hundreds in New York and Connecticut (USACE, 1998).

Estimates of the value of the Long Island Sound commercial fishing industry vary widely. The Long Island Sound Study estimated the commercial fisheries value at $148 million based on a $53 million harvest and a multiplier drawn from an input-output model of marine-oriented industries in New London, Connecticut (USEPA, 1990b). The value of the commercial fishery includes two factors: revenue generated by the sale of fish landings and revenues generated those markets that supply and are supplied by the industry. Addition of these two factors provides an estimate of the total value of commercial fishing in Long Island Sound. The value of commercial fish revenues as measured by NMFS data displayed in Tables 4-42 and 4-43 (Note: the method for reporting commercial fishing landings changed in 1994. Thus, data presented in Tables 4-42 and 4-43 can not be considered a time series from 1986 to 2001). Using 2001 data, the value of commercial landings totaled 10,639,511 pounds (1,923,694 kilograms) worth $35,468,369. Revenues generated by industries that supply and are supplied by the commercial fishing activities include upland activities such as the sale of fishing gear, petroleum products, and food; production of vessels; and non-fishing related activities such as the services provided by marinas. An estimate of those revenues is not available.

Table 4-42. Commercial Fishing Landing and Values for NMFS Statistical Area 611 by Year: 1986 to 1993 (Reporting method: Weigh-outs)

Year	Weight (lbs)	Value ($)
1986	17,826,382	15,884,991
1987	9,758,209	16,134,552
1988	11,309,044	17,956,044
1989	7,697,800	26,461,096
1990	10,417,574	36,004,143
1991	12,288,191	39,365,735
1992	13,779,084	57,451,961
1993	15,320,930	45,161,698

Source: NMFS, 2002c

Table 4-43. Commercial Fishing Landing and Values for NMFS Statistical Area 611 by Year: 1994 to 2001 (Reporting method: Vessel Trip Reports)

Year	Weight (lbs)	Value ($)
1994	23,122,259	63,938,542
1995	15,909,659	59,977,961
1996	15,347,988	62,794,905
1997	14,805,929	47,214,965
1998	13,858,881	48,493,389
1999	8,647,127	29,166,500
2000	13,998,385	49,082,691
2001	10,639,511	35,468,369

Source: NMFS, 2003

- **WLIS**: Commercial shell and fin fishing ports within 10 nautical miles (18.5 kilometers) of the WLIS 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 (Appendix H-7 and H-9; USACE, 1998). Prime lobster grounds were mapped in 1982 due west and east of the WLIS Alternative for at least five nautical miles (9.3 kilometers; USACE, 1981). 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 (USACE, 1991). Other bivalve beds have been harvested between Manhasset and Huntington, as well as, offshore between New Rochelle, New York and Guilford, Connecticut (USACE, 1981; 1982a, b). Mussels have been harvested off Lloyd's Neck, New York (USACE, 1981). In addition, shellfish aquaculture beds are located off Lloyd's Neck, New York.

  Commercial lobstering and fin fishing, near the WLIS Alternative is active. Fin fishing has historically occurred along the Connecticut and New York coasts (USACE, 1981). Prior to the lobster die-off the regions of the WLIS Alternative were known as very good lobstering areas (Appendix H-8). Commercial trawling activity occurs east of Eaton's Neck, New York. Anecdotal evidence from lobsterman's meetings (Appendix H-8) suggests that the WLIS Alternative is an active lobstering area. In addition, lobstermen indicated that there is little bottom trawling in or near WLIS because of harvesting restrictions and bottom obstructions (See Figure 4-42) (Appendix H-8).

- **Bridgeport**: Commercial shell and fin fishing ports within 10 nautical miles (18.5 kilometers) of the Bridgeport Alternative include Westport, Southport, Fairfield, Stratford, Milford, and Bridgeport, in Connecticut, and, Stony Brook Harbor and Port Jefferson in New York (Appendix H-7 and H-9; USACE, 1998). Anecdotal evidence from meetings with local lobstermen (Appendix H-8) suggests that the lobstering around the Bridgeport Alternative is good (Figure 4-42), and that the alternative is lobstered year round by Bridgeport and Fairfield, Connecticut lobstermen (Appendix H-8). No dragging occurs near the Bridgeport Alternative

(Appendix H-8). Oyster beds occur off Port Jefferson, in New York, and off Norwalk to Bridgeport, in Connecticut (USACE, 1991; USACE, 1981). Other bivalve beds have been harvested off Port Jefferson, as well as offshore between New Rochelle, New York and Guilford, Connecticut (USACE, 1981; USACE 1982a, b). Shellfish aquaculture beds are located off Smithtown Bay, Stony Brook Harbor, and Port Jefferson, New York. Commercial fin fishing has historically occurred along the Connecticut and New York coasts (USACE, 1981).

- **Milford**: Commercial shell and fin fishing ports within 10 nautical miles (18.5 kilometers) of the Milford Alternative include Bridgeport, Stratford (Housatonic River), Milford, and New Haven in Connecticut, and Port Jefferson and Mt. Sinai Harbor, in New York (Appendix H-7 and H-9; USACE, 1998). Anecdotal evidence from lobstermen's meetings (Appendix H-8) suggests that the lobstering around the Milford Alternative is good (Figure 4-42). Limited information on trawling activities was provided by fishermen at these meetings, but it seems to indicate that there is no active trawling conducted at the Milford Alternative.

- **CLIS**: Commercial shell and fin fishing ports within 10 nautical miles (18.5 kilometers) of the CLIS Alternative include Milford, New Haven, Branford, and Guilford in Connecticut (Appendix H-7 and H-9; USACE, 1998). Anecdotal evidence from lobsterman's meetings (Appendix H-8) suggests that the lobstering around the CLIS Alternative is good (Figure 4-42; Appendix H-8). Oyster beds occur off New Haven, Connecticut (USACE, 1991; USACE, 1981). Other bivalve beds are harvested offshore between Port Jefferson and Mattituck, as well as, between New Rochelle, New York and Guilford, Connecticut (USACE, 1981; USACE, 1982a; USACE, 1982b). Mussels have been harvested off Mt Sinai and Mattituck, New York (USACE, 1981). 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 CLIS Alternative (Appendix H-8). Trawling activity occurs along three transects (Figure 4-42), one north, south, and east of the CLIS Alternative. The transects north and south of the CLIS 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 (USACE, 1981).

Recreational Fisheries. 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 (USACE, 1991). During these months, offshore angling is concentrated around ledges, shoals, banks, and other places where habitat and depth changes induce fish to congregate (USACE, 1998). 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 three nautical miles (5.5 kilometers) east of the WLIS Alternative in Connecticut (USACE, 1982a; USACE, 1982b).

The majority of the recreational catch is comprised of six finfish species (in decreasing order of total weight harvested): bluefish *(Pomatomus saltatrix)*, scup, tautog *(Tautoga onitis)*, winter flounder, summer flounder *(Paralichthys dentatus)*, and striped bass *(Morone saxatilis)*. In 1997, the most recent Connecticut data for recreational catches, these species totaled over 8 million pounds (total weight harvested) of the total 9,249,724 pounds harvested by recreational fisherman (Table 4-44) (CTDEP, 1999). Recent declines in total catch and harvest numbers for recreational fisheries in Long Island Sound have been attributed to the decline of the bluefish, scup, winter flounder, and tautog populations (CTDEP, 1999; USACE, 1998). These declines are most likely a result of recent diminished fish stocks and the successful implementation of harvest regulations that imposed restrictions on recreational fishing in the 1990s (CTDEP, 1999). Recreational shellfishing is also a popular activity in Long Island Sound; oysters, mussels, and hard clams are the focus of most of these activities (USACE, 1991).

Table 4-44. Annual Averages (1981 to 1997) of Fish Caught, Fish Harvested, and the Total Weight Harvested in Connecticut for Major Recreational Species

Species	Number Fish Caught	Total Fish Harvested	Total Weight Harvested
Bluefish	2,110,997	1,812,224	6,101,477
Dogfish Shark	26,860	4,774	18,372
Skate/Ray	160,889	10,922	7,926
Cod and Hake	26,122	25,475	13,591
Pollock	10,089	9,831	18,317
Eel	13,602	9,235	6,422
Other Flounder	72,879	23,882	4,432
Summer Flounder	359,305	203,768	306,087
Winter Flounder	609,379	505,400	529,015
Herring	225,333	178,134	114,541
Other Fish	230,164	215,084	43,502
Scup	1,825,772	1,325,638	787,393
Black Sea Bass	30,735	8,088	6,824
Sea Robin	121,426	16,460	6,831
Striped Bass	303,295	20,923	264,919
White Perch	336,401	330,201	44,213
Atlantic Mackerel	99,497	68,235	97,749
Cunner	235,013	63,538	11,266
Tautog	281,542	195,768	570,045
Total (All Fish)[1]	7,119,904	5,055,397	9,249,724

[1] Totals of all species include species other than those listed in table
Source: CTDEP, 1999

Recreational fishing activities in Long Island Sound have long supported the local socioeconomic framework of many coastal towns and cities throughout the Sound (Appendix H-7 and H-9). This includes direct money spent on fishing gear, bait, and charter/party boats by both in-state and out-of-state fishermen, and the indirect money out-of-state anglers spend on food, lodging, and shopping while in-state, among others. Recreational fishing in Long Island Sound was valued at $1.1 billion in 1990 (USEPA, 1990). This value includes a measure of direct and indirect effects.

- **WLIS**: 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 WLIS Alternative (USACE, 1982a; USACE, 1982b). Smith Reef is north, Cable and Anchor Reef is east, and Budd Reef is northeast of the WLIS Alternative. Major ports with party and charter boats near the WLIS Alternative include Huntington and Northport, New York and Norwalk and Stamford, Connecticut (USACE, 1998).

- **Bridgeport**: 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 Cedar Point, Pine Creek Point, and due east of the Bridgeport Alternative. In New York, a state permitted artificial reef exists off Smithtown Bay. Penfield Reef is the closest reef to the Bridgeport Alternative; two nautical miles (3.7 kilometers) northeast. Major ports with party and charter boats in the vicinity of Bridgeport, Long Island Sound include Port Jefferson, New York, and Norwalk and Bridgeport, Connecticut (USACE, 1998).

- **Milford**: Recreational fishing occurs most often at artificial reefs off New York and reefs and areas of high relief, off Connecticut. In Connecticut, Charles Island as well as reefs and artificial structures along the Milford shoreline are heavily fished. Major ports with party and charter boats in the area of the Milford Alternative include Port Jefferson and Mt. Sinai, New York, Bridgeport, and New Haven, Connecticut (USACE, 1998).

- **CLIS**: 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 CLIS Alternative; approximately five nautical miles (9.3 kilometers) northeast of the site. Major ports with party and charter boats near the CLIS Alternative include Mt. Sinai and Mattituck, New York, and New Haven, Connecticut (USACE, 1998).

4.14.2 Commercial Navigation

Navigation-dependent activities are very important to the economies of New York and Connecticut. These industries require dredging and the affordable disposal of dredged material for their continued economic vitality. In order to show the significance of navigation related economic activity, an economic analysis was conducted by DRI-WEFA (Data Resources Inc.–Wharton Economic Forecasting Associates; now known as Global Insight) for this Long Island Sound DEIS. The study analyzed the amount of economic activity in coastal areas around Long Island Sound in New York, Connecticut and Rhode Island, from industries that are dependent on navigation. The study used DRI-WEFA's input-output model, described in Appendix E-1, to estimate the significance of the navigation-dependent industries to employment, income, sales, and taxes in the regions. The complete analysis is contained in Appendix E-1.

The economic analysis contained in Appendix E-2 shows that navigation-dependent industries, principally freight transportation, boat building, marinas, commercial fishing, and passenger transportation, in Connecticut and New York accounted for more than 27,700 jobs through their direct, indirect, and induced impacts. The contribution of each industry to gross state product (GSP) is found in Appendix E-2 (Table 3-3 for Connecticut and Table 3-28 for New York). Also including direct, indirect, and induced impacts, these industries produce approximately $3 billion in gross state product and contribute more than $1.8 billion to area incomes. Without these industries, government tax revenues would be reduced by more than $441 million, including impacts from reduced income and sales taxes. The designation of one or more disposal sites in western/central Long Island Sound, or the identification of other cost-effective means of disposal of dredged materials on a project-specific basis, will help to ensure that navigation-dependent industries in the study area continue to contribute significantly to the economies of the two states.

The analysis contained in Appendix E-1 is a characterization of the economic significance of navigation on a Sound-wide basis. This analysis used the entire Long Island Sound coastline for the economic study area, including eastern-most areas in eastern Connecticut, eastern Long Island, New York, and portions of Rhode Island. Appendix E-2 focused on the economic impact within the modified ZSF and includes only the western and central portions of the Sound, extending eastward to Clinton, Connecticut and Mattituck, New York.

Based on the analysis conducted by DRI-WEFA, the sectors that are impacted the most from navigation-dependent economic activity are manufacturing, transportation, and public utilities. Other sectors, such as financial, trade, and services are moderately impacted by navigation activities. Specific industries that are the most dependent on continued navigation access are freight transportation by water, commercial fishing, ship building, boat building, and marinas, and passenger transportation by water. The estimate of the impacts of recreational boating and related industries in the study area is approximately $21.4 million ($17.7 million in Connecticut and $3.7 million in New York).

Table 4-45 is a summary of the results of the economic analysis contained in Appendix E-2. The table shows the economic benefits generated by navigation-dependent industries in the

Table 4-45. Economic Benefits Generated by Navigation-Dependent Industries in Long Island Sound

State	2001 Employment	2001 GSP ($Millions)	2001 Income ($ Millions)	2001 Taxes ($ Millions)
New York	23,857	2726.3	4341.1	600.7
Connecticut	17,481	1812.8	1553.4	185.4
Rhode Island	11,511	1042.5	579.6	66.2
Total	52,849	5581.6	6474.1	852.3

western/central Long Island Sound study area. An economic analysis for eastern Long Island Sound will be performed in a subsequent document.

The Corps conducted a survey in 2001 of commercial and recreational navigation-dependent facilities. The survey identified 959 facilities in Long Island Sound, 513 in Connecticut and 446 in New York (USACE, 2001b; Appendix B). Major dredging centers, identified as locations where large amounts of dredged material are expected to be produced, and associated navigation-dependent facilities are listed in Table 4-46 and Figure 2-1. Federal shipping channels are found in Port Chester, Greenwich, Stamford, Norwalk, Southport, Bridgeport, Stratford, New Haven, and Port Jefferson (see Figure 4-43). In addition, designated lightering zones are located over the entire Bridgeport Alternative and the northeast corner of the CLIS Alternative (see Figure 4-43). The majority of commercial ports in the region are petroleum industry ports served by barges (USACE, 1998). Approximately 70 percent of the total short tonnage received by these ports in 1981 was related to petroleum products including residual and distillate fuels oils and gasoline (USACE, 1981). Residual fuel oil is used primarily for power generation, distillate fuel oil for home heating and industry, and gasoline for vehicle use. Other important commodities that move through these ports include sand and gravel, chemicals, chemical products, coal, wood and paper products, and iron and steel scrap (USACE, 1998; USACE, 1981).

The total commercial tonnage throughput for Long Island Sound equaled 22,743,000 short tons (20,632,103 metric tons) in 2000 and the total number of vessel trips was estimated at 65,000 (Table 4-47). This information was obtained from the Corps document "Waterborne Commerce of the United States (WCUS)" (USACE, 2000h). WCUS is compiled biennially by the Corps of Engineers to present detailed data on the movements of vessels and commodities at the ports and harbors of the United States. Tonnage represents the total amount of cargo transported from the point of loading. These numbers do not include cargo carried on general ferries or coal and petroleum products loaded from shore facilities directly into bunkers of vessels for fuel. A trip represents a vessel movement. For self-propelled vessels a trip is logged between every point of departure, and every point of arrival. For loaded barges, a trip is logged from the point of loading of the barge to the point of unloading the barge (excluding fleeting areas). Shipping lanes used by these vessels generally extend from the ports towards the middle of Long Island Sound as shown in Figure 4-43 (USACE, 1998).

Table 4-46. Commercial and Recreational Navigation Dependent Facilities Associated with Major Dredging Centers

Major Long Island Sound Dredging Centers	Number of Navigation Dependent Facilities
Connecticut	
Guilford/ Branford	32
New Haven	33
Housatonic River/ Milford	33
Bridgeport	33
Norwalk	67
Stamford	28
Greenwich	19
New York	
Port Chester	13
Mamaroneck/ New Rochelle	51
East Chester Bay	20
Manhasset and Little Neck Bays	38
Hempstead Harbor	23
Oyster Bay/ Cold Spring	17
Huntington & Northport Bay	35
Smithtown Bay/ Stony Brook	10
Port Jefferson/ Mount Sinai	21

Source: USACE, 2001b; Appendix B.

- **WLIS**: The major dredging centers in the WLIS region are Norwalk, Stamford, and Greenwich Harbor in Connecticut, and Port Chester Harbor, Oyster Bay, and Huntington Harbor in New York. The number of commercial and recreational navigation-dependent facilities associated with those dredging centers are shown in Table 4-46. The major harbors located in the vicinity of the WLIS Alternative are Westport Harbor, Norwalk Harbor, Stamford Harbor, and Greenwich Harbor in Connecticut, and Port Chester Harbor, Oyster Bay, and Northport Harbor in New York. Port activity for these harbors is shown in Table 4-47.

- **Bridgeport**: The major dredging centers in the Bridgeport region are Bridgeport and Norwalk, in Connecticut, and Stony Brook and Port Jefferson, in New York. The number of commercial and recreational navigation dependent facilities associated with those dredging centers are shown in Table 4-46. The major harbors located in the vicinity of the Bridgeport Alternative are Bridgeport Harbor and Westport Harbor in Connecticut, and Port Jefferson Harbor in New York. Port activity for these harbors is shown in Table 4-47.

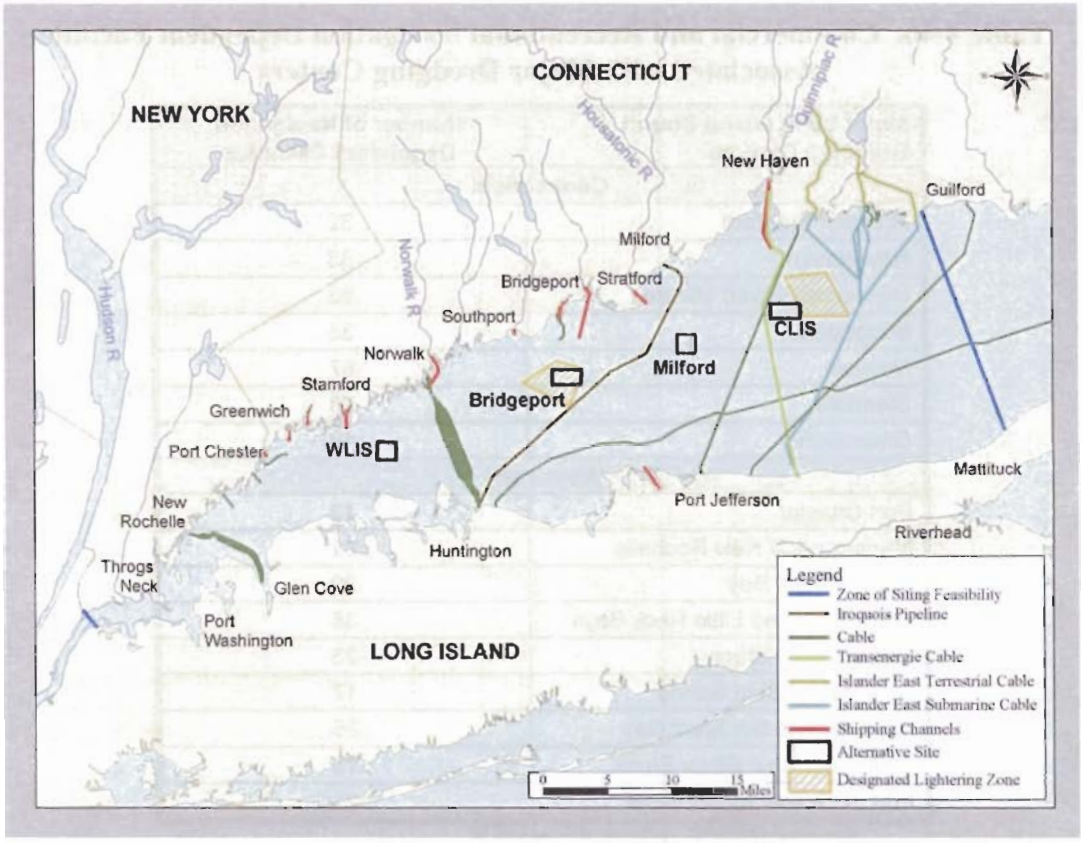

Figure 4-43. Shipping Channels, Cable Crossings, and Energy Locations in Long Island Sound

Source: NOAA Chart 12300, 12363, 12354, 42 Edition.
CTDEP, 2002b; Maptech, 2001; USCG, 2002

- **Milford**: The major dredging centers in the Milford region are New Haven Harbor, Milford Harbor, and Bridgeport Harbor in Connecticut, and Port Jefferson in New York. The number of commercial and recreational navigation-dependent facilities associated with those dredging centers are shown in Table 4-46. The major harbors located in the vicinity of the Milford Alternative are New Haven Harbor, Milford Harbor, Housatonic River, and Bridgeport Harbor in Connecticut, and Port Jefferson Harbor in New York. Port activity for these harbors is shown in Table 4-47.

- **CLIS**: The major dredging centers in the CLIS region are Guilford Harbor and New Haven Harbor in Connecticut. The number of commercial and recreational navigation dependent facilities associated with those dredging centers are shown in Table 4-46. The major harbors located in the vicinity of the CLIS Alternative are Guilford Harbor and New Haven Harbor. Port activity for these harbors is shown in Table 4-47.

Table 4-47. Foreign and Domestic Waterborne Commerce for Long Island Sound in 2000 by Weight, Maximum Vessel Draft, and Total Trips

State\Town	Weight (Thousand Short Tons)	Maximum Vessel Draft(ft)	Trips
Connecticut			
Guilford Harbor	-	9	4
New Haven Harbor	10,604	38	3,967
Milford Harbor	-	8	12
Housatonic River	140	16	69
Bridgeport Harbor	4,255	40	22,217
Westport Harbor	-	10	78
Norwalk Harbor	595	16	2,173
Stamford Harbor	1,037	16	3,105
Greenwich Harbor	-	6	3,090
Connecticut Total	**16,631**		**34,715**
New York			
Port Chester Harbor	80	14	194
New Rochelle Harbor	-	5	124
East Chester Creek	1,118	13	3,932
Manhasset Bay	57	14	365
Hempstead Harbor	1,410	16	2,943
Glen Cove Harbor	-	3	2
Glen Cove Creek	217	12	858
Oyster Bay	390	16	393
Northport Harbor	-	15	18
Port Jefferson Harbor	2,840	25	21,658
New York Total	**6,112**		**30,487**
Long Island Sound Total	**22,743**		**65,202**

Source: USACE, 2000h

4.14.3 Recreational Activities and Beaches

Recreational activities are plentiful in Long Island Sound and include swimming, diving, and sunbathing. Beaches and coastal resources for the purposes of swimming and sunbathing activities were valued at $843 million in 1990, the most recent data for recreational activities in the region and intrinsic values were estimated at $152 million (USEPA, 1990b). Diving is also a popular activity in Long Island Sound and takes place in the sheltered waters of the Sound around reefs and in areas where clearer water can be found (USACE, 1981). Beaches in the Long Island Sound area include Gulf Beach, Silver Sands Park and Walnut Beach (Milford), Long Beach (Stratford), Jennings Beach (Fairfield), Penfield Beach (Fairfield), Sherwood Island Park, Burial Hill and Compo Beaches (Westport), and Calf Pasture Beach (Norwalk) in Connecticut, and Asharoken Beach (Northport), Crab Meadow Beach (Northport), Sunken Meadow (Kings Park), Sound Beach (Port Jefferson), and Wildwood State Park (Wildwood) in New York (Maptech, 2001).

Recreational boating includes vessels engaged in sport fishing, sailing, motoring, and ferry activity (USACE, 1998). Other recreational navigation includes single-day and multi-day trips on both sail and motor operated vessels that most often occur during the months of May through September (USACE, 1998). Recreational boating is a popular use in the Sound as illustrated by the New York Sea Grant's findings of over 65 marinas with pump out facilities on the North Shore of Long Island alone (USACE, 1998). It is estimated that at least 125 marinas with pump out facilities exist on the Connecticut shore (Boating Almanac, 1993). In 1981, the New England River Basins Commission estimated that 80,000 recreational craft were berthed in Long Island Sound, predicting that 46,000 new slips would be required by 2020 (USACE, 1981).

In 2001, the Corps conducted a study in support of this DEIS entitled the *Economic Significance of Navigation-Dependent Industries* (USACE, 2001d; Appendix E-1). This study reviewed several reports including a 1996 Corps Engineering and Research Development Center (ERDC) study entitled "Estimating the Local Economic Impacts of Recreation at Corps of Engineers Projects." The ERDC analyzed the benefits derived from recreational boating in the United States including estimated sales, income, and employment impacts of recreational boating activity. Economic impacts were measured by calculating the number of boats moored, the number of visits to the boats, and amount of money spent per visit. Moored vessels are defined as those placed in the water for extended periods of time, while unmoored vessels are normally transported to the water's edge using trailers and placed in the water at specified boat ramps. Using data generated from the 1996 ERDC study, the Corps (USACE, 2001d; Appendix E-1) estimated the economic impact of recreational boating in Long Island Sound, adjusting the information to reflect 2001 dollars. Although Long Island Sound was not examined by the ERDC, the Corps determined that the results for Baltimore and Philadelphia would be comparable to Long Island Sound, allowing for extrapolation using economic multipliers (Appendix E-1). Based on the calculations, the Corps estimated that boaters in Long Island Sound spend between $54.25 and $129.37 per visit, depending on whether the trip is a single or multi-day event (Table 4-48). The study also found that boaters spend an average of 33 days per year on their vessels (Appendix E-1).

- **WLIS**: Pearfield Point is the closest beach to WLIS. It is due north and 2.8 nautical miles (5.1 kilometers) from 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 WLIS 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 (see Table 4-48).
- **Bridgeport**: Beaches in the vicinity of the Bridgeport Alternative include Jennings Beach and Penfield Beach (Fairfield), Seaside Park (Bridgeport), Sherwood Island State Park, Burial Hill and Compo Beaches (Westport), and Calf Pasture Beach (Norwalk) in Connecticut, and Sunken Meadow Beach (Kings Park) and Sound Beach (Port Jefferson) in New York. Jennings Beach and Seaside Park are approximately three nautical miles (5.5 kilometers) from the Bridgeport Alternative

Table 4-48. Recreational Boating Estimates by Geography, Sales, Income, and Employment for 2001

Geography	Sales ($ Thousands)	Income ($ Thousands)	Number of People Employed
Eastern Connecticut	3,092.8 - 7,375.4	1,620.9 - 3,865.3	83 - 199
Central Connecticut	3,170.6 - 7,560.9	1,661.7 - 3,962.7	85 - 204
Western Connecticut	1,708.2 - 4,073.6	895.3 - 2,134.9	46 - 110
Total Connecticut	7,971.6 - 19,009.9	4,177.9 - 9,962.9	214 - 513
Bronx/Queens, New York	827.7 - 1,973.7	433.8 - 1,034.4	22 - 53
Nassau, New York	628.5 - 1,498.8	329.4 - 785.5	17 - 40
Suffolk, New York	6,419.0 - 15,307.4	3,364.2 - 8,022.5	173 - 412
Westchester, New York	367.2 - 875.6	192.4 - 458.9	10 - 24
Total New York	8,242.4 - 19,655.5	4,319.8 - 10,301.3	222 - 529
Long Island Sound Total	**16,214.0 - 38,665.5**	**8,497.7 - 20,264.2**	**436 – 1,042**

Source: USACE, 2001d; Appendix E-1

and closest to the Bridgeport site. Due to the proximity of the major population centers of Fairfield and Bridgeport to the Bridgeport Alternative, coastal areas adjacent to the alternative receive significant recreational usage (see Table 4-48).

- **Milford**: Beaches in the vicinity of the Milford Alternative include Gulf Beach (Milford), Laurel (Milford), Walnut Beach (Milford), Silver Sands State Park (Milford), Long Beach (Stratford), in Connecticut, and Sound Beach (Port Jefferson), in New York. Laurel and Walnut Beaches are the closest to the Milford Alternative, approximately five nautical miles (9.3 kilometers) northeast. 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 Bridgeport, Stratford, Milford, and New Haven to the Milford Alternative, the alternative receives significant recreational usage (see Table 4-48).
- **CLIS**: Beaches in the vicinity of the CLIS 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 CLIS 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 CLIS Alternative, the alternative receives significant recreational usage (see Table 4-48).

4.14.4 Parks and Natural Areas

Areas of special concern in Long Island Sound include national wildlife refuges, state parks, county and city lands, and habitat management and conservation areas (see Table 4-49). State parks in Connecticut are located throughout the Sound and can be found in Westport, and Milford. Connecticut is also home to the U.S. Department of Fish and Wildlife's Stewart B. McKinney National Wildlife Refuge that include 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.

Table 4-49. Federal and State Parks and Areas of Special Concern by Location

Park Name	Location	Closest Site
Connecticut		
Greenwich Point State Park	Stamford	WLIS
U.S. Fish And Wildlife Service Stewart B. McKinney National Wildlife Refuge	Extends along the coast of southern Connecticut from Sheffield Island near Norwalk to New London	WLIS, Bridgeport, Milford, CLIS
Sherwood Island State Park	Westport	Bridgeport
Charles E. Wheeler Wildlife Management Area	Stratford	Milford
Silver Sands State Park	Milford	Milford
Quinnipiac River Marsh Wildlife Management Area	New Haven	CLIS
Great Harbor Wildlife Management Area	Guilford	CLIS
New York		
Wildwood State Park	Wildwood	CLIS
Nissequogue River State Park	Smithtown	Bridgeport
Sunken Meadow State Park	Kings Park	Bridgeport
Crab Meadow Beach Park	Northport	WLIS
Caumsett State Park	Huntington	WLIS
Target Rock National Wildlife Refuge	Huntington	WLIS
Pelham Bay Park	New Rochelle	WLIS
Manursing Island Park	Rye	WLIS

Source: CTDEP, 2002c; NYSDEC, 2002b

- **WLIS**: Areas of special concern in the region near the WLIS Alternative as shown in Table 4-49 are Sherwood Island State Park, Stewart B. McKinney National Wildlife Refuge, Caumsett State Historic Park, and Target Rock National Wildlife Refuge (CTDEP, 2002c; NYSDEC, 2002b). The Caumsett State Park is the closest park (approximately two nautical miles [3.7 kilometers]) to the WLIS Alternative.
- **Bridgeport**: Areas of special concern in the area near the Bridgeport Alternative as shown in Table 4-49 are Sherwood Island State Park, Stewart B. McKinney National Wildlife Refuge, and Nissequogue River State Park (CTDEP, 2002c; NYSDEC, 2002b). Sherwood Island State Park is the closest to the Bridgeport Alternative. It is approximately six nautical miles (11 kilometers) north and west of the alternative.
- **Milford**: Areas of special concern near the Milford Alternative as shown in Table 4-49 are the Charles E. Wheeler Wildlife Management Area, Silver Sands State Park, Stewart B. McKinney National Wildlife Refuge, and the Quinnipiac River Marsh Wildlife Management Area (CTDEP, 2002c; NYSDEC, 2002b). The Milford Point

Unit of the Steward B. McKinney National Wildlife Refuge is the closest park (approximately three nautical miles [5.5 kilometers]) to the Milford Alternative.

- **CLIS**: Areas of special concern in the area of the CLIS Alternative as shown in Table 4-49 are the Stewart B. McKinney National Wildlife Refuge, Quinnipiac River Marsh Wildlife Management Area, Great Harbor Wildlife Management Area, and Wildwood State Park (CTDEP, 2002c; NYSDEC, 2002b). The Outer Island Unit of the Stewart B. McKinney National Wildlife Refuge is the closest park (approximately seven nautical miles [13 kilometers]) to the CLIS Alternative.

4.14.5 Historical and Archaeological Resources

Natural and cultural resources in the form of submerged vessels occur in several locations in Long Island Sound. A search of the University of Maine Warren C. Reiss Marine (WRCM)[5] shipwreck database, and the NOAA Automated Wrecks and Obstructions Information System (AWOIS)[6] database revealed several potentially significant archaeological sites (personal communication Dr. Mitch Mulholland, University of Massachusetts, 2002). A total of 39 shipwrecks were found in Long Island Sound, focused around the areas of New Haven, Bridgeport, Milford, and Stratford, Connecticut (see Table 4-50). These shipwrecks include barges, steam engines, passenger ferries, and schooners that sunk between the years of 1741 and 1930. Several other sunken vessels were also noted, however the occurrence of these vessels is anecdotal, and exact locations are not well known.

All of the vessels identified are protected under the standards set for the National Register of Historic Places (personal communication Dr. Mitch Mulholland, University of Massachusetts, 2002). It is assumed that numerous additional vessels exist as shipwrecks in Long Island Sound; however the locations and details are unknown. According to the New York Historic Preservation Office, the Bechman Packard was sunk in 1939 off the coast of Eaton's Neck in Asharoken, New York, but its location is not known (USACE, 1998).

From August 20 to September 6, 2002, a reconnaissance-level integrated geophysical survey was conducted by the Corps and EPA at the Bridgeport and Milford Alternatives in support of the EIS (USACE, 2003i; Appendix I). Pursuant to NEPA and the National Historic Preservation Act, Section 106, the objective of this survey was to collect geophysical data (sidescan, magnetometry and subbottom profile) to be used in geomorphological characterizations of the sites, and identify and evaluate targets of potential historical and archaeological interest.

[5] The WCRM database contains information on shipwrecks from known published secondary sources, and limited primary research in regional and national archives. Most shipwreck locations cited in archival records are general statements, such as "lost off Bridgeport."

[6] The AWOIS database is a database of all wrecks and obstructions identified by NOAA. These items are normally found listed on recently published nautical charts. The AWOIS database is located at http://anchor.ncd.noaa.gov/awois/search.cfm and may be queried to retrieve a listing of all wrecks and obstructions in an area based on nautical chart numbers or Latitude and Longitude

Table 4-50. Shipwrecks Found in Long Island Sound by Name, Type, Date, and Location

Name	Type	Date	Location
Long Island Sound			
J W Harris	Steamer	1837	Long Island Sound (region unknown)
Excel	Sloop	1884	Long Island Sound (region unknown)
Harry P. Knowleton	Schooner	1907	Long Island Sound (region unknown)
Montauk	Ship	1849	Off North Shore, Long Island
Western Long Island Sound Region			
Shippan	Steam Paddle	1870	Stamford, Connecticut
Elizabeth Segar	Schooner	1872	Shippan Point, Connecticut
Colonel L F Peck	Sloop	1907	Stamford, Connecticut
Adrienne	Gas	1911	Stamford, Connecticut
Bridgeport Region			
Alice	Steam Paddle	1852	Bridgeport, Connecticut
Fearless	Schooner	1871	Bridgeport, Connecticut
J W Andrews	Barge	1871	Bridgeport, Connecticut
Racer	Schooner	1907	Bridgeport, Connecticut
E M Duffield	Schooner	1908	Bridgeport, Connecticut
Wawa	Gas Engine	1909	Bridgeport, Connecticut
Stephen E Babcock	Steam Screw	1911	Bridgeport, Connecticut
Scott Brothers	Barge	1911	Bridgeport, Connecticut
Calvin Tomkins	Steam Screw	1920	Bridgeport, Connecticut
Alert	Steam Screw	1921	Bridgeport, Connecticut
Lexington	Steamboat	1840	off Bridgeport, Connecticut
R J Wilson	Barge	1905	off Bridgeport, Connecticut
Thomas Johnson	Ferry	1741	Long Island Sound (location unknown)
Milford Region			
Lexington	Steamboat	1840	off Bridgeport, Connecticut
R J Wilson	Barge	1905	off Bridgeport, Connecticut
Thomas Johnson	Ferry	1741	Long Island Sound (location unknown)
Washington	Steam Paddle	1831	Milford, Connecticut
W H Gattrick	Barge	1870	Milford, Connecticut
S Hale	Schooner	1907	Off Stratford, Connecticut
Central Long Island Sound Region			
Chief Justice Marshall	Steam Paddle	1835	New Haven, Connecticut
Senator	Schooner	1870	New Haven, Connecticut
Berkley	Barge	1905	New Haven, Connecticut
H C French	Steamer	1906	New Haven, Connecticut
N E T Co No 10	Barge	1906	New Haven, Connecticut
Walter J Schloefer	Canal boat	1906	New Haven, Connecticut
Leslie	Gas	1906	New Haven, Connecticut
Edward F Cullen	Barge	1908	New Haven, Connecticut
Helen R Cullen	Barge	1908	New Haven, Connecticut
Joseph W Drayton	Barge	1908	New Haven, Connecticut
Witch Hazel	Schooner	1911	New Haven, Connecticut
Cynthia	Steam Screw	1930	New Haven, Connecticut

Source: Personal communication, Dr. M. Mulholland, University of Massachusetts, 2002.

After completion of the survey, digital navigation files were processed to create post-plots of the actual track lines. Side scan sonar imagery was mosaiced and interpreted using GeoDAS Desktop™ sonar processing software to identify areas exhibiting different acoustical properties representative of targets possibly having a man-made origin or evidence of dredged material deposited on the sea floor. Each target was measured for length, width, and height and also described briefly. These targets were then compared to the acquired magnetic data. Acquired magnetic data were interpreted using 2D profiles of total magnetic field intensity. Subbottom profile data were interpreted to identify near-surface subbottom stratigraphy (upper 20 feet [6 meters]) and possibly large obstructions/cultural resources buried beneath the seafloor. To determine the presence of any possible significant cultural resources that should be inspected or avoided, the geophysicist and archaeologist compared all original magnetic, side scan, and subbottom profiler data. Every possible magnetic anomaly or sonar target was cross referenced with the other data for proper analysis, including field notes to eliminate modern targets such as lobster traps, navigation buoys, and modern boats. The quality of the magnetic data allowed even small ferrous objects to be seen as anomalies in the field. Therefore, side scan targets without corresponding magnetic anomalies were not considered possible significant cultural resources, because even small colonial shipwreck sites would contain at least enough ferrous material to produce a minor magnetic anomaly. To compile a list of targets, all magnetic anomalies of 5 gammas or more were considered to be possible cultural resources unless other data indicated that modern objects caused them (*i.e.*, if the signal resembled those observed during other surveys which resulted in items like lobsterpots).

Fifty-two magnetic anomalies (equal to or greater than five gammas) were identified in the data, forty-seven in the Bridgeport Alternative (Figure 4-44) and five in the Milford Alternative (Figure 4-45). From their magnetic and sonar signatures most targets appeared to be lobster traps or were too small to be included as possible cultural resources. Nine targets in the Bridgeport Alternative and two targets in the Milford Alternative qualified as possible cultural resources. If either of these sites were recommended for designation, additional investigations of these targets would be required (Table 4-51).

At the Bridgeport Alternative, the most prominent target was SS5 (M50; see Figure 4-44), a possible shipwreck, which measured 247 gammas. This target was 69 feet (21 meters) in length with a width of 49 feet (15 meters) and little or no relief above the seafloor. The remaining sidescan targets in the site were most likely related to modern day fishing/ lobstering activities and possibly features/objects related to the deposition of dredged materials in the site.

One of the targets (45 gammas) in the Milford site, designated as SS1 (M4; see Figure 4-45), is a probable shipwreck, close to the position of a shipwreck symbol on NOAA charts of the area. According to NOAA's AWOIS database the charted wreck, AWOIS #1797, is of unknown origin and history. This probable shipwreck was 150 feet (46 meters) long, 36 feet (11 meters) wide and has a height above the seafloor of 13 feet (3.9 meters). The remaining sidescan targets in the site were likely related to modern day fishing/lobstering activities.

Table 4-51. Possible Cultural Resources from Remote Sensing Data

OSI Anomaly No.	Alternative Site	Magnetic Flux gamma	Type of Anomaly[1]	Longitude NAD 83	Latitude NAD 83	Comments (refer to Figures 4-43 and 44
M4	Milford	45	m+	-73 2.18	41 7.49	Charted wreck, assoc. w/ SS1; sss[2] targets @ 1560, 1574, &1979
M5	Milford	22	d	-73° 2.09	41° 7.33	nst[3]
M16	Bridgeport	9	d	-73° 11.91	41° 4.13	nst[3]
M27	Bridgeport	14	C	-73° 12.20	41° 4.91	sss[2] target strbrd; (SS2 @events 2950.0-50.7)
M29	Bridgeport	11	m+	-73° 12.20	41° 4.40	nst[3]
M32	Bridgeport	12	C	-73° 12.30	41° 4.31	mostly m+, sss[2]: multiple small targets (SS3)
M40	Bridgeport	10	C	-73° 12.45	41° 4.36	nst[3]
M45	Bridgeport	6	d	-73° 12.59	41° 4.39	sss[2]: target to port (SS4)
M46	Bridgeport	26	m+	-73° 12.59	41° 4.67	nst[3]
M48	Bridgeport	25	C	-73° 12.73	41° 4.41	nst[3] ; (anomaly @ event 3449.0-3450.5)
M50	Bridgeport	248	d	-73° 13.12	41° 4.71	large sss[2] target: SS5

[1] Types of Anomaly: m+ = positive monopole magnetic anomaly; m- = negative monopole; d=dipole (positive and negative flux); c=complex
[2] sss = side scan sonar
[3] nst = no sonar target associated with the magnetic anomaly
Source: USACE, 2003if; Appendix I

Similar geophysical data (with the exception of magnetometry) to identify targets of potential cultural and archaeological interest was obtained from the CLIS and WLIS Alternatives. However, each of these alternative sites are currently active and historically utilized dredged material disposal locations. Any cultural and archaeological resources that may have existed within these specific locations would have been previously disturbed or else are currently protected from any further impacts as a result of prior disposal activities. No further evaluation of these alternatives is recommended.

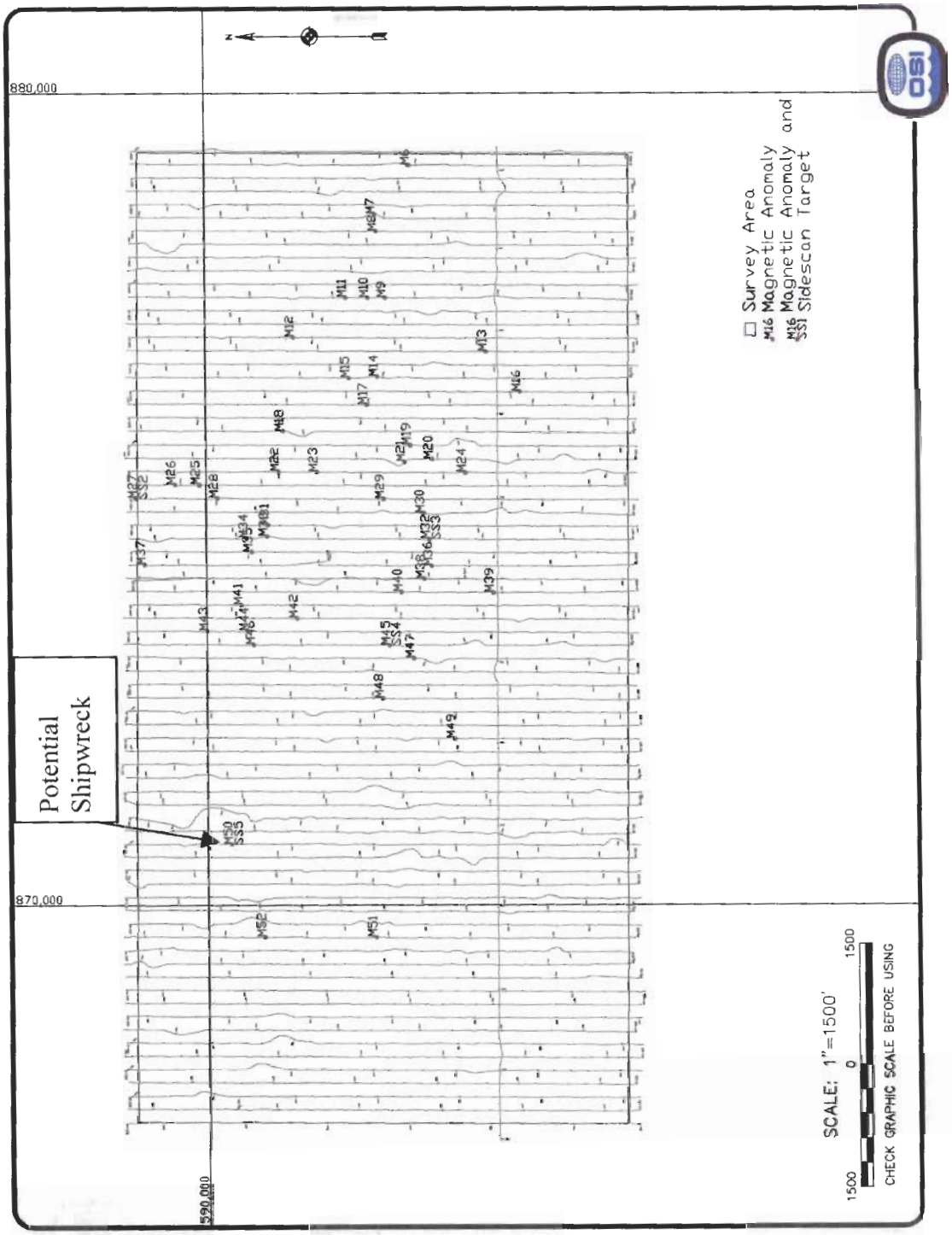

Figure 4-44. Bridgeport Alternative Disposal Site Survey Area, Showing Locations of Magnetic Anomalies and Sidescan Sonar Targets

Source: USACE, 2003i

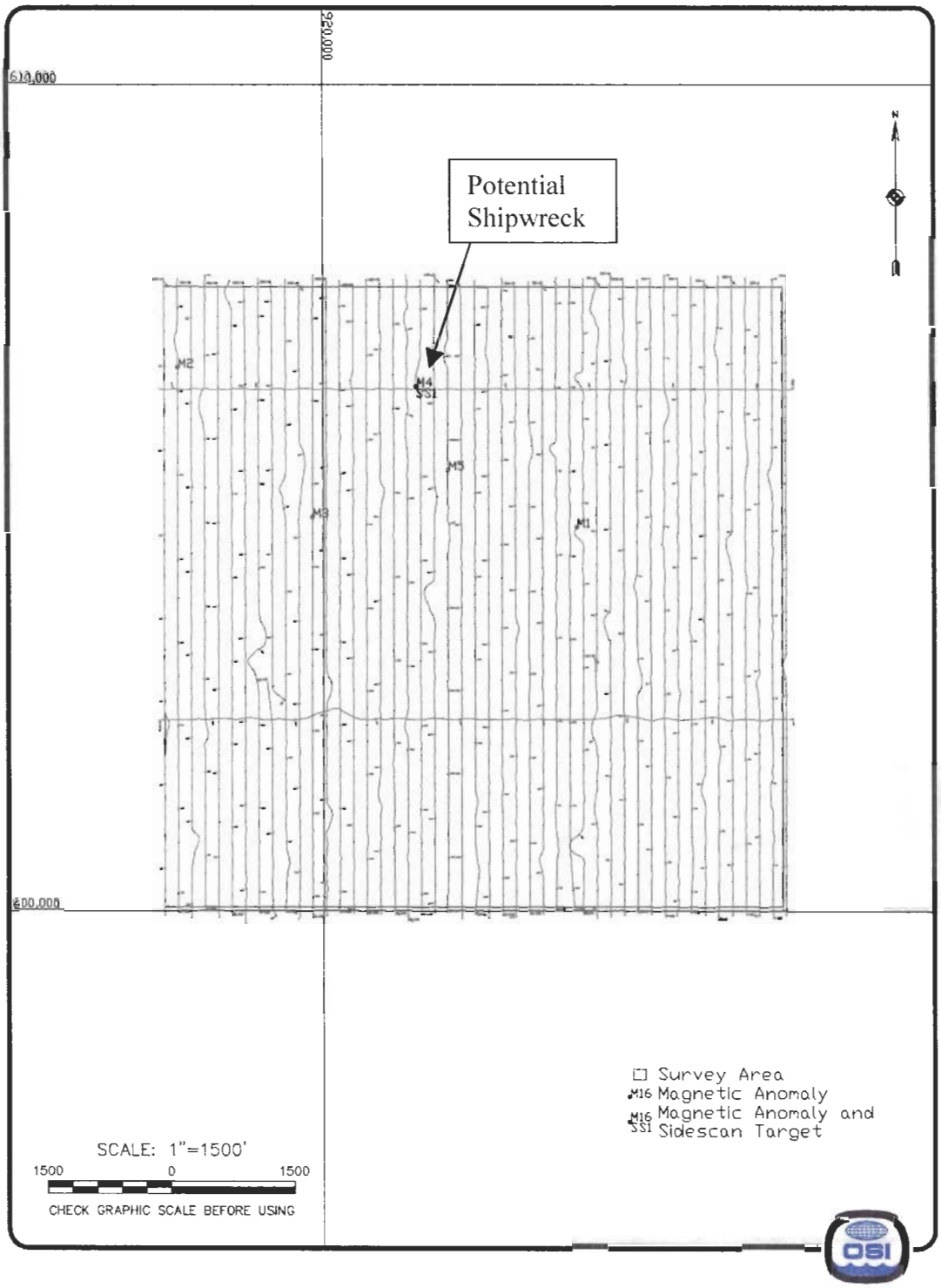

Figure 4-45. Milford Alternative Site Survey Area, Showing Locations of Magnetic Anomalies and Sidescan Sonar Targets

Source: USACE, 2003i; Appendix I

4.14.6 Other Human Uses

Military use **[MPRSA 228.6(a)(8)].** Active military sites in Long Island Sound occur at several locations in both Connecticut and New York. Such activities include a decommissioned U.S. Army engine production plant (Stratford, Connecticut), U.S. Air Force 103rd Air Control Squadron (New Haven, Connecticut), U.S. Coast Guard stations (Fort Trumbull, New Haven, Connecticut and Eaton Neck, New York)(USACE, 1998). Table 4-52 illustrates the major branches, installations, and units in the Long Island Sound region. Connecticut has historically been an economic center for military production (Appendix E-1).

Table 4-52. Military Installations in Western Long Island Sound by State, Branch, Installation, City, and Major Unit or Activity

State	Branch	Installation	City	Major Unit or Activity
Connecticut	Army	Stratford Engine Plant (Decommissioned)	Stratford	Production Plant
Connecticut	Air Force	Orange AGS	New Haven	103 Air Control Squadron (Air National Guard)
Connecticut	Coast Guard	Station New Haven	New Haven	Group/MSO Long Island Sound
New York	Coast Guard	Station Eaton's Neck	Eaton's Neck	Group/MSO Long Island Sound

Sources: www.militaryworld.com/reference, www.dcmilitary.com/servicelinks/coastguard, www.uscg.mil/d1/roles/units.htm, www.globemaster.de/html/seaunits.html. January 9, 2003.

Mineral and energy development **[MPRSA 228.6(a)(8), 228.6(a)(3)].** Energy resources in Long Island Sound include pipelines, electrical wires, and submerged cables, all of which supply Long Island, New York with power and communication needs. From west to east:

- A major cable extends from New Rochelle, New York southeastward to Port Washington on Long Island, New York (greater than 11 nautical miles [20 kilometers] west of the WLIS Alternative);
- A set of seven cables cross Long Island Sound southward from Norwalk, Connecticut to Northport, New York (approximately four nautical miles [7 kilometers] east of the WLIS Alternative);
- Terminating in Northport, New York is the Iroquois pipeline that extends past the Bridgeport Alternative (less than two nautical miles [3.7 kilometers] south) northeastward past the Milford Alternative (less than one nautical mile 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 six nautical miles [11 kilometers] south of the CLIS Alternative);
- From New Haven and Guilford several cables can be found heading southward towards Port Jefferson and Shoreham, New York. One cable passes to the north of the CLIS Alternative, and it is approximately one nautical mile away from the northwest corner of the site.

Exact locations and destination of cables, pipelines, and electrical wires can be found in Figure 4-43.

4.15 Air Quality and Noise

4.15.1 Present Air Quality and Noise

The State of Connecticut is presently considered a non-attainment zone for ozone (O3)[7]. Non-attainment zones are areas where the National Ambient Air Quality Standards (NAAQS)[8] have not been met. Ozone non-attainment zones are classified, in increasing degrees of severity, as follows: marginal, moderate, serious, severe, and extreme. The western part of Long Island Sound located in a severe non-attainment zone and the eastern part of the sound is located in a serious non-attainment zone. The exact geographic area of the severe area is all of Fairfield County, Connecticut except the town of Shelton, plus Bridgewater and New Milford, which are both in Litchfield County, Connecticut. The exact area of the serious area is all of Hartford, Middlesex, New Haven, New London, Tolland and Windham, Connecticut counties, plus the town of Shelton in Fairfield County, plus all of Litchfield County, Connecticut except the towns of Bridgewater and New Milford, Connecticut.

The CTDEP monitors air quality and creates and enforces air pollution control programs contained in its state implementation plan (SIP). One part of the CTDEP- SIP[9] is an attainment demonstration which shows that by 2007, both of the non-attainment areas in the state will meet EPA's Ozone NAAQS due to pollution control programs implemented by the State and EPA.

Ozone is formed when nitric oxide (NO), hydrocarbons, oxygen (O_2), and sunlight combine in the atmosphere. Nitrogen oxides are released during the combustion of fossil fuels (*e.g.*, operation of gasoline and diesel-powered construction equipment, including dredges, scows, and dump trucks).

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[7] Reference for CT's two non-attainment areas: EPA designated these areas as such in a final rule published in the Federal Register on November 6, 1991 (56 FR 56694).

[8] EPA's ozone NAAQS standards: 40 CFR 50.9 (one hour standard), and 40 CFR 50.10 (8 hour standard).

[9] CTDEP's State Implementation Plan (SIP): 40 CFR 52.370

4.15.2 Present Noise in the Vicinity of the Federal Navigation Projects

There are varying levels of background noise in and around Long Island Sound. Noise in the vicinity of the federal navigation channel can include that generated by vessels, such as tugs and motorboats, and by dredges. Noise created in the navigation channel will often be far from shore and not noticeable to people on the land. Such noise may be noticeable, however, in areas where the channel is located close to the shoreline.

4.15.3 Present Noise at the Associated Non-Federal Dredging Sites

The associated dredging sites consist primarily of recreational marinas and fuel terminals. Background noise levels at marinas are moderate. Noise levels at the fuel terminals in Long Island Sound are generally somewhat higher than at the marinas due to the industrial nature of the terminals and their location in urban areas.

4.15.4 Present Noise at the Potential Open-water Disposal Sites

Background noise levels vary at the different potential disposal sites. The potential disposal sites include very quiet areas in open water, residential areas with low to moderate background noise levels, and areas near urban development and loud highway traffic. The background noise levels at each disposal site are described in Section 5.6 of the Environmental Consequences section.

4.15.5 Future Noise Levels without Project Conditions

The overall background noise levels in the Long Island Sound and the surrounding land areas are not expected to significantly change in the future.

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CHAPTER 5 – ENVIRONMENTAL CONSEQUENCES

Prior to designation of a dredged material disposal site, it is necessary to understand the potential environmental impacts that could occur at a particular site as a result of dredged material disposal. Environmental impacts may become evident in the form of physical, chemical, or biological responses to the disposal activity. This chapter considers information about the disposal process and what is known about its potential impact to the marine environment. The chapter also considers the environmental and socioeconomic consequences that may result from not designating an open-water disposal site (*i.e.*, no action) and for designating one or more of the four open-water alternative sites considered. The physical and chemical processes that occur during the disposal of dredged material are first presented (Section 5.1) followed by an overview of known environmental consequences of open-water dredged material disposal (Section 5.2). The information in Section 5.1 is provided to set the stage for the review of known impacts. The sections are followed by a brief discussion of the costs associated with various alternatives (Section 5.3), potential impacts of the No Action Alternative (Section 5.4), and the analysis of the specific impacts that could occur at each of the alternative sites (Section 5.5). Section 5.6 summarizes and compares the findings from Sections 5.4 and 5.5 and evaluates these data to decide on the preferred alternative for designation of open-water dredged material disposal sites in western and central Long Island Sound.

5.1 Open-Water Disposal Processes

Dredging and dredged material disposal in Long Island Sound has historically been accomplished using a bucket dredge to fill split hull or pocket scows for transport to the disposal site or by using hopper dredges. Hopper dredges, which suction material from the bottom into split hull hoppers, have seen limited use in the past several years in Long Island Sound. Large dredging projects (greater than 500,000 cubic yards; 382,277 cubic meters), such as New Haven, Bridgeport, and Norwalk, have historically used scows of 5000 cubic yards (3823 cubic meters) capacity. For medium sized projects (200,000 to 500,000 cubic yards; 152,911 to 382,277 cubic meters) 1500 to 3000 cubic yards (1147 to 2294 cubic meters) scows are typically used. For projects under 150,000 to 200,000 cubic yards (114,683 to 152,911 cubic meters), scows of 1500 cubic yards (1147 cubic meters) or less are used. These types of equipment are expected to be used in the future in Long Island Sound.

To understand the potential impact of dredged material disposal it is important to appreciate the nature and characteristics of dredged material during individual disposal events. This process has been extensively studied and is well understood. Several factors influence the behavior of the descending plume including the properties of the sediment (*e.g.*, mud, sand, and clumps), water depth, water column stratification, and entrainment of site water during descent. However, in general, the behavior of the plume follows the three general phases listed below (Scorer, 1957; Woodward, 1959; Csanady, 1973; Brandsma and Divoky, 1976; Tsai and Proni, 1985; Ecker and Downing, 1987; Kraus, 1991):

- ***Convective Descent.*** This phase begins with the release of the sediment into the water. The material descends through the water column under the influence of gravity, generally maintaining its identity as a single plume (Brandsma and Divoky, 1976; Figure 5-1). During its descent, the area occupied by the plume expands as water is entrained. Kraus (1991) found that plumes resulting from the disposal of up to 5000 cubic yards (3,823 cubic meters) of sediment in waters up to 20 meters (66 feet) deep spread 100 to 200 meters (328 to 656 feet) around the original discharge point. The suspended sediment concentration is reduced due to dilution. The duration of this phase depends on the depth of the water, lasting only seconds to minutes in relatively shallow areas. Field and laboratory studies indicate that approximately 1 to 5 percent of the sediment discharged from a barge remains in the water column following the convective descent phase (Ruggaber and Adams, 2000; Ruggaber and Adams, submitted; Tavolaro, 1984; USACE, 1986).

- ***Dynamic Collapse.*** This phase occurs when the descending plume impacts the bottom and diffuses horizontally due to its own momentum (Figure 5-1). In areas with deep (several hundreds to thousands of feet) stratified water columns, this process is complicated by the fact that the plume may reach a depth of neutral buoyancy before hitting the seafloor. In those situations, the plume's downward vertical momentum tends to make it overshoot the neutral buoyant depth, creating a vertical oscillation, and increasing turbidity and dispersion. However, in shallow water depths such as in Long Island Sound, dredged material plumes experience dynamic collapse by impacting the bottom regardless of the water stratification because their initial momentum is too great to be overcome by the plume buoyancy.

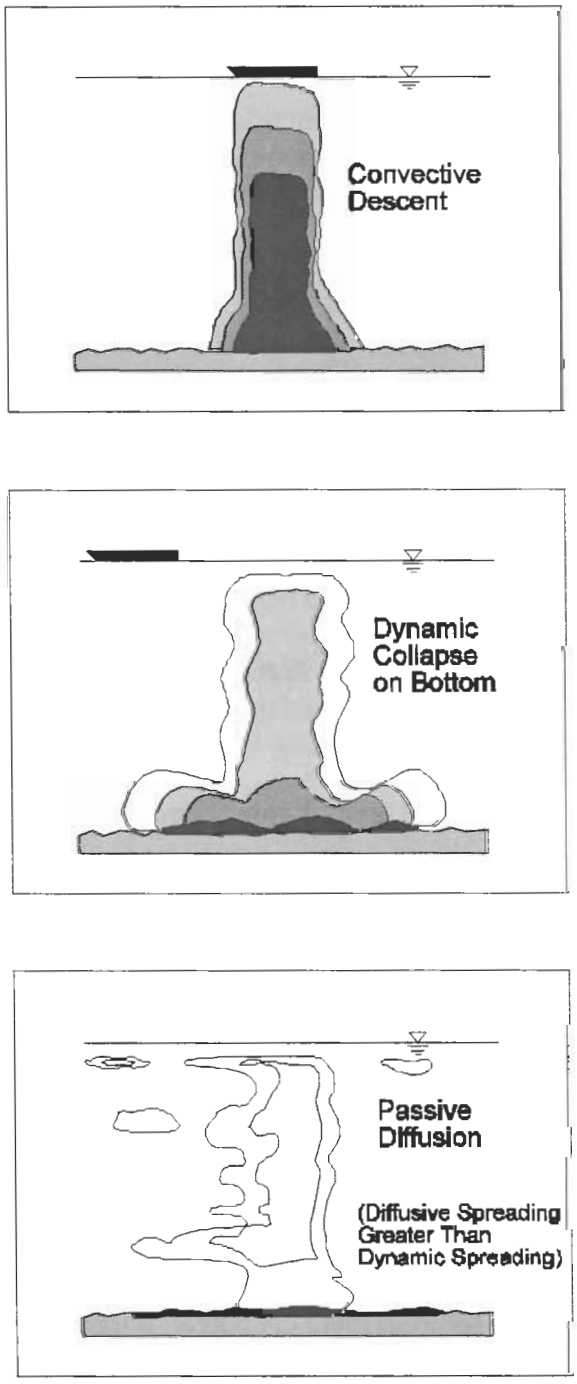

Figure 5-1. Examples of Convective Descent, Dynamic Collapse, and Passive Diffusion

- ***Passive Diffusion.*** Passive diffusion refers to the transport and diffusion of the disposed material by the ambient, oceanographic conditions (currents and turbulence) rather than the dynamics of the plume body (Figure 5-1). This phase results in the dispersion and transport of the suspended sediments, and

may last for several hours depending on the specific gravity and particle size of the sediment. Numerous field studies (see Section 5.2.1 for further details) have confirmed that plumes are transient, short-term (*i.e.*, hours in duration) features of dredged material disposal from barges (Dragos and Lewis, 1993; Dragos and Peven, 1994; SAIC, 1988).

Disposal in the marine environment exposes the deposited dredged material to currents, which have the potential to carry the material elsewhere in the surrounding aquatic environment. There are two ways that this transport may occur. During the disposal operation, the portion of the dredged material that is released (a fraction of any fine silt and clay particles present) may remain in the water column as a turbid plume for several hours where it will drift with the current. Once deposited on the seafloor, the sediments are exposed to currents, which if sufficiently strong may begin to move the sediments, either along the seafloor or into and through the water column.

5.2 Overview of Environmental Consequences

A review of the available literature was conducted to identify information that describes the known consequences of dredged material disposal in the marine environment. Physical, chemical, and biological effects, including known impacts to fisheries, were evaluated to describe the impacts of disposal. Reported effects of disposing dredged material at open-water sites include direct, indirect, and cumulative impacts, both beneficial and adverse across a broad range of spatial and temporal scales (Wright, 1978; USACE, 1981; USACE, 1982a; USACE, 1982b; Fredette *et al.*, 1993). These and other studies described below considered both short-term and long-term impacts, as well as those occurring within and outside of disposal site boundaries. Based on these data, the primary effects of dredged material disposal were identified as:

- Physical, chemical, and biological impacts within the water column;
- Topographic changes to the sea floor and biological perturbations within the site;
- Erosion and transport of deposited dredged material mounds;
- Bioaccumulation of contaminants.

These effects and potential impacts are described in the following sections. The section is organized into four subsections each of which focuses on physical, biological, or chemical impacts appropriate to the primary effect.

5.2.1 Impacts in the Water Column

Impacts to the water column resulting from the disposal of dredged material are temporary due to the rapid descent of the material and availability of unlimited dilution water. Impacts are also spatially limited to the region of the disposal site due to the relatively small cross sectional area of the descending material (*i.e.*, the convective phase). The intermittent nature of the disposal operations, short time period that material stays in the water column, and rapid dilution and settling further limit such effects. Some entrainment of organisms (*e.g.*,

phytoplankton, zooplankton, and larval stages of fish and invertebrates) may occur during the descent of the dredged material; however, the number of organisms affected would be small compared to the size of the overall community at the site and within Long Island Sound. Impacts of the descending sediment plume on pelagic fish, reptiles, and mammals have not been demonstrated, but are thought to be small because those organisms are mobile enough to avoid the descending material, and can burrow out from beneath a modest thickness of deposited material. Wright (1978) indicated that avoidance of disposal plumes by fish was noted in early dredged material studies conducted under the Corps Dredged Material Research Program.

The primary impacts to the water column are associated with the residual particles that remain suspended after the plume has reached the seafloor. These particles result in increased turbidity, which has been associated with mechanical damage to respiratory surfaces (Saila *et al.*, 1971). In addition, the residual turbidity changes the light penetration, resulting in reduced photosynthesis. However, impacts such as these are limited in duration and spatially due to the short time needed for dredged material to reach the bottom (Kraus, 1991; Dragos and Lewis, 1993; Dragos and Peven, 1994), particularly in surface waters where the majority of plankton growth occurs. 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, and fish and lobster 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 disposal is not likely.

The frequency of disposal operations may influence the potential for water quality impact at the disposal site. For example, if the frequency of disposal is high, the potential for disposal on top of relic plumes increases, possibly resulting in water quality criteria exceedences. There is less potential for this type of impact when disposal frequency is low. Careful site management can be used to mitigate these potential impacts.

Other potential effects on the water column from dredged material disposal may include the release of nutrients or contaminants from sediments during the descent phase. Nutrients and contaminants in sediments are generally bound to the sediment and particulate organic particles. However, various levels of nutrients and contaminants can occur in the pore water (water within the sediments) depending on the physical and chemical properties of the sediment. Under some circumstances nutrient and contaminant levels in pore waters may exceed levels found in the overlying water column. However, the total amount of nutrients and contaminants associated with the sediment pore waters of a volume of dredged material is generally small relative to that associated with the receiving water at a disposal site (*i.e.*, small concentrations and volume compared with a small concentrations and large volume) and only a small portion of these chemicals are released during the disposal process. In addition, the incremental addition of nutrients or contaminants from dredged material disposal relative to other sources such as rivers, treatment facilities, and nonpoint sources is believed to be insignificant. USACE (1982a, b) studied impacts in Long Island Sound from dredged material disposal, but was unable to describe cumulative effects due to "complex and interrelated environmental factors" that made it impossible to separate the influence of

dredged material disposal from other possible sources and perturbations. Bioaccumulation studies in the water column at the New London Disposal Site (NLDS) in the early 1980s were unable to ascribe small increases in PCB concentrations in caged mussels to dredged material disposal alone, but showed that the increases in the water column did not continue after disposal operations were complete and that the region returned to pre-disposal levels shortly there after (Arimoto and Feng, 1983; Fredette *et al.*, 1993).

5.2.2 Topographic Changes

The overlap of multiple dredged material disposal events ultimately builds discernable mounds within a disposal site, altering the topography of the area. While changes associated with single events are likely to be negligible, the cumulative impact can be more substantial. For example, the footprint on the sea floor of a single dredged material disposal event (barge load) may range from a few hundred square feet to several thousand square feet depending on water depth, type of material, and size of barge (Poindexter, 1990). The footprint from a barge unloaded in approximately 600 feet (183 meters) of water off San Francisco was found over an area of 500 by 1000 feet (152 by 305 meters) (USACE, 1986). In contrast, studies from Long Island Sound show that the footprint of a barge load of dredged sediment discharged in 100 feet (30 meters) of water may spread over an area of the seafloor ~400 feet (120 meters) in diameter. As multiple disposal events occur, accumulations that range from several inches to several feet in height are built above the original seafloor. The impacts associated with these changes can be both physical and biological.

Physical Impacts. One physical impact due to changes in topography is the alteration of local bottom water currents within a site. These alterations are not known to interfere with regional flow patterns and transport within a system. Another physical impact is a change in water depth above the dredged material disposal site. However, each site is actively managed to control the number and elevation of mounds created to avoid interferences with shipping and navigation.

Numerous studies have documented the stability of disposal mounds on the seafloor (SAIC, 2001a; SAIC 2001b; SAIC, 2001c; SAIC, 1979; SAIC, 1994). Several processes that operate at longer time scales can reduce mound height or modify the mound topography, including physical and biological processes that "smooth" the roughness of the mound (SAIC, 1994). The most prevalent process occurring right after disposal is reconsolidation of the sediment due to the weight of the material in the mound. As a result of this settling process, the water trapped in the dredged material is expelled, reducing the total volume of the mound.

In some situations, bottom currents can transport and redistribute materials from the mound surface. The amount of transport and redistribution depends on the sediment texture (grain size), sediment cohesiveness, and current strength. Biological process such as colonization (including burrowing) and foraging by megafauna also act to "smooth" the mound's surface and change its topography. These physical and biological processes also modify the nature of the surface sediments on the mounds over time. Studies have demonstrated that the surface sediments of dredged material mounds can have the fine-grained sediments removed by storms and currents (winnowed), leaving behind coarse sediments (Pratt *et al.*, 1973;

SAIC, 1979). Such winnowing eventually reaches an equilibrium distribution that reflects the critical erosion velocity at the site.

A major mechanism that works against mound stability at shallow coastal disposal sites is major storms such as hurricanes or "nor'easters." Such storms can induce erosion by imparting energy to the seafloor through wave generation. The storm intensity, wind direction, speed, and duration of the storm interact with the water depth and sediment type to determine whether or not erosion occurs and the amount of material affected. SAIC (1994) examined the loss of material from mounds in the CLIS Disposal Site using bathymetric methods following the passage of Hurricane Gloria in 1985 and found no significant loss of material from the historic mounds. However, the study noted possible changes of 0.4 or 0.8 inches (1 or 2 centimeters) in mound height based on data from sediment profile images. Such information is often used to establish the minimum water depth for disposal sites.

Studies over the past 25 years, including those of the DAMOS program, have documented the general stability of dredged material mounds by recording bathymetry before and after active disposal operations, and periodically thereafter. Data from the New London Disposal Site (NLDS) in eastern Long Island Sound are particularly relevant to showing mound stability. This open-water disposal site, located 4.6 nautical miles (8.5 kilometers) south of Eastern Point, in Groton Connecticut, (eastern Long Island Sound) in 14 to 24 meters (46 to 79 feet) of water, has been actively used as a dredged material disposal site since 1955. Over its history, it has received dredged material from a variety of projects of varying sediment texture and quality. This site experiences relatively strong bottom currents (55 centimeters/ second [1.8 feet/second]) but is largely protected from storm-generated seas by Fishers Island, located a few kilometers to the east. As a result, the site has retained the majority of the material placed there.

High precision bathymetry studies completed at NLDS in 1992, 1995, 1997, 1998, and 2000 (SAIC, 2001a; SAIC, 2001b; SAIC, 2001c) have detailed changes in the topography of the site as disposal occurs and repeatedly document that the bathymetry or topography of historic mounds are not changing. Some mounds in the site are more than 20 years old and have not changed since consolidating (settling) 9 to 12 months following disposal.

Another example of long-term mound stability at an open-water site is from the Brenton Reef Site in Rhode Island Sound. The mound was created by the disposal of 9 to 10 million cubic yards (7 to 7.6 million cubic meters) of dredged material in the late 1960s (Saila *et al.*, 1969; 1971). Bathymetric studies conducted intermittently over the intervening 35 years (SAIC, 1979; Wiley *et al.*, 1996) show the mound dimensions (*i.e.*, height and footprint) have not changed substantially, even though this site is located in approximately 100 feet (30 meters) of water and is exposed to strong currents and ocean wave energy generated from offshore storms. Sediment samples collected across the mound suggest that it has become armored with sand, which has enhanced protection against erosion (SAIC, 1979).

A third example of mound stability and erosion is an evaluation of sediment resuspension at the former Mud Dump Site in the New York Bight (Clausner *et al.*, 1996). Studies of this former dredged material disposal site found an absence of fine-grained sediments at depths

shallower than 65 feet (20 meters) in the Bight Apex. Sediments shallower than 65 feet (20 meters) (*e.g.*, on top of the inactive dredged material disposal mounds in the area) consist primarily of coarse/sandy material. Correspondingly, sediments in deeper waters were more heterogeneous with some areas in sheltered topographic lows consisting of fine grained sediments or mud. In this situation, storm induced erosion was determined to be significant at depths shallower than 65 feet (20 meters). The areas of fine grained sediments were attributed in part to the gradual relocation of fine sediments from the mound tops which caused the shallow-water areas to become progressively sandy, armoring the seabed and making it less prone to erosion. As a result, material disposed in this area over the past century has formed a distinct and stable topographic mound on the seafloor.

The Brenton Reef and the former Mud Dump Sites differ from those in the Long Island Sound in that they are located in the open ocean and exposed to long fetch, and thus are more severely impacted by major storms. Regardless of the location, the fact that distinct and stable disposal mounds are present at these highly energetic locations demonstrates that mounds become armored and protected against resuspension and resulting transport. Moreover, the data from dredged material disposal sites that are protected from such storms show that the deposited sediments remain within the disposal site.

Biological Impacts. One of the key biological impacts due to changes in topography is the burial of organisms in the disposal area. Those species that are not able to avoid the descending dredged material plume or burrow through the deposited material may be eliminated from the site following multiple disposal events. Burial becomes problematic if the buried organisms constitute a significant shellfishery or are a spatially limited, unique community or population within the water body. Identification and avoidance of such resources during site designation or selection can avoid this type of impact.

Burial of organisms occurs at sites where dredged material is deposited. Some organisms possess the ability to move through the sediment layer that deposits on them and others do not. Vertical migration through the deposited sediments is influenced by a number of factors including sediment type, sediment depth, burial duration, temperature, and adaptive features such as an organism's ability to burrow and to survive low oxygen conditions. Maurer *et al.* (1986) indicate that major taxa such as mollusks (clams), crustaceans (*e.g.*, crabs, lobsters), and polychaetes (worms) respond differently to burial. Sediment type (*e.g.*, mud, sand, and mixtures of mud and sand) greatly influences the ability of buried organisms to migrate though the sediment to their normal depths of habitation. As a result, the type of material disposed can influence the level of survival, the rate of recovery of the site, as well as the diversity of the community that recolonizes the area, particularly if the sediment characteristics are very different from the native sediment at the site.

Also important are the life habits of organisms inhabiting the disposal site such as feeding type (*e.g.*, epifaunal suspension feeders, deep burrowing siphonate suspension feeders, infaunal non-siphonate suspension feeders, burrowing siphonate feeders). Those organisms that burrow deeply into sediments tend to be able to survive greater burial depths, often up to 20 inches (50 centimeters), and are more likely to survive a burial event. Other type of feeders can generally survive only a few inches of burial (0.4 to 4 inches [1 to

10 centimeters]). 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.

Biological impacts also include those to the benthic community and local food web caused by changes in the physical properties of the substrate when deposited dredged material (*e.g.* sand, mud, clays, and rock) alters the habitat type. Dredged material disposal may result in physical changes to the sediment properties of the site (*e.g.*, sediment texture and particulate organic matter). Such changes may be an outcome of the actual disposal (*e.g.*, mud on sand or sand on mud or intermediate sediment texture) or may result from alteration in the sediment texture through erosion. Such changes define 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. This in turn may influence the use of the disposal site by higher trophic levels and potentially effect the response of various species to the mound, including those of recreational or commercial importance.

Sediments disturbed by natural processes or dredged material disposal operations may be recolonized by aquatic organisms through several mechanisms. As summarized in Maurer *et al.* (1986) recolonization mechanisms may include 1) emigration of adults from undisturbed areas, 2) seasonal reproduction and larval recruitment from undisturbed areas, 3) vertical migration through the sediments, and 4) nocturnal swimming. Each mechanism can influence the rate of recolonization as it may depend on natural reproductive cycles and active or passive transport to the affected sediments. The relative importance of the above recolonization mechanisms to site recovery is specific to the conditions in the site, communities in adjacent sediments, and the life cycle of the various organisms.

The recolonization and rate of dredged material disposal mound recovery has been studied extensively over the past 30 years. The recolonization generally follows a systematic progression described by Rhoads and Germano (1982, 1986). This successional progression forms the basis for evaluation of benthic community recovery on dredged material mounds in the northeast and is amenable to rapid assessment using sediment profiling camera systems. The successional process is generally categorized as proceeding from Stage I (pioneering assemblages) through Stage II (infaunal deposit feeders) to Stage III assemblages (typically head-down deposit feeding organisms). The measurement tool used in these assessments is often supplemented with traditional benthic community analyses to verify the remotely sensed information. Studies at the NLDS in the late 1990s documented general agreement between results from traditional benthic infaunal grab sample methods and the successional and assemblage information obtained from the camera system (SAIC, 2001c).

DAMOS and other programs have repeatedly documented rapid recolonization of mound surfaces with infaunal assemblages typical of the sediments surrounding the disposal site. For example, monitoring at the NLDS (SAIC, 2001a; SAIC, 2001b; SAIC, 2001c) shows the impact to infaunal community is confined to the deposition footprint of the mound and that a gradient in benthic assemblages and communities exists across a mound within 1-2 years of disposal. Initial mound recolonization is very rapid (months) and proceeds from Stage I to Stage II/Stage III assemblages within a few years. These studies also document 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 physical disruption of the seafloor lower. Such gradients are not inconsistent with the findings of Maurer *et al.* (1986) relative to the ability of organism to migrate through various depths of sediments after burial. Mounds that have been in place at the NLDS for several years consistently support mature benthic assemblages that are similar to reference areas outside of the disposal site and are stable over time (SAIC, 2001c).

DAMOS has documented similar recovery at other dredged material sites in New England. The Rockland Disposal Site located within West Penobscot Bay in Maine is of particular interest. The site, which is in about 230 feet (70 meters) of water, received dredged material through the 1980s, with about 27,000 cubic yards (20,600 cubic meters) disposed in the 1990s (SAIC, 2001d). The 2000 survey concluded that the "seafloor within the Rockland Disposal Site has recovered from the disturbance caused by past dredged material placement and that the benthic conditions are now equal to or better than the surrounding areas of seafloor" (SAIC, 2001d).

Features such as sharp temperature changes, abrupt changes in topography or bottom type or artificial structures (artificial reefs) are said to be the best locations to find and land fish and motile shellfish like lobster. Clarke and Kasal (1994) explored the concept of stable dredged material mounds providing substantial fisheries resource benefits as a long-term management objective for dredged material disposal. The basis of this study was that mounds and berms create conditions conducive to enhanced fisheries production as supported by anecdotal reports of fishery utilization. Few definitive scientific studies of this phenomenon have been conducted since publication of this early concept paper although limited data from the Rockland, Maine Disposal Site suggests that the disposal mound supports an active population of megafauna (SAIC, 2001d).

However, there is abundant anecdotal evidence from other areas that add credence to the theory. Lobstermen from Long Island Sound (Appendix H-8) repeatedly and consistently report that trawling and lobstering is more productive near active disposal sites. 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. Wright (1978) reported that the former Eaton's Neck Dredged Material Disposal Site in western Long Island Sound was one of the best lobstering locations in the Sound. It was believed that this was primarily due to the changes in topography and bottom type from the disposal of sediments and other material.

It is known that the sediments within disposal sites do recover and develop biological communities that are healthy and able to support species typically found in the ambient surroundings. Except in the case where sediments have been placed over major shellfisheries (see for instance, Saila *et al.*, 1971), adverse long-term impact to fin and shellfisheries has not been demonstrated in the literature. On the contrary, the impacts due to topographic changes and sediment type may contribute to the overall productivity within coastal areas. However, specific types of organisms that prefer the benthic habitat prior to the placement of dredged material may be displaced to surrounding areas following disposal activities. As a result, community composition may change without affecting productivity.

5.2.3 Erosion

Erosion may result in movement of the deposited sediments away from the point of impact with the seafloor, and if extensive enough, out of the disposal site. Factors influencing erosion include water depth, duration, and strength of storm disturbances, intensity of local currents (*e.g.,* tidal currents), mound configuration, bottom topography, and sediment characteristics. Human activities, such as trawling, that alter the bottom topography may also influence erosion. Erosion may occur at a disposal site through two natural processes: storm events and local tidal currents. The first process is intermittent and may impart energy to the seafloor causing deposited particles to lift into the water column. Erosion caused by storms depends greatly on the water depth; intensity, duration and direction of winds; and the type of material on the mound (sand, silt, *etc*). Erosion caused by this process may resuspend and transport a few inches of sediments, although the amount resuspended and transported is site- and storm-specific.

Understanding the potential for erosion based on storm frequency and intensity is a critical aspect of dredged material site designation and site management strategies (*i.e.*, not allowing mounds to build higher than the critical erosion depth for a site). Sites located in water depths below the critical erosion depth potential are typically not affected by major storms. As described previously, mound erosion from the passage of Hurricane Gloria over CLIS in 1985 did not result in significant loss of material from its historic mounds (SAIC, 1994), although possible changes of 0.4 to 0.8 inches (1 or 2 centimeters) in mound height may have occurred.

The second erosion process is related to the normal movement of bottom water due to tidal and other local currents. Erosion associated with these currents is periodic and less intense than that experienced during storms. Current velocity, mound configuration, and sediment type greatly influence the amount of erosion that occurs. This type of erosion may winnow fine-grained sediments (silt and clays) from the deposited material leaving behind material that is coarser and less susceptible to erosion and transport from the mound. The biological community associated with the sediments also influences whether erosion can occur (*e.g.*, organisms may loosen the sediments allowing easier resuspension or form mats that restrict the ability of the currents to lift the sediments).

The interplay between erosion and benthic organisms may also 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. Over time, and in the absence of major physical disturbances, this interplay would establish, or reestablish biological communities on the mounds as described previously. The time frame for the changes in these benthic communities has been extensively studied on dredged material mounds. Thus, mound erosion has three elements that relate to indirect impact of dredged material disposal 1) recovery of benthic communities following disposal, 2) habitat changes on the mound through time, and 3) influence of these changes on the food web including commercial and recreational fisheries in and near a site over time.

Limiting the probability of large-scale erosion and transport of mounds within and from the disposal site is an important consideration when designating a site. However, erosion and

winnowing of the surface sediments (upper 0.8 to 1.6 inches [2 to 4 centimeters]) is a normal response due to tidal and long-term currents. It may provide positive attributes such as armoring of the surface against further erosion and creating microhabitats within the disposal site that provide greater variability in benthic habitat, leading to continued, if not greater, utilization of the area by fish and shellfish.

5.2.4 Bioaccumulation

Bioaccumulation is defined as the uptake and retention of contaminants (*e.g.*, metals and organic compounds) into the tissues of organisms from all possible external sources (Brungs and Mount, 1978; Spacie and Hamelink, 1985). While bioaccumulation of a contaminant by an organism may or may not result in detrimental impacts to that organism, it can be an indicator that the population, similar organisms, and higher trophic-level organisms that prey on the contaminated organisms may be potentially at risk of adverse impacts. Understanding pathways by which contaminants may potentially bioaccumulate is essential for evaluating the effects of dredged material disposal. This includes cumulative impact of historical dredged material as well as other disposal activities and other contaminant sources to a region.

There are five major pathways for contaminant entry into organisms (1) water, (2) particles (detrital or resuspended), (3) sediment, (4) contact with interstitial pore water of the sediments, and (5) grazing (herbivorous or carnivorous). The importance of each pathway depends in large measure on the life history of the organism and bioavailability of the contaminant. For example, benthic infaunal and epifaunal organisms are in close and immediate contact with bottom sediments and are more likely to be exposed to contaminants through contact with or consumption of sediment and pore-water. For these organisms, feeding mode (*i.e.*, filter or deposit) would also influence the initial entry pathway and dictate the exposure to and assimilation of contaminants. Because these organisms are non-migratory, they can be chronically exposed to local concentrations of contaminants in the sediments.

Demersal species that live on the bottom may be exposed through sediment and food pathways depending on their trophic level (*e.g.*, primary or secondary carnivores). These organisms are more motile than benthic infauna and can encounter varying levels of contaminants through different prey species and feeding ranges.

Further removed from the sediment environment that contains most of the bioaccumulative contaminants are the pelagic organisms. Pelagic organisms generally prey on other pelagic organisms. Thus, these organisms are primarily exposed to contaminants present in the water column and their water-column food. Additionally, because many pelagic fish move across large coastal areas, they may be exposed to widely different types and levels of contaminants throughout their life cycle.

Grazing occurs at all trophic levels. Herbivorous organisms graze on primary producers (*e.g.*, plankton) and plant detritus. These primary consumers can include zooplankton and filter feeding benthic species (*e.g.*, bivalves) as well as higher organisms such as whales. Small and large fish and crustaceans graze on zooplankton and benthic infauna and are in

turn consumed by other fish. The ultimate trophic level of grazers includes the carnivorous fish, some marine mammals, and humans.

In aquatic environments, contaminants are bioavailable only if they are in a form that can be transferred into an organism, usually through its skin, gill epithelium, gut epithelium, or other cell membranes (Newman and Jagoe, 1994). Nearly always, contaminants in solution in the water are more bioavailable than those bound to sediment particles or present in food (Neff, 1984). Most bioaccumulative contaminants of concern (*e.g.*, PCBs, DDTs, dioxins) are hydrophobic (*i.e.*, they dissolve in water at only low concentrations, if at all) and are strongly bound to sediment particles. Some of these sediment particles enter the water column by natural processes such as river outflow or are resuspended by currents and storm events. Others are resuspended by human activity (*e.g.*, dredged material disposal events, fish trawling, and underwater mining).

For bioaccumulation to occur, the rate of uptake must be greater than the rate of loss (excretion) of the contaminant from the organism. Highly soluble contaminants often occur in bioavailable forms in the environment and rapidly penetrate the tissues of aquatic organisms. However, at sublethal concentrations, these contaminants are not retained and are lost just as rapidly from the tissues by diffusion, active transport, or metabolic modification. As a result, their concentrations in tissues are equal to or lower than their concentrations in the water or sediment. For other contaminants, organisms' metabolic processes regulate contaminant levels independent of ambient concentrations (Chapman *et al.,* 1996). This is especially true for many metals. Other chemicals (*e.g.*, some PAHs) may be taken up rapidly, but are transformed and excreted rapidly and, therefore, are not bioaccumulated.

A component of bioaccumulation is biomagnification. Biomagnification is the transfer of a chemical through trophic levels resulting in elevated concentrations with increasing trophic levels (Connell, 1989; Gobas *et al.*, 1993). Recent studies have shown that very few chemicals biomagnify in aquatic environments (*e.g.*, LeBlanc, 1995). Generally, even though higher trophic levels have higher contaminant concentrations relative to lower trophic levels, the increase can be explained in many cases by the relative increase in lipid content as trophic level increases or by decreased chemical elimination efficiencies of higher trophic level organisms (LeBlanc, 1995).

Although bioaccumulation is a naturally occurring process within the aquatic environment, the placement of dredged material at a disposal site can alter the conditions controlling bioaccumulation (*e.g.*, chemical concentrations, grain size) resulting in a localized change in the rate of uptake and possible risks of associated adverse health affects. Sediment testing of dredged material is designed to limit the effect. Available studies (Arimoto and Feng, 1983; Gentile *et al.*, 1984; Peddicord, 1988) conducted prior to the application of the current testing requirements (USEPA and USACE, 1991) demonstrate that some dredged material may result in short-term, spatially limited increases in the bioavailability of compounds at or near dredged material mounds. These studies did not find adverse impacts to organisms from dredged material disposal.

5.3 Cost Analysis for All Alternatives Considered

For this DEIS, thirteen different disposal alternatives were evaluated in a preliminary cost analysis. The thirteen disposal alternatives consisted of the following: four open-water sites in Long Island Sound —WLIS, Bridgeport, Milford and CLIS; the HARS disposal site offshore of Sandy Hook, New Jersey; a hypothetical Rhode Island Sound disposal site, alternatives for which designation is currently being studied in a separate EIS document being prepared by EPA and the Corps; an off-shore site on the outer continental shelf 20 nautical miles (37 kilometers) seaward of Montauk; an offshore site on the outer continental slope 71 nautical miles (131 kilometers) seaward; 3 upland disposal options — a hypothetical upland site with a one mile (1.6 kilometers) haul distance from the harbor being analyzed, a hypothetical upland site with a 10 mile (16 kilometers) haul distance, a hypothetical upland site with a 25 mile (40 kilometers) haul distance; an upland site in eastern Pennsylvania with transport by rail; and a generic in-harbor disposal alternative with a confined disposal facility.

This preliminary cost analysis was performed based on disposal cost data developed by the Corps cost engineers. The construction cost estimates were based on the following: past Corps experience with different disposal methods; engineering analysis of costs, including the cost of transporting the material, mobilization and demobilization of equipment, and labor costs; and best professional judgment. For each harbor in the study area, a likely range of dredging amounts was determined, and a cost per cubic yard for each disposal alternative was developed. Only dredged material amounts over 25,000 cubic yards (19,114 cubic meters) were analyzed. For most of the alternatives, the cost of disposal is strongly related to the distance from the harbor to the disposal site, and so the distance from each harbor to each site was determined. The total cost of disposal is also related to the volume of material dredged, since disposal costs per cubic yard generally decrease with larger dredging jobs due to economies of scale and fixed mobilization and demobilization costs. Costs also reflect rehandling of material for those alternatives not involving in-water disposal.

The complete results of the cost analysis are contained in Appendix E. The tables in the appendix show the analysis of each harbor, the range of disposal amounts analyzed, the alternative disposal options, the distance from each harbor to each disposal site, the estimated cost per cubic yard, and the total estimated disposal cost.

The cost analysis determined that the open-water site alternatives in Long Island Sound, namely CLIS, WLIS, Bridgeport and Milford, are generally the four lowest-cost alternatives for dredged material disposal for harbors around the Sound. The second lowest-cost group includes disposal at a hypothetical Rhode Island Sound site, disposal at HARS, and disposal at the outer continental shelf 20 nautical miles (37 kilometers) out. The third lowest-cost group includes disposal at the outer continental shelf 71 nautical miles (131 kilometers) out, upland disposal with a one mile (1.6 kilometers) haul distance, and disposal in-harbor with a confined disposal facility. The most expensive options are upland disposal with a 10 mile (16 kilometers) haul distance, upland disposal with a 25 mile (40 kilometers) haul distance, and disposal at an upland site in Pennsylvania with transport by rail.

For each disposal alternative, disposal costs are presented here for a 26,000 cubic yard (19,878 cubic meter) dredging project, which represents a typical non-Federal dredging project, and for a 100,000 cubic yard (76,455 cubic meter) project, which represents a typical Federal dredging project or a large non-Federal project. Disposal costs for each alternative for each of these two project sizes are shown below in Table 5-1. The average disposal cost for all harbors analyzed is shown, on a per cubic yard basis, as well as the range of disposal costs for all of the harbors, which generally is dependent on the location of the harbor relative to the disposal option. Costs per cubic yard include all related costs, such as engineering, design, mobilization, demobilization, *etc.* It should be noted that this cost analysis is based on the assumption that the material analyzed includes the minimum testing requirements. The complete set of harbors analyzed for all alternatives and the complete range of project volumes is contained in Appendix E-3.

Table 5-1. Disposal Costs per Cubic Yard (cy)[1]

	26,000 cy project		100,000 cy project	
Disposal Alternative	**Average Disposal Cost**	**Range**	**Average Disposal Cost**	**Range**
CLIS	$25.85	$22-$29	$16.54	$15-$19
Milford	$25.15	$21-$28	$16.10	$14-$18
Bridgeport	$24.47	$21-$27	$15.79	$14-$17
WLIS	$23.94	$21-$28	$15.60	$14-$18
HARS	$33.26	$28-$40	$21.65	$18-$25
RI Sound Site	$38.44	$32-$42	$24.57	$21-$27
Outer Cont. Shelf 20 nmi.	$37.95	$32-$41	$24.23	$21-$26
Outer Cont. Shelf 71 nmi.	$48.04	$43-$51	$32.02	$27-$35
Upland - 1mi.	$51.45	NA	$32.18	NA
Upland - 10 mi.	$55.47	NA	$36.12	NA
Upland - 25 mi.	$59.49	NA	$40.06	NA
Upland - Rail to PA	$91.73	$85-100	$72.62	$65-$82
In-harbor Confined Disposal Facility	$50.77	NA	$33.60	NA

NA = no range; all harbors have same cost for these alternatives

[1] Average disposal costs for CLIS and Milford represent costs for dredging centers and harbors in the central region of Long Island Sound; WLIS and Bridgeport represent costs for dredging centers and harbors in the western region of Long Island Sound; Average disposal costs for all other alternatives represent costs from all sources in the western and central regions of Long Island Sound.

As can be seen in Table 5-1, disposal costs for a 26,000 cubic yard (19,878 cubic meters) project at CLIS, WLIS, Bridgeport, and Milford would generally average $24 to $26 per cubic yard, with the complete range from $21 to $29 depending on the location of the specific alternative relative to the specific harbor. For a 100,000 cubic yard (76,455 cubic meters) project, the average cost per cubic yard is lower, due to economies of scale, and averages $15 to $17 for these alternatives, with a complete range of $14 to $19. For an analysis of the cost differential between the four open-water Long Island Sound alternatives, see Section 5.3.1 below.

For the second lowest-cost group of alternatives, which includes a hypothetical Rhode Island Sound site, HARS, and the outer continental shelf 20 nautical miles (37 kilometers) out, average disposal costs are $33 to $38 per cubic yard for a 26,000 cubic yard (19,878 cubic meter) project, and $22 to $25 for a 100,000 cubic yard (76,455 cubic meter) project. These average costs represent an increase of 40% to 60% over the open-water Long Island Sound alternatives. However, for some harbors in the western-most Sound in and near New York City, the cost of the HARS alternative is relatively close to the WLIS alternative.

For the third lowest-cost group of alternatives, which includes disposal at the outer continental shelf 71 nautical miles (131 kilometers) out, upland disposal with a one mile (1.6 kilometers) haul distance, and in-harbor confined disposal facility, the average disposal cost is $48 to $51 per cubic yard for a 26,000 cubic yard (19,878 cubic meter) project, and $32 to $33 per cubic yard for a 100,000 cubic yard (76,455 cubic meter) project.

The remaining alternatives have the highest costs. Upland disposal with a 10 mile (16 kilometers) haul distance has an estimated cost of $55 per cubic yard for a 26,000 cubic yard (19,878 cubic meter) project and $36 per cubic yard for a 100,000 cubic yard (76,455 cubic meter) project. Upland with a 25 mile (40 kilometers) haul distance has an estimated cost of $59 per cubic yard for a 26,000 cubic yard (19,878 cubic meter) project and $40 per cubic yard for a 100,000 cubic yard (76,455 cubic meter) project. Upland by rail to Pennsylvania has an average cost of $92 per cubic yard for a 26,000 cubic yard (19,878 cubic meter) project and $73 per cubic yard for a 100,000 cubic yard (76,455 cubic meter) project.

The results of this cost analysis indicate that the lowest cost alternatives are the CLIS, WLIS, Milford and Bridgeport disposal sites. The other alternatives would all result in higher disposal costs. In the dredging needs survey conducted as part of this DEIS, respondents from private facilities generally indicated that disposal costs more than 20 percent over current costs would be unaffordable and threaten the viability of their businesses (USACE, 2001b). With alternatives other than the four Long Island Sound sites, disposal costs would generally increase by well over 20 percent over current costs. These higher costs would likely restrict both Federal and non-Federal dredging projects. With static budgets and increasing unit costs for disposal, fewer projects would be dredged over any given period, resulting in longer intervals between maintenance operations for individual harbors. Average controlling depths in these harbors would be reduced over time, limiting access to navigation dependent facilities. As disposal costs increased, private facilities and government entities might choose not to dredge rather than pay higher disposal costs. Those alternatives with the

highest disposal costs would likely be the same under the No Action Alternative, if the sites or disposal methods are too expensive to be used.

5.3.1 Cost Analysis for Alternatives Analyzed in Detail

In this section, the estimated construction and disposal costs for the four open-water Long Island Sound alternatives are presented and compared in greater detail. All of the cost figures presented in this section are contained in the complete cost analysis tables contained in Appendix E. The estimated costs per cubic yard for each harbor in the study area and for each of the four open-water Long Island Sound alternative sites are shown in Tables 5-2 and 5-3, below. Table 5-2, shows estimated disposal costs per cubic yard for a 26,000 cubic yard (19,878 cubic meters) sample project, which represents a typical non-Federal project subject to MPRSA. Disposal costs are shown for each harbor in the study area, and for each of the four alternative sites analyzed in detail. Table 5-3, shows estimated disposal costs per cubic yard for a 100,000 cubic yard (76,455 cubic meters) sample project. This represents a typical Federal project or large non-Federal project.

In Tables 5-2 and 5-3, the harbors are grouped into three areas. Area 1 consists of harbors in the westernmost portion of the Sound, from New York City to the Connecticut state line, including harbors on Long Island from New York City to due south of the New York/ Connecticut state line. Area 2 consists of harbors in the western Sound from the New York/ Connecticut state line to the Bridgeport area, and due south from Bridgeport on Long Island. Area 3 consists of central Long Island Sound, extending from Bridgeport to Clinton, Connecticut and shore immediately opposite on Long Island. In each table, disposal costs are compared to WLIS for harbors in the western part of the Sound, in Areas 1 and 2, and disposal costs are compared to CLIS for harbors in the central part of the Sound, in Area 3.

The differences in disposal costs between the four alternative sites are due to the location of each harbor relative to each specific disposal site. For harbors in the western part of the Sound, in Areas 1 and 2, estimated disposal costs between WLIS and the Bridgeport site are generally within 10 percent of each other. For harbors in the central part of the Sound, in Area 3, estimated disposal costs between CLIS and the Milford site are generally within 5 percent of each other. If only one site is designated, disposal costs would be 15 to 25 percent higher for some users, than if both sites are designated. For example, if CLIS is designated, disposal costs would be up to 20 percent higher for harbors in the western part of the Sound; compared to if WLIS were also designated. If only WLIS is designated, disposal costs would be up to 15 percent higher for harbors in the central part of the Sound for dredging projects of 100,000 cubic yard (76,455 cubic meters), and up to 25 percent higher for dredging projects of 26,000 cubic yard (19,878 cubic meters), compared to if CLIS were also designated. Thus, the economics of dredging and dredged material disposal in Long Island Sound are such that designation of both sites has cost advantages for maintenance of navigation channels, harbors, and berthing areas of Long Island Sound.

Table 5-2. Disposal Costs for a 26,000 Cubic Yard (cy) Sample Project — Typical Non-Federal Project

Harbor		WLIS	Bridgeport		Milford		CLIS	
		Cost/ cy	Cost/ cy	%Diff from WLIS[1]	Cost/ cy	%Diff from WLIS[1]	Cost/ cy	%Diff from WLIS[1]
Area 1 - Western LIS - NYC Area								
NY	Port Chester Harbor	$22.08	$24.66	1.12	$25.86	1.17	$27.13	1.23
	Milton Harbor	$23.17	$24.98	1.08	$26.60	1.15	$27.77	1.20
	Mamaroneck Harbor	$23.18	$25.01	1.08	$26.62	1.15	$27.79	1.20
	Larchmont Harbor	$23.22	$25.05	1.08	$26.67	1.15	$27.81	1.20
	Echo Bay	$23.43	$25.38	1.08	$26.98	1.15	$28.08	1.20
	New Rochelle Harbor	$23.55	$25.56	1.09	$27.13	1.15	$28.23	1.20
	East Chester Creek	$24.08	$26.35	1.09	$27.79	1.15	$28.89	1.20
	West Chester Creek	$24.40	$26.83	1.10	$28.19	1.16	$29.40	1.20
	Bronx River	$24.57	$27.06	1.10	$28.40	1.16	$29.65	1.21
	Flushing Bay	$24.57	$27.06	1.10	$28.40	1.16	$29.65	1.21
	Little Neck Bay	$24.08	$26.35	1.09	$27.79	1.15	$28.89	1.20
	Manhasset Bay	$24.35	$26.76	1.10	$28.13	1.16	$29.31	1.20
	Port Washington	$24.22	$26.55	1.10	$27.96	1.15	$29.10	1.20
	Hempstead Harbor	$23.54	$25.54	1.08	$27.12	1.15	$28.21	1.20
	Average Area 1	$23.75	$25.94	1.09	$27.40	1.15	$28.57	1.20
Area 2 - Western LIS - Western Connecticut & Long Island								
CT	Southport Harbor	$23.22	$21.00	0.90	$23.23	1.00	$24.11	1.04
	Westport Harbor	$23.31	$22.12	0.95	$23.72	1.02	$24.60	1.06
	Norwalk Harbor	$21.73	$23.55	1.08	$24.64	1.13	$25.95	1.19
	Wilson Point Harbor	$20.96	$23.20	1.11	$24.28	1.16	$25.42	1.21
	Five Mile River	$20.81	$23.18	1.11	$24.26	1.17	$25.42	1.22
	Westcott Cove	$20.50	$23.49	1.15	$24.57	1.20	$25.88	1.26
	Stamford Harbor	$20.81	$24.09	1.16	$25.45	1.22	$26.78	1.29
	Mianus River	$21.73	$24.17	1.11	$25.56	1.18	$26.88	1.24
	Greenwich Harbor	$21.62	$24.15	1.12	$25.54	1.18	$26.85	1.24
NY	Glen Cove Creek	$23.32	$25.22	1.08	$26.83	1.15	$27.96	1.20
	Oyster Bay Harbor	$21.77	$24.25	1.11	$25.68	1.18	$27.00	1.24
	Cold Spring Harbor	$21.88	$24.29	1.11	$25.75	1.18	$27.04	1.24
	Huntington Harbor	$21.69	$23.66	1.09	$24.85	1.15	$26.16	1.21
	Northport Harbor	$22.08	$23.82	1.08	$25.08	1.14	$26.39	1.20
	Stony Brook Harbor	$23.74	$22.85	0.96	$23.49	0.99	$24.43	1.03
	Average Area 2	$21.94	$23.54	1.08	$24.86	1.14	$26.06	1.19

(Table Continued)

Table 5-2. Disposal Costs for a 26,000 Cubic Yard (cy) Sample Project — Typical Non-Federal Project (continued)

	Harbor	WLIS		Bridgeport		Milford		CLIS
		Cost/ cy	% Diff from CLIS[2]	Cost/ cy	% Diff from CLIS[2]	Cost/ cy	% Diff from CLIS[2]	Cost/ cy
Area 3 - Central LIS - Central Connecticut & Long Island								
CT	Clinton Harbor	$28.81	1.20	$26.65	1.11	$25.03	1.04	$24.02
	Guilford Harbor	$27.92	1.20	$25.58	1.10	$24.18	1.04	$23.31
	Stony Creek	$27.40	1.21	$24.96	1.10	$23.77	1.05	$22.62
	Pine Orchard Harbor	$27.08	1.22	$24.58	1.11	$23.51	1.06	$22.12
	Branford Harbor	$26.98	1.22	$24.51	1.11	$23.43	1.06	$22.12
	Farm River	$26.46	1.24	$24.15	1.13	$23.08	1.08	$21.38
	New Haven Harbor	$26.65	1.20	$24.28	1.09	$23.25	1.05	$22.19
	West River	$26.74	1.20	$24.34	1.09	$23.31	1.04	$22.35
	Milford Harbor	$24.94	1.12	$23.14	1.04	$21.31	0.96	$22.23
	Housatonic River	$24.73	1.07	$22.88	0.99	$21.50	0.93	$23.18
	Bridgeport Harbor	$23.97	1.01	$21.31	0.90	$22.19	0.94	$23.62
	Black Rock Harbor	$23.82	1.00	$21.04	0.88	$22.69	0.95	$23.80
NY	Port Jefferson Harbor	$24.09	1.02	$22.46	0.95	$22.88	0.97	$23.69
	Mattituck Harbor	$28.17	1.18	$26.07	1.09	$24.64	1.03	$23.92
	Average Area 3	$26.27	1.15	$24.00	1.05	$23.20	1.01	$22.90

[1]Percent Difference from WLIS = (Cost per cubic yard at the site/Cost per cubic yard at WLIS
[2]Percent Difference from CLIS = (Cost per cubic yard at the site/Cost per cubic yard at CLIS

Table 5-3. Disposal Costs for a 100,000 Cubic Yard (cy) Sample Project — Typical Federal Project or Large Non-Federal Project

Harbor		WLIS	Bridgeport		Milford		CLIS	
		Cost/ cy	Cost/ cy	%Diff from WLIS[1]	Cost/ cy	%Diff from WLIS[1]	Cost/ cy	%Diff from WLIS[1]
Area 1 - Western LIS - NYC Area								
NY	Mamaroneck Harbor	$15.07	$16.17	1.07	$16.87	1.12	$17.45	1.16
	Echo Bay	$15.23	$16.33	1.07	$17.03	1.12	$17.60	1.16
	New Rochelle Harbor	$15.31	$16.41	1.07	$17.11	1.12	$17.68	1.15
	East Chester Creek	$15.65	$16.75	1.07	$17.45	1.12	$18.06	1.15
	West Chester Creek	$15.86	$16.96	1.07	$17.66	1.11	$18.72	1.18
	Bronx River	$15.97	$17.07	1.07	$17.77	1.11	$19.05	1.19
	Flushing Bay	$15.97	$17.07	1.07	$17.77	1.11	$19.05	1.19
	Manhasset Bay	$15.83	$16.93	1.07	$17.63	1.11	$18.60	1.17
	Hempstead Harbor	$15.30	$16.40	1.07	$17.10	1.12	$17.67	1.15
	Average Area 1	$15.58	$16.68	1.07	$17.38	1.12	$18.21	1.17
Area 2 - Western LIS - Western Connecticut & Long Island								
CT	Southport Harbor	$15.09	$13.92	0.92	$15.10	1.00	$15.67	1.04
	Norwalk Harbor	$14.30	$15.31	1.07	$16.01	1.12	$16.58	1.16
	Wilson Point Harbor	$13.90	$15.08	1.08	$15.78	1.14	$16.35	1.18
	Stamford Harbor	$13.82	$15.66	1.13	$16.36	1.18	$16.94	1.23
	Greenwich Harbor	$14.24	$15.70	1.10	$16.40	1.15	$16.97	1.19
NY	Glen Cove Creek	$15.16	$16.26	1.07	$16.96	1.12	$17.54	1.16
	Oyster Bay Harbor	$14.32	$15.76	1.10	$16.46	1.15	$17.04	1.19
	Huntington Harbor	$14.28	$15.38	1.08	$16.10	1.13	$16.67	1.17
	Northport Harbor	$14.48	$15.48	1.07	$16.20	1.12	$16.77	1.16
	Stony Brook Harbor	$15.43	$14.88	0.96	$15.27	0.99	$15.88	1.03
	Average Area 2	$14.50	$15.34	1.06	$16.06	1.11	$16.64	1.15

Harbor		WLIS		Bridgeport		Milford		CLIS
		Cost/ cy	% Diff from CLIS[2]	Cost/ cy	% Diff from CLIS[2]	Cost/ cy	% Diff from CLIS[2]	Cost/ cy
Area 3 - Central LIS - Central Connecticut & Long Island								
CT	Clinton Harbor	$17.98	1.15	$16.88	1.08	$16.18	1.04	$15.61
	Guilford Harbor	$17.52	1.16	$16.42	1.08	$15.72	1.04	$15.15
	Branford Harbor	$17.03	1.17	$15.93	1.10	$15.23	1.05	$14.50
	New Haven Harbor	$16.88	1.16	$15.78	1.09	$15.11	1.04	$14.54
	West River	$16.92	1.16	$15.82	1.08	$15.15	1.04	$14.62
	Milford Harbor	$16.14	1.11	$15.04	1.03	$14.08	0.97	$14.56
	Housatonic River	$16.05	1.07	$14.90	0.99	$14.18	0.94	$15.07
	Bridgeport Harbor	$15.58	1.01	$14.08	0.92	$14.54	0.95	$15.35
	Black Rock Harbor	$15.48	1.00	$13.94	0.90	$14.80	0.96	$15.47
NY	Port Jefferson Harbor	$15.66	1.02	$14.68	0.95	$14.90	0.97	$15.40
	Mattituck Harbor	$17.65	1.14	$16.63	1.07	$16.01	1.03	$15.55
	Average Area 3	$16.63	1.10	$15.46	1.03	$15.08	1.00	$15.07

[1]Percent Difference from WLIS = (Cost per cubic yard at the site/Cost per cubic yard at WLIS
[2]Percent Difference from CLIS = (Cost per cubic yard at the site/Cost per cubic yard at CLIS

5.4 Impacts Associated with the No Action Alternative

As discussed in Section 3.2, NEPA requires an EIS to include an evaluation of 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 can then be assessed and compared with the effects of the proposed action and the other "action" alternatives. This assessment was not based on modeling activities, but rather relied on existing data.

In this case, the No Action Alternative to the proposed action would be to refrain from designating any open-water site(s) in western or central Long Island Sound for the long-term disposal of dredged material from the harbors, navigation channels, and inlets in the western and central regions of the Sound. While it is impossible to be certain of how dredging needs resulting from sediment build-up in the central and western regions of Long Island Sound would be handled if no disposal sites are designated, several hypothetical scenarios might reasonably be considered. First, disposal site authorization for private projects involving less than 25,000 cubic yards (19,114 cubic meters) of material would simply continue being evaluated on a project-specific basis under CWA § 404. Second, for projects subject to MPRSA §106(f) (*i.e.*, either federal projects or private projects involving greater than 25,000 cubic yards [19,114 cubic meters] of material), project proponents would need to pursue one or more of the following courses of action:

(1) Utilize an alternative open-water site either inside or outside of Long Island Sound that has been "selected" by the Corps and concurred with by EPA under MPRSA § 103;

(2) Use an already designated site outside of the central and western Long Island Sound;

(3) Await EPA designation of a different disposal site outside of the central and western portions of Long Island Sound;

(4) Develop and utilize appropriate land-based disposal/reuse alternatives;

(5) Cancel the proposed dredging projects.

Each of the above No Action Alternative scenarios for projects subject to MPRSA § 106(f) poses a different set of problems over the long-term. For the first scenario involving the use of Corps-selected sites, use of such sites is limited to no more than two five-year periods, as explained in Chapter 1. Over the long-term, this approach would require the Corps to select sites as needed around the central and western regions of the Sound, or elsewhere, thus spreading any environmental effects throughout and possibly outside the central and western regions of the Sound. This would be contrary to the MPRSA principle, as discussed above, which favors the continued use of historically used sites. In addition, as also discussed above, under this approach, CLIS would soon become unavailable, and WLIS would only be available for one additional five-year term. 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 outcomes. Moreover, to the extent that sites outside of the central and

western portions of the Sound were considered for selection by the Corps, the greater haul distances involved would increase the cost and duration of each project. This could potentially render many projects infeasible. (See discussion below regarding the adverse ramifications of preventing needed dredging in the central and western regions of the Sound.) Although of less significance, it is also worth noting that increased haul distances might 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 also 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 disposal sites are all too far away from the central and western regions of the Sound to constitute reasonable alternatives. As explained elsewhere in this EIS, reliance on such sites would greatly increase the cost, duration, and transportation safety risk of dredged material disposal projects from the central and western regions of the 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 discussion below regarding the effects preventing needed dredging in the central and western portions of the Sound). Furthermore, some of these distant sites have restrictions on their use that would preclude the disposal of material from Long Island Sound (*e.g.*, 40 C.F.R. 228.15(d)(1) Fire Island Inlet site restricted to disposal of material from Fire Island Inlet).

The third No Action Alternative scenario identified above is also not a viable option. An on-going effort to designate a new disposal site in New England involves a possible disposal site designation in Rhode Island Sound. The site alternatives under consideration are too far away to make them reasonable alternatives for 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.

The fourth No Action Alternative scenario identified above is also not currently available. Neither New York nor Connecticut have available upland sites which would provide a reasonable, long-term, alternative to a site designation. Although both state and federal agencies are pursuing upland alternative no one has been able to identify an area with sufficient long-term land-based dredged material disposal capacity or beneficial use or treatment options so as to obviate the need for all open-water disposal. Complete reliance on land-based disposal would also likely raise the cost and duration of dredging projects, possibly rendering some infeasible. In addition, land-based disposal could potentially result in air and fuel, water, and land.

The fifth No Action Alternative scenario — simply canceling a great deal 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 use of other transportation methods to move products, not to mention greater air emissions and traffic congestion from increased truck traffic on the region's highways and roads.

Finally, it should be remembered that the no action alternatives are for meeting the overall, long-term dredging needs of the central and western regions of Long Island Sound. For each particular proposal to dispose of dredged material, the need for open-water disposal and alternatives to such disposal will be evaluated on a project-specific basis. Such alternatives for consideration will include the possibility of upland disposal and other non-open water options.

The specific types of impacts that might arise from the various No Action Alternative scenarios are discussed in more detail below. For all types of impacts associated with Scenario 1, (new sites are selected either within or outside of Long Island Sound), the level of impact would vary depending on the number of sites selected and the volume of dredged material disposed. The existing conditions at the selected sites would first need to be assessed.

5.4.1 Sedimentation and Erosion

The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in the increased potential for adverse environmental impacts because the new locations selected are likely to be areas where disposal has not previously occurred. Sedimentation and erosion are more likely because material would be dispersed over a greater area within or outside of Long Island Sound. Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), potential adverse environmental impacts to sedimentation is expected to decrease since less material would be disposed. Erosion conditions, however, would remain unchanged, since erosion is based on the hydrodynamics of Long Island Sound. Finally, if Scenario 4 is selected (land based alternative), impacts are expected to be minimal because land based alternatives would avoid impacts to water quality.

5.4.2 Sediment Quality

The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in increased potential for impacts to sediment quality since it is likely that material would be dispersed over a greater area within or outside of Long Island Sound. The extent of impacts would depend on the sediment quality at the selected sites. Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for adverse environmental impacts to sediment quality would remain unchanged. Finally, if Scenario 4 is selected (land based alternative), impacts are expected to be minimal within Long Island Sound because land based alternatives would result in less material being disposed.

5.4.3 Water Quality

The impacts of open-water disposal on water quality are considered short-term in duration and minor in nature. The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in the increased potential for environmental impacts to water quality, specifically to the water column, since it is likely that material would be dispersed over new areas within or outside of Long Island Sound.

Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for adverse environmental impacts associated with water quality would remain unchanged since less material would be disposed. Finally, if Scenario 4 is selected (land based alternative), impacts are expected to be minimal within Long Island Sound because this alternative would result in less material being disposed. However, a greater potential for impacts exist to adjacent upland areas and groundwater due to potential runoff from land based activities.

5.4.4 Impacts to Benthic Invertebrates

The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in the increased potential for impacts to benthos, since it is likely that material would be dispersed over a greater area within or outside of Long Island Sound. Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for adverse environmental impacts to benthos would remain unchanged since less material would be disposed. Finally, if Scenario 4 is selected, a non-open water alternative, impacts to benthos would not be expected because material would be disposed upland.

5.4.5 Impacts to Fish and Shellfish

The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in the increased potential for impacts to fish and shellfish resources. Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for adverse environmental impacts associated with fish and shellfish resources would remain unchanged since less material would be disposed. Finally, if Scenario 4 is selected, a non-open water alternative, impacts to fish and shellfish resources would not be expected because material would be disposed upland.

5.4.6 Impacts to Marine and Coastal Birds and Marine Mammals and Reptiles

Under Scenario's 1, 2, 3 and 5, (new sites are selected either within or outside of Long Island Sound, use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for impacts to marine and coastal birds, and marine mammals and reptiles would remain unchanged. However, coordination with NMFS and USFWS would be necessary to assess potential impacts to these species regardless of what disposal scenario is chosen. Finally, if Scenario 4 is selected (land based alternative), impacts to marine birds, mammals, and reptiles would lessen because less material would be disposed, but impacts to coastal birds and terrestrial species could slightly increase.

5.4.7 Impacts to Endangered and Threatened Species

Under Scenario's 1, 2, 3, and 5 (new sites are selected either within or outside of Long Island Sound, use of a designated sites, wait for a designation of a different site, and cancellation of projects), the potential for impacts to endangered and threatened species would lessen since less material would be disposed. As discussed in Section 4.12, endangered and threatened

species likely to be present within Long Island Sound on more than an occasional basis is 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 what disposal scenario is chosen. Finally, if Scenario 4 is selected (land based alternative), impacts to endangered and threatened marine species would lessen since material would be disposed upland, but impacts to endangered and threatened terrestrial species could slightly increase.

5.4.8 Contaminant Levels in Selected Species (Bioaccumulation Potential)

The No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), may result in an increased bioaccumulation potential because the dispersion of dredged material across a greater area could result in the exposure of more individual organisms or species to chemical concentrations, depending on the existing sediment quality at the selected sites. Under Scenarios 2, 3, 4, and 5 (use of a designated site, wait for a designation of a different site, use of upland alternatives, and cancellation of projects), the bioaccumulation potential would remain unchanged.

5.4.9 Socioeconomic Impacts

5.4.9.1 Impacts to Commercial Fishing Activities

The socioeconomic impacts to commercial fishing activities would remain unchanged under the No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound). Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), significant socioeconomic impacts are expected to commercial fishing activities depending on the homeport of the individual vessels. Impacts have been estimated for 6 of the 14 study area harbors in Connecticut and 2 of the 7 harbors in New York. The lack of dredging and resultant shoaling could result in potential groundings, collisions, tidal delays, and spoilage of catch and lost fishing days. Relocation to another port could result in increased operating costs. Commercial fishing, which includes fin fishing, shell fishing, and sport fishing is expected to result in a $76 million loss to Gross State Product by 2020 ($52 million for Connecticut, $24 million for New York). A specific analysis of the estimated magnitude of the economic impacts of the No Action Alternative is contained in the economics section of the DEIS (Appendix E-2). Finally, if Scenario 4 is selected (land based alternative), socioeconomic impacts to commercial fishing activities would remain unchanged since less material would be disposed.

5.4.9.2 Impacts to Recreational Fishing

The socioeconomic impacts to recreational fishing activities would remain unchanged under the No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound). Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), socioeconomic impacts may be significant, but to a lesser extent than commercial fishing because of the diversity of vessel types and drafts. This impact also depends on the homeport of the individual vessels. Sport fishing currently contributes about $325 million to Gross State Product of the study area of western and central Long Island Sound (see Appendix E-2). Finally, if Scenario 4 is selected (land

based alternative), socioeconomic impacts to recreational fishing activities would remain unchanged since less material would be disposed.

5.4.9.3 Impacts to Shipping and Navigation

The socioeconomic impacts to shipping and navigation under the No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound), would remain unchanged since it is likely that dredging activities at various sites would be managed as to not interfere with shipping and navigation traffic. However, under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), socioeconomic impacts to shipping and navigation are expected to increase. Without EPA designation of one or more open-water disposal sites in Long Island Sound, or use of existing sites, dredging of Federal projects in the study area would potentially decline. With Federal budgets expected to be held at less than or near constant level, the lack of available, reasonably affordable disposal options would require more expensive disposal practices, and would mean less frequent dredging for most Long Island Sound harbors. With greater time between dredging operations, more shoal material would accumulate in the channels and anchorages of these harbors, the average controlling depths would decrease, and depth-related restrictions on navigation access to these harbors would increase. The potential for collisions and groundings would increase. This would restrict vessel operations at commercial ports, causing some businesses to close or shift to other ports within and outside of Long Island Sound, or use means of reducing draft, such as shifting to cargo barges, lightering of cargo, or light loading at the point of origin. All of these actions would increase the cost of waterborne transport and some may require substitution of land-based transport, mainly trucks, to move the goods.

Reduced navigation access at smaller harbors would limit recreational opportunity and fishing time, and over time would contribute to a reduction in vessel size and drafts of the fleets using these harbors. At some point it is likely that increased costs for harbor maintenance would trigger a re-examination of the role of public funding of harbor maintenance for economically marginal harbors, both small and large. In addition, all Federal projects, and non-Federal dredging projects greater than 25,000 cubic yard (19,114 cubic meters) (such as the dredging of large marinas, significant state and municipal facilities, or deep-draft berths) would be much less likely to occur without an affordable, approved disposal site.

Dredging and disposal for non-Federal projects up to 25,000 cubic yards (19,114 cubic meters) would likely continue to occur as they do currently, since the restrictions on disposal of dredged material due to MPRSA only apply to those projects over 25,000 cubic yard (19,114 cubic meters). However, these smaller, non-Federal projects could still be impacted under the No Action Alternative, because of the dependence of these users on the Federal channels that provide them access. With less frequent or curtailed maintenance of the Federal channels, the private facilities along those channels would find maintenance dredging less viable, since the controlling depths could be less in the access channels than in their berths or slip space. For example, over time a marina may see its customer base converted to smaller craft as average channel controlling depths decline with less frequent channel dredging, regardless of how frequent the marina's slip areas are dredged.

The Survey of Dredging Needs, a survey of private facility owners around Long Island Sound conducted as part of this DEIS (summarized in Appendix B), indicated that, in general, private facility owners viewed disposal costs as "unaffordable" when above $20 to $25 per cubic yard. There was some variation in this figure, with the unaffordable responses ranging from a low of $10 for a private facility to several highs in the $50 to $100 range. The high-end responses were generally from large deep-draft facility managers. In the Survey of Dredging Needs and in the public scoping meetings, many marina owners expressed concern that they would go out of business without an affordable, environmental safe, designated site to dispose of their dredged material. Without an open-water site, other disposal alternatives such as upland disposal, off-shore disposal, or use of other, more distant, sites such as HARS, would generally be considered unaffordable, with average costs of $25 to $50 per yard and even higher for some alternatives. As discussed in the cost analysis contained in Section 5.3, nearly all of the alternatives to open-water disposal would result in significantly higher disposal costs to some private, municipal, and Federal dredging projects in the study area.

The current level of navigation-dependent economic activity around the Sound would likely decrease if a designated site within the western or central Long Island Sound was not available, as harbors shoal in and the dredging of channels, anchorage areas, berths, and mooring areas is performed less frequently or not at all. The over $3 billion in gross state product ($1.55 billion for Connecticut, $1.45 billion for New York) currently produced by the direct, indirect, and induced impacts of the navigation-related industries would be threatened, and a portion of the 27,700 jobs and $441 million ($158.5 million for Connecticut, $282.5 million for New York) in tax revenues would also be threatened. A specific analysis of the estimated magnitude of the economic impacts of the No Action Alternative is contained in the economics appendices section of the DEIS (Appendix E-2). Finally, if Scenario 4 is selected (land based alternative), socioeconomic impacts would also increase since costs associated with disposal in open-water would now have to be transported by trucks.

5.4.9.4 Impacts to Recreational Activities and Beaches

The socioeconomic impacts to recreational activities and beaches would remain unchanged under the No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound). Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), impacts to most recreational activities and beaches should be minimal with the exception of recreational boating, which could be significant in specific harbors. Recreational boating is very popular in Long Island Sound. Shoaling of access channels and facilities results in reduced boat use with resulting loss of recreational opportunities, revenue to marinas, other services, and destinations. This effect is multiplied throughout the local and regional economies. Finally, if Scenario 4 is selected (land based alternative), socioeconomic impacts to recreational activities and beaches would remain unchanged.

5.4.9.5 Impacts to Parks and Natural Areas

The socioeconomic impacts to parks and natural areas would remain unchanged under the No Action Alternative Scenario 1 (new sites are selected either within or outside of Long Island Sound). Under Scenario's 2, 3, and 5 (use of a designated sites, wait for a designation of a different site, and cancellation of projects), impacts to parks and natural areas should be minimal. The only exceptions are areas accessible only by boat (see Section 5.4.9.4) and which shoal and require dredging. It expected that the majority of these types of areas are small and require less than 25,000 cubic yard (19,114 cubic meters) to maintain access. Finally, if Scenario 4 is selected (land based alternative), socioeconomic impacts to parks and natural areas would remain unchanged.

5.4.9.6 Impacts to Historic and Archaeological Resources

The socioeconomic impacts to historic and archaeological resources would increase under the No Action Alternative Scenario 1 (if new sites are selected either within or outside of Long Island Sound) since disposal would occur over a greater area in Long Island Sound which may require additional investigations of potential historic and archeological resources. Regardless of disposal option selected, coordination with State and Tribal Historic Preservation Offices would be required. Under Scenario 2 (the use of a designated sites), the impact to historic and archaeological resources are expected to remain unchanged from current conditions for any open-water disposal at previously used designated and selected sites within Long Island Sound, as these sites would have undergone previous evaluations for the presence of these resources. Under Scenario's 3 and 5 (wait for a designation of a different site and cancellation of projects), impacts to historic and archaeological resources would remain unchanged. Finally, if Scenario 4 is selected (land based alternative), socioeconomic impacts to historic and archeological resources would remain unchanged.

5.4.9.7 Impacts to Other Human Uses

Under all scenarios, socioeconomic impacts to other human uses are expected to remain unchanged. "Other human uses" refers to such use as military uses, and cable and pipeline crossings. Disposal activities would avoid transporting material through any military use areas to avoid any conflicts, and, avoid cable and pipeline routes. For disposal of any material outside of Long Island Sound, there is the potential for interaction with military vessels and crossings. Evaluations would need to be conducted as appropriate to determine transportation routes to avoid conflicts.

5.4.10 Air Quality/Noise

5.4.10.1 Overview of Effects on Air Quality

Some level of air emissions may result either from dredging operations or from vessels or vehicles used to haul dredged material to a disposal site. Yet, the designation of one or more open-water disposal sites in the western and central portions of Long Island Sound is expected to have little or no impact on air quality. This is the case for several reasons.

The designation of a disposal site does not itself authorize any particular dredging or dredged material disposal operations and, therefore, does not produce any emissions itself. Moreover, we do not expect that designating one or more sites will result in any more dredging than would otherwise occur. Dredging will occur as necessary to maintain safe navigation and marine commerce. Thus, any site designations, or lack thereof, would not be expected to change the emissions resulting from the dredging itself.

With respect to disposal operations, it is expected that designating one or more disposal sites will not have any significant adverse effect on air emissions. There are several reasons for this conclusion. Air emissions that might result from disposal at a designated site chosen from one of the open-water site alternatives under consideration would not yield significantly more emissions than exist under current conditions involving disposal at the sites currently in use under the Corps MPRSA §103 site selection authority or, for small private projects, its CWA §404 authority. Furthermore, if no sites are designated and the Corps authorized the short-term use of other sites in the region under either of these authorities, the travel distances, and therefore emissions, for disposal would be similar to either current conditions or to conditions that would prevail if a site were designated. Because the material would be placed under water with these disposal alternatives, dust and volatilization would not occur and there would be no long-term effects on air quality from these alternatives.

It is possible, however, that if no sites were designated and no local open-water disposal sites were authorized for use, then air emissions could worsen to some degree. This would occur if open-water sites much further away had to be used for disposal, resulting in longer vessel trips with greater emissions due to the necessity of using larger barges and more powerful tugs with larger engines. In addition, if the lack of a designated open-water disposal site led to greater upland disposal, it is possible that air emissions would increase due to (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 distance the trucks would have to travel to reach the land-based disposal site(s). In addition, pollutants would be generated by heavy construction equipment during disposal on land. Activity and equipment would have to comply with Connecticut Air Pollution Control Regulations[2], Vehicle Emission Standards[3], and Fugitive Dust Regulations[4] to minimize impacts.

5.4.10.2 Effects of the Designation of Potential Dredged Material Open-Water Sites on Odors

The designation of potential open-water dredged material sites would comply with Connecticut Air Pollution Control Regulations concerning odors. Designation of a disposal site does not constitute the approval of any specific dredging or disposal operation and, therefore, does not directly generate any odors. Furthermore, it is not expected that in the dredged material would be noticed during dredging and disposal since this would depend on

[2] CT Air Pollution Control Regulations: Section 22a-174 of the Connecticut General Statutes.
[3] CT Air Pollution Control Regulations: Section 22a-174-27.
[4] CT Air Pollution Control Regulations: Section 22a-174-18(b).

the type of dredge used, the temperature, the direction of the wind, and the proximity of the dredge and scow to populated areas. It is also expected that dredging and disposal would occur far enough from populated areas that any potential odors would mix sufficiently with ambient air to prevent objectionable odors on land. Odors from the dredged material should not be noticeable at the open-water disposal sites because the material would be under water. In addition, to the extent that dredging and open-water disposal of dredged material did generate any odors, it is not expected that designating a disposal site would change those conditions to any significant degree. However, if none of the alternative sites under consideration were designated, and no other open-water sites were used, so that upland disposal became necessary, then it is possible that odor problems could result depending on how the materials were handled and where they were disposed of in relation to sensitive receptors.

5.4.10.3 Overview and Methods to Assess Noise

Dredging operations produce noise similar to noise created by other diesel equipment. If a clamshell dredge is used, noise is produced by the engines that lift and lower the dredge bucket, and by the operation of the clamshell.

If a hydraulic dredge is used, noise is produced by the engines that power the pump. The specific amount of noise produced would depend on the type of equipment used by the dredging contractor. It is expected that the degree of noise produced by the designation of one or more disposal sites in Long Island Sound would not be substantially different from background noise levels in the area.

5.5 Impacts Associated with the Alternatives

This section addresses the potential impacts to the physical, biological, and socioeconomic resources that could occur as a result of dredged material disposal at each of the alternative sites. Potential concerns analyzed include the possibility of sedimentation and erosion of material following disposal, as well as the potential impacts of disposal on sediment quality, water quality, benthos, fish and shellfish, marine and coastal birds, marine mammals and reptiles, endangered and threatened species, contaminant levels in selected species, commercial and recreational fishing, shipping and navigation, recreational activities and beaches, parks and natural areas, historic and archeological resources, and other human uses. This section is structured into subsections that address each of these potential impact categories. Within each subsection, a discussion of the approach to evaluate impacts is provided followed by a description of the impacts specific to each of the alternative sites.

5.5.1 Sedimentation and Erosion

As discussed in Section 5.2, the disposal of dredged material at open ocean sites results in the deposition of non-native sediments in a 'footprint' or mound at the disposal site. Over time, as currents move over this mound, hydraulic forces act on the sediment particles in the form of shear and lift. The response of the particles to these forces is related to current speed, particle size, shape, density, and any friction or cohesion exerted by adjacent sediment grains. At some point, the fluid may exert sufficient force to cause the grains to move and

the sediment will be eroded from the bottom and suspended (or resuspended) into the water column for transport.

The potential for erosion of dredged material deposited at each of the alternative disposal sites was examined using sediment transport models. A model is a simple representation of physical reality and as such may be limited in its predictive ability. Quantitatively modeling sediment transport is complicated by uncertainty in the current speed, particle size, shape, density, and friction terms and heuristic methods must be applied. To increase confidence in the model predictions, the current literature was assessed and two sediment transport models were applied.

First, an erosion model incorporating waves and currents for non-cohesive sediments was applied to each site (see Section 4.6 and Appendix G-3 for results). This model, based on the work of Grant and Madsen (1979), compares an estimated bottom shear stress under waves and currents to the critical shear stress necessary to initiate motion of the sediment grains. The bottom shear stress is a function of the current speed, wave height, wave period, water depth, and bottom roughness. Currents for each of the alternative sites were derived from available data as described in Chapter 4. Wave heights and periods were estimated from historical wind data using a fetch and duration wave model as described in Section 4.5. The Grant-Madsen model assumes that sediments are non-cohesive; therefore, a fairly coarse-grain size was used. The grain size was based on those typical for dredged material from nearby harbors (*i.e.*, New Haven, Norwalk, Bridgeport, and Guilford, Connecticut).

Second, the Corps sediment erosion and transport model (LTFATE) was used to derive erosion and transport estimates for cohesive, fine-grained sediments from a mound that would be present in the site after disposal of 16 million cubic yards (12 million cubic meters) of material (see Appendix G-3). Sediments with a significant clay fraction are cohesive and any undisturbed sediments will tend to become cohesive over time due to consolidation and biological reworking. The LTFATE model incorporates the effects of sediment cohesion, along with hydrodynamics, in its simulation of sediment transport. It also predicts changes in mound geometry if dredged material erosion and deposition cause bathymetry changes (*i.e.*, mound evolution). Without extensive field measurements for model calibration and verification, the prediction of Grant-Madsen and LTFATE should not be considered actual expected values. Rather, because the models represent physical processes consistently, their use provides a systematic and conservative means to compare between the alternative sites.

The LTFATE model was applied to each of the four alternative sites using a conservative, hypothetical case study. The details described in Appendix G-3 are summarized in the following subsections for each alternative site. Specifically, the model assumed a 16 million cubic yards (12 million cubic meter) (estimated total future disposal needs), mound exposed to a 10-year storm (*i.e.,* a storm with a recurrence frequency of 10 years). The model input was developed based on prior analyses of waves and measured currents (USACE, 2001g, Appendix G-1; Morton *et al.*, 1982; Fredriksson and Dragos, 1996). Near-bottom currents were determined for each site by combining peak tidal velocity with the expected mean velocity caused by the wind stress of a 10-year storm during a 3-day simulation. The simulated mound was configured as an idealized rectangular, flat-top mound with a volume

equal to 16 million cubic yards (12 million cubic meters). Assuming a shoulder slope of 1/10, the mound was configured as high as necessary to fit it within each site with a set back margin of 10 percent on all sides.

LTFATE is sensitive to geotechnical parameters of the sediments, also known as erosion potential parameters. These parameters are normally derived from laboratory flume measurements using undisturbed sediment cores collected in the field. Flume measurements are used to describe the resistance to erosion and the rates of erosion as a function of depth in the sediment layer and are a measure of the critical shear stress above which sediments are mobilized. These measurements are complicated, but are necessary to calibrate cohesive sediment transport models like LTFATE. Such geotechnical data are unavailable from the sediments at the alternative sites. Therefore, erosion potential parameters measured in a flume tank study for the Portland, Maine Disposal Site were used in the LTFATE model simulations described here (WES, 1998). While these data are not site-specific, they represent the best available data for New England (Tom Fredette, personal communication, March 2003), and are reasonably representative of dredged material sediments for the alternative sites. The use of non-site specific parameters, where no local data are available, is a valid approach, given the fact that the models are intended to elucidate the relative differences between the four alternative sites.

In the marine environment, current-flow can be complicated by the presence of any combination of tidal currents, wind-driven currents, estuarine currents, and wave-induced motions. Wave-induced motion in particular, adds to the effect of tidal and other currents and increases the potential for sediment transport as a result of the combination of unidirectional and oscillatory flows. The oscillatory motion of passing waves decreases in magnitude downward from the water surface so that at a certain depth, the back and forth motion is no longer present. The water depth to which wave-induced flow is significant in determining the sediment transport is a function of sediment particle size and cohesion, as well as the wave regime that exists. In many coastal environments, the total amount of sediment resuspended and transported during a single storm can be greater than the total for the rest of the year (see for instance Hubbard, 1986).

The following sections summarize the results of the Grant-Madsen and LTFATE modeling at each of the alternative sites.

5.5.1.1 Sedimentation and Erosion at the Western Long Island Sound Alternative

The Grant and Madsen (1979) model predictions showed that waves and currents associated with 2- and 10-year storms at WLIS would generate bottom orbital velocities of 10 and 20 centimeters/second (0.3 to 0.7 feet/second), corresponding to sediment mobility parameters of 0.1 and 0.4, respectively. The mobility parameter is the ratio of the estimated friction velocity to the critical friction velocity for the initiation of sediment motion. Mobility parameters less than 1.0 indicate sediment stability. These results are consistent with available information about the stability of the mounds at WLIS. Bathymetric surveys conducted at WLIS before (*i.e.*, August 1985) and after (October 1985) Hurricane Gloria revealed no large-scale changes in bottom topography at the site as a result of the storm. Additional monitoring surveys conducted in August 1986, November 1987, and July 1988

also showed long-term stability of the disposal mounds and no evidence of erosion of dredged material (SAIC, 1988; USACE, 1989; Parker and Revelas; 1989).

The LTFATE model was applied to a mound configured to a height of 22 feet (6.7 meters) above the present seafloor as measured. This mound was overlain on the recent high-resolution bathymetry of WLIS. The 10-year storm wave height was estimated to be 11.2 feet (3.4 meters) with a wave period of 6.6 seconds (Table 4-5, Section 4.6). Near-bottom currents were developed by combining a typical peak tidal velocity (8.7 inches [22 centimeters] per second) with the expected mean caused by the wind stress of a 10-year storm (6 inches [15 centimeters] per second).

The results of the simulation are present in Figure 5-2. The predicted maximum depth of erosion was 0.61 feet (0.19 meters) on the leading edge of the mound while the average depth of erosion over the model grid was 0.39 feet (0.12 meters). The depositional area in the western and lower central portions of the site as seen in Figure 5-2 is the deep axial depression where material eroded from the mound would accumulate. The total volume of erosion, defined as the mass of sediment eroded over the entire site, was 1.07 million cubic yards (0.84 million cubic meters). The total volume eroded from the mound was 0.7 million cubic yards (0.54 million cubic meters) or approximately 4 percent of the mound.

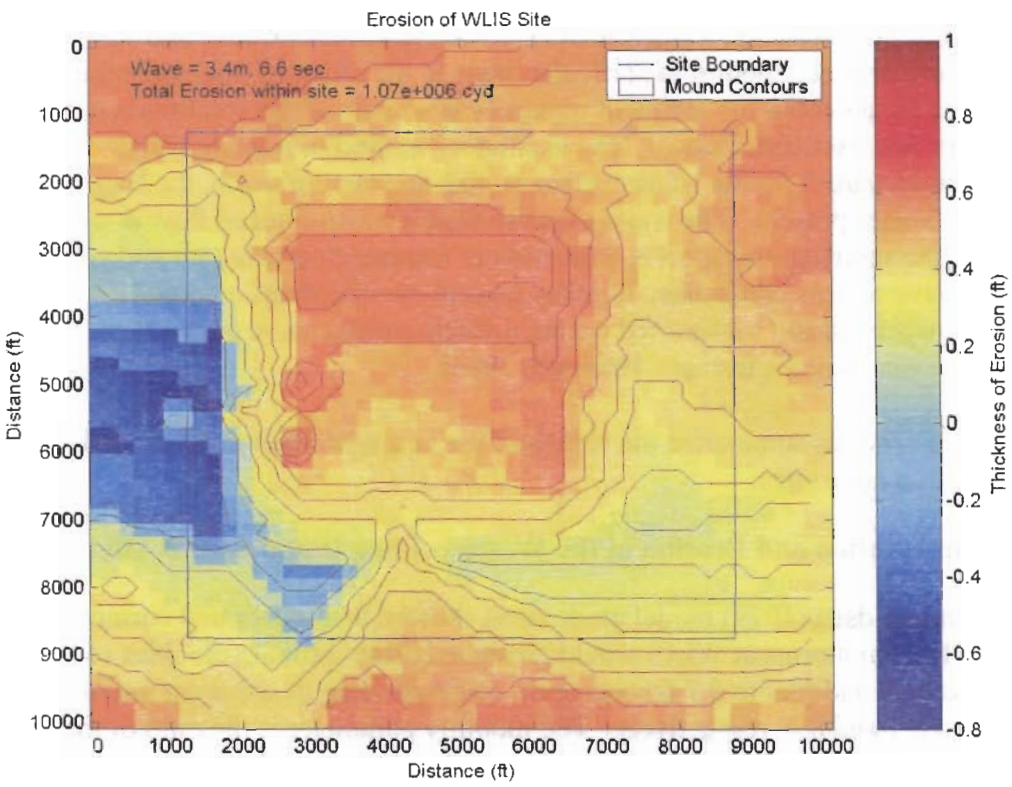

Figure 5-2. Change in Bathymetry at the Western Long Island Sound Alternative Predicted Using a 10-year Storm Simulation

(Note: Positive values indicate erosion.)

Model predictions of sediment transport by waves and currents show 2- and 10-year storms would not erode bottom sediments for the site as it is today, or might reasonably be expected to be in the future. These results are consistent with survey observations of historical sediment stability including observations of stability during Hurricane Gloria. Under a worst case scenario that places 16 million cubic yards of potential future dredged material deposited in one mound in WLIS (22 feet high [6.7 meters]), the model predictions suggest erosion, approximately 4 percent of the mound, under 10-year storm conditions. The results suggest that sediment stability could be achieved for WLIS by a site management approach which limits the height of disposal mounds.

5.5.1.2 Sedimentation and Erosion at the Bridgeport Alternative

The Grant and Madsen (1979) model predictions showed that waves and currents associated with a 2-year storm at Bridgeport would generate bottom orbital velocities of 28 centimeters/ second (0.9 feet/second). This corresponds to sediment mobility parameters of 0.7, which are not sufficient to cause erosion of coarse-grained sediment in 64 feet (19.5 meters) of water at the site (approximate mean site depth). Waves and currents associated with a 10-year storm would generate bottom orbital velocities of 45 centimeters/second (1.5 feet/ second), corresponding to a sediment mobility parameter of 1.6, which is sufficient to cause erosion of coarse-grained sediment.

The LTFATE model results were applied to a mound that was configured to a height of 18 feet (5.5 meters) above the present sea floor. The model bathymetry was configured with a sloping planar bottom consistent with the bathymetry at the site over which the mound was placed. The 10-year storm wave height was estimated to be 10.7 feet (3.3 meters) with a wave period of 6.4 seconds. Near-bottom currents were developed by combining a typical peak tidal velocity (10 inches [25 centimeters] per second) with the expected mean caused by the wind stress of a 10-year storm (4.3 inches [11 centimeters] per second).

The maximum erosion was predicted on the leading edge of the mound, with a depth of 0.77 feet (0.23 meters). The average depth of erosion over the model grid was 0.45 feet (0.14 meters) on the southern boundary and deepest area of the model, as seen in Figure 5-3. The total volume of erosion, defined as the mass of sediment eroded over the entire site, was 1.27 million cubic yards (0.99 million cubic meters). The total volume eroded from the mound was 0.9 million cubic yards (0.76 cubic meters) or approximately 6 percent of the mound.

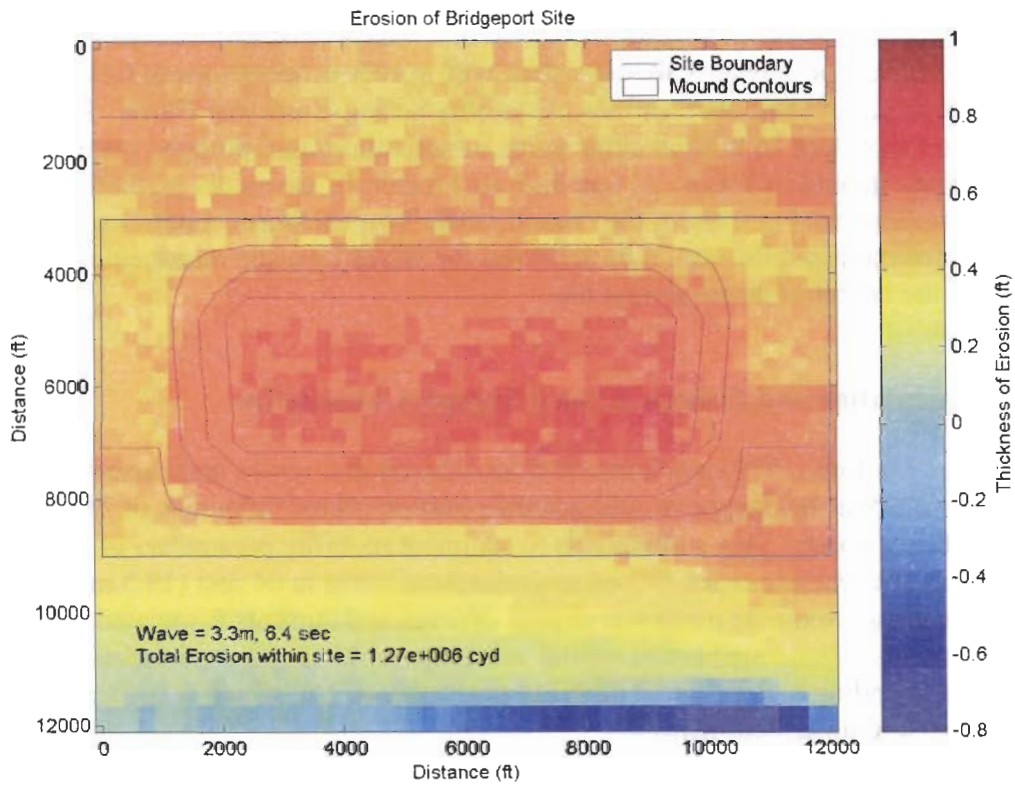

Figure 5-3. Change in Bathymetry at the Bridgeport Alternative Predicted using a 10-year Storm Simulation

(Note: Positive values indicate erosion.)

Model predictions of sediment transport by waves and currents show 10-year storms would mobilize and erode some bottom sediments from the site as it is today, or might reasonably be expected to be in the future. Under a worst case scenario that places 16 million cubic yards (12 million cubic meters) of potential future dredged material deposited in one mound in the Bridgeport Alternative (18 feet high [5.5 meters]), the model predictions suggest significant erosion, approximately 6 percent of the mound, under 10-year storm conditions. The results suggest that sediment stability could be achieved for Bridgeport by a site management approach which limits the height of disposal mounds.

5.5.1.3 Sedimentation and Erosion at the Milford Alternative

The Grant and Madsen (1979) model predictions showed that waves and currents associated with a 2-year storm at Milford would generate bottom orbital velocities of 27 centimeters/second (0.9 feet/second). This corresponds to sediment mobility parameters of 0.6, which are not sufficient to cause erosion of coarse-grained sediment in 61 feet (18.5 meters) of water at the site (approximate mean site depth). Waves and currents associated with a 10-year storm would generate bottom orbital velocities of 44 centimeters/second (1.4 feet/second), corresponding to a sediment mobility parameter of 1.4, which is sufficient to cause erosion of coarse-grained sediment.

The LTFATE model results were applied to a mound that was configured to a height of 21 feet (6.4 meters) above the present sea floor. The model bathymetry was configured with a sloping planar bottom consistent with the bathymetry at the site, over which the mound was placed. The 10-year storm wave height was estimated to be 10.3 feet (3.1 meters) with a wave period of 6.3 seconds. Near-bottom currents were developed by combining a typical peak tidal velocity (7.9 inches [20 centimeters] per second) with the expected mean caused by the wind stress of a 10-year storm (3.5 inches [9 centimeters] per second).

The maximum erosion was predicted on the leading edge of the mound and in the northwest corner with a depth of 1.01 feet (0.31 meters) (Figure 5-4). The average depth of erosion over the model grid was 0.62 feet (0.2 meters). The minimum erosion occurs on the deepest portion of the model grid in the southeast corner. The total volume of erosion, defined as the mass of sediment eroded over the entire site, was 1.44 million cubic yards (1.10 million cubic meters). The total volume eroded from the mound was 1.0 million cubic yards (0.76 million cubic meters) or approximately 6 percent of the mound.

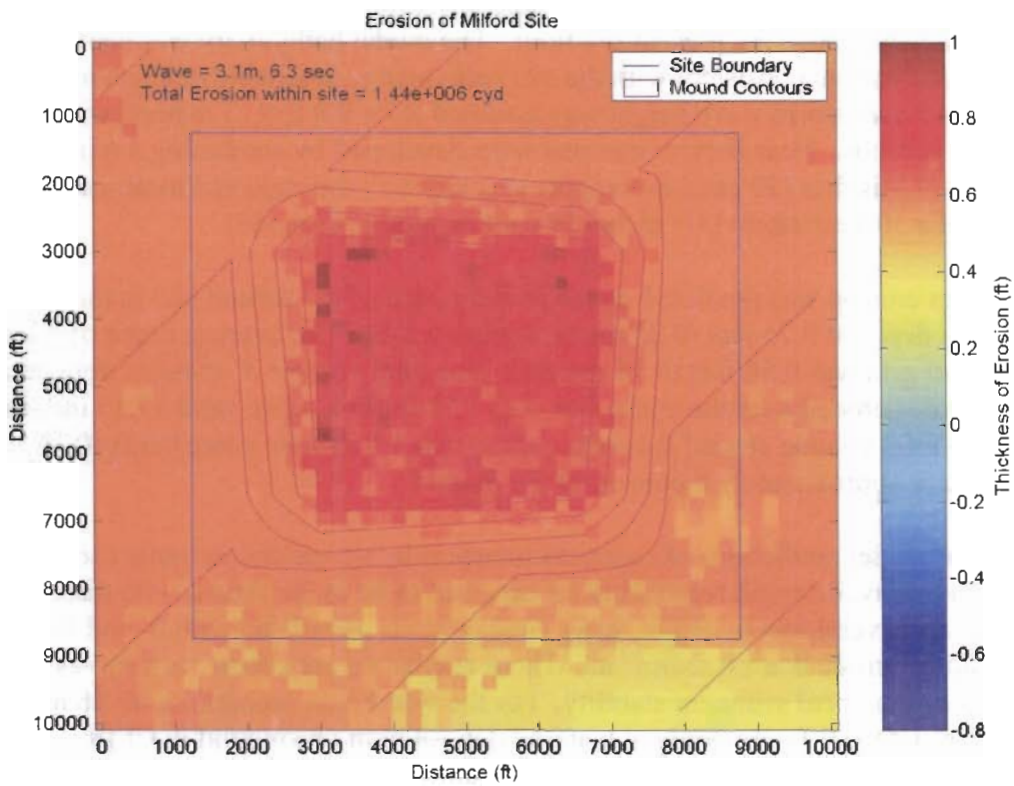

Figure 5-4. Change in Bathymetry at the Milford Alternative Predicted Using a 10-year Storm Simulation

(Note: Positive values indicate erosion.)

Model predictions of sediment transport by waves and currents show 10-year storms would mobilize and erode some bottom sediments from the site as it is today, or might reasonably be expected to be in the future. Under the worst case scenario that places 16 million cubic yards (12 million cubic meters) of potential future dredged material deposited in one mound in the Milford site (21 feet high [6.4 meters]), the model predictions suggest significant erosion, approximately 6 percent of the mound, under 10-year storm conditions. The results suggest that sediment stability could be achieved for Milford by a site management approach which limits the height of disposal mounds.

5.5.1.4 Sedimentation and Erosion at the Central Long Island Sound Alternative

The Grant and Madsen (1979) model predictions showed that waves and currents associated with 2- and 10-year storms at CLIS would generate bottom orbital velocities of 17 and 31 centimeters/second (0.6 to 1 feet/second). This corresponds to sediment mobility parameters of 0.3 and 0.8, respectively, which are not sufficient to cause erosion of coarse-grained sediment in 68 feet (21 meters) of water at the site (approximate mean site depth). The model also predicted resuspension from estimated bottom shear stress and the size and density of sediment particles.

The LTFATE model results were applied to a mound that was configured to a height of 18 feet (5.5 meters) above the present sea floor. The model bathymetry was configured with a sloping planar bottom consistent with the site bathymetry, over which the mound was placed. The 10-year storm wave height was assumed to be 9.8 feet (3 meters) with a wave period of 6.1 seconds. Near-bottom currents were developed by combining a typical peak tidal velocity (7.9 inches [20 centimeters] per second) with the expected mean caused by the wind stress of a 10-year storm (3.5 inches [9 centimeters] per second).

The maximum erosion was predicted on the leading edge of the mound and in the northwest corner, with a depth of 0.76 feet (0.23 meters) (Figure 5-5). The average depth of erosion over the model grid was 0.54 feet (0.16 meters). The total volume of erosion, defined as the mass of sediment eroded over the entire site, was 1.51 million cubic yards (1.15 million cubic meters). The total volume eroded from the mound was 1.0 million cubic yards (0.76 million cubic meters) or approximately 6 percent of the mound.

In conclusion, model predictions of sediment transport by waves and currents show that for the site as it is today, or might reasonably be expected to be in the future, with disposal mounds that are several feet in height, waves and currents associated with 2- and 10-year storms would not erode bottom sediments. These results are consistent with survey observations of historical sediment stability. For the worst case scenario of all 16 million cubic yards of potential future dredged material deposited in one mound in CLIS (18 feet high [5.5 meters]), the model predictions show significant erosion, approximately 6 percent of the mound, under 10-year storm conditions. The results suggest that sediment stability could be achieved for CLIS by a site management approach which limits the height of disposal mounds.

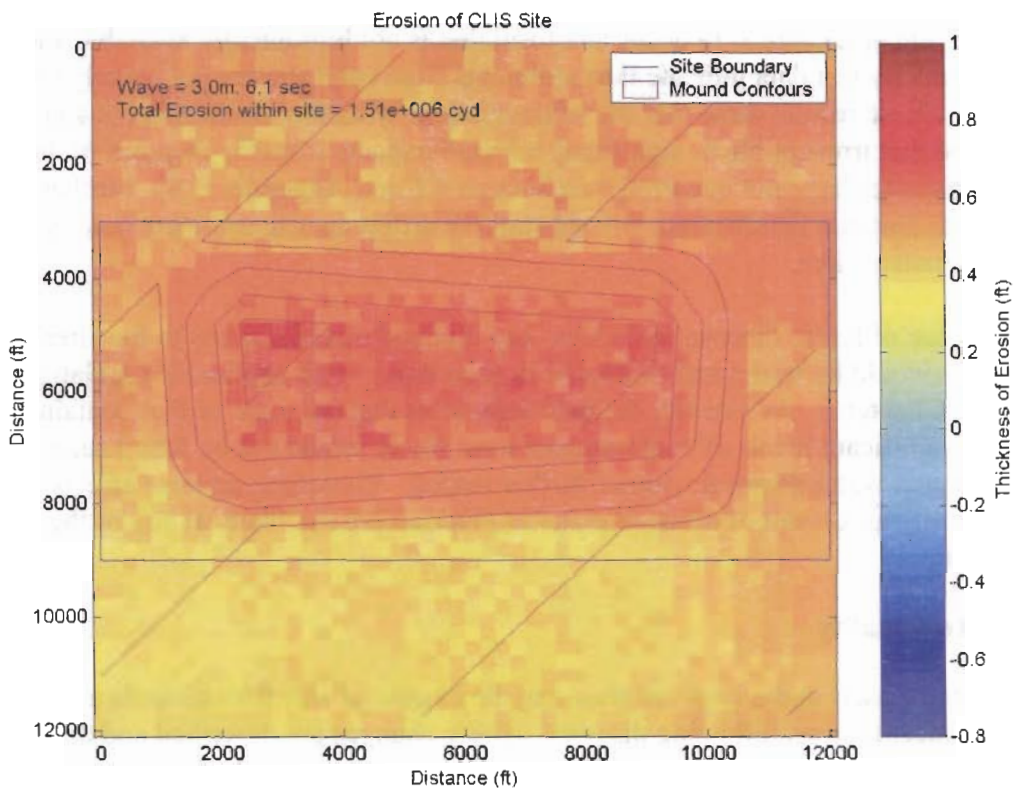

Figure 5-5. Change in Bathymetry at the Central Long Island Sound Alternative Predicted Using a 10-year Storm Simulation

(Note: Positive values indicate erosion.)

5.5.1.5 Summary of Impacts Related to Sedimentation and Erosion.

The potential for resuspension of noncohesive sediments by waves and currents at each alternative was estimated by applying the Grant-Madsen model. Model results predict that the Bridgeport and Milford Alternative sites have the highest potential for resuspension and the CLIS and WLIS Alternative sites the least.

The potential for the erosion of fine cohesive material from a single mound deposited on the site was evaluated by applying the LTFATE model. Model results predict that the potential for erosion is greatest at the Milford Alternative and least for the WLIS Alternative. The potential for erosion was similar for the Bridgeport and CLIS Alternatives.

5.5.2 Sediment Quality

There are no significant differences in sediment quality among the four alternative disposal sites evaluated. There is some variation in grain size and TOC, among and within each site, but the sediment properties are within the range observed in undisturbed Long Island Sound sediments. Similarly, variations in metals concentrations at the sites generally can be

attributed to differences in grain size and TOC. 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 each site are not acutely toxic to amphipods. These results show that the sediment quality within the sites is not significantly degraded and that irreversible or significant adverse impacts from the disposal of dredged material in the sites have not occurred (see Section 4.6 and Appendix F-4). Further, the available data does not demonstrate any substantive differences in sediment quality among the four alternative sites.

For the purpose of future disposal activities, any dredged material taken to the alternative disposal sites would be tested and evaluated in accordance with applicable regulations, as described in Chapter 1. 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 disposal without further testing. Therefore, adverse effects to sediment quality as a result of dredged material disposal are not likely at any of the alternative sites.

5.5.3 Water Quality

Water quality impacts at the disposal sites may be caused by short-term inputs and changes in particle concentrations following disposal. These changes are described and discussed in Section 5.1. These changes result in sporadic and temporary (<few hours) increases in suspended solids in the water column due to unconsolidated sediments that are stripped away from the descending sediment mass as it travels through the water column to the seafloor. A detailed discussion of dredged material disposal plume behavior is presented in Section 5.1.

Grains of sediment and other particulate material present in the water column are measured as total suspended solids (TSS) in milligrams of solids per liter of water (mg/L). As discussed in Section 4.7.1, the term "turbidity" is often used when referring to suspended solids in the water column; however turbidity is an optical property of water referring to the blockage of light as it passes through water. Particles do not remain suspended in the water column indefinitely; they fall to the bottom at settling rates that depend upon their size and density. Suspended sediments present in the water column during and after disposal operations can potentially affect the feeding activities of fish and benthic organisms and at extremely high concentrations can kill or injure fish and benthic organisms. Contaminants present in the dredged material disposal plume can also potentially be available to marine organisms.

Most of the sediments disposed in Long Island Sound consist of very fine sand to silt and clay (SAIC, 1994). As discussed in Section 5.1, while the bulk of the dredged material will settle to the bottom in the first few minutes after release, low concentrations of fine particles may persist for several hours in the water column, during which time they may be moved by the currents. The maximum amount of sediment that may be released to the water column by a disposal event is estimated by the SAIC (1994) and Tavolaro (1984) at 1 to 5 percent of the dredged material (dry mass). Dragos and Lewis (1993) and others demonstrated that the plume was detectable following disposal events at the New York Mud Dump Site in the New York Bight (water depth approximately 92 feet [28 meters]) for only a few hours.

Laboratory experiments suggest the total amount of material released by a disposal event is approximately 1 percent.

To better define the potential impact of disposal on the water column and to compare the potential impacts across the alternative sites, the Corps Short Term Fate (STFATE) dredged material disposal model was applied at each of the alternative sites to predict disposal plume behavior (see Appendix G-3). STFATE was developed to model plume behavior including physical mixing, transport, settling and contaminant dilution in and around the disposal site during the first few hours after the release of dredged material (see Appendix G-3). It is based on the work of Brandsma and Divorky (1976) and Koh and Chang (1973) and models the behavior of the plume as a dense liquid (since the concentration of discharged dredged material in the plume is usually low), applying conservation of mass, momentum, buoyancy, and particle fall velocities. The model is applied on a project specific basis and the results are used to establish conditions for management of disposal.

The STFATE model simulations were performed for each of the four alternative sites on grids encompassing the disposal site and surrounding area (model parameters are described in Appendix G-3). The water depths were set to a uniform depth that represents the mean site depth. STFATE requires information on water depths, current velocity, sediment characteristics, and results of toxicity tests to estimate the water quality resulting after disposal. Because a stratified water column may cause greater loss of material during the descent phase, the most conservative ("worst") case was modeled. A stratified density profile representing typical summer conditions was determined from historical data (USACE, 2001g) and used for all model runs (surface layer salinity of 27 psu, and temperature equal to 12°C [54°F]; and a bottom layer salinity of 31 psu, and temperature of 8°C [46 °F]). It was also assumed that water from the dredging site would be slightly fresher (less saline) than water at the disposal site. The disposal operation parameters, including volume of dredged material and barge dimensions, were based on information from typical barge configurations and sizes previously used in Long Island Sound. Estimates of the current velocities were determined from a statistical analysis of current meter data described in Section 4.5.

Sediment samples collected for the recent proposed harbor dredging projects in New Haven, Norwalk, and Guilford were used to establish grain size and contaminant toxicity parameters (USACE, 2001k; 2001l; 2001m) and are considered representative of typical dredged sediments that might be disposed in the alternative sites in the future. The average geotechnical composition of the sampled sediments was selected and consisted of a mix of 10 percent fine sand, 76 percent silt, and 14 percent clay. Field experience shows that the clamshell dredging operations typically used to dredge sediments in Long Island Sound results in a significant portion of the cohesive sediment remaining as clumps within the barge and during disposal. For that reason, mixes of 40 percent and 60 percent clumps were used for all STFATE modeling runs.

In the New Haven, Norwalk, and Guilford dredged material evaluations, biological testing was used to determine the sensitivity of indicator organisms to elutriated contaminants. This was done by determining the dilution required of sediment samples to reach elutriate levels fatal to 50 percent of the indicator organisms (*i.e.,* LC_{50}). Of the nearly 40 elutriate analyses

done in the three studies, the four most toxic had LC_{50}'s ranging from 22 percent and 49 percent with an average of 34 percent. The "Green Book" *Evaluation of Dredged Material Proposed for Ocean Disposal — Testing Manual*, sets a dilution criteria of 1/100th of the elutriate LC_{50} concentration. This criteria should not be exceeded after the period of initial mixing (4 hours after dumping) anywhere in the designated disposal site or at anytime outside the disposal site. The STFATE model was used to evaluate water quality by tracking predicted plume dilution in the water column and comparing it to water quality criteria of 1/100th of the elutriate LC_{50} (0.34%). A series of STFATE model runs were performed that varied the percentage of clumps, and water content of the sediment in the barges plus the strength of the currents. This provided a matrix of conditions against which to compare the alternative sites for water quality impact. Conditions of high currents, smaller clumping percentage, high water content, and larger barge size tend to be more representative of typical operations.

5.5.3.1 Water Quality at the Western Long Island Sound Alternative

For WLIS, the STFATE model calculations were performed on a 7,500 feet by 7,500 feet (2,300 meter by 2,300 meter) grid encompassing the disposal site and surrounding area with grid resolution of 150 feet (46 meters) North by 250 feet (76 meters) East. The water depth was set to a uniform depth of 98 feet (30 meters). As discussed in Section 4.5.2, long-term current meter measurements were made near WLIS (Fredriksson and Dragos, 1996) and short-term measurements were made inside the boundaries of WLIS (USACE, 2001g; Morton *et al.*, 1982). Depth-averaged currents for the period of the simulation were determined from a statistical analysis of these data and corresponded to release during peak spring flood tide, superimposed on a 75% frequency of occurrence of wind-driven and/or density-driven currents totaling 0.9 feet/second (0.3 meter/second), directed toward the west-southwest. These conditions were selected to represent the highest expected currents over the duration of any disposal event, which is typically only 2 to 3 hours. Also simulated were less extreme conditions, *i.e.*, currents corresponding to release during peak flood tide (average for times other than spring conditions) and average wind-driven and/or density-driven currents superimposed (0.6 feet/second [0.2 meter/second] directed toward the west-southwest).

STFATE predicted the spread of the material in the water column during settlement, the footprint of the material on the bottom, and the distribution in space and time of the residual plume of suspended solids and contaminants relative to background conditions. For WLIS, as with all four alternative sites, model simulations showed the vast majority of the released dredged material settled to the bottom in close proximity to the point of release. The high current conditions chosen for the simulation were the most significant factor in determining the residual plume conditions. This might be expected given that a current of 0.9 feet/second (0.3 meter/second) would cross half the width of WLIS in less than one hour. For all simulations, the center of the site was chosen as the release point. The results of the STFATE model predictions for dilution relative to the toxicity criteria (1/100th of the LC_{50}) are presented in Table 5-4. All dilutions were well within the limits after the four hour initial mixing period. However, toxicity criteria exceedences occurred when the plume passed out of the site boundaries, approximately 90 minutes after release. The dilution returned to permissible levels within another 20 minutes beyond the site boundary (see Appendix G-3).

Had the spring tide current (worst case) not carried the plume over the short travel distance from the site center to the site boundary, the dilution criteria would not have been exceeded. Barge size was another significant factor, but the percent volume of clumps and percent volume of free water used in the simulations were not significant in the ranges simulated. The results suggest that dilution of contaminants below the proscribed 1/100th LC_{50} level for worst case projects could be achieved simply by adjusting the management approach either by 1) limiting barge size, 2) limiting operations to times other than during spring tide, 3) positioning the release point according to the ambient currents, or 4) expanding the site boundaries.

Table 5-4. STFATE Model Parameters and Dilution Results for the Western Long Island Sound Alternative

Barge Volume (cy)	Current Speed (feet/second) and Direction[1]	Clumps (% vol)	Free Water (% vol)	Elutriate Toxicity Criteria Exceedence (Cause)
5,000	0.9	40%	10%	Exceedence Outside Boundary
5,000	0.9	60%	25%	Exceedence Outside Boundary
5,000	0.6	40%	10%	No Exceedence
5,000	0.6	60%	25%	No Exceedence
3,000	0.9	40%	10%	No Exceedence
3,000	0.9	60%	25%	No Exceedence
3,000	0.6	40%	10%	No Exceedence
3,000	0.6	60%	25%	No Exceedence

[1] All current directions are west southwest

5.5.3.2 Water Quality at the Bridgeport Alternative

For Bridgeport, the STFATE model calculations were performed on a 12,000 feet by 6,000 feet (3,600 meter by 1,800 meter) grid encompassing the disposal site and surrounding area with grid resolution of 150 feet (46 meters) North by 333 feet (101 meters) East. The water depth was set to a uniform depth of 64 feet (19.5 meters). A statistical analysis of available current data was used to characterize current velocities for the Bridgeport Alternative (see Section 4.5.3). Depth-averaged currents for the period of the simulation were determined from a statistical analysis of these data and corresponded to release during peak spring flood tide, superimposed on a 75% frequency of occurrence of wind-driven and/or density-driven currents totaling 0.9 feet/second (0.3 meter/second), directed toward the west-southwest. Also simulated were less extreme conditions, *i.e.*, currents corresponding to release during peak flood tide (average for times other than spring conditions) and average wind-driven and/or density-driven currents superimposed (0.6 feet/second [0.2 meter/second] directed toward the west-southwest).

As with WLIS, the Bridgeport simulations showed that the high current conditions chosen for the simulation were the most significant factor in determining spread of the residual plume. The results of the STFATE model predictions for dilution relative to the toxicity criteria are presented in Table 5-5. The dilutions were all well within the limits after the four hour initial

mixing period. The toxicity criteria exceedences occurred when the plume passed out of the site boundaries, approximately 100 minutes after release, although the dilution reached permissible levels within another 30 minutes passed the site boundary (see Appendix G-3). As with WLIS the spring tide current (worst case) carried the plume over the short travel distance from the site center to the site boundary. Barge size was another significant factor, but the percent volume of clumps and percent volume of free water used in the simulations were not significant in the ranges simulated. The results suggest that, like WLIS, dilution of contaminants below the proscribed $1/100^{th}$ LC_{50} level for worst case projects could be achieved simply by adjusting the management approach either by 1) limiting barge size, 2) limiting operations to times other than during spring tide, 3) positioning the release point according to the ambient currents, or 4) expanding the site boundaries.

Table 5-5. STFATE Model Parameters and Dilution Results for the Bridgeport Alternative

Barge Volume (cy)	Current Speed (feet/second) and Direction[1]	Clumps (% vol)	Free Water (% vol)	Elutriate Toxicity Criteria Exceedence (Cause)
5,000	0.9	40%	10%	Exceedence Outside Boundary
5,000	0.9	60%	25%	Exceedence Outside Boundary
5,000	0.6	40%	10%	No Exceedence
5,000	0.6	60%	25%	No Exceedence
3,000	0.9	40%	10%	No Exceedence
3,000	0.9	60%	25%	No Exceedence
3,000	0.6	40%	10%	No Exceedence
3,000	0.6	60%	25%	No Exceedence

[1] All current directions are west southwest

5.5.3.3 Water Quality at the Milford Alternative

For Milford, the STFATE model calculations were performed on a 7,500 feet by 7,500 feet (2,300 meter by 2,300 meter) grid encompassing the disposal site and surrounding area with grid resolution of 150 feet (46 meters) North by 250 feet (76 meters) East. The water depth was set to a uniform depth of 61 feet (18.5 meters). A statistical analysis of available current data was used to characterize current velocities for the Milford Alternative (see Section 4.5.4). Depth-averaged currents for the period of the simulation were determined from a statistical analysis of these data and corresponded to release during peak spring flood tide, superimposed on a 75% frequency of occurrence of wind-driven and/or density-driven currents totaling 1.1 feet/second (0.34 meter/second), directed toward the west-southwest. Also simulated were less extreme conditions, *i.e.*, currents corresponding to release during peak flood tide (average for times other than spring conditions) and average wind-driven and/or density-driven currents superimposed (0.7 feet/second [0.21 meter/second] directed toward the west-southwest).

The results of the STFATE model predictions for the Milford site for dilution relative to the toxicity criteria are presented in Table 5-6. The dilutions were within the limits after the

4-hour initial mixing period in the zero current simulations. The toxicity criteria exceedences occurred for all model simulations, except a zero current conditions, when the plume passed out of the site boundaries. Because the currents are strong at the Milford Alternative relative to its small size, currents carried the plume rapidly over the short travel distance from the site center to the site boundary. Unlike WLIS and Bridgeport, however, this was the case for both barge sizes. The smaller barge size was not enough to sufficiently decrease the time needed for dilution. For Milford the model results suggest that, dilution of contaminants below the proscribed 1/100th LC_{50} level for worst case projects could only be achieved by limiting operations to times of minimal tidal currents or by expanding the site boundaries.

Table 5-6. STFATE Model Parameters and Dilution Results for the Milford Alternative

Barge Volume (cy)	Current Speed (feet/second) and Direction[1]	Clumps (% vol)	Free Water (% vol)	Elutriate Toxicity Criteria Exceedence (Cause)
5,000	1.1	40%	10%	Exceedence Outside Boundary
5,000	1.1	60%	25%	Exceedence Outside Boundary
5,000	0.7	40%	10%	Exceedence Outside Boundary
5,000	0.7	60%	25%	Exceedence Outside Boundary
3,000	1.1	40%	10%	Exceedence Outside Boundary
3,000	1.1	60%	25%	Exceedence Outside Boundary
3,000	0.7	40%	10%	Exceedence Outside Boundary
3,000	0.7	60%	25%	Exceedence Outside Boundary
5,000	0.0	40%	10%	No Exceedence
5,000	0.0	60%	25%	No Exceedence

[1] All current directions are west southwest

5.5.3.4 Water Quality at the Central Long Island Sound Alternative

For CLIS, the STFATE model calculations were performed on a 12,000 feet by 6,000 feet (3,600 meter by 1,800 meter) grid encompassing the disposal site and surrounding area with grid resolution of 150 feet (46 meters) North by 333 feet (101 meters) East. The water depth was set to a uniform depth of 68 feet (21 meters) (approximate mean site depth). A statistical analysis of available current data was used to characterize current velocities for the CLIS Alternative (see Section 4.5.5). Depth-averaged currents for the period of the simulation were determined from a statistical analysis of these data and corresponded to release during peak spring flood tide, superimposed on a 75% frequency of occurrence of wind-driven and/or density-driven currents totaling 1.1 feet/second (0.34 meter/second), directed toward the west-southwest. Also simulated were less extreme conditions, *i.e.*, currents corresponding to release during peak flood tide (average for times other than spring conditions) and average wind-driven and/or density-driven currents superimposed (0.7 feet/ second [0.21 meter/second] directed toward the west-southwest).

As with WLIS and Bridgeport, the CLIS simulations showed that the high current conditions chosen for the simulation were the most significant factor in determining spread of the residual plume. The results of the STFATE model predictions for dilution relative to the toxicity criteria are presented in Table 5-7. The dilutions were all well within the limits after the four hour initial mixing period. The toxicity criteria exceedences occurred when the plume passed out of the site boundaries, approximately 90 minutes after release, although the dilution reached no exceedence levels within another 30 minutes beyond the site boundary (Appendix G-3). As with WLIS and Bridgeport, the spring tide current (worst case) carried the plume over the short travel distance from the site center to the site boundary. Unlike WLIS and Bridgeport, however, this was the case for both barge sizes. The smaller barge size was not enough to sufficiently decrease the time needed for dilution. Again, the percent volume of clumps and percent volume of free water used in the simulations were not significant in the ranges simulated. For CLIS the model results suggest that, dilution of contaminants below the proscribed $1/100^{th}$ LC_{50} level for worst case projects could be achieved by adjusting the management approach either by 1) further limiting barge size, 2) limiting operations to times other than during spring tide, 3) positioning the release point according to the ambient currents, or 4) expanding the site boundaries.

5.5.3.5 Summary of Impacts to Water Quality

The STFATE model applied for each of the four alternative sites showed that the potential for water quality impacts was greatest for the Milford Alternative. At Milford, toxicity criteria were exceeded for all current speeds and clump volumes except the zero current condition. To ensure that contaminant concentrations remained below the toxicity criteria, disposal operations for the hypothetical project tested must be restricted to periods of low tidal current. The potential for water quality perturbations is similar among the other three alternative sites and the likelihood of exceeding the toxicity criteria can be reduced by: 1) limiting operations to times other than during spring tide; 2) positioning the release point according to the ambient currents; and 3) limiting the barge size.

Table 5-7. STFATE Model Parameters and Dilution Results for the Central Long Island Sound Alternative

Barge Volume (cy)	Current Speed (feet/second) and Direction[1]	Clumps (% vol)	Free Water (% vol)	Elutriate Toxicity Criteria Exceedence (Cause)
5,000	1.1	40%	10%	Exceedence Outside Boundary
5,000	1.1	60%	25%	Exceedence Outside Boundary
5,000	0.7	40%	10%	No Exceedence
5,000	0.7	60%	25%	No Exceedence
3,000	1.1	40%	10%	Exceedence Outside Boundary
3,000	1.1	60%	25%	Exceedence Outside Boundary
3,000	0.7	40%	10%	No Exceedence
3,000	0.7	60%	25%	No Exceedence

[1] All current directions are west southwest

5.5.4 Impacts to Benthic Invertebrates

The disposal of dredged material has a variety of direct and short-term impacts on the benthic community. For example, the descending dredged material plume may dislodge small surface dwelling animals (*e.g.*, some amphipod and polychaete species) and transport them some distance along the bottom as the plume collapses. Such disturbance is probably very similar to that experienced by these animals during storms. Increased suspended sediment levels could affect respiration and feeding, although conditions would be relatively short-lived. However, the primary direct impact of dredged material disposal to the benthic community is likely to be associated with burial of some organisms and changes in topography. As described in Section 5.2, topographic changes occur primarily by the building of mounds as the disposed material lands on the bottom. As this occurs, the benthic animals remaining under the descending plume would, of course, be buried. This burial would likely kill or damage many of the animals directly, but the overall impact to the community depends of the depth of burial, the nature of the material (fine versus coarse), the taxa involved, and their ability to burrow back to the surface. For example, Kranz (1974) found that nut clams (*Nucula annulata*) could successfully emerge after burial by 20 inches (50 centimeters) of their native sediment (mud), but could not recover after burial under 16 inches (40 centimeters) of fine sand. Many polychaete worms actively burrow through the sediment and are thus predisposed to recovery from burial. The active crawler, *Nephtys incisa*, an important member of the infaunal community at WLIS, was able to reach the surface of the sediment after burial to 8 inches (21 centimeters) depth (Saila *et al.*, 1971). Even some tube-dwelling worms may reach the surface simply by extending their tubes.

Because the native species will have been buried, the nature of the community present immediately after disposal will primarily be determined by the animals that were present in the dredged material and that were able to survive the process of dredging, transport to the site, and disposal. However, the likelihood of surviving this process is not known with any degree of certainty. Therefore, for at least a short period of time immediately after disposal, the community is likely to be effectively eliminated for some period of time, or be comprised of very different species. The most immediate and intense effects would occur at the center of the disposal mound where the native fauna would be buried the deepest and populations would be severely impacted (*e.g.*, Zajac and Whitlatch, 1988). Zajac and Whitlatch (1988) speculated that some of the population changes occurring near the center may result from migration of some taxa, such as the polychaete *Nephtys incisa*, from the area. The effects would lessen at increasing distance from the center of the disposal mound. Overall, it has been suggested that disturbance by dredged material disposal resets the progression of benthic community development in a fashion similar to storm events (Rhoads *et al.*, 1978).

Often, these impacts to the benthos are temporary, as the native community either borrows to the surface or recolonizes the area. However, long-term or cumulative effects to the benthos may result. The rate at which the community returns depends on many factors. The first consideration is the texture of the deposited material as discussed in Section 5.2.2. Any substantial change in texture reduces the chances that the community present after disposal would be similar to that present before. Physical disturbance to the sea floor by storms would also affect the timing, and perhaps the nature, of recovery. McCall (1978) concluded

that sea floor disturbances from natural events had considerable influence on the benthos in Long Island Sound.

Another factor strongly influencing recovery of the benthic community is the biological variability inherent in the general Long Island Sound ecosystem. Several studies have shown that the basic species composition of the benthos in various regions of the western and central Sound basins has been fairly consistent over the last four or five decades, although substantial shifts in populations of some of the predominant taxa have occurred. For example, McCall (1978) and Reid *et al.* (1979) witnessed significant declines in clam populations in the early 1970s. McCall (1978) thought that this particular collapse resulted from an unusual plankton mortality event. Zajac and Whitlatch (1988) studied the population dynamics of the worm *Nephtys incisa*, one of the important taxa inhabiting the infaunal communities in the Sound. Zajac and Whitlatch found that initial recruitment after disposal at their study station in the CLIS Disposal Site was by adults migrating from other areas. Subsequent population increases then would occur by recruitment of new age classes to the area. Importantly, Zajac and Whitlatch discovered that this recruitment was low at the disposal site, but that it was not related to the disposal events as recruitment was also low elsewhere. Therefore, while it may appear that recovery of a mound may be slower than anticipated, that delay may be related to factors (*e.g.,* temperature, DO) other than those arising from disposal (Zajac and Whitlach, 1988).

Because of the uncertainties regarding the nature of the dredged material (*i.e.*, texture and grain size) to be disposed as well as those associated with the biological factors mentioned above, it is difficult to predict the specific benthic community assemblage that would inhabit the alternative disposal sites shortly after disposal ends. However, longer-term studies have shown that the infaunal community on the mounds does eventually begin to resemble nearby, unimpacted areas (SAIC, 2002a; SAIC, 2002b; SAIC, 2002c).

5.5.4.1 Impacts to Benthic Invertebrates at the Western Long Island Sound Alternative

The benthic community at WLIS is comprised primarily of the three major taxonomic groups, Annelida, Mollusca, and Crustacea. Many species belonging to these groups have shown remarkable abilities to burrow up through deposited dredged material, although mortalities do increase with increasing depth of burial (Maurer *et al.*, 1981a; Maurer *et al.*, 1981b; Maurer *et al.*, 1982). The numerically dominant animal at WLIS was the small nut clam *Nucula annulata* (Appendix H-1), which has been shown to be able to reach the sediment surface from a depth of 6 inches (16 centimeters) in 8 days (Maurer *et al.*, 1981a).

Because of the current community assemblage at WLIS, the sudden change in community type during and immediately after disposal would probably be similar in significance to that at CLIS, but more significant than that at the Bridgeport or Milford Alternative sites. The WLIS Alternative had similar numbers of species per sample and similar species diversity to that at CLIS, but values for both measures were higher than those at the Bridgeport or Milford Alternative sites (Table 4-23). There was slightly more variability in the sedimentary habitats at WLIS, which were predominantly muddy, but in some places had

fairly sandy sediments. This variability likely contributed to some of the higher species numbers and diversity at WLIS.

5.5.4.2 Impacts to Benthic Invertebrates at the Bridgeport Alternative

As described for WLIS, the benthic community at the Bridgeport Alternative is comprised primarily of the three major taxonomic groups, Annelida, Mollusca, and Crustacea. Many species belonging to these groups have shown remarkable abilities to burrow up through deposited dredged material, as described in Section 5.2.2. However, the Bridgeport Alternative had fewer species per sample and lower species diversity than the WLIS and CLIS Alternatives sites (Table 4-24). As a result, it is anticipated that impacts on the benthic community would be somewhat less significant at Bridgeport than at WLIS or CLIS, but comparable to those at Milford.

5.5.4.3 Impacts to Benthic Invertebrates at the Milford Alternative

The benthic community at the Milford Alternative is comprised primarily of the three major taxonomic groups, Annelida, Mollusca, and Crustacea. Many species belonging to these groups have shown remarkable abilities to burrow up through deposited dredged material. The Milford Alternative, similar to Bridgeport, had fewer species per sample and lower species diversity than the WLIS and CLIS Alternative sites (Table 4-25). Because of the current community assemblage at Milford, the sudden change in community type would probably be somewhat less significant than that at WLIS or CLIS, and comparable to that at Bridgeport.

5.5.4.4 Impacts to Benthic Invertebrates at the Central Long Island Sound Alternative

The benthic community at the CLIS Alternative is comprised 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. The CLIS Alternative had similar numbers of species per sample and similar species diversity to that at WLIS, but values for both measures were higher than those at the Bridgeport or Milford Alternative sites (Table 4-26). Because of the current community structure at CLIS, the sudden change in community type would probably be similar in significance to that at WLIS, but more significant than that at the Bridgeport or Milford Alternative sites.

5.5.4.5 Summary of Impacts to the Benthic Invertebrates

The immediate impacts of dredged material disposal on the benthos are most likely to be sudden reductions in infaunal abundances and species numbers, and, therefore, a reduction in species diversity. These impacts will be most severe where the plume impacts the bottom. Because values for abundance and diversity were higher at WLIS and CLIS, the immediate impacts will likely be more significant there than at Bridgeport of Milford. Studies of the effects of disturbance (including dredged material disposal) indicate that it is highly probable that the benthic habitats at a site will eventually be recolonized by a functioning infaunal community, although it may not be exactly the same as the one present before disposal. Recolonization will mostly occur via migration from surrounding habitats or by the settling

of the planktonic larvae of infaunal animals. The potential for recolonization is similar among all four alternative sites.

5.5.5 Impacts to Fish and Shellfish

There are potentially both short and long-term impacts to fish and shellfish from the disposal of dredged material in Long Island Sound. While these impacts can range from acute mortality associated with the burial of fish and shellfish to the temporary displacement of fish during periods of high turbidity, direct impacts to these organisms from the disposal of dredged material are generally limited to the footprint of the disposal mound. The footprint of potential disturbance can be estimated by evaluating the size and thickness of dredged material deposits formed at WLIS and CLIS over the past five years (SAIC, 2002a; SAIC, 2002b; SAIC, 2002b). Typical disposal mounds in Long Island Sound have a central footprint with deposits 20 inches to over 14 feet (51 centimeters to 4.3 meters) thick and an apron of a thin layer of material tapering to zero thickness. These mounds are built sequentially from individual disposal events and form a relatively flat profile 300 to 1150 feet (91 to 351 meters) in diameter with the apron extending several hundred feet further.

Short-term Impacts

As described in Section 5.1, dredged material disposed from a bottom dumping vessel descends rapidly to the seafloor as a single column-like mass. As the leading edge of this mass makes contact with the seafloor, the column begins to collapse, causing the dredged material to spread laterally as it forms a relatively flat, circular footprint. All epibenthic and infaunal animals in the central footprint would likely be buried, including lobsters and clams. Because thickness of the deposit in the apron area is comparatively thin and increases incrementally with subsequent disposal events, some of the larger organisms would survive burial by digging through the deposited material (see Rhoads and Carey [1997] for discussion of recovery potential). Because of their relative mobility, many fish should be able to avoid injury from the initial impact of the dredged material by moving away from the descending sediment mass, although it is unlikely that all fish would escape unharmed. For example, in response to the descending material, demersal species such as flounder and tautog may seek refuge in or near the substrate, or simply not move quickly or far enough to avoid being buried. Unlike shellfish and other benthic organisms, most finfish would not be expected to survive burial.

To assess the potential impacts on forage species, lobsters and demersal fish, the potential area of the central footprint was calculated for each disposal site alternative, based on historical disposal patterns and compared to the relative abundance of species in the area. These estimates are presented in the sections evaluating site-specific impacts (Sections 5.1.1.2 to 5.1.1.4). Unless the short-term impact area is very large (relative to the habitat area occupied by any life stage of each species) the direct impact of burial, while killing or injuring numerous fish, larvae or eggs, is not likely to cause a measurable reduction in the population inhabiting any region of Long Island Sound.

Immediately following the actual disposal event, increased turbidity may also be a temporary problem for finfish in the disposal area, creating a direct impact for some species and life stages and an indirect impact for others. Suspended sediments may physically injure adult and juvenile finfish by lacerating the protective gill covering, and irritating or clogging the gill system (O'Connor, 1991). Any damage to the gills of finfish can inhibit the effective exchange of oxygen, thereby impairing respiration and increasing the chances of mortality (LaSalle *et al.*, 1991). The impacts of increased turbidity to finfish depend largely on the life stage present during disposal. While adult and juvenile finfish are capable of leaving a disposal area that has stressfully high turbidity levels, egg and larval stages of finfish and shellfish have little or no control over their mobility. As a result, younger life stages present at a disposal site may experience higher rates of turbidity-associated impacts.

Elevated turbidity levels may also alter certain finfish behaviors, such as migration, spawning, foraging, schooling, and predator evasion (O'Connor, 1991). The consequences of these altered behaviors are considered an indirect impact. Fish species that migrate through Long Island Sound during early spring, such as fourspot flounder, striped searobin and windowpane flounder, may avoid disposal areas temporarily during periods of high turbidity. Following these turbid periods, finfish and shellfish may be drawn back to the disposal site by irregularities in the substrate and the presence of new material containing infaunal organisms and other forage. The biological response of fish and shellfish to the placement of dredged material is discussed more thoroughly under "Long-term Impacts" which follows this section.

Restrictions prohibiting dredging from June 1 to September 30 of any year were developed and imposed by state fishery resource experts primarily protect shellfish populations. Additional restrictions between February and June may be imposed on a case-by-case basis to protect spawning winter flounder, and/or the migration of anadromous fish to freshwater spawning grounds, based on recommendations by state or federal fishery biologists during the Corps permit review. As a result, there would be no disturbance to the migration or spawning of these and other species at the disposal sites during this critical period.

Seasonal restrictions which prohibit dredging coastal embayments in Long Island Sound from the end of May to October avoid the late spring and summer periods when the majority of eggs and larvae are present. The fish species at greatest risk during the disposal season are those whose larvae or juveniles utilize mud and silt bottoms for refuge in the winter (*e.g.*, red hake), and species with demersal and adhesive eggs that are present in early spring or late fall (*e.g.*, winter flounder). Therefore, while impacts from disposal events are periodic and short-lived, and disposal activities are intended to avoid the presence of most species during their early life stages, there exists the potential to adversely impact some species located within the affected area of the disposal site.

Long-term Impacts

Perhaps the most significant long-term impact to the fish and shellfish community associated with the disposal of dredged material is the potential alteration of the community as the result of changes to habitat and food resources. It is likely that most finfish would leave the area

during the actual disposal event to escape the associated turbidity. This departure from the area would be temporary and, once disposal activities had ceased and the turbidity diminished, the finfish would likely return to the region to forage. However, as described in Section 5.5.4, it may take time for the benthic community to reestablish following a disposal event, reducing the foraging opportunities in the area until the recolonization process is well under way. It is not expected that disposal of dredged harbor sediments would alter long-term habitat conditions at any of the alternative sites. Sediments permitted for disposal are likely to be of similar textural characteristics to the existing mud bottoms, although with higher organic content. Recolonization and bioturbation of the surface of the disposal mound and deposition of ambient sediments will bring the mound surface into equilibrium with the surrounding habitat within six months to one year (SAIC 2002a; SAIC, 2002b; SAIC, 2002c).

The changes in bottom topography associated with dredged material disposal are not expected to cause measurable impacts to aquatic life at any of the alternative sites. The gradual slopes of disposal mounds (mound height generally increases from 20 inches to 14 feet (51 centimeters to 4.3 meters) over a length of at least 325 feet (99 meters) for an angle of less than three percent) would not likely prevent pelagic species from reentering the area after the end of disposal operations, nor would most demersal organisms avoid recolonizing an area with new and distinct contouring. Some larval demersal fish such as windowpane flounder, winter flounder, or summer flounder might prefer an undisturbed silt or mud habitat for refuge and actively avoid fresh dredged material due to the presence of relief and difficulty of concealment in the absence of a loose sediment layer. There is little field or experimental data to determine a threshold for quality of refuge for these demersal species. This potential displacement of refuge would be limited to a period of one to two years after which the surface characteristics of the shallow mounds are difficult to distinguish from ambient conditions in terms of surface texture and small scale relief.

While some finfish species may delay returning to the site because of the change in benthic community, others may be attracted to the high density of colonizing species and disturbed sediments (Clarke and Kasal, 1994). Scientific studies on this subject have been limited, but those that have been conducted suggest that demersal fish species are likely to recolonize an area in which the topographic features have been modified (Clarke *et al.*, 1988). Another study suggested that the minor changes in currents resulting from the new contouring might attract prey species such as polychaetes and mysid shrimp, thus attracting larger predators such as finfish (Clarke and Kasal, 1994). To evaluate the relative value of benthic food sources to fish resources, the Benthic Resources Assessment Technique (BRAT) was developed (Clarke and Lunz, 1985). The technique has demonstrated that early successional assemblages established on dredged material disposal mounds have higher fisheries value in biomass and higher potential usage by benthic feeding fishes (particularly juveniles) than nearby reference areas (Lunz, 1986).

BRAT is used to relate the availability and species of prey (biomass of size classes determined from quantitative benthic samples) to fish trophic groups (largely based on size and food preference). Although quantitative data on biomass of invertebrates by size class is not available for the alternative sites, assumptions can be made about the short term effects of

disposal based on existing studies in Long Island Sound. Assessments of benthic populations at the Massachusetts Bay Disposal Site are consistent with observations with Sediment Profile Imaging and benthic studies conducted over the past twenty-five years in Long Island Sound. These assessments showed that within a month after cessation of disposal, mounds contain large numbers of very small invertebrates, chiefly polychaetes, and later tube-building amphipods. Mounds that have not been disturbed for several years (either by disposal or environmental stress such as hypoxia) have smaller numbers of large burrowing invertebrates including polychaetes and small clams. As a result disposal mounds provide foraging habitat for larval and young of the year (YOY) demersal fish while inactive mounds provide foraging habitat for larger adult demersal fish.

Some finfish and shellfish species are seasonally more abundant in the region of the alternative disposal sites during different seasons than in Long Island Sound proper this may reflect the attraction of recently deposited sediments noted above based on the data collected by the Long Island Sound Trawl Survey (Appendix H-6) (Table 5-8). The reasons for the patterns of resource use (fish distribution) are complex and include hydrodynamics, water temperature, the presence of refuge, habitat preference, prey distribution, as well as disturbance. The purpose of this analysis is to illustrate the patterns of fish distribution and identify those species most likely affected by disposal activities. The results presented here are most useful for species that are well represented by bottom trawl data; some highly mobile pelagic predators such as striped bass may be underrepresented in the trawl data (Gottschall *et al.*, 2000). The table is organized to highlight those species with a higher catch per unit effort (CPUE) near the alternative site than the average for Long Island Sound in spring (April to June) and fall (September to October). As discussed in Section 4.10.1, the analysis was conducted by grouping sampling stations into habitat areas and disposal site analysis areas and calculating average CPUE for each season and year for each area. Disposal site analysis areas are 6 by 3 nautical mile (11 by 5.5 kilometers) rectangles surrounding each alternative (Appendix H-6). The results from these analysis areas therefore represent standardized seasonal estimates of fish abundance over a seventeen-year period in the region surrounding each alternative. In the case of existing disposal sites, this data represents a comparative record of seasonal fish abundance near disposal activity during disposal and recovery periods. These active areas were compared to adjacent habitat areas similar to the disposal sites but remote from disposal activities. This approach cannot identify direct impacts from disposal (burial), or exclude factors such as hypoxia, commercial fishing, or recreational fishing. However, if impacts due to disposal are spatially persistent and sufficient to affect fish abundance (positively or negatively) in the region immediately surrounding disposal sites, this comparative analysis would identify those species most affected. The analysis areas also provide an assessment of the relative abundance of species present around each alternative at the beginning (fall) and end (spring) of disposal activities.

Three alternative sites had the highest average CPUE within any habitat area or disposal site analysis area for some species (bolded text in Table 5-8). This indicates that, on average, the grouping of trawl stations around these alternative sites had the highest catch for these species within the entire Long Island Sound. These species would more likely be present near the alternative disposal site of that region than in other regions of the Sound and would have a higher potential to be adversely affected by disposal activities at the alternative sites at

Table 5-8. Species with Catch per Unit Effort (CPUE) Higher than the Average CPUE for Long Island Sound[1]

Alternative Site	Spring (April – June)	Fall (September – October)
WLIS	American lobster **Cunner** **Fourbeard rockling** **Fourspot flounder** Northern searobin Red hake Scup **Smooth dogfish** **Striped searobin** Windowpane flounder Winter flounder	American lobster Weakfish[2] **Striped searobin**
Bridgeport	**American lobster** Atlantic herring Silver hake Windowpane flounder Winter flounder	**American lobster** American shad Bluefish Butterfish Scup Weakfish
Milford	**Black sea bass** Scup **Silver hake** Winter flounder	Butterfish Fourspot flounder Hogchoker Red hake Summer flounder Tautog Weakfish Windowpane flounder
CLIS	Scup Silver hake Summer flounder Winter flounder	Butterfish Weakfish

[1] Based on trawl data collected by Connecticut DEP 1984-2000.Species in bold have highest overall abundance at specified alternative during the season indicated.
[2] High in the western basin of Long Island Sound in 1999 and 2000

those times. Detailed discussions of potential impacts on individual species at each alternative are presented below. Impacts were assessed by determining the abundance relative to other parts of Long Island Sound and other species; the life history characteristics of each species (life stage, migration, foraging requirements, refuge) and the likelihood that the species would be present during the disposal season (nominally October to May but usually more restricted by dredging requirements).

5.5.5.1 Impacts to Fish and Shellfish at the Western Long Island Sound Alternative

The location of WLIS in the western basin of Long Island Sound places the site in an area with distinctive fish and lobster resources. In particular, this area of the sound has a complex, heterogeneous bottom habitat, and experiences early onset of vernal warming and relatively high nutrient loading compared to the rest of Long Island Sound. The WLIS Alternative itself is located within a deep mud habitat flanked by transitional and sand habitats (Figure 4-33 and Section 4.10.2). These western basin characteristics and other potential factors result in trawl catches above the average for the total Sound for spring

collection of eleven individual species (see Table 5-8) and total CPUE (Figure 5-6). Of these species, five (Cunner, Fourbeard rockling, Fourspot flounder, Smooth dogfish, Striped searobin) recorded the highest average spring CPUE of any analysis area (habitat areas are groups of trawl stations with similar habitat characteristics, disposal site analysis areas are 3 by 6 nautical miles (5.5 by 11 kilometers) areas surrounding each alternative, see Figure 4-34) during the trawls collected from WLIS in 2000. The WLIS area has been sparsely sampled due to the very high density of fixed lobster gear in this region prior to 2000 (Appendix H-6). In addition to the density of fixed gear, there are areas of rough or rocky bottom that make trawling on straight transects difficult. The catastrophic decline of the Western Long Island Sound lobster fishery in 1999 spurred state agencies to increase efforts to evaluate lobster resources and as a component of this effort, the CTDEP Fisheries Division added additional trawl stations in the far western Sound in 2000. Although these results are more limited than those for the other alternatives, they illustrate the fish resources that may be present in or near the WLIS Alternative in spring.

Three species were recorded with above average CPUE for the WLIS analysis area in the fall of 2000 (the only year available for analysis of data from WLIS) (Table 5-8). Of these, one had the highest average CPUE of any analysis area (Striped searobin). Fall CPUE was higher than spring CPUE at all habitats and disposal site analysis areas including WLIS, However, while the spring CPUE at WLIS is higher than surrounding areas, the fall CPUE at the WLIS site was lower than surrounding habitats (Figure 5-6; USACE, 2003g).

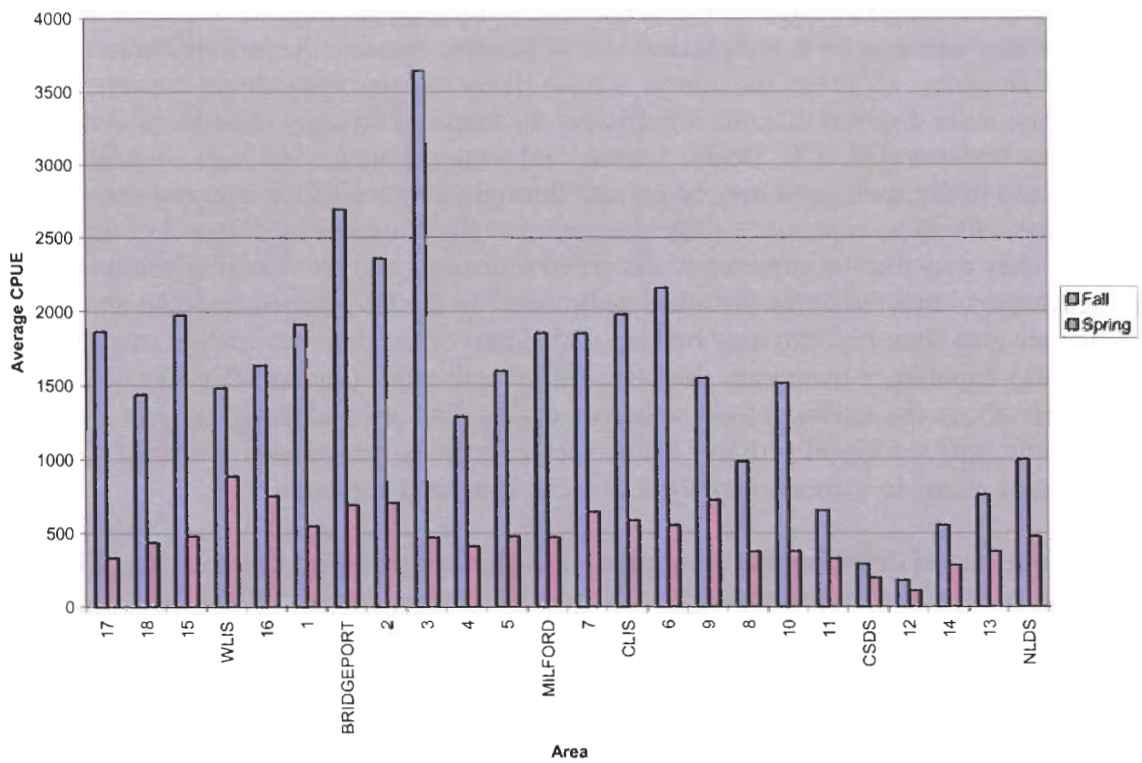

Figure 5-6. CPUE for All Finfish Species 1984 to 2000 by Area

The predicted direct impacts (*e.g.*, death or injury from burial) of disposal on fish and lobster populations in the western Sound are most likely to include burial of lobsters and juvenile red hake within the central footprint of the mound (Table 5-9), although some direct impacts are possible with any benthic fish or invertebrate species present at the site during disposal. Benthic fish species that may be present during some portion of the period when disposal occurs include: winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling. Indirect impacts are likely to include temporary displacement of finfish from benthic foraging areas and refuge on mud habitat from late fall to early spring (October to May) and 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: American lobster, cunner, winter flounder, and striped searobin. Other species that may also experience indirect effects include: Fourbeard rockling, fourspot flounder, scup, smooth dogfish, summer flounder, tautog, weakfish, and windowpane flounder. These predictions are based on three factors: 1) the majority of the finfish species migrate out of western Long Island Sound for the period when disposal usually occurs (winter months); 2) the life history patterns and relative abundance of selected species; and 3) disposal activity at the WLIS site from 1984 to 2000 has had no discernable impact on fish populations in the western basin (Appendix H-6). As previously discussed, trawl data from areas near WLIS are limited to one year of data (2000) and do not provide a comprehensive time series to evaluate local impacts. However, data from the western basin from 1984 to 2000 are consistent with the results from 2000 and have been used to characterize the spatial and temporal fish population (Appendix H-6).

Three species with high average CPUE at the WLIS site may not migrate out of the western sound in winter and may be at the greatest risk of adverse impacts: American lobster, cunner, and winter flounder. Of these, the lobster is most likely to experience direct impacts immediately under disposal mounds if sufficient thickness of dredged material inhibits escape from burrows (USACE, 1997). Cunner and winter flounder had high abundance at the WLIS site in the spring and may be present throughout much of the disposal season. They are most likely to experience some disruption of food sources by disposal of dredged material. They may also be attracted to disturbed sediments and recolonizing benthos or prey upon scavengers attracted to the disturbed sediments. In the fall, striped searobin and weakfish are also abundant and may overlap with a part of the disposal season, striped searobin may experience temporary displacement of epibenthic (animals that live on or immediately above the seafloor) food resources during disposal and weakfish may avoid the water column near a disposal activity. Other species such as striped bass and bluefish may use a disposal plume to increase predation as it can hide their presence.

The potential area of direct impact to infauna and sedentary demersal finfish at the WLIS Alternative is estimated to be between 85,000 and 332,000 square feet (8000 to 31,000 square meters) based on average annual mound sizes at the existing WLIS disposal site. This area of between 2 and 7.6 acres (0.01 to 0.03 square kilometers) represents much less than 0.1% of the available deep mud habitat in this part of the western basin (over 9 square nautical miles [17 square kilometers], Figure 4-33). Loss of large burrowing infauna and some demersal finfish within an area of this size each year will be balanced, in

Table 5-9. Potential Impact of Dredged Material Disposal on Finfish and Lobster at the Western Long Island Sound Alternative

Common Name	Relative abundance	Use of Site[1]	Impact Potential
Alewife	Low abundance	Feeding on plankton	Not likely
American shad	Low abundance	Feeding on plankton; spring travel to spawn in rivers	Not likely
Atlantic herring	Very low abundance	Feeding on plankton in spring	None
American lobster	High abundance	Feeding, burrowing	Mortality of residents under central mound
Black sea bass	Not present	Feeding on plankton, absent in winter	None
Bluefish	Very low abundance	Feeding on epibenthos and pelagic species, absent in winter	None
Butterfish	Very low abundance	Feeding on plankton, absent in winter	None
Cunner	High abundance in spring	Feeding on epibenthos	Temporary displacement from foraging areas in spring
Fourbeard rockling	High abundance in spring	Feeding on epibenthos, resident on mud	Temporary displacement from foraging and refuge areas in spring
Fourspot flounder	High abundance in spring	Feeding on epibenthos, adults found on deep mud in spring	Temporary displacement from foraging and refuge areas in spring
Hogchoker	Low abundance	Feeding on epibenthos, found on deep mud in fall	Temporary displacement from foraging and refuge areas in fall
Little skate	Very low abundance	Feeding on epibenthos, found on sand in spring	None
Northern searobin	High abundance in late spring	Feeding on epibenthos, found on deep sand habitats	Not likely, limited to temporary displacement
Red hake	High abundance in late spring	Feeding on plankton in spring; adults on mud habitats	Potential mortality of juveniles in fall
Scup	High abundance	Feeding on epibenthos, winter offshore	Temporary displacement from foraging areas in spring
Silver hake	Low abundance in spring	Feeding on pelagic prey, juveniles found on mud in fall	Minimal
Smooth dogfish	High abundance in spring	Feeding on epibenthos, may be present in winter	Temporary displacement from foraging areas
Striped searobin	High abundance in late spring to fall	Feeding on epibenthos	Temporary displacement from foraging areas in spring and fall
Summer flounder	Low abundance	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas in spring and fall
Tautog	Moderate abundance	Feeding on epibenthos, prefer structure	Temporary displacement from foraging areas
Weakfish	High abundance in fall	Feeding on pelagic prey	Temporary displacement from foraging areas in fall
Windowpane flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas in spring
Winter flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but may be offshore in winter	Temporary displacement from foraging areas in spring

[1] Use based on Gottschall *et al.*, 2000 and USACE, 2001h

part, by the increase in recolonizing small infauna and some refuge value within the mound contours. The direct impacts of death and burial 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.

Deposition of dredged material at the WLIS Alternative is not expected to alter the habitat that is currently available for fish and lobster. The site is located in a deep mud habitat with existing dredged material in an area of complex, heterogeneous bottom habitat.

Overall, impacts to fish and lobster resources from future dredged material disposal at the WLIS Alternative would be generally unchanged from the present. Periodic habitat and migration disruption within the WLIS Alternative would continue to result from disposal operations. These impacts would be localized and short-term. Habitat disruption would be partially offset by increased topographic relief within the site and recolonization by benthic food sources.

5.5.5.2 Impacts to Fish and Shellfish at the Bridgeport Alternative

The location of the Bridgeport Alternative on the northeastern margin of the western basin of Long Island Sound places the site in an area with distinctive fish and lobster resources. In particular, this area of the Sound has relatively complex, heterogeneous bottom habitat combined with more ocean-like characteristics than other parts of the western basin. The site is located between the Cable and Anchor Reef and Stratford Shoal, two important shoal areas with hard bottom and structure adjacent to mud habitats.

The combination of these and other factors results in above-average (*i.e.*, compared to all of Long Island Sound) trawl totals for fall collection of six individual species (Table 5-8) and total CPUE (Figure 5-6). Of these species, American lobster recorded the highest annual average spring and fall CPUE of any analysis area (habitat or disposal site) during the trawls collected from 1984 to 2000. Five species recorded above average CPUE from the Bridgeport Alternative in the spring. Fall CPUE was higher at all analysis areas, but the fall CPUE at the Bridgeport site was the second highest of all analysis areas (Figure 5-6). The highest fall CPUE was collected at Habitat Area 3 directly across the Sound from the Bridgeport area in the shallow transitional sand of Smithtown Bay.

The predicted direct impacts of dredged material disposal on fish and lobster populations in the western Sound are most likely to include burial of lobsters and red hake within the central footprint of the mound (Table 5-10), although, some direct impacts are possible with any benthic fish or invertebrate species present at the site during disposal. Benthic fish species that may be present during some portion of the period when disposal occurs include: summer flounder, winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling. Indirect impacts are likely to include temporary displacement of finfish from benthic foraging areas and refuge on mud habitat from late fall to early spring (October to May) and displacement of migrating adults in spring and adults and young of the year in fall. The species most likely to experience indirect effects include: American lobster, Atlantic herring, butterfish, red hake, scup, silver hake, windowpane flounder, and winter flounder. Other species that may experience indirect effects include: American shad, fourbeard rockling,

fourspot flounder, striped searobin, summer flounder, and weakfish. As described for WLIS, these predictions are based on three factors: 1) the majority of the finfish species migrate out of western Long Island Sound for the period when disposal usually occurs; 2) the life history patterns and relative abundance of selected species; and 3) disposal activity at a comparable site (the WLIS site) from 1984 to 2000 has had no discernable impact on fish populations in the region (Appendix H-6).

Two species with high average CPUE at Bridgeport may not all migrate out of the western Sound in winter and may be at the greatest risk of direct and indirect impacts: American lobster and winter flounder. Of these, the lobster is most likely to experience direct adverse impacts immediately under disposal mounds if sufficient thickness of dredged material inhibits escape from burrows (USACE, 1997). The CPUE for lobster based on the available trawl data was higher at Bridgeport than at any of the other disposal sites (Appendix H-6), therefore, the impacts of disposal on the lobster population might be greater than at the other alternative sites. Winter flounder had high abundance at the Bridgeport site in the spring and may be present throughout much of the disposal season. They are most likely to experience some disruption of food sources by disposal of dredged material, but may also be attracted to disturbed sediments and recolonizing benthos or prey upon scavengers attracted to the disturbed sediments. In the fall, weakfish are also abundant and may overlap with a part of the disposal season; however, weakfish do migrate out of the Sound from December to April and may miss most disposal activity.

The potential area of direct impact to infauna and sedentary demersal finfish at the Bridgeport Alternative is estimated to be between 85,000 and 332,000 square feet (8000 to 31,000 square meters) based on average annual mound sizes at the existing WLIS disposal site (Bridgeport would receive material that would otherwise go to WLIS). This area of between 2 and 7.6 acres (0.01 to 0.03 square kilometers) represents much less than 0.1% of the available deep mud habitat in this part of the western basin (over 20 square nautical miles [37 square kilometers], Figure 4-33). Loss of large burrowing infauna and some demersal finfish within an area of this size each year will be balanced, in part, by the increase in recolonizing small infauna and some refuge value within the mound contours. The direct impacts of death and burial 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.

Disposal of dredged material at the Bridgeport Alternative is not expected to alter the habitat that is currently available for fish and lobster. The site is located in a deep mud habitat with some existing dredged material placed at the site over 20 years ago.

Overall, changes to the fish resources at the Bridgeport Alternative will be minimal if the site is designated. It is important to note, however, that this site is actively trawled and fished; use of the site would hamper fishing for lobster and groundfish (see section 5.5.9.1 below). Periodic habitat and migration disruption within the site would result from disposal operations; however, these impacts would be localized and short-term. Habitat disruption would be partially offset by increased topographic relief within the site and recolonization by benthic food sources. Direct effects to the lobster community may be greater at this site than

Table 5-10. Potential Impact of Dredged Material Disposal on Finfish and Lobster at the Bridgeport Alternative

Common name	Relative abundance	Use of Site[1]	Impact Potential
Alewife	Low abundance	Feeding on plankton	Not likely
American shad	Moderate abundance	Feeding on plankton; spring travel to spawn in rivers	Temporary displacement from foraging areas
Atlantic herring	High abundance	Feeding on plankton in spring	Temporary displacement from foraging areas
American lobster	High abundance	Feeding, burrowing	Mortality of residents under central mound
Black sea bass	Low abundance	Feeding on plankton, absent in winter	Not likely
Bluefish	Moderate abundance	Feeding on epibenthic and pelagic species, absent in winter	Not likely
Butterfish	High abundance in fall	Feeding on plankton, absent in winter	Temporary displacement from foraging areas in fall
Cunner	Low abundance	Feeding on epibenthos	Not likely
Fourbeard rockling	Moderate abundance in spring	Feeding on epibenthos, resident on mud	Temporary displacement in spring
Fourspot flounder	Moderate abundance in spring	Feeding on epibenthos, adults found on deep mud in spring	Temporary displacement in spring
Hogchoker	Low abundance	Feeding on epibenthos, found on deep mud in fall	Not likely
Little skate	Very low abundance	Feeding on epibenthos, found on sand in spring	None
Northern searobin	Low abundance in late spring	Feeding on epibenthos, found on deep sand habitats	Not likely
Red hake	High abundance in late spring	Feeding on plankton in spring; adults on mud habitats	Potential mortality of juveniles in fall
Scup	High abundance	Feeding on epibenthos, winter offshore	Temporary displacement from foraging areas
Silver hake	High abundance in spring	Feeding on pelagic prey, juveniles found on mud in fall Feeding on pelagic prey, found on mud	Temporary displacement from foraging areas
Smooth dogfish	Low abundance	Feeding on epibenthos, may be present in winter	Not likely
Striped searobin	Moderate abundance in late spring to fall	Feeding on epibenthos	Temporary displacement from foraging areas
Summer flounder	Moderate abundance	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas
Tautog	Low abundance in spring	Feeding on epibenthos, prefer structure	Not likely
Weakfish	Moderate abundance in fall	Feeding on pelagic prey	Temporary displacement from foraging areas in fall
Windowpane flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas in spring
Winter flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but may be offshore in winter	Temporary displacement from foraging areas in spring

[1] Use based on Gottschall *et al.*, 2000 and USACE, 2001h

at the others due to the relatively dense lobster population at Bridgeport based on CPUE of trawl surveys.

5.5.5.3 Impacts to Fish and Shellfish at the Milford Alternative

The location of the Milford Alternative on the northwestern margin of the central basin of Long Island Sound places the site in an area with broadly distributed fish and lobster resources. In particular, this 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 site is located to the east of Stratford Shoal, an important shoal area with hard bottom and structures adjacent to mud habitats. The combination of these factors (and others) results in above average trawl totals for spring collection of four individual species (see Table 5-8), and the lowest spring CPUE of any of the alternative sites (Figure 5-6). Of these species, black sea bass and silver hake recorded the highest annual average spring CPUE of any analysis area (habitat or disposal site) during the trawls collected from 1984 to 2000.

Eight species recorded above-average CPUE from the Milford Alternative in the fall. None of these had the highest fall CPUE, but the diversity of abundant species is notable. Fall CPUE was higher at all analysis areas and the fall CPUE at the Milford Alternative was comparable to surrounding habitat analysis areas (Figure 5-6).

The predicted direct impacts of disposal at the Milford Alternative on fish and lobster populations in the central Sound are most likely to include burial of lobsters and juvenile red hake within the central footprint of the mound (Table 5-11), although some direct impacts are possible with any benthic fish or invertebrate species present at the site during disposal. Benthic fish species that may be present during some portion of the period when disposal occurs include: summer flounder, winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling. Indirect impacts are likely to include temporary displacement of finfish from benthic foraging areas and refuge on mud habitat from late fall to early spring (October to May) and displacement of migrating adults in spring and adults and young of the year in fall. The species most likely to experience indirect effects include: American lobster, black sea bass, red hake, scup, silver hake, summer flounder, tautog, and winter flounder. Other species that may experience indirect effects include: American shad, bluefish, butterfish, fourbeard rockling, fourspot flounder, hogchoker, silver hake, smooth dogfish, striped searobin, weakfish, and windowpane flounder. Bluefish may use a disposal plume to increase predation as it can hide their presence. These predictions are based on three factors: 1) the majority of the finfish species migrate out of central Long Island Sound for the period when disposal activity occurs; 2) the life history patterns and relative abundance of selected species; and 3) disposal activity at a comparable site (CLIS Alternative) from 1984 to 2000 has had no discernable long term impact on fish populations in the region (Appendix H-6).

Table 5-11. Potential Impact of Dredged Material Disposal on Finfish and Lobster at the Milford Alternative

Common name	Relative abundance	Use of Site[1]	Impact Potential
Alewife	Low abundance	Feeding on plankton	Not likely
American shad	Moderate Abundance	Feeding on plankton; spring travel to spawn in rivers	Temporary displacement from foraging areas
Atlantic herring	Low abundance	Feeding on plankton in spring	Not likely
American lobster	High abundance	Feeding, burrowing	Mortality of residents under mound
Black sea bass	High abundance in spring	Feeding on plankton, absent in winter	Temporary displacement from foraging areas in spring
Bluefish	Moderate Abundance	Feeding on epibenthic and pelagic species, absent in winter	Temporary displacement from foraging areas
Butterfish	Moderate abundance in fall	Feeding on plankton, absent in winter	Temporary displacement from foraging areas
Cunner	Low abundance	Feeding on epibenthos	Not likely
Fourbeard rockling	Moderate abundance in spring	Feeding on epibenthos, resident on mud	Temporary displacement from foraging areas in spring
Fourspot flounder	Moderate abundance in spring	Feeding on epibenthos, adults found on deep mud in spring	Temporary displacement from foraging areas in spring
Hogchoker	Moderate Abundance	Feeding on epibenthos, found on deep mud in fall	Temporary displacement from foraging areas
Little skate	Very low abundance	Feeding on epibenthos, found on sand in spring	None
Northern searobin	Low abundance in late spring	Feeding on epibenthos, found on deep sand habitats	Not likely
Red hake	High abundance in late spring	Feeding on plankton in spring; adults on mud habitats	Potential mortality of juveniles in fall
Scup	High abundance	Feeding on epibenthos, winter offshore	Temporary displacement from foraging areas
Silver hake	High abundance in spring	Feeding on pelagic prey, juveniles found on mud in fall Feeding on pelagic prey, found on mud	Temporary displacement from foraging areas
Smooth dogfish	Moderate abundance	Feeding on epibenthos, may be present in winter	Temporary displacement from foraging areas
Striped searobin	Mod. abundance in late spring to fall	Feeding on epibenthos	Temporary displacement from foraging areas
Summer flounder	High abundance in early fall, mod. in spring	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas
Tautog	High abundance in spring	Feeding on epibenthos, prefer structure	Temporary displacement from foraging areas
Weakfish	Moderate abundance in fall	Feeding on pelagic prey	Temporary displacement from foraging areas in fall
Windowpane flounder	Moderate abundance in spring	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas in spring
Winter flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but may be offshore in winter	Temporary displacement from foraging areas in spring

[1] Use based on Gottschall *et al.*, 2000 and USACE, 2001h

Two species with high average CPUE at Milford may not migrate out of the central sound in winter and may be at the greatest risk of direct adverse impacts: tautog and winter flounder. Winter flounder had high abundance at the Milford Alternative in the spring and may be present throughout much of the disposal season. They are most likely to experience some disruption of food sources by disposal of dredged material, but may also be attracted to disturbed sediments and recolonizing benthos or prey upon scavengers attracted to the disturbed sediments. In the fall, tautog and weakfish are also abundant and may overlap with a part of the disposal season and they may avoid the water column near disposal activity. However weakfish do migrate out of the Sound from December to April and may miss most disposal activity.

Disposal of dredged material at the Milford Alternative would not be expected to alter the habitat that is currently available for associated fish and lobster. The site is located in a deep mud habitat, with some existing dredged material (shallow transitional areas are included in the analysis area but do not occur within the disposal site) that was placed at the site more than 20 years ago.

The potential area of direct impact to infauna and sedentary demersal finfish at the Milford Alternative is estimated to be between 85,000 and 1,039,000 square feet (8000 to 96,000 square meters) based on average annual mound sizes at the existing CLIS disposal site (Milford would receive material that would otherwise go to CLIS). This area of between 2 and 24 acres (0.1 square kilometers) represents much less than 0.1 percent of the available deep mud habitat in this part of the central basin (over 40 square nautical miles [74 square kilometers], Figure 4-33). Loss of large burrowing infauna and some demersal finfish within an area of this size each year will be balanced, in part, by the increase in recolonizing small infauna and some refuge value within the mound contours. The direct impacts of death and burial on this scale are not expected to cause a measurable reduction in the regional population of any of the species potentially affected within the central basin.

Overall, changes to the fish resources at the Milford Alternative will be minimal if the site is designated. Periodic habitat and migration disruption within the Milford Alternative would result from disposal operations. These impacts would be localized and short-term. Habitat disruption would be partially offset by increased topographic relief within the site and recolonization by benthic food sources. Direct effects to the lobster population may be difficult to separate from natural variation in population size in the large central basin as lobsters move in to recolonize vacant space.

5.5.5.4 Impacts to Fish and Shellfish and the Central Long Island Sound Alternative

The location of the CLIS Alternative in the central basin of Long Island Sound places the site in an area with broadly distributed fish and lobster 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 combination of these factors (and others) results in above-average trawl totals for spring collection for four individual species (see Table 5-8) and total CPUE very similar to most of the central sound (Figure 5-6). Of these species, none recorded the highest

average spring CPUE of any analysis area (habitat or disposal site) during the trawls collected from the CLIS Alternative.

Only two species recorded above average CPUE from the CLIS Alternative in the fall trawls. None had the highest average CPUE of any analysis area. Fall CPUE was higher at all analysis areas and the fall CPUE at the CLIS Alternative was slightly higher than all surrounding habitats except the shallow mud Habitat Area 6 (Figure 5-6).

The predicted direct impacts of dredged material disposal at CLIS on fish and lobster populations in the central Sound are most likely to include burial of lobsters and red hake within the central footprint of the mound (Table 5-12), although, some direct impacts are possible with any benthic fish or invertebrate species present at the site during disposal. Benthic fish species that may be present during some portion of the period when disposal occurs include: summer flounder, winter flounder, windowpane flounder, fourspot flounder, and fourbeard rockling. Indirect impacts are likely to include temporary displacement of finfish from benthic foraging areas and refuge on mud habitat from late fall to early spring (October to May) and displacement of migrating adults in spring and adults and young of the year in fall. The species most likely to experience indirect effects include: American lobster, red hake, scup, and winter flounder. Other species that may 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 may use a disposal plume to increase predation as it can hide their presence. This prediction is based on three factors: 1) the majority of the finfish species migrate out of central Long Island Sound for the period when disposal usually occurs; 2) the life history patterns and relative abundance of selected species; and 3) disposal activity at the CLIS site from 1984 to 2000 has had no discernable long term impact on fish and lobster populations in the region (Appendix H-6).

Winter flounder, a species with high average CPUE at the CLIS Alternative, may not migrate out of the central Sound in winter and may be at the greatest risk of adverse impacts. Winter flounder had high abundance at the CLIS Alternative in the spring and may be present throughout much of the disposal season. They are most likely to experience some disruption of food sources by disposal of dredged material, but may also be attracted to disturbed sediments and recolonizing benthos or prey upon scavengers attracted to the disturbed sediments. In the fall, weakfish are also abundant and may overlap with a part of the disposal season and they may avoid the water column near disposal activity. However weakfish do migrate out of the Sound from December to April and may miss most disposal activity.

Disposal of dredged material at the CLIS Alternative is not expected alter the habitat that is currently available for associated fish and lobster. The site is located in a mix of mud habitats with existing dredged material that has recently been placed at the site.

The potential area of direct impact to infauna and sedentary demersal finfish at the CLIS Alternative is estimated to be between 85,000 and 1,039,000 square feet (8000 to 96,000 square meters) based on average annual mound sizes at the existing CLIS disposal

Table 5-12. Potential Impact of Dredged Material Disposal on Finfish and Lobster at the Central Long Island Sound Alternative

Common name	Relative abundance	Use of Site[1]	Impact Potential
Alewife	Low abundance	Feeding on plankton	Not likely
American shad	Low abundance	Feeding on plankton; spring travel to spawn in rivers	Not likely
Atlantic herring	Low abundance	Feeding on plankton in spring	Not likely
American lobster	High abundance	Feeding, burrowing	Mortality of residents under mound
Black sea bass	Moderate abundance in spring	Feeding on plankton, absent in winter	Temporary displacement from foraging areas
Bluefish	Moderate abundance	Feeding on epibenthic and pelagic species, absent in winter	Temporary displacement from foraging areas
Butterfish	Moderate abundance in fall	Feeding on plankton, absent in winter	Temporary displacement from foraging areas
Cunner	Low abundance	Feeding on epibenthos	Not likely
Fourbeard rockling	Moderate abundance in spring	Feeding on epibenthos, resident on mud	Temporary displacement from foraging areas
Fourspot flounder	Moderate abundance in spring	Feeding on epibenthos, adults found on deep mud in spring	Temporary displacement from foraging areas
Hogchoker	Moderate abundance	Feeding on epibenthos, found on deep mud in fall	Temporary displacement from foraging areas
Little skate	Very low abundance	Feeding on epibenthos, found on sand in spring	None
Northern searobin	Low abundance in late spring	Feeding on epibenthos, found on deep sand habitats	Not likely
Red hake	High abundance in late spring	Feeding on plankton in spring; adults on mud habitats	Potential mortality of juveniles in fall
Scup	High abundance	Feeding on epibenthos, winter offshore	Temporary displacement from foraging areas
Silver hake	High abundance in spring	Feeding on pelagic prey, juveniles found on mud in fall Feeding on pelagic prey, found on mud	Temporary displacement from foraging areas
Smooth dogfish	Moderate abundance	Feeding on epibenthos, may be present in winter	Temporary displacement from foraging areas
Striped searobin	Moderate abundance in late spring to fall	Feeding on epibenthos	Temporary displacement from foraging areas
Summer flounder	Moderate abundance	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas
Tautog	Moderate abundance	Feeding on epibenthos, prefer structure	Temporary displacement from foraging areas
Weakfish	Moderate abundance in fall	Feeding on pelagic prey	Temporary displacement from foraging areas
Windowpane flounder	Moderate abundance in spring	Feeding on epibenthos; found in all habitats, but offshore in winter	Temporary displacement from foraging areas
Winter flounder	High abundance in spring	Feeding on epibenthos; found in all habitats, but may be offshore in winter	Temporary displacement from foraging areas

[1] Use based on Gottschall *et al.*, 2000 and USACE, 2001h

site. This area of between 2 and 24 acres (0.01 to 0.1 square kilometers) represents much less than 0.1% of the available deep mud habitat in this part of the central basin (over 40 square nautical miles [74 square kilometers], Figure 4-33). Loss of large burrowing infauna and some demersal finfish within an area of this size each year will be balanced, in part, by the increase in recolonizing small infauna and some refuge value within the mound contours. The direct impacts of death and burial on this scale are not expected to cause a measurable reduction in the regional population of any of the species potentially affected within the central basin.

Overall, changes to the fish resources at the CLIS Alternative will be minimal if the site is designated. As described above, the CLIS Alternative has received dredged material from at least 1941 to the present, and is located in a broad area of homogeneous habitat and relief. New relief and fresh sediments may encourage species preferring structural or multi-habitats to colonize the area. Periodic habitat and migration disruption within CLIS would continue to result from disposal operations. These impacts would be localized and short-term. Habitat disruption would be partially offset by increased topographic relief within the site and recolonization by benthic food sources. Direct effects to the lobster population may be difficult to separate from natural variation in population size in the large central basin as lobsters move in to recolonize vacant space.

5.5.5.5 Summary of Impacts to Fish and Shellfish

Finfish resources, as indicated by long-term trawl data, appear to be highest for the Bridgeport and WLIS Alternatives and lowest for the Milford and CLIS Alternatives. However, impacts to finfish resources are expected to be minimal, consisting of short-term, local disruptions and the potential loss of non-migratory species. These impacts are expected to be similar among the alternative sites. Most of the finfish species that frequent the alternative sites are migratory and would avoid disposal activities. Recovery of the finfish resources to pre-disposal levels is expected for all alternative sites.

The American lobster is the primary shellfish resource inhabiting any of the alternatives. Similar to finfish, lobster resources appear to be highest for the Bridgeport and WLIS Alternatives and lowest for the Milford and CLIS Alternatives based on long-term trawl data. Therefore, the short-term impacts associated with disposal, burial and loss of habitat and food will be the greatest at Bridgeport and WLIS. Recovery of the lobster populations at each alternative site is likely as evidenced by the reports of high lobster productivity at dredged material disposal sites (Appendix H-6).

5.5.6 Impacts to Marine and Coastal Birds and Marine Mammals and Reptiles

As discussed in Sections 4.12, the use of the alternative sites by birds, mammals, and reptiles is likely to be very limited. A number of these species have been identified as possibly present at the alternative sites, however, based on available information regarding seasonal distributions and foraging habits, it is likely that most of these species would be only occasional visitors to the sites. As a result, potential impacts to these species or individuals are very limited and adverse effects on the populations are unlikely.

5.5.7 Impacts to Endangered, Threatened, or Candidate Species

Impacts to Endangered Species Act listed or candidate species as the result of disposal activities at the alternative sites are expected to be virtually non-existent due to seasonal distributions and foraging habits. As discussed in Section 4.12, the only endangered or threatened species likely to be present at the alternative sites on more than an occasional basis is the Atlantic sturgeon. Atlantic sturgeon were reported only infrequently in the CTDEP trawl surveys (Appendix H-6 and Appendix H-3), primarily in September and October. The population within Long Island Sound is small and migratory; therefore, it is unlikely that significant numbers will be present at a disposal site when a discharge occurs. In addition, most individuals were found in the eastern portion of the Sound. Based on this information, it is unlikely that the disposal events will have an effect on this species.

5.5.8 Contaminant Levels in Selected Species (Bioaccumulation Potential)

Potential risks to human health and the environment associated with the bioaccumulation of chemicals as a result of the disposal of dredged material at any of the four alternative sites appear to be very low. In addition, risks at the sites are comparable to each other, as well as to those at the reference areas and throughout the rest of Long Island Sound, as indicated by the relatively consistent nature of chemical levels in tissue throughout the Sound.

Although it is not possible to quantitatively predict future tissue concentrations in species at any of the alternative sites, tissue concentrations in organisms are primarily associated with sediment concentrations through bioaccumulation and trophic transfer. However, sediments proposed for open-water disposal are subjected to a risk evaluation, and those identified as being associated with possible risks to human health and the environment are managed accordingly (Section 4.13.2 and Appendix H-10). For example, sediments found to be associated with elevated risks are either not accepted for open-water disposal or may be managed through procedures which ensure that the material is isolated from the marine environment and would not pose a potential for unacceptable adverse effects due to bioaccumulation. These types of procedures have been demonstrated to be a successful management tool for over 30 years in the Long Island Sound (Fredette, 1991; Fredette *et al.*, 1992). Through the use of these risk-based evaluations to select the appropriate management tools, it is expected that tissue concentrations (and subsequent risks) would not change significantly as the result of placement of dredged material. Therefore, it is expected that potential risks associated with each of the alternative sites would either remain the same or possibly be reduced through the addition of material with lower chemical concentrations than currently exist in surface sediments.

5.5.9 Socioeconomic Impacts

As shown in Section 4.15, Long Island Sound is a region of social and economic importance with highly valuable resources. This section analyzes the potential adverse and beneficial impacts that could result from the use of the alternative sites for the disposal of dredged material. Because the four alternative sites share the same socioeconomic environment, socioeconomic impacts are very similar among all the alternative sites.

5.5.9.1 Impacts on Commercial Fishing Activities

Commercial fishing activities occur at or near each of the alternative sites in Long Island Sound. These activities may be affected by disposal activities through inference with fishing methods or changes to the resource itself. For example, disposal activities may result in a restriction on the amount of time that the site is available for commercial fishing activities because fishermen do not want to risk loss of gear when active disposal is underway. In contrast, many fishermen report that their catch is better in or near active disposal sites, and actively work the vicinity during or soon after disposal operations (Appendix H-8). Thus, even though fishing activity may temporarily be displaced by disposal at a site, this anecdotal information suggests that fishermen may experience positive impacts such as improved catches of finfish or lobster as a result of disposal activities.

Open-water shellfishing and aquaculture activities, including oyster propagation and harvesting, in Long Island Sound occur primarily in nearshore areas (Section 4.11), some distance from the proposed alternative sites. These activities would not be impacted by disposal at any of the alternative sites, because the transport of dredged material to those areas is managed and plume dilution is assured by the distance.

Commercial Fishing at the Western Long Island Sound Alternative

WLIS is currently an active lobstering site. Prior to the lobster "die off" in 1999 (see Section 4.11) this site was considered a prime lobstering area. Anecdotal information from interviews conducted with Long Island Sound lobsterman during the preparation of this DEIS indicates that this area is still considered very good habitat for lobster (Figure 4-42; Section 4.14.1; Appendix H-8). This suggests that the current use of this area for disposal of dredged material has not had a detrimental effect on the lobstering industry; the disposal mounds may in fact provide productive habitat for lobster. However, because disposal may also occur at WLIS under Section 404 of the CWA (see Section 1.2), there would be no change in its status. Commercial fish trawling will not be affected because this site is not currently used due to harvesting restrictions and bottom obstructions.

Commercial Fishing at the Bridgeport Alternative

Bridgeport is an active lobstering area, currently used year round. As discussed in Section 4.14.1 (see Figure 4-42), current Long Island Sound lobsterman rate lobster production at Bridgeport as "good" and better than most areas of the Sound (Appendix H-8). The primary impact of disposal at this site would be to restrict the area available for placing lobster trawls (pots) during and immediately following disposal activities. The actual impact to lobster production is difficult to predict as there may be short-term losses compensated by longer-term recovery to predisposal conditions. Commercial fish trawling is not known to occur at the site, thus no impact to the trawlers is expected. Changes in habitat may affect the fisheries productivity in the area but that is not possible to predict.

Commercial Fishing at the Milford Alternative

Milford is an active lobstering area, currently used year round. As discussed in Section 4.14.1 (see Figure 4-42), current Long Island Sound lobsterman rate lobster production at Bridgeport as "good" and better than most areas of the Sound (Appendix H-8). Disposal at this site would impact lobstering primarily by restricting the area available for placing lobster pots during and immediately following disposal activities. Impact to lobster production is difficult to predict as there may be short-term losses compensated by longer-term recovery to predisposal conditions. Changes in habitat may have a short-term affect on fisheries productivity in the area. However, commercial fish trawling is not known to occur in the site because of the prevalence of lobster pots, thus no significant impact to the trawlers is expected. Changes in habitat may affect the fisheries productivity in the area, but it is not possible to predict.

Commercial Fishing at the Central Long Island Sound Alternative

Historically, CLIS was known as one of the best areas to lobster. However, since the recent overall decline in lobster stocks in Long Island Sound, lobstering at the CLIS Alternative has become less productive (see Section 4.11.2). However, it is still rated as "good" by Long Island Sound lobsterman (Figure 4-42; Appendix H-8). However, because disposal may also occur at CLIS under Section 404 of the CWA (see Section 1.2), there would be no change in its status. Changes in habitat may affect the fisheries productivity in the area, but is not possible to predict. Although commercial fish trawling does not occur within the boundaries of the CLIS Alternative, it does occur in the vicinity CLIS Alternative. In fact this is the only area within the western and central Sound that fishermen can trawl successfully due to the abundance of lobster pots in other areas of the region. However, past disposal is not known to have affected either the lobster or trawling fisheries in or near the site.

5.5.9.2 Impacts to Recreational Fishing

Recreational fishing in Long Island Sound most frequently occurs from spring to fall (USACE, 1991). Reefs and areas of high relief are major fishing sites for the recreational fishermen. There are several reefs in Long Island Sound that are within two to five nautical miles (4 to 9 kilometers) of the alternative sites where recreational fishing occurs (see Section 4.14.1 for additional information on reefs). Over these distances, dredged material transported in the water column will be diluted by several orders of magnitude through ambient mixing (see Appendix G-3). Therefore, water column impacts are not expected at reefs. Based on this information, impacts to recreational fishing are minimal.

5.5.9.3 Shipping and Navigation

The impacts of dredged material disposal on shipping and navigation would be limited at each of the four alternative sites because they are located outside of currently designated shipping lanes. Designation of the Bridgeport Alternative might create conflicts with the USCG designated lightering zone (see Section 4.14.2) which overlays the entire alternative site. Designation of the CLIS Alternative might also create a conflict with a USCG designated lightering zone that overlays the northeast corner of the alternative site. However,

the Corps will coordinate with the USCG to shift the designated lightering zone boundary adjacent to CLIS to ensure that dredged material deposited at the site now and in the past is not disturbed by anchors.

Designation of one or more of the four alternative sites analyzed in detail in this DEIS will have no negative impacts on navigation related economic activity in the study area (See Section 3.5 for the complete cost analysis). The designation of one of the four open-water Long Island Sound sites, and particularly the designation of two of the sites, will result in the continued availability of affordable disposal of dredged material in Long Island Sound. Designation of one or two of these sites will facilitate the continued economic health of navigation-dependent industries in the study area, and will preserve the benefits of navigation-related economic activity currently enjoyed by the region (summarized in Section 5.4.1 and presented in detail in Appendix E-2).

5.5.9.4 Impacts to Recreational Activities and Beaches

Effects to recreational beaches in the vicinity of the four alternative sites would be relatively unaffected by the use of any of the alternative sites for the disposal of dredged material due to the distance between the proposed sites and the shore. None of the sites is closer than 2 nautical miles (4 kilometers) to public beaches. The closest alternative is Bridgeport which is 2 nautical miles (4 kilometers) from Penfield Beach in Fairfield, Connecticut. Based on the results of the modeling presented in Section 5.5.3, this distance is beyond any expected transport of dredged material plumes due to tidal motion or currents, thus no impacts on recreational beach activities such as sunbathing or swimming are expected to occur. With the exception of Milford, where there is a known exposed shipwreck, recreational diving activities would not be affected. There are no expected effects on recreational boating activities.

5.5.9.5 Parks and Natural Areas

Because they are land-based, areas of special concern in Connecticut and New York are not likely to be affected by the use of any of the four alternative sites. All of these areas are at least 2 nautical miles (4 kilometers) from the proposed alternative sites, therefore, impacts from offsite transport of dredged material are not expected to occur at any of the locations.

5.5.9.6 Historic and Archaeological Resources

As discussed in Section 4.14.5, a review of submerged vessel reports in the NOAA Automated Wrecks and Obstructions Information System (AWOIS) and Warren C. Reiss Marine (WCRM) shipwrecks databases illustrated a total of 39 shipwrecks in Long Island Sound. Due to the limits in the databases (see Section 4.15.5) the exact locations are not known for most of these vessels, but none of the known shipwrecks of historical significance are located within the boundaries of the alternative sites. However, the Bridgeport region is known to have at least 13 shipwrecks, the CLIS region is know to have at least 12 shipwrecks, the Milford region is known to have at least six shipwrecks, and the WLIS region is known to have at least four shipwrecks.

In addition, a geophysical survey conducted at the Bridgeport and Milford Alternative sites identified the location and size of potential shipwrecks (Section 4.15.5; Appendix I). Based on this survey, nine targets in the Bridgeport Alternative and two targets in the Milford Alternative qualified as possible cultural resources that will require avoidance or inspection (Table 4-51). Of these targets, one target at Bridgeport (Figure 4-44) and one target at Milford (Figure 4-45) are possible shipwrecks (see Section 4.14.5). As a result, the potential for negative impacts to archaeological resources at the Bridgeport and Milford Alternative sites is high. At CLIS and WLIS the risk of unknown shipwrecks being damaged or buried by disposal activities is a possibility due to the minimal historical information. However, any existing wrecks that have not yet been identified are likely buried by past disposal activities and are thus protected from degradation.

No other natural or cultural features of historic importance have been identified in the vicinity of the alternative sites. Although the continental shelf was once a relatively dry coastal plain suitable for prehistoric human habitation, erosion associated with sea level rise would have severely impacted site preservation. Potential prehistoric sites in Long Island Sound have likely been deeply buried by dredged material disposal and natural sedimentation.

5.5.9.7 Other Human Uses

Military activity does not occur at or near any of the four alternative sites. Energy resources located near the sites, but not within their boundaries, include:

- **Bridgeport.** The Iroquois pipeline that originates in Milford, Connecticut and extends southwest to Northport, New York and a cable (also beginning in Northport) that heads eastward through Long Island Sound before heading toward the Atlantic Ocean.
- **Milford.** The Iroquois pipeline that extends to Northport, New York and two cables in the Milford region.
- **CLIS**. A cable, beginning in New Haven, and heading south through Long Island Sound to Shoreham, New York before heading toward the Atlantic Ocean and several cables leading southward from New Haven and Guilford toward Port Jefferson and Shoreham, New York.

None of these utilities are located within the site boundaries and are buried under existing sediments. Therefore, none of these resources are expected to be impacted by disposal activities at the alternative sites. While, at the time of this evaluation, only three pipelines were in place, development of several new pipelines is currently anticipated (data not available).

5.5.9.8 Summary of Socioeconomic Impacts

The potential impacts to commercial fin fishing are greatest for the CLIS Alternative because it is the only alternative in which commercial trawling is known to occur and is located in the

only area of the western and central basins that can be trawled successfully. Past disposal activities at CLIS have not adversely affected commercial trawling. Primary impacts are reduced lobster populations at the sites and restriction of the area available for setting pots. Impacts to recreational fishing are expected to be minimal and likely will not differ among the alternative sites.

It is expected that designation of an open-water disposal site will have no impact on the navigation-related economic activities for any of the four alternative sites. However, because of the presence of the U.S. Coast Guard designated lightering zone at the Bridgeport Alternative, the area may experience some interruptions in shipping related to disposal operations. A lightering zone is also located just within the northeast corner of the CLIS Alternative. The Corps will coordinate with the USCG to shift the designated lightering zone boundary adjacent to CLIS to ensure that dredged material deposited at the site now and in the past is not disturbed by anchors.

Disposal activities are not expected to adversely impact the recreational activities, beaches, parks, and natural areas associated with any of the four alternative sites. In addition, Milford is the only site with a known exposed shipwreck. Therefore, there is not likely to be an impact on historical and archeological resources at the other three alternative sites. There are no potential impacts associated with military activities at any of the alternative sites.

There are pipelines and or cables in the vicinity of three of the alternative sites (Bridgeport, Milford, and CLIS). However, there are no pipelines or cables located within the boundaries of any of the alternative sites. Therefore, there are no anticipated impacts associated with disposal at any of the alternative sites.

5.5.10 Air Quality/Noise

5.5.10.1 Overview and Methods to Assess Effects on Air Quality

The designation of one or more disposal sites in the western and central portions of Long Island Sound is not expected to have significant impacts on air quality. Impacts would occur only during construction, and would come from air emissions or dust generation associated with the operation of equipment. All equipment would be properly outfitted with air pollution controls, as required by the air quality control regulations (Section 176(c)(1) of the Clean Air Act) and proper controls for minimizing the generation of dust would be implemented. Some volatile organic compounds may be released from exposed disposal sediments on barges. The effects on air quality are described in general terms.

5.5.10.2 Effects of Dredging Operations in Long Island Sound

Future authorizations of specific dredging and dredged material disposal projects by the Corps would be evaluated under the General Conformity Requirements of Section 176(c)(1) of the Clean Air Act in order to determine if the proposed action would cause or contribute to an exceedence of the National Ambient Air quality Standards (NAAQS) and to determine if the project conforms to the State Implementation Plan (SIP). The primary pollutants of concern with dredging related actions are NOx, and Carbon Monoxide (CO). It should be

noted however, that some projects might satisfy the conformity requirements pursuant to one of the specific exemptions outlined in EPA Regulations at 40 CFR 51.853(c)(ix).

5.5.10.3 Effects of Disposal at Open-Water Sites in Long Island Sound

During transport of the dredged material from dredging sites to disposal sites, tugs and other equipment used in the process would generate minor amounts of air pollutants. Because the material would be placed under water with these disposal alternatives, dust and volatilization would not occur and there would be no long-term effects on air quality from these alternatives.

5.5.10.4 Effects of Disposal at Alternative Sites

For upland sites, the trucks hauling the material to the site would emit pollutants, including NO_2. Transportation to the furthest disposal sites would generate the most air pollutants and consume the most fuel.

Pollutants would be generated by heavy construction equipment during disposal on land. Activity and equipment would comply with Connecticut Air Pollution control Regulations, Vehicle Emission Standards, and Fugitive Dust Regulations to minimize impacts.

5.5.10.5 Effects of Dewatering Sites

During transport of dredged material from the dredging sites to the dewatering site, tugs, trucks, and other equipment used in this process, would generate minor amounts of air pollutants. Because the material would still retain significant amounts of moisture during dewatering, dust and volatilization would not occur and long-term effects from this process would not be expected.

5.5.10.6 Effects of the Designation of Potential Dredged Material Open-Water Sites on Odors

The designation of potential open-water dredged material sites would comply with Connecticut Air Pollution Control Regulations which concerns odors. It is not expected that material in the dredged material would be noticed during dredging and disposal since this would depend on the type of dredge used, the temperature, the direction of the wind, and the proximity of the dredge and scow to populated areas. It is expected that, dredging and disposal would occur far enough from populated areas that any potential odors would mix sufficiently with ambient air to prevent objectionable odors on land.

Odors from the dredged material should not be noticeable at the open-water disposal sites because the material would be under water. Odors may or may not be noticeable at the shoreline or upland sites.

5.5.10.7 Overview and Methods to Assess Noise

Dredging operations produce noise similar to noise created by other diesel equipment. If a clamshell dredge is used, noise is produced by the engines that lift and lower the dredge

bucket, and by the operation of the clamshell. If a hydraulic dredge is used, noise is produced by the engines that power the pump. The specific amount of noise produced would depend on the type of equipment used by the dredging contractor. It is expected that the degree of noise produced by the designation of one or more disposal sites in Long Island Sound would not be substantially different from background noise levels in the area.

5.5.10.8 Summary of Air Quality and Noise Impacts

Impacts to local air quality are expected to consist mainly of exhaust fumes from tugs and other equipment used during operations. These minimal, short-term impacts are no likely to differ among alternative sites. Tugs will generate some noise while transporting the barges, but this is expected to be minor and should not differ among the alternative sites.

5.6 Comparison of Alternatives, Discussion of Cumulative Impacts, and Selection of Preferred Alternative

Table 5-13 summarizes the various resources discussed for each of the alternative sites in Chapters 4 and 5 and provides a conclusion as to whether there is likely to be an adverse impact, no impact, or a potential benefit to the resource associated with the selection of each of the four alternative sites and the No Action Alternative. This matrix addresses information relevant to the five general (40 CFR Section 228.5) and 11 specific (40 CFR Section 228.6(a)) MPRSA site selection criteria outlined in Table 3-1. The purpose of this section is to integrate the information on the resources summarized in Table 5-13 with the site selection criteria to provide a comparison of the advantages and disadvantages associated with the selection of each of the alternative sites, including the No Action Alternative. The evaluation also considers potential short- and long-term impacts as well as potential cumulative impacts. Based on this comparison, the preferred alternative, which is defined as the alternative that provides the greatest practicable net benefit with the least environmental and socioeconomic impact, is determined.

Based on the information presented in Chapter 4, there are many similarities among the four alternative sites evaluated; therefore, several of the site selection criteria were found to not discriminate (*i.e.*, were considered equal) among the alternative sites. Those criteria that were not used to discriminate among the alternative sites (*i.e.*, non-discriminatory) are discussed in Section 5.6.1. In addition, as indicated in Table 5-13, some impacts were identified that are potentially mitigated through site management actions; related MPRSA criteria are discussed in Section 5.6.2. Section 5.6.3 provides a discussion of the discriminatory site selection criteria. The No Action Alternative is compared to the four alternative sites in Section 5.6.4. Section 5.6.5 considers potential cumulative impacts of the various five alternatives evaluated. The rationale for recommending the preferred alternative is summarized in Section 5.7.

5.6.1 Non-Discriminating Criteria and Use Conflicts

Three of the MPRSA general site selection criteria (40 CFR 228.5) and two specific site selection criteria were addressed during the site selection process and therefore not found applicable to the choice of an alternative.

Table 5-13. Summary of Impacts at Alternative Sites

Impacts (Reference to MPRSA Criteria, 40 CFR)	Alternatives				
	Western Long Island Sound	Bridgeport	Milford	Central Long Island Sound	No Action
Depth (feet)	79-118	60-68	50-72	59-77	NA
Sedimentation and Erosion (§ 228.6(a)(7)) Grant Madsen model: potential resuspension under 10yr and 2yr storm return conditions; grain size typical of Long Island Sound dredged material; coarse-grained, non-cohesive sediments	GM 10yr storm return = No significant erosion of coarse-grained sediments in 98 ft of water GM 2yr storm return = No significant erosion of coarse-grained sediments in 98 ft of water	GM 10yr storm return = Significant erosion of coarse-grained sediments in 64 ft of water GM 2yr storm return = No significant erosion of coarse-grained sediments in 64 ft of water	GM 10yr storm return = Significant erosion of coarse-grained sediments in 61 ft of water GM 2yr storm return = No significant erosion of coarse-grained sediments in 61 ft of water	GM 10yr storm return = No significant erosion of coarse-grained sediments in 69 ft of water GM 2yr storm return = No significant erosion of coarse-grained sediments in 69 ft of water	Impacts expected to be minimal since less material would be disposed. Erosion conditions would remain unchanged
LTFATE model: erosion under standard mound configuration and 2 and 10 yr storm return; fine-grained, cohesive sediments	LTFATE 10yr storm total erosion 1.07×10^6 cy	LTFATE 10yr storm total erosion 1.27×10^6 cy	LTFATE 10yr storm total erosion 1.44×10^6 cy	LTFATE 10yr storm total erosion 1.51×10^6 cy	
	No Impact	**Impact**	**Impact**	**No Impact**	**No Impact**
Water Column (Transport) (§ 228.6(a)(6)) and Water Quality (§ 228.5(b) and § 228.6(a)(9)) STFATE model used to evaluate potential for water quality violations. A characteristic dredged material was used under specific site conditions and for 75% and 50% frequency of occurrence, which established upper limits of currents under 1) 3 strongest hours of	75% current = 0.9 feet/second 50% current = 0.6 feet/second Intermittent, short-term changes within the residual plumes following disposal Potential for water quality impacts under worst case conditions Estimated erosion of mound = 4%	75% current = 0.9 feet/second 50% current = 0.6 feet/second Intermittent, short-term changes within the residual plumes following disposal Potential for water quality impacts under worst case conditions Estimated erosion of mound = 6%	75% current = 1.1 feet/second 50% current = 0.7 feet/second Intermittent, short-term changes within the residual plumes following disposal Potential for water quality impacts under typical and worst case conditions Estimated erosion of mound = 6%	75% current = 1.1 feet/second 50% current = 0.7feet/second Intermittent, short-term changes within the residual plumes following disposal Potential for water quality impacts under worst case conditions Estimated erosion of mound = 6%	Impacts are minimal. Potentially less due to smaller volumes and fewer disposal events

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (*Reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	**Bridgeport**	**Milford**	**Central Long Island Sound**	**No Action**
spring tide flood condition combined superimposed wind driven currents (worst case) and 2) typical 3 hour flood tides using recent elutriate test data for projects from Long Island Sound.	**Impact[2]**	**Impact[2]**	**Impact**	**Impact[2]**	**No Impact**
Sediment Quality (*§ 228.6(a)(4)*)	Contaminants are: 1) similar to reference areas in the western basin of Long Island Sound, and the other alternatives and 2) consistently below concentrations considered adverse to organisms Acute toxicity not found in the site or at nearby reference areas Required testing and site management will minimize exposure of organisms to unacceptable contaminant levels	Contaminants are: 1) similar to reference areas in the western basin of Long Island Sound, and the other alternatives and 2) consistently below concentrations considered adverse to organisms Acute toxicity not found in the site or at nearby reference areas Required testing and site management will minimize exposure of organisms to unacceptable contaminant levels	Contaminants are: 1) similar to reference areas in the central basin of Long Island Sound, and the other alternatives and 2) consistently below concentrations considered adverse to organisms Acute toxicity not found in the site or at nearby reference areas Required testing and site management will minimize exposure of organisms to unacceptable contaminant levels	Contaminants are: 1) similar to reference areas in the central basin of Long Island Sound, and the other alternatives and 2) consistently below concentrations considered adverse to organisms Acute toxicity not found in the site or at nearby reference areas Required testing and site management will minimize exposure of organisms to unacceptable contaminant levels	No impacts under present conditions No impact or changes expected under smaller projected project size and volumes
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Plankton and Larval Forms (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*) (*§ 228.6(a)(10)*)	Small, short-term entrainment losses; No significant cumulative impact	Small, short-term entrainment losses; No significant cumulative impact	Small, short-term entrainment losses; No significant cumulative impact	Small, short-term entrainment losses; No significant cumulative impact	Impacts are minimal. Potentially less due to smaller volumes and fewer disposal events
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (*Reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	**Bridgeport**	**Milford**	**Central Long Island Sound**	**No Action**
Benthos (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*) (*§ 228.6(a)(10)*)	Benthic community comprised primarily of Annelida, Mollusca, and Crustacea, of which many species can burrow though deposited sediment Abundance = 23,000/m^2 Species = 36/grab Diversity = 3.6 Habitat Quality RPD = 0.4 – 4.9 cm Stage: = I, III OSI = -1-10.5 Short-term reductions in abundance and diversity within the site Recovery to levels similar to predisposal within months to several years as documented at other dredged material disposal sites in Long Island Sound	Benthic community comprised primarily of Annelida, Mollusca, and Crustacea, of which many species can burrow though deposited sediment Abundance = 9000 to 12,000/m^2 Species = 20-25/grab Diversity = 2.3 to 2.8 Habitat Quality RPD = 1.8 cm Stage: = III, II-III OSI = 7.9 Short-term reductions in abundance and diversity within the site Recovery to levels similar to predisposal within months to several years as documented at other dredged material disposal sites in Long Island Sound	Benthic community comprised primarily of Annelida, Mollusca, and Crustacea, of which many species can burrow though deposited sediment Abundance = 10,000 to 14,000/m^2 Species = 19-21/grab Diversity = 2.2 to 2.4 Habitat Quality RPD = 1.2 cm Stage: = III OSI = 7.1 Short-term reductions in abundance and diversity within the site Recovery to levels similar to predisposal within months to several years as documented at other dredged material disposal sites in Long Island Sound	Benthic community comprised primarily of Annelida, Mollusca, and Crustacea, of which many species can burrow though deposited sediment Abundance = 10,000 to 17,000/m^2 Species = 29-36/grab Diversity = 3.0 to 3.6 Habitat Quality RPD = 2.2 – 3.4 cm Stage: = I on III, III OSI = 6.2-9.2 Short-term reductions in abundance and diversity within the site Recovery to levels similar to predisposal within months to several years as documented at other dredged material disposal sites in Long Island Sound and at this site specifically	Impacts are minimal. Potentially less impacts from burial due to smaller volumes and fewer disposal events
	No Impact[5]	**No Impact[5]**	**No Impact[5]**	**No Impact[5]**	**No Impact**
Fish, Lobster, and Other Invertebrates (*§ 228.6(a)(2)*) (*§ 228.6(a)(9)*) (*§ 228.6(a)(10)*)	In an area of distinctive lobster and fisheries resources with complex heterogeneous bottom habitat	In an area of distinctive lobster and fisheries resources with complex heterogeneous bottom habitat near shoal areas	In an area of broadly distributed lobster and fisheries resources with relatively homogeneous bottom habitat and nearby shoal areas	In an area of broadly distributed lobster and fisheries resources with relatively homogeneous bottom habitat	Impacts are minimal. Potentially less impacts from burial due to smaller volumes and fewer disposal events

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (*Reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	**Bridgeport**	**Milford**	**Central Long Island Sound**	**No Action**
	Above average trawl total for 11 species in spring and total CPUE; 3 species above average in fall	Above average trawl total for 5 species in spring; 6 species above average in fall. Highest among sites - annual average spring and fall CPUE for lobster	Above average trawl total for 4 species in spring and lowest total CPUE in the spring; 8 species above average fall CPUE	Above average trawl total for 4 species in spring and total CPUE similar to most of central Long Island Sound; 2 species above average in fall	
	Fall/Spring CPUE 120/115 lobsters/tow 90/0 squid/tow ~1500/890 fish/tow 12.5/12.3 species	Fall/Spring CPUE 207/171 lobsters/tow 240/0 squid/tow ~2690/694 fish/tow 12.1/12.7 species	Fall/Spring CPUE 70/40 lobsters/tow 205/10 squid/tow ~1860/476 fish/tow 13.0/13.6 species	Fall/Spring CPUE 85/45 lobsters/tow 220/20 squid/tow ~2000/588 fish/tow 13.7/14.3 species	
	Short-term local disruption and potential loss of non migratory species during disposal	Short-term local disruption and potential loss of non migratory species during disposal	Short-term local disruption and potential loss of non migratory species during disposal	Short-term local disruption and potential loss of non migratory species during disposal	
	Majority of finfish species are migratory and recovery to levels similar to predisposal is documented at this site and throughout Long Island Sound	Majority of finfish species are migratory and recovery to levels similar to predisposal is documented throughout Long Island Sound	Majority of finfish species are migratory and recovery to levels similar to predisposal is documented throughout Long Island Sound	Majority of finfish species are migratory and recovery to levels similar to predisposal is documented at this site and throughout Long Island Sound	
	Topographic changes likely to have minimal short-term impact to habitat, resident species and migratory species	Topographic changes likely to have minimal short-term impact to habitat, resident species and migratory species	Topographic changes likely to have minimal short-term impact to habitat, resident species and migratory species	Topographic changes likely to have minimal short-term impact to habitat, resident species and migratory species	
	No Impact[5]	**Impact**	**No Impact[5]**	**No Impact[5]**	**No Impact**

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (*Reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	**Bridgeport**	**Milford**	**Central Long Island Sound**	**No Action**
Birds, Mammals, Reptiles (*§ 228.6(a)(2)*)	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	No dredged material related change from present conditions is expected
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Endangered Species (Section 7 ESA consultation by NMFS and USFWS is currently under review)	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	These species are occasional visitors to the site but do not rely on it for critical habitat; impacts are not expected No significant cumulative impact	No dredged material related change from present conditions is expected
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Bioaccumulation Potential (*§ 228.6(a)(9)*)	Disposal of material deemed acceptable under the ocean disposal regulations is not likely to change the present low risk levels in organisms in or near the site	Disposal of material deemed acceptable under the ocean disposal regulations is not likely to change the present low risk levels in organisms in or near the site	Disposal of material deemed acceptable under the ocean disposal regulations is not likely to change the present low risk levels in organisms in or near the site	Disposal of material deemed acceptable under the ocean disposal regulations is not likely to change the present low risk levels in organisms in or near the site	Impacts are minimal. Potentially less impacts due to smaller volumes and fewer disposal events
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (Reference to MPRSA Criteria, 40 CFR)	Alternatives				
	Western Long Island Sound	Bridgeport	Milford	Central Long Island Sound	No Action
Fishing Activities *(§ 228.5(a) and §228.6(a)(8))*	Recreational and commercial fishing and lobstering occur within and near the site Conflicts with commercial and recreational fishing activities can be mitigated through the site management process No known impacts to commercial fishing value within the vicinity of this site	Recreational and commercial fishing and lobstering occur within and near the site Conflicts with commercial and recreational fishing activities can be mitigated through the site management process Trawling within the site would cease, impacting commercial fishing within the vicinity of this site	Recreational and commercial fishing and lobstering occur within and near the site Conflicts with commercial and recreational fishing activities can be mitigated through the site management process Trawling within the site would cease, impacting commercial fishing within the vicinity of this site	Recreational and commercial fishing and lobstering occur within and near the site Conflicts with commercial and recreational fishing activities can be mitigated through the site management process No known impacts to commercial fishing value within the vicinity of this site	Impacts potentially significant due to possible reduction in dredging of harbors and channels and resultant shoaling
	No Impact	**Impact**	**Impact**	**No Impact**	**Impact**
Shipping, Navigation *(§ 228.5(a) and §228.6(a)(8))*	Minimal interferences that can be mitigated through site management practices.	Potential interference with USCG designated lightering zone	Minimal interferences that can be mitigated through site management practices	Minimal interferences that can be mitigated through site management practices. Interference with USCG designated lightering zone northeast of site but the Corps will be requesting that this anchorage area be altered to ensure old dredged material mounds are not disturbed.	Impacts potentially significant due to possible reduction in dredging of harbors and channels and resultant shoaling
	No Impact[3]	**Impact[4]**	**No Impact[3]**	**Impact[4]**	**Impact**
Beaches and Swimming *(§ 228.5(b) and §228.6(a)(3))*	No impact; distance too large for transport of material to these areas	No impact; distance too large for transport of material to these areas	No impact; distance too large for transport of material to these areas	No impact; distance too large for transport of material to these areas	No impact; distance too large for transport of material to these areas
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (*Reference to MPRSA Criteria, 40 CFR*)	Alternatives				
	Western Long Island Sound	**Bridgeport**	**Milford**	**Central Long Island Sound**	**No Action**
Parks / Natural Areas / Sanctuaries and Research Preserves (*§ 228.5(b) and §228.6(a)(8)*)	None of these entities exist within or near the site	None of these entities exist within or near the site	None of these entities exist within or near the site	None of these entities exist within or near the site	No impact
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Historic / Archaeological Resources (*§ 228.6(a)(11)*)	No impact; no confirmed wrecks in site	Possible wreck identified within site	Wreck identified within site	No impact; no confirmed wrecks in site	No impact
	No Impact	**Impact**	**Impact**	**No Impact**	**No Impact**
Other Human Uses (*§ 228.5(a) and §228.6(a)(8)*)	No impacts to cables east of site Interference with recreation such as boating or other human uses is not expected	No impacts to cables and pipelines that exist near the site Interference with recreation such as boating or other human uses is not expected	No impacts to cables and the pipeline that exists near the site Interference with recreation such as boating or other human uses is not expected	No impacts to cables that exist near the site Interference with recreation such as boating or other human uses is not expected	No impact
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Use of previous disposal sites (*§ 228.6(a)(7)*)	Actively used site	Historic Site	Historic Site	Actively used site	Assume current actively used sites would continue through site selection process for individual projects
	No Impact	**No Impact**	**No Impact**	**No Impact**	**No Impact**
Air Quality/Noise (*NEPA Requirement*)	No expected adverse impact to air quality or noise	No expected adverse impact to air quality or noise	No expected adverse impact to air quality or noise	No expected adverse impact to air quality or noise	Potentially significant increase in land based transport depending on alternatives selected to move material, particularly if larger volumes managed through upland disposal operations than conducted at present
	No Impact	**No Impact**	**No Impact**	**No Impact**	**Impact**

(Table Continued)

Table 5-13. Summary of Impacts at Alternative Sites (continued)

Impacts (Reference to MPRSA Criteria, 40 CFR)	Alternatives				
	Western Long Island Sound	Bridgeport	Milford	Central Long Island Sound	No Action
Economic Impacts (§ 228.5(a) and §228.6(a)(8))	Disposal costs $14 to $28 per cy Most expensive for harbors closest to CLIS	Disposal costs $14 to $28 per cy	Disposal costs $14 to $28 per cy	Disposal costs $15 to $29 per cy Most expensive for harbors closest to WLIS	Substantial and significant impacts to regional water borne commerce, recreational use of the LIS and, economy of the area.
	No Impact	**No Impact**	**No Impact**	**No Impact**	**Impact**
Cumulative Impacts (§ 228.6(a)(7))	Site is actively used; Site has been monitored extensively with no known adverse impacts attributable to its use; Evidence of positive influence from site and disposal activities on lobster through habitat modification	Site has been closed for 20 years; No evidence of adverse impacts in or from the site since closure; Sediment quality is acceptable and contaminant concentrations are similar to adjacent areas; Site is within a region that is commercially fished with no evident differences within or outside of the site	Site has been closed for 20 years; No evidence of adverse impacts in or from the site since closure; Sediment quality is acceptable and contaminant concentrations are similar to adjacent areas; Site is within a region that is commercially fished with no evident differences within or outside of the site	Site is actively used; Site has been monitored extensively with no known adverse impacts attributable to its use; Site has been the focus of significant research on dredged material management approaches and methods which provides a long history and value for continuing dredged material research; Evidence of positive influence on local fisheries during disposal and periods of limited use	Substantial and significant impacts to regional water borne commerce, recreational use of the LIS and, economy of the area.
	No Impact	**Impact**	**Impact**	**No Impact**	**Impact**

[1] MPRSA criteria 228.5(c) 228.5(d) and 228.5(e), 228.6(a)(4) and 228.6(a)(s) were addressed during the site screening process. See Section 5.6 for further discussion.
[2] Results of the water quality modeling predicted potential impacts at this Alternative, however, it is expected that these impacts can be mitigated or prevented through site management practices.
[3] Long-term impacts to shipping and navigation are not expected because they can be mitigated by notice to mariners and other site management practices.
[4] The Corps will coordinate with the USCG to shift the designated lightering zone boundary adjacent to CLIS to ensure that dredged material deposited at the site now and in the past is not disturbed by anchors.
[5] It was determined that there may be minimal short-term impacts to fish and benthos. However, it was determined that there would not be any long-term or cumulative adverse impacts to these resources.

1. **228.5(c) If at any time during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis for ocean dumping do not meet the criteria for site selection set forth in Section 228.5 through 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.**

   The general criteria of Section 228.5(c) is relevant only to existing and historical sites and is related to site terminations if the site is not meeting the Section 228.5 and 228.5(a) criteria. None of the alternatives evaluated failed this test and therefore all were retained in the alternatives analysis.

2. **228.5(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation site study.**

   The requirements under Section 228.5(d) limit the size of disposal sites to enable identification and control of immediate impact and to enable effective monitoring and surveillance programs. The long history of dredged material site monitoring in New England (*i.e.*, the DAMOS Program) and specifically at active and historic dredged material disposal sites within Long Island Sound provides ample evidence that these surveillance and monitoring programs are feasible for physical, chemical and biological impacts regardless of the alternative site chosen. Thus, the assessment required by Section 228.6(a)(5) indicates that monitoring and surveillance are neither limiting nor discriminatory with respect to the alternative sites evaluated. Moreover, having sites located relatively close to shore and near ports provides for more cost effective surveys than those further form shore, thus there are no cost reasons, contingent on available federal budgets, that would favor one alternative site over another.

3. **228.5(e) USEPA will, wherever feasible, designate ocean dumping sites beyond the edge of the Continental shelf and other such sites that have been historically used.**

   The criteria of 228.5(e) states that EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the Continental shelf. However, as discussed in Section 3.1, sites beyond the edge of the continental shelf were eliminated from consideration during the development of the ZSF.

4. **228.6(a)(4) Types and quantities of wastes (*dredged material*) proposed to be disposed of, and proposed methods of release, including methods of packaging the waste (*dredged material*), if any.**

   Section 228.6(a)(4) addresses the types and quantities of waste considered for disposal at a site. As discussed in Chapter 1, only dredged material found suitable for disposal in the marine environment will be placed at any of the alternative sites. Therefore, there is no available information to discriminate between the alternative sites on the basis of the types and quantities of material. Similarly there is no information that would discriminate among the sites on the basis of the disposal method, which is predominantly via hopper dredge or barges.

5. **228.6(a)(5) Feasibility of surveillance and monitoring.**

   Specific criteria 228.6(a)(5) was written to ensure that any site chosen can be surveyed and monitored properly to ensure that no unanticipated impacts occur at a site. Any location chosen within the ZSF could be surveyed and monitored as needed, therefore this criteria was addressed.

Several other MPRSA site selection criteria were determined to be partly or completely non-discriminatory, either because the site screening process eliminated them or because the detailed review of available site-specific information presented in Chapter 4 did not reveal any significant differences between the alternative sites. Several of the criteria are multi-faceted, addressing varying issues not all of which were discriminatory. Those facets that were non-discriminatory are summarized in this section (*i.e.*, Section 5.6.1), while those facets that were discriminatory are discussed under either Section 5.6.2 or Section 5.6.3. For each criterion, those portions relevant to the current section are discussed.

1. **228.5(a) The dumping of dredged material into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation;**

   228.6(a)(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean.

   Based on the information evaluated in Chapter 4, none of the alternative sites evaluated under this DEIS are located in or near desalination plants, areas where minerals are extracted, where aquaculture activities take place, nor any other competing, legitimate use of the ocean. The site screening described in Chapter 3 carried forward only those sites that were not located in concentrated areas of heavy commercial or recreational navigation although all four alternative sites are subject to vessel passage throughout the year. Section 5.6.2 further considers these potential impacts and considers potential mitigation measures. Conclusions regarding interference with fisheries and shellfisheries are drawn in Section 5.6.3 below.

2. **228.5(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations of effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery;**

   228.6(a)(3) Location in relation to beaches and other amenity areas.

   The coast of Connecticut and northern Long Island have a number of beaches and other amenity areas. However, as discussed in Chapter 4, each of the alternative sites evaluated is located at least 2.5 nautical miles (5 kilometers) from the nearest beach or other amenity area. The movement of the water column due to tides and storms is generally east and west at each site, thus material transported from the sites is less likely to move north or south toward the beach areas. In addition, the tidal excursion is only about 1 to 2 nautical miles (2 to 4 kilometers), and during such transport, any residual dredged material remaining in the water column after disposal would be dispersed to ambient conditions. As a result, it is unlikely that significant amounts of dredged material would be transported to these beach and amenity areas. Similarly there are no marine sanctuaries near any of the sites nor known limited fisheries or shellfisheries at or near any of the alternative sites.

3. **228.6(a)(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).**

   Impacts from current and past disposal activities were assessed at each of the alternative sites considered in this DEIS. While changes in bathymetry from past and ongoing disposal within each alternative were measured, where possible, no long-term adverse impacts to the chemistry and biology at the sites were identified at any of the alternative sites. In fact it was difficult to identify dissimilarities within the alternative sites relative to nearby reference areas particularly those alternative sites that had not received dredged material over the past 10 to 20 years. Thus, the evaluation did not find reason to choose one of the alternative sites over the others on the basis of past disposal activities.

4. **228.6(a)(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.**

   Comparison of the alternative sites did not identify water quality or ecology conditions that could differentiate among the alternative sites. Potential impacts from disposal on water quality were generally identical among the sites, although subtle differences considered in Section 5.1.2 could be present depending on the timing of disposal operations within the tidal cycle. It could be argued that the known poor water quality (*i.e.*, seasonal hypoxia) in the western region of the Sound could be a consideration against selecting either the WLIS or Bridgeport Alternatives. However,

the assumption underlying that rationale is that disposal of dredged material would exert a greater sediment oxygen demand (SOD) in the region relative to the present situation. Studies of Welsh and Eller (1991) and others have shown that the SOD imparted by the sediments of the 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 SOD exerted by dredged material placed at WLIS or any of the alternative sites will have significant impact on the hypoxia in this region or within the central basin of Long Island Sound. In addition, disposal usually occurs during the fall and winter months when hypoxic conditions are not likely to exist.

5. **228.6(a)(10) Potentiality for development or recruitment of nuisance species in the disposal site.**

   As indicated above, the contribution of dredged material to eutrophication already present in Long Island Sound is very small and not expected to contribute to conditions that could lead to the development of nuisance species. Thus, there are no dissimilarities among the alternative sites that allow preference of one alternative site over the others under this criterion.

6. **228.6(a)(11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.**

   Natural or cultural features of known significance were not found in any of the alternative sites. Moreover, past and current disposal activities may have buried and thus protected any cultural resources that are present at the sites. Therefore, dissimilarities among the alternative sites that would allow a preference of one alternative site over the others under this criterion were not identified.

5.6.2 Impacts and Use Conflicts that Could be Mitigated

The evaluation of alternative sites identified several undesirable conditions within each of the sites that were not sufficiently dissimilar to enable a preference for one site over the others. However, because the evaluation suggested undesirable impacts could result from the disposal at the alternative sites, mitigation actions were applied to criteria to determine if one or more of the alternative sites would be preferable. Criteria fitting this condition are considered in this subsection.

1. **228.5(a) The dumping of dredged material into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.**

   Shipping traffic may cross any of the alternative sites, thus there are no identifiable differences among the alternative sites from a shipping perspective. However, it was

determined during the alternative site evaluation that the USCG has designated an area including the entire Bridgeport Alternative as an anchorage for vessels. This in and of itself would not constitute substantial inference with disposal operations or visa versa because potential impacts can be mitigated through site management of normal navigation rules. However, the prospect of having sea anchors disturbing recently deposited dredged material mounds is not desirable.

The alternative sites are located in waters that are at least 60 feet (18.3 meters) deep. Given mound height restrictions of no more that 60 feet (18.3 meters) below the water surface, any potential for grounding and interference with navigation is not expected. In addition, disposal operations would be conducted under permit and with full notification to mariners of the locations of disposal buoys and activities. Thus, interference with shipping can be mitigated. Also, the imposition of dredging windows eliminates the potential for interference with recreational vessels from the late spring into fall.

2. **228.5(b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations of effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.**

The evaluation of short-term water quality impacts with the STFATE model described in Chapter 5 indicates that disposal operations at all of the alternative sites would likely meet the limiting permissible concentrations (LPC) within four hours of disposal. However, exceedence of the LPC at the site boundaries could occur at all sites under spring tide conditions, especially when large barges (*e.g.*, 5000 cubic yard [3822 cubic meters]) are used for disposal. The STFATE modeling results for the Milford Alternative found that the LPC would frequently be exceeded outside of the site boundaries under nearly all scenarios evaluated. LPC exceedences at Milford were projected for both normal and spring tide conditions, and for both large (5000 cubic yard [3822 cubic meters]) and moderate sized barges (3000 cubic yard [2294 cubic meters]). Thus, Milford has the greatest potential for not meeting water quality requirements. Moreover, mitigation of these impacts through management activities such as restrictions on barge size or disposal times would likely not be successful. At the other alternative sites, the exceedence could be mitigated through management actions, although greater potential for water quality exceedences regardless of barge size evaluated could occur at CLIS under spring tide conditions. Thus, restriction of disposal operations during spring tides is warranted at that alternative to ensure ocean disposal criteria are met at all times.

There is no expectation of long-term water column impact at any of the sites because the plumes are intermittent and rapidly dissipate to ambient conditions. Similarly, no impacts to beach, shoreline, marine sanctuary, or known geographically limited

fishery or shellfishery would be expected at any of the alternative sites because the residual plumes would dilute to background with four hours of disposal.

Because site management can avoid, minimize or mitigate these potential impacts this evaluation could not discriminate among the sites except for Milford. Mitigation at Milford would require increasing the proposed boundaries of the Milford Alternative. However, this type of mitigation was not deemed necessary given the potential of the adequacy of the other alternatives for meeting the open-water disposal needs of this region of Long Island Sound, including sites that have been recently used for dredged material disposal without any identified short- or long-term impact.

5.6.3 Discriminating Criteria and Use Conflicts

It was possible to discriminate among the alternative sites evaluated using three criteria. Evaluation of two of these specific site selection criteria [Sections 228.6(a)(1) and 228.6(a)(6)] involves similar factors such as the water depth at the site, its bathymetry, and the physical characteristics of the sediment. Therefore, these two criteria as considered together this in section. The third criterion addresses the site location in relation to living resources.

1. **228.6(a)(1) Geographical position, depth of water, bottom topography and distance from coast;**

   228.6(a)(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.

   The geographic position of the alternative sites places each within a water body that is bounded to the north and south by land, thereby restricting the direction or amount of wind and wave energy that can be imparted to the sites. Very little difference in these factors was found among the sites, although oceanographic currents tended to be higher at the Milford Alternative than at the other sites. Currents also tend to run east and west at each alternative although instantaneous currents may be in any direction and vary with wind and tidal stage.

   An analysis of waves potentially experienced at the sites during storms with a 2-year and 10-year return potential found clear differences among the sites. The 10-year storm return modeling indicated that wave height and period were largest at WLIS (11.2 feet [3.4 meters] and 6.6 second) and smallest at CLIS (9.8 feet [3.0 meters] and 6.1 seconds). Milford and Bridgeport were intermediate, at 10.3 feet (3.1 meters)/ 6.3 seconds and 10.7 feet (3.3 meters)/6.4 seconds, respectively. The sites also had different water depths both within and among the alternative sites. Water column depths ranged between 78 to 118 feet (24 to 36 meters) at WLIS and 52.5 to 75 feet (16 to 23 meters) at Milford. Depths at CLIS and Bridgeport were intermediate at 59 to 74 feet (18 to 22.5 meters) and 60 to 68 feet (18.3 to 20.7 meters), respectively.

   As a result of these differences in physical factors, there is differing potential for resuspension, dispersion, and transport of the deposited sediments at each of the

alternative sites. This interaction is best described by the strength of the induced currents at the sea floor by the waves (*i.e.*, orbital velocity). These bottom orbital velocities were lowest at WLIS (10 and 20 centimeters/second [0.3 and 0.7 feet/ second] for 2- and 10-yr storm return potential, respectively) and CLIS (17 and 31 centimeters/second [0.5 and 1 feet/second], respectively). The highest values were estimated at Milford (27 and 44 centimeters/second [0.9 and 1.4 feet/second], respectively) and Bridgeport (28 and 45 centimeters/second [0.9 and 1.5 feet/second, respectively). As a result, it was determined that there is greater potential for sediment resuspension and transport at Bridgeport and Milford than at CLIS and WLIS during strong storms that sporadically pass over this region. Based on this information, CLIS and WLIS would be preferred because of the reduced likelihood of transport of material.

2. **228.6(a)(2) Location in relation to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile phases.**

With regard to breeding, spawning, nursery, feeding or passage areas of living resources in adult or juvenile phases, the data presented in this DEIS shows that fisheries resource richness may increase from the central towards the western end of the Sound. The Bridgeport Alternative was found to be in the area of greatest species richness and is considered to be in the most productive area of the Sound. CLIS was in the second most productive area of the Sound, while Milford was in the least productive area from a fisheries perspective. The high fisheries productivity in vicinity of Bridgeport argues against its choice as a preferred alternative. The same rationale could be applied to CLIS, however, it is presently an active disposal site and there is no evidence that current activities have had an adverse impact to fisheries there. Similarly, high fisheries productivity in the area of WLIS argues that disposal at this site is not affecting the fishery there. In contrast, the low fishery resources at the Milford site would make it more desirable relative to the other sites. However, as considered elsewhere, this alterative is subjected to significant energy and erosion potential, which may contribute to the lower fisheries productivity.

Similar arguments can be made for the shellfisheries in and near the alternative sites, especially lobster. The region in which the alternative sites are located is actively lobstered with good to excellent lobstering prior to the crash of the lobster populations in 1999. The lobster CPUE reported for the State of Connecticut fisheries trawls support these areas as having higher productivity relative to lobster. On the basis of this data, the Bridgeport Alternative is considered the least desirable location to place dredged material. As considered above there is no evidence that placement of dredged material at Milford, WLIS or CLIS would improve or degrade the lobster productivity in these areas.

Evidence presented in this DEIS also shows that the benthic infauna community at WLIS and CLIS tends to be more diverse and the number and abundance of species at these locations is higher than at Milford and Bridgeport. The higher diversity and abundance at these alternative sites may be related to the disruption and

recolonization following recent disposal activities. However, this is not considered a reason to prefer one alternative compared to another. Disposal of dredged material at the alternative sites is not expected to have a direct or long-term adverse impact to the living resources in the Sound, although short-term loss of benthic infauna species under the footprint of the dredged material mounds would occur at each alterative site. However, these communities are expected to recover quickly as demonstrated consistently under the DAMOS program.

5.6.4 Comparison of the No Action Alternative with the Alternative Sites

Under the No Action Alternative, there is potential for smaller volumes of material being disposed at a more frequent rate. As a result it is expected that there might be a small incremental improvement in environmental quality. However, the impacts on socioeconomic resources such as commercial and recreational fishing or shipping and navigation could be significant. As a result, implementation of the No Action Alternative is likely to increase the threat of spills and pollution and predicted to have substantial and significant adverse impact to the economies of Connecticut and New York. Therefore, the No Action Alternative is not recommended as a preferred alternative.

5.6.5 Cumulative Impacts

The Council on Environmental Quality 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 on 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.

With respect to the disposal of dredged material at designated sites in Long Island Sound, cumulative impacts could occur as a result of multiple disposal events at the same designated site and as a result of other, unrelated activities such as shipping, recreation, and fishing that occur on or near Long Island Sound. Other environmental stressors (*i.e.,* hypoxia) may also contribute.

Potential cumulative impacts that could occur at these alternative sites include topographic change, alteration of local bottom currents, burial of organisms in disposal area, changes in the benthic community, and potential changes to the local food web. Each of these changes has been ongoing at sites in Long Island Sound for decades. The evaluation conducted in this DEIS did not, however, find evidence that any of these changes has resulted in unacceptable, incremental adverse impacts to the Sound and anecdotally may enhance certain living resources by providing new or better habitat.

In Long Island Sound, disposal of dredged material could result in releases of contaminants in the water column, impacts to fish and shellfish, and impacts to navigation. Other activities in the Sound result in releases of contaminants (*e.g.*, nonpoint source pollution or spills from

vessels), environmental stresses on fish and shellfish, and use of the Sound by ships and recreational watercraft. Thus, the impacts of the disposal of dredged material in the Sound, together with those resulting from other unrelated activities, could result in cumulative impacts. However the dredged material component of these cumulative impacts is not expected to be significant or to threaten a violation of any federal, state, or local requirements.

5.7 Preferred Alternative and Rationale for Preference

The initial site screening process led to the identification of four alternative disposal sites for further evaluation with respect to MPRSA site selection criteria, in addition to the no action alternative. It was determined that any potential short-term, long-term, or cumulative impacts to the marine environment associated with the selection of any of the alternative sites would be minimal. It was further determined that any potential impacts associated with dredged material disposal at these sites could be mitigated through proper site management. Disposal site management and monitoring at the two preferred alternatives are described in detail in the companion SMMPs.

The two preferred alternatives are the WLIS and CLIS disposal sites. Both of these sites are located and managed to have minimal adverse environmental effects, currently used for dredged material disposal, and have been used as such for approximately 20 years. EPA regulations (40 CFR 228.5(e)) state that it is generally preferable to designate disposal sites in areas that have been used in the past, rather than to locate sites in new, relatively undisturbed areas. Monitoring of the WLIS and CLIS disposal sites has verified that past and present management practices have been successful in minimizing the short- and long-term, and cumulative adverse impacts to water quality and benthic habitat (see SMMPs for CLIS and WLIS). The northeast corner of the existing CLIS disposal site is next to a USCG designated lightering zone, the use of which could result in disruption of disposal mounds by anchors. The Corps will coordinate with the U.S. Coast Guard and local pilots association to modify the boundaries of this anchorage area regardless of a site designation to protect these existing mounds.

5.7.1 Other Disposal Site Alternatives

The Bridgeport and Milford historical disposal sites are not the preferred alternatives for the following reasons. Compared with CLIS and WLIS, the Bridgeport and Milford sites both have a greater potential for erosion of non-cohesive silt and sandy sediments. If such erosion occurred, it could result in adverse impacts to surrounding areas following disposal activities and make site management difficult. While both were used historically for the disposal of dredged material and therefore are subject to the same consideration required by 40 CFR 228.5(e), neither has been used in over 20 years and, as a result, their characteristics are nearly identical to adjacent areas that were not historically subjected to dredged material disposal.

Furthermore, the Bridgeport alternative is located in an area with relatively higher lobster and fisheries resources than those found in the CLIS and WLIS disposal sites. The Bridgeport disposal site boundaries also fall within a USCG designated lightering zone, the use of which

could result in disruption of disposal mounds by anchors. The anchorage area could be moved if necessary, but doing so would entail additional costs and temporary disruptions to users of this USCG regulated area.

5.7.2 No Action Alternative

The "no action alternative" is also not the preferred alternative. As discussed in Chapter 3, for dredging projects subject to MPRSA §106(f), project proponents would need to find other suitable disposal alternatives.

While it is impossible to be certain of how dredging needs resulting from sediment build-up in the central and western regions of Long Island Sound would be handled if no disposal sites are designated, several hypothetical scenarios might reasonably be considered. First, disposal site authorization for private projects involving less than 25,000 cubic yards (19,114 cubic meters) of material would simply continue being evaluated on a project-specific basis under CWA § 404 and disposal would continue at WLIS and CLIS. Second, for projects subject to MPRSA §106(f) (*i.e.*, either federal projects or private projects involving greater than 25,000 cubic yards [19,114 cubic meters] of material), project proponents would need to pursue one or more of the following courses of action:

(1) Utilize an alternative open-water site either inside or outside of Long Island Sound that has been "selected" by the Corps and concurred with by EPA under MPRSA § 103;

(2) Use an already designated site outside of the central and western Long Island Sound;

(3) Await EPA designation of a different disposal site outside of the central and western portions of Long Island Sound;

(4) Develop and utilize appropriate land-based disposal/reuse alternatives;

(5) Cancel the proposed dredging projects.

The first of these alternatives, selecting disposal sites on a short-term, project-specific basis, may have, at a minimum, a possibly greater impact if it results in multiple sites being selected and dispersing dredged materials over a greater area of the Sound. The fourth and second alternative, land-based disposal or reuse, may result in adverse environmental impacts to upland areas and freshwater systems, and also have been determined to be more expensive methods of dredged material disposal. Moreover, it is presently uncertain whether or not adequate upland disposal capacity could be found for the large volumes of material at issue from large individual projects. Upland disposal alternatives will, of course, continue to be investigated on a project-specific basis as part of the assessment of the "need" for open-water disposal that is done for each disposal permit. The third alternative, awaiting EPA designation of a different disposal site and the fifth alternative, curtailing dredging activities throughout western and central Long Island Sound, would seriously compromise navigational safety and marine commerce and could result in vessels running aground and leaking oil and other hazardous materials. Therefore, this also poses a serious environmental

risk. The socioeconomic impacts of the latter two alternatives have been determined to be unacceptable.

5.7.3 Summary of the Preferred Alternative

EPA has determined that designating the WLIS and CLIS disposal sites as open-water dredged material disposal sites in Long Island Sound are the Agency's preferred alternatives. The Corps has played a crucial role in the designation of disposal sites in Long Island Sound and concurs with this determination. These sites satisfy the MPRSA criteria and are environmentally, operationally, and economically feasible sites. This DEIS concludes that, properly monitored and managed, the continued use of these sites will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. Furthermore, disposal at these sites in a manner consistent with the restrictions imposed by this designation on disposal locations, time periods for disposal, and types of material to be disposed, will mitigate adverse impacts to the environment to the greatest extent practicable.

Material to be disposed at the designated sites will be tested according to applicable regulations and national and regional guidance, and the material must satisfy the applicable legal requirements. As discussed elsewhere in this DEIS, the requirements of CWA § 404 must be satisfied by small private projects, and the requirements of the MPRSA and CWA § 404 must be satisfied by large private projects and by federal projects. In addition, it was determined that there are socioeconomic benefits associated with selecting the WLIS and CLIS disposal sites as the preferred alternatives.

5.7.4 Reconfiguration of the Western Long Island Sound and Central Long Island Sound Site Boundaries

During development of the DEIS, EPA and the Corps reviewed the present locations and surrounding areas of WLIS and CLIS. Based on this assessment, EPA and the Corps determined that: 1) the location of WLIS should be shifted to the northwest due to concerns about shoaling along the southern boundary; and, 2) the northern and eastern boundaries of CLIS should be reconfigured to include historic mounds located outside of the present site. A summary of these proposed changes is provided below. The realigned boundaries are in sufficient proximity to the former boundaries that the site characterization presented in Chapter 4 remains applicable.

5.7.4.1 Western Long Island Sound

Review of existing data on the WLIS Alternative and its surrounding areas showed that the southern boundary of the site is located in an area that shoals rapidly. To address this issue, EPA and the Corps have determined that WLIS should be shifted approximately 1,106 feet (337 meters) to the west and 607 feet (185 meters) to the north (see Figure 5-7). The overall size of the site will remain the same (1.2 nautical miles by 1.3 nautical miles [2.2 by 2.4 kilometers]), but the site will be approximately 1260 feet (384 meters) to the northwest. This shift moves the site out of the area that shoals rapidly and into an area that is deeper overall. The western portion of the site will include areas of the historic Stamford Site and

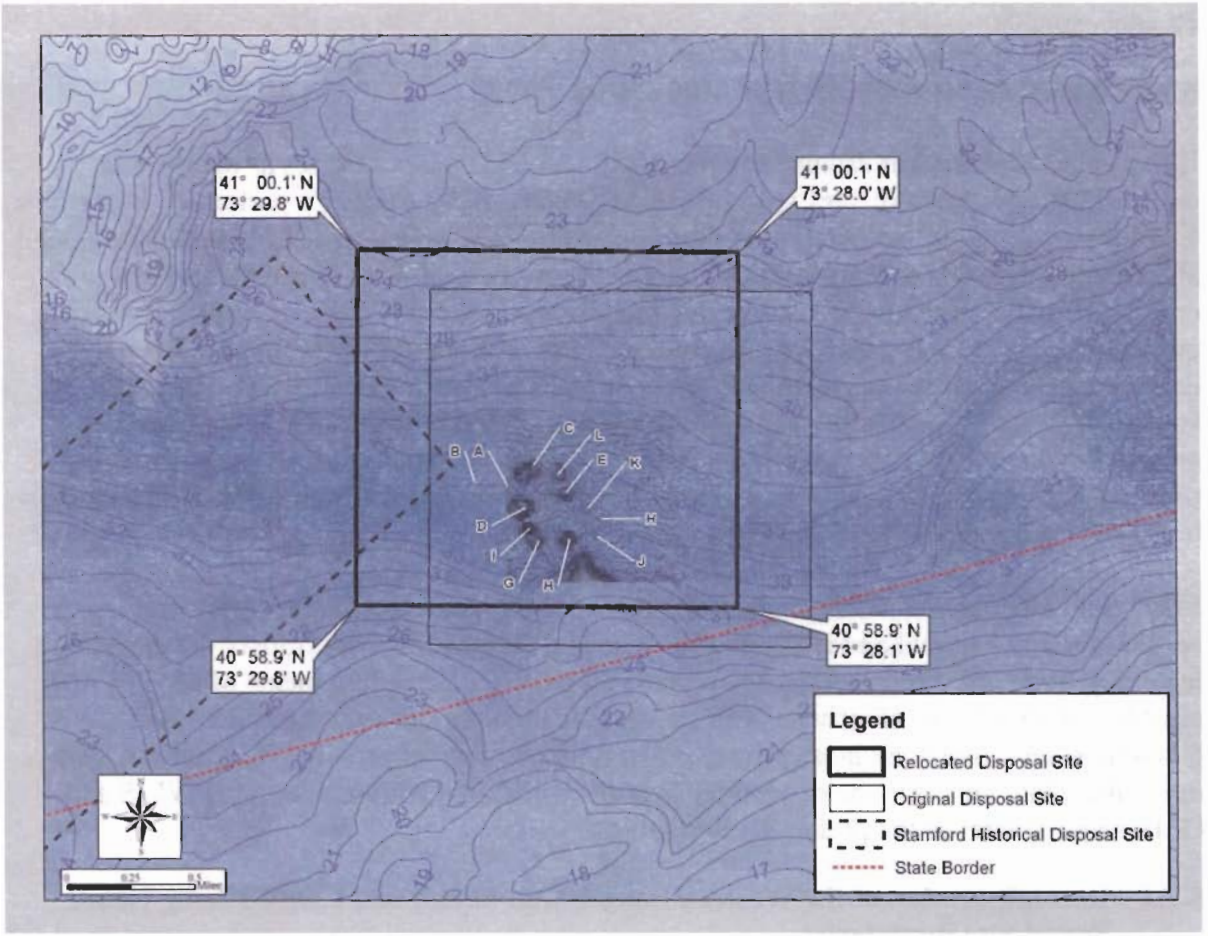

Figure 5-7. Reconfigured Site Boundary for WLIS

thus will not affect previously unimpacted areas. All historic mounds (see figure 5-7; mounds A though J) created in the present WLIS Dredged Material Disposal site will continue to be located within the new WLIS location. Previously, approximately two percent of the WLIS site was located in New York waters. In the relocated position, the entire site will be managed and monitored with uniform regulatory consistency under federal and state requirements.

5.7.4.2 Central Long Island Sound

During consideration of the CLIS Alternative, it was determined that the currently established boundary for CLIS does not include the historic Field Verification Program (FVP) disposal mound and only partially includes the historic Cap Site 2 (CS-2) mound. Over the years, the precise location and shape of the CLIS site has been shifted at least four times (the existing CLIS site, an Interim CLIS site, a New Haven Disposal site, and a Historic New Haven Disposal site; see Figure 3-7) resulting in the creation of disposal mounds that lie on the seabed within an area exceeding the current 1 by 2 nautical mile (1.9 by 3.7 kilometer) rectangle.

FVP and CS-2 mounds were created in the early 1980's. The FVP mound was created for the joint EPA/Corps research investigation into field application of the dredged material testing methods (Peddicord, 1988). Sediment placed at FVP originated from Black Rock Harbor, Connecticut and was considered to be sediment unsuitable for unconfined open-water disposal. It was disposed without capping so that researchers could study the results. The DAMOS Program has continued to monitor the FVP mound periodically since the completion of the Field Verification Program in 1986 (*e.g.*, Morris, 1997; Wiley and Charles, 1995). The benthic community on the mound has cycled between Stage III and Stage I, possibly in response to the levels of contaminants present in the sediments.

CS-2 was an experimental cap site created at the same time as FVP along with a second capped mound, Cap Site 1, located to the south of CS-2. Both of these mounds involved capping of sediments dredged from Black Rock Harbor, Connecticut. These capped mounds have also been monitored by the DAMOS Program.

To enable the efficient long term management of all historic disposal mounds in the CLIS region, EPA and the Corps concluded that it was reasonable to reconfigure the boundaries of CLIS from those currently in use to one encompassing both historic mounds (FVP and CS-2) (Figure 5-8). This change would enable management actions to be taken to contain any contaminants present in these historic dredged material sediments and which may be exposed to the surrounding ecosystem.

The review of the boundaries determined that expansion of the CLIS boundary, rather than shifting the 1 by 2 nautical mile (1.9 by 3.7 kilometer) rectangle, was necessary to accomplish the goal of managing all historic mounds in this Alternative. For example, shifting the 1 by 2 nautical mile (1.9 by 3.7 kilometer) rectangle to include CS-2 and FVP would have caused the total or partial exclusion of other historic disposal mounds (*e.g.*, MQR, NHAV-83, and STNH-S) that should be managed. The increase in bounded area necessary to include FVP and CS-2 involves shifting the northern boundary out about 700 feet (215 meters) and the eastern boundary out about 1,230 feet (375 meters) from the present configuration. This forms a 1.1 by 2.2 nautical mile (2.0 by 4.0 kilometer) site, with an increased area of approximately 347 acres (1.4 square kilometers). Thus, the designated CLIS site will be increased to a size approximately 20 percent larger than the original site, which will include these mounds and enable management actions to take place in the future.

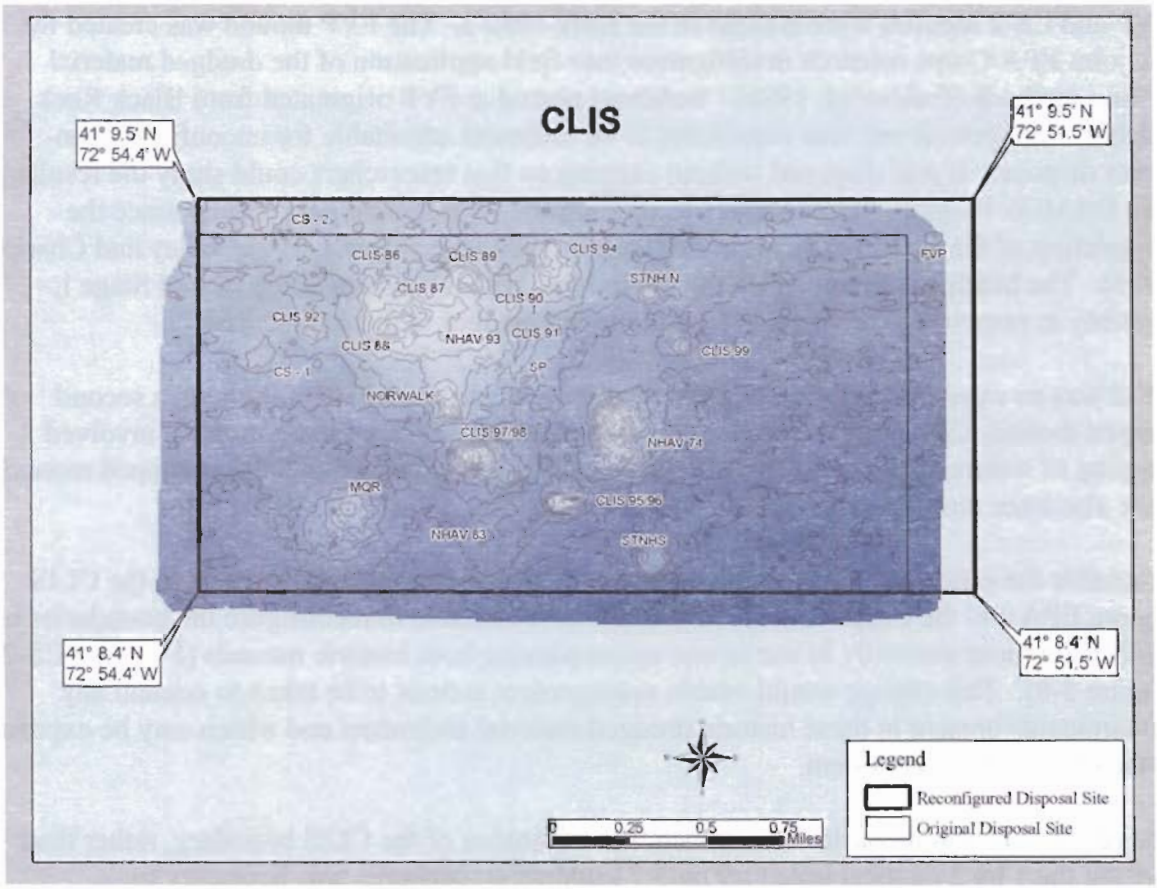

Figure 5-8. Reconfigured Site Boundary for CLIS

CHAPTER 6 – COMPLIANCE WITH FEDERAL ENVIRONMENTAL STATUTES AND EXECUTIVE ORDERS/MEMORANDUM

This chapter describes the federal laws, regulations, and programs that are relevant to the designation of open-water dredged material disposal sites in Long Island Sound. Chapter 1, Section 1.2 also addresses the legal requirements of the CWA and the MPRSA.

Federal Statutes

1. American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996.

Compliance: Consultation with the Indian tribes that may be affected by the proposed action in order to ensure that the action does not interfere with their rights to traditional religious practices will take place during the development and review of this DEIS.

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

Compliance: The "general conformity" requirements of Section 176(c)(1) of the Clean Air Act, 42 U.S.C. § 7506(c)(1), may apply to the designation of a dredged material disposal site. Such a designation produces no emission, however, and therefore would clearly satisfy the general conformity requirement. It should also be noted that the future authorizations of specific dredging and dredged material disposal projects by the Corps would be evaluated under the general conformity requirements of Section 176(c)(1) of the Clean Air Act since these projects would actually produce air emissions. "Conformity" would be evaluated on a project-specific basis for these projects. At the same time, however, some such projects might satisfy the conformity requirements pursuant to one of the specific exemptions stated in EPA's regulations. *See* 40 CFR § 51.853(c)(ix).

3. Clean Water Act, as amended, 33 U.S.C. 1251 *et seq.*

Compliance: The Clean Water Act does not apply specifically to an EPA designation of a long-term dredged material disposal site under the MPRSA. Future non-Federal projects involving the open-water disposal of less than 25,000 cubic yards (19,114 cubic meters) of dredged material will require a Section 404 permit under this Act. A State Water Quality Certification pursuant to Section 401 of CWA will also be required. (See Section 1.2.1 and Section 1.2.4.) Federal projects or non-Federal projects involving more than 25,000 cubic yards (19,114 cubic meters) of material will also need to satisfy the standards of Section 404 of the Clean Water Act and 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: 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 project is being coordinated with the NMFS and the 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 this Act.

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 DEIS. In addition, this project 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 and New York have been consulted and their recommendations have been included in this DEIS. Also, when possible, their recommendations will be incorporated into the final action.

8. Magnuson-Stevens Fishery Conservation and Management Act, as amended, 16 U.S.C. 1801 *et seq.*

Compliance: EPA has coordinated with the NMFS and preparation of an Essential Fish Habitat Assessment in compliance with the Act. EPA will also either include any conservation recommendations from NMFS in its final action or explain why it has not done so.

9. Marine Mammal Protection Act of 1972, 16 U.S.C. 1361.

Compliance: This action is being coordinated with the NMFS and the USFWS to determine whether any marine mammals under their respective jurisdictions may be affected by the project.

10. Marine Protection, Research, and Sanctuaries Act of 1972, as amended, 33 U.S.C. 1401 *et seq.*

Compliance: Pursuant to MPRSA §102, EPA promulgated criteria to guide the selection of open-water disposal sites. These criteria are set forth at 40 CFR Part 228. These criteria

were followed in evaluating the potential designation of open-water disposal sites. The requirements of this Act are discussed more fully in Chapter 1 of this DEIS.

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

Compliance: NEPA does not apply to this action, as discussed in Chapter 1. EPA is preparing this DEIS, however, consistent with EPA's voluntary NEPA Policy. This is discussed more fully in Chapter 1 of this DEIS.

12. National Historic Preservation Act of 1966, 16 U.S.C. 470.

Compliance: The project was coordinated with the State Historic Preservation Offices in Connecticut and New York and it was determined that no historic property would be affected by the proposed project. The basis for this determination is explained in the DEIS. In addition, EPA consulted with Federal Historic Preservation Officers and interested Indian tribes regarding possible effects on historic/archaeological resources.

13. Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. 3002.

Compliance: This statute should not be triggered by this action because (a) no human remains or objects will be found during this action, which involves designating open-water sites for potential future disposal of dredged material, (b) this action will not take place on either federal or Indian lands. In any event, interested Indian tribes were consulted with in the consideration of alternative courses of action for this DEIS.

14. Preservation of Historic and Archaeological Data Act of 1974, 16 U.S.C. 469.

Compliance: The chance of this action leading to future damage to resources covered by this Act was considered and there is no expectation that this project will damage archeological, historic, scientific, or prehistoric data. If there is an unexpected discovery of data covered by this act, EPA will notify the National Park Service Departmental Consulting Archaeologist.

Executive Orders

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

Compliance: This Order has been incorporated into the National Historic Preservation Act of 1980. Coordination with the State Historic Preservation Offices in the states of Connecticut and New York 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.

3. Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, 11 February 1994.

Compliance: This DEIS has evaluated the potential adverse risks to human health this project poses to minority and low income populations and found that there are no expected 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: This DEIS has evaluated the potential adverse risks to children's health and found that there are no expected disproportionately high, adverse health or safety threats to children from this action.

5. Executive Order 12962, Recreational Fisheries, 9 June 1995.

Compliance: This DEIS has considered the goals of this executive order and the project is not expected to have disproportionately high or adverse effects on recreational fisheries.

6. Executive Order 13158, Marine Protected Areas.

Compliance: EPA has considered the location of any "marine protected areas" in considering alternative courses of action for this project. The action will avoid harm to the natural and cultural resources protected by any designated marine protected areas.

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.

CHAPTER 7 - PUBLIC INVOLVEMENT

7.1 Introduction

As stated in Chapter 1, this DEIS is being prepared consistent with the requirements of the NEPA and EPA's voluntary NEPA compliance policy. 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 (italics added)."

Federal regulations that guide compliance with NEPA by the EPA (40 CFR Parts 6 and 25), the Corps (33 CFR Part 230), and the CEQ (40 CFR 1500 *et seq.*) are more explicit in their requirements for public involvement throughout the EIS process.

This DEIS 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, EPA and the Corps have conducted an extensive public involvement program throughout the development of the DEIS. The agencies established a "Working Group" comprised of stakeholders from the Long Island Sound region and they held numerous public meetings and workshops to provide the public with information on the EIS process, the results of studies conducted in support of the DEIS, and to give the public ample opportunity to provide input on the process and substance of the NEPA document. The following sections describe in detail the elements of the EPA/Corps public involvement program.

7.2 Major Public Involvement Activities

7.2.1 Notice of Intent and Public Announcement

EPA published a Notice of Intent to prepare an EIS to consider the potential designation of one or more open-water dredged material disposal sites in Long Island Sound in the Federal Register on June 3, 1999 and mailed it to approximately 7000 interested parties registered on the Long Island Sound EIS mailing list. The Notice of Intent outlined the project and gave notification of the public "Scoping" meetings (described below).

On March 27, 2002, EPA and the Corps published an Environmental News Notice on the modification of the ZSF. This notice informed the public that this DEIS would focus on sites

in western and central Long Island Sound. Consideration of one or more dredged material disposal sites in eastern Long Island Sound would be the subject of a Supplemental EIS.

7.2.2 Public Scoping Meetings

Scoping is the process through which federal agencies responsible for the development of an EIS determine the scope of the project, including the range of alternative actions that also may meet the purpose of and need for the proposed action; the projected area extent 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. Public scoping meetings were held on June 15, 1999 in Port Jefferson, New York; June 16, 1999 in Stratford, Connecticut; and June 23, 1999 in Groton, Connecticut to inform the public about the project; explain the respective roles of the two lead agencies, other cooperating or coordinating federal, state, and tribal agencies, and the public; and to request comments on the draft scope of work for the EIS and related studies (see recorded Public Scoping notes Appendix A). The Scoping meetings also were used to identify and record public concerns, issues, and environmental considerations for potential examination and analysis in the DEIS. Approximately one hundred and thirty people attended the three public Scoping meetings.

7.2.3 Public Workshops

Two series of public workshops were conducted in October 1999 and April 2000 to discuss and seek public input on the development of the EIS. Workshop topics included the identification of dredged material disposal alternatives, the evaluation criteria used to screen alternative sites, the process of screening and evaluating disposal sites, and a review of existing data and data collection needs. Workshop notices and fact sheets on issues to be discussed at the workshops were sent to the 700+ interested parties on the Long Island Sound EIS mailing list.

The first two workshops were held on October 12, 1999 in Port Jefferson, New York, and October 13, 1999 in Stratford, Connecticut (USACE, 2000a; Appendix A-3). These workshops used small group discussions to solicit public input on dredging needs and alternatives, the site screening process, data review, and recommendations and evaluation factors for site screening. Thirty-six individuals attended the Port Jefferson, New York workshop, and forty-nine individuals registered for the Stratford, Connecticut workshop.

Two more workshops were held on April 11, 2000 in Port Jefferson, New York, and April 12, 2000, in Groton, Connecticut to provide an update on the status of the EIS Work Plan, field work accomplished to date and future field work plans, and the alternatives screening process using the weights and values for the evaluations factors. Following presentations on these issues, breakout groups were used to solicit feedback from the public. Thirty-nine individuals attended the Port Jefferson, New York workshop, and seventy-four individuals registered for the Groton, Connecticut workshop (see *Workshop Proceedings April 2000*, Appendix A-3; USACE, 2000b).

7.2.4 Working Group Meetings

A volunteer public Working Group was formed in 2000 and is made up of 35 people who represent the marine industry, boaters, environmental groups, fishing interests, local towns, and individuals. The group met five times during the development of the DEIS. The meetings were arranged using an open forum discussion, and all who were interested were welcome (A list of the original members can be found in the report *Working Group Meeting #1* in Appendix A-3; USACE, 2000c). However, as the meetings progressed, others became interested and a list of attendees to each meeting can be found in the various meeting reports (Working Group Meetings #1 to #5 Appendix A-3).

The first Working Group meeting was held on July 19, 2000 in Old Lyme, Connecticut. Meeting topics included discussion of the economic and environmental approach used in developing the DEIS (see *Working Group Meeting #1 Report*, Appendix A-3; USACE, 2000c). Twenty-seven individuals were present, including contractor support and federal agency personnel.

The second Working Group meeting took place on April 26, 2001 in Bridgeport, Connecticut. Meeting topics included discussion of completed field work. This included presentations of field studies for lobster, fish, and benthic resources, fishing activities, upland disposal alternatives, Geographic Information System (GIS) meta databases, dredging needs and economic analyses (see *Working Group Meeting #2*, Appendix A-3; USACE, 2001a). Thirty-three individuals attended this meeting, including contractor support and federal agency personnel.

The third Working Group meeting was held on March 5, 2002, in Port Jefferson, New York. Meeting topics included discussion of field reports, specifically the field data and dates the reports would be published (see *Work Group Meeting #3*, Appendix A-3; USACE, 2002a). Thirty-three individuals attended, including contractor support and federal agency personnel.

The fourth Working Group meeting was held on July 24, 2002, in Bridgeport, Connecticut. Meeting topics included discussion of site screening criteria, the alternative site field sampling program, status of the project and next steps (see *Work Group Meeting Bridgeport, Connecticut July 24, 2002*, Appendix A-3; USACE, 2002b). Forty-four people attended, including contractor support and federal agency personnel.

The fifth Working Group meeting was held November 20, 2002 in Stamford, Connecticut. Meeting topics included discussion of the results of the field work at the alternative sites, progress update, and next steps (see *Working Group Meeting Stamford, Connecticut, November 20, 2002*, Appendix A-3; USACE, 2003a). Twenty-nine people were in attendance, including contractor support and federal agency personnel.

7.2.5 Interagency Meetings

During development of the DEIS, the Corps and EPA met at various points and significant stages during the process to receive input from the federal and state agencies. Conference calls also took place at various points in the process. An overview of these meetings and

conference calls is provided below. In addition, to the meetings and conference calls outlined below communication between the cooperating agencies, the Corps and EPA were on going throughout the process, by e-mail and telephone.

A Federal/State Interagency Coordination Meeting was held on March 12, 1999 at the CTDEP in Hartford, Connecticut. Participants included EPA New England, the Corps New England District, NMFS, New York State Department of Conservation, CTDEP, and contractors. The purpose of this meeting was to discuss the overall history of disposal of dredged material in Long Island Sound, the current site designation process, an overview of the MPRSA Section 103 authority, the 1998 Corps/EPA Letter of Agreement, and initiation of EIS scoping, which included possible studies required and data gaps.

A pre-scoping meeting was held on June 9, 1999 at EPA New England office. Participants included EPA New England and Region 2, the Corps, CTDEP, and NYSDOC (by phone), and facilitator (contractor). The purpose of this meeting was to discuss the logistics and content of anticipated Scoping meetings that were held in New York and Connecticut

An interagency meeting was held at the NMFS on September 1, 1999. Attendees included EPA New England and Region 2, the Corps, NMFS, CTDEP, NYSDEC, and NYDOS. The purpose of this meeting was to discuss the breadth of the existing fisheries data for Long Island Sound, define sampling designs for sediments and benthos (tissue and populations) for the field sampling at the four existing dredged material disposal sites of WLIS, CLIS, Corn Field Shoals Disposal Site, and the New London Disposal Site and, to discuss future fishery sampling events. Sampling protocols were discussed, as well as proposals for locations of samples at and near the existing sites. Agencies were asked about the presence of existing data, known data gaps, essential fish habitats, and, any data that may assist in identifying alternative sites.

On February 1, 2000 an interagency meeting was held at the CTDEP offices in Hartford, Connecticut. Attendees included EPA New England and Region 2, the Corps, NMFS, CTDEP, NYSDEC, NYDOS, Rhode Island Department of Environmental Management (RIDEM), and contractors. The purpose of this meeting was to obtain consensus on the ZSF to be used for evaluating alternatives dredged material disposal sites; to present and discuss a proposed approach for evaluating alternatives, including methods for screening sites; and obtain input and feedback from the agencies. (Factsheets 1999 – *Site Screening Process, Evaluation Factors Scoring Example, Evaluation Factors For Site Screening*, Appendix A)

A conference call was held on March 7, 2000 to receive input from the agencies on field sampling for the summer of 2000, specifically, the tissue and resource sampling program for lobsters, benthos, and fish for the four existing sites. Participants included EPA New England and Region 2, the Corps, CTDEP, NYSDEC, and contractors. Topics discussed included number of samples to be taken, sample locations, analytes to be tested, and existing available information that would assist in developing the sampling program.

On July 27, 2000, the Corps met with representatives from various CTDEP Divisions (Waste, Enforcement, Permitting, Remediation, and Water), at CTDEP offices in Hartford,

Connecticut. The purpose of this meeting was to discuss information those departments had regarding landfills, potential habitat creation areas, potential restoration/remediation sites, brownfield areas, or other areas that could benefit from dredged materials, now or in the future. This information would be incorporated into the EIS regarding potential non-open-water dredged material disposal alternatives.

On March 8, 2002, a meeting was held at the Corps' New England District offices in Concord, Massachusetts to discuss the modification to the ZSF. Attendees included EPA New England and Region 2 (by phone), the Corps, and NMFS. Based on ecological and geographical considerations, the participants determined that the ZSF should include the western and central basins of the Sound, with the eastern portions of the Sound to be analyzed at a later date.

An interagency meeting was held on May 16, 2002 at the CTDEP offices in Hartford, Connecticut. Attendees included EPA New England and Region 2, the Corps, NMFS, CTDEP, NYSDEC, NYSDOS, and contractors. The purpose of this meeting was to update the agencies on the overall status of the EIS, present an overview of the ZSF modification, and to conduct site screening. The agencies agreed to evaluate data needs for lobsters, benthic community structure, site chemistry sediment toxicity, and amounts of dredged materials previously disposed of at these sites, and obtain GIS compatible resource data.

A conference call was held on June 19, 2002 with the Corps, EPA New England, NMFS, CTDEP, NYSDOC and contractors. The purpose of this call was to discuss field sampling efforts for the alternative sites, of Milford and Bridgeport, and, to follow up with the state of New York on any available resource data in their waters. Discussions focused on appropriate methods for querying commercial lobster fishers to determine use of the areas, use of CTDEP trawl data, toxicity testing, side scan sonar surveys, sediment profile imaging, sampling locations, and number of samples.

A conference call was held on January 21, 2003. Participants included the Corps, EPA New England, and CTDEP. The purpose of the call was to provide an update on the overall EIS schedule, upcoming anticipated reviews that would be required by the agencies, as well as upcoming meetings.

In addition to the meetings discussed above and as directed under Section 106 of the National Historic Preservation Act and NEPA, the Tribal nations of Eastern Pequot Tribe, Mashantucket Pequot Tribal Nation, Mohegan Tribe, and the Narragansett Indian Tribe were contacted to participate in the EIS process. Under NEPA a Tribe may be recognized as a cooperating agency if the Tribe has any special expertise concerning the project. The Eastern Pequot Tribal Nation and the Narragansett Indian Tribe have responded that as several of the proposed sites fall within their aboriginal territories, they may be able to provide special expertise pertaining to historic and cultural resources. The Mashantucket Pequot Tribe, Mohegan Tribe, and Wampanoag Tribe of Gay Head (Aquinnah) have not responded to this request for cooperating agency status. However, they as well as all Tribal members involved in the EIS, will be considered as interested parties throughout the process and will provide review comments and expertise.

7.3 Distribution Outlets

There were various avenues used to distribute information to the general public, the Working Group, Federal and state agencies, the Tribes and other interested parties. These included, but were not limited to, mailing lists, e-mails, notices, websites, media, and the Long Island Sound Study Citizens Advisory Committee. A description is provided below of how information was dispersed and to whom, during the development of this DEIS.

The mailing list is made up of approximately 700 people and has 7 different categories; general notification; marine interests to include marina owners, marine industries, dredging companies, and consultants; press; state and federal agencies and Tribes; stakeholders or people who contacted EPA and the Corps; local cities and towns; and, people who commented early in the process. This mailing list was gathered in 1999 from various sources such as websites, state and federal agency mailing lists, environmental mailing lists, the Long Island Sound Study mailing list, industry mailing lists, and others. The list was added to, changed and maintained by people and organizations contacting either EPA or the Corps on their name and address changes. This mailing list was used to send out the Notice of Intent, workshop announcements, Environmental News notice, and Notice of Availability of this DEIS.

The June 3, 1999, Notice of Intent and the workshop announcement were mailed to approximately 700 people or organizations. The October 1999 and April 2000 Workshop announcements with fact sheets were mailed to approximately 700 people who were registered on the full mailing list as interested parties. In March of 2002 an Environmental News Notice on the modification of the Zone of Siting Feasibility was sent to approximately 3000 interested parties with a specific affiliation. The Notice of Availability for this DEIS was sent to approximately 700 names and addresses.

E-mail was the most common form of communication during this process, particularly for the Working Group. Working Group members were notified by e-mail of upcoming meetings, and might have included agendas, presentations, and any follow-up after meetings. The e-mail address list consists of original Working Group members and others who contacted EPA or the Corps with their e-mail address. This list is made up of at least 75 names. Communication between meetings was also done by e-mail. In cases where a Working Group member did not have e-mail, paper copies of the e-mail notice were mailed, along with any attachments accompanying the notice (fact sheets, agendas, meeting notes). At times a follow-up phone call was made to Working Group members, depending on the time frame or substance of the meeting.

EPA developed a public website (http://www.epa.gov/region01/eco/lisdreg/index.html) where all reports, meeting notes, and any documentation develop during this EIS process are posted.

Press releases were sent to the media at various milestones during this project such as the publication of the Notice of Intent, workshops, field work, research, narrowing of the focus of this EIS, and at other important milestones.

The Long Island Sound Study has a Citizens Advisory Committee that meets four times a year. The Citizens Advisory Committee has a Sediment Focus Group sub-committee, which meets after the regular Citizens Advisory Committee meeting and has conference calls every two months. An EPA employee attended all of the Citizens Advisory Committee meetings and engaged in the Sediment Focus Group sub-committees. In addition, the Long Island Sound Study has a newsletter that is sent to over 4,000 households or business. An update article on the development of this EIS was published every quarter from 1999 to 2002.

7.4 List of EIS Repositories

MR. Frank Aiello, Executive Director New Haven Free Public Library 133 Elm Street New Haven, CT 06510-2057 (302) 946-8130	Ms. Estherine C. Bonanno, Library Director Port Jefferson Free Library 100 Thompson Street Port Jefferson, NY 11777 (631) 473-0022
Ms. Marsha Stuart New London Public Library 63 Huntington Street New London, CT 06320-6194 (860) 447-1411	Ms. Janet Crozier, Executive Director Acton Public Library 60 Old Boston Post Road Old Saybrook, CT 06475-2200 (860) 395-3184
Mr. Steve Kwaznik Bridgeport Public Library 925 Broad Street Bridgeport, CT 06604-4871 (203) 576-7777	Ms. Joan Grott, Library Director Mamaroneck Public Library Inc. 136 Prospect Ave. Mamaroneck, NY 10543 (914) 698-1250
Ms. Xiaomei Gong Information Service Supervisor Ferguson Library 1 Public Library Plaza Stamford, CT 06904 (203) 964-1000	Ms. Judy Rivas, Head of Reference Services Norwalk Public Library 1 Belden Ave. Norwalk, CT 06850-3397 (203) 899-2780 x123 (203) 899-2780 x142
Mr. Salvatore L. Stingo, Head Librarian Milford City Library 57 New Haven Ave. Milford, CT 06460-3345 (203)783-3290	

7.5 List of Working Group Members

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Mr. Vincent Cashin President CT State Marine Pilots, Assn. 9 Nottingham Drive Old Lyme, CT 06371	Mr. Rick Comeau Fox Navigation 50 12th Street, State Pier New London, CT 06320
Mr. Donald Coyle Admin. Community Development Village Hall, 121 West Broadway Port Jefferson, NY 11777	Mr. Rob Crafa Friends of the Bay P.O. Box 564 Oyster Bay, NY 11771

Ms. Nancy D'Estang P.O. Box 602 Old Mystic, CT 06372	Mr. Orest Dubno Gateway Terminal 400 Waterfront Street New Haven, CT 06512
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Mr. Tom Gulbransen Battelle Memorial Institute Box 3500, L.I. Tech. Center 3500 Sunrise Highway Great Neck River, NY 11739	Mr. Peter Hall Browns Boatyard 165 Thimble Island Road Guilford, CT 06444
Mr. John Johnson Machine Works At Essex, Inc. 75 Crystal Ave. New London, CT 06320	Mr. Keith Jones Brookhaven National Lab. Building 901A Upton, NY 11973
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Mr. Harry Watson Pfizer Inc. Council Eastern Point Road, Bldg 156 Groton, CT 06340	

7.5.1 Attendees of Working Group Meetings

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Ms. Sally Richards Marina Commission - Guilford, CT 69 Andrews Road Guilford, CT 06437	Mr. Jim Russell RTG P.O. Box 9047 Providence, RI 02940
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Mr. Joe Schnierlein 38 Grandview Ave. Norwalk, CT 06850	Mr. Walter Schieferdecker Essex Island Marina Foot of Ferry Street Essex, CT 06426
Mr. Bill Shadel Save The Sound, Inc. 20 Marshall Street S. Norwalk, CT 06854	Mr. Bill Spicer Spicer's Marine 93 Marsh Road Noank, CT 06340
Mr. Geoff Steadman CT Harbor Management Assoc. 345 Main Street Westport, CT 06880	Ms. Rosemarie Sullivan 1095 Brooklawn Ave. Fairfield, CT 06432
Ms. Erika Swanson Representative DeLauro 59 Elm Street Hew Haven, CT 06510	Mr. Stephen Tagliatela Saybrook Point Inn and Marina 2 Bridge Street Old Saybrook, CT 06475
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Mr. Martin Tristine President Logistec Connecticut, Inc. 100 Water Street P.O. Box 9411 New Haven, CT 06534	Mr. Fred Walters Town of Greenwich Parks & Rec. 101 Field Point Road Greenwich, CT 06807
Ms. Amanda Waters Save The Sound, Inc 20 Marshall Street S. Norwalk, CT 06854	Mr. Grant Westerson CT MTA 20 Plains Road Essex, CT 06426

Ms. Delight Wilson Save The Sound, Inc. 20 Marshall Street S. Norwalk, CT 06854	Mr. Adam Yablonsky 175 E. Old County Road Hicksville, NY 11801

7.5.2 State Agency Attendees of Working Group Meetings

Connecticut Department of Environmental Protection (CTDEP), Office of Long Island Sound Programs Elm St Hartford, CT Mr. George Wisker	NY Sea Grant/Long Island Sound Office 146 Suffolk Hall SUNY at Stony Brook Stony Brook, NY 11794-5002 Ms. Kimberly Zimmer
New York State Department of Environmental Conservation 205 Bellmeande Road Suite 1 East Setauket, NY 11733 Ms. Karen Chytalo Mr. Rick D'Amico Mr. Charles deQuillfeldt	New York State Department of Environmental Conservation Region 2 4740 21st Street Long Island City, NY 11101 Mr. Alex Lechich Ms. Kathryn McGucken

7.5.3 Federal Agency Attendees of Working Group Meetings

U. S. Army Corps of Engineers New England District 696 Virginia Road Concord, MA 01742-2751 Mr. Tom Fredette Mr. Mark Habel Mr. Christopher High Ms. Sue Holtham Mr. Michael Keegan Mr. Richard Ring	U.S. Environmental Protection Agency Region 1 1 Congress Street Suite 1100 Boston, MA 02114-2023 Ms. Jeannie Brochi Ms. Ann Rodney Ms. Meg Tennant Mr. David Tomey
U.S. Army Corps of Engineers New York District Ms. Beth Nash	U.S. Environmental Protection Agency Region II Ms. Patricia Pechko
Long Island Sound Office 888 Washington Street Stamford, CT Mr. Joe Salata	NOAA/NMFS 212 Rogers Ave. Milford, CT 06460-6499 Mr. Michael Ludwig

7.5.4 Contractor Attendees of Working Group Meetings

Battelle 397 Washington Street Duxbury, MA 02332 Mr. Carlton Hunt Ms. Lynn McLeod Ms. Jennyfer Smith	Coastal Vision 215 Eustis Ave. Newport, RI 02840 Mr. Drew Carey
DRI-WEFA Mr. Scott Hazelton	ENSR 2 Technology Park Drive Westford, MA Ms. Pamela Amofshy Mr. Kenneth Hickey Mr. Stan Humphries Mr. Pete Jackson Mr. Dion Lewis Mr. David Mitchell Ms. Isabelle Morin Ms. Elizabeth Powers

7.6 List of Accepted and Designated Cooperating Agencies

NMFS Northeast Regional Office One Blackburn Drive Gloucester, MA 1930-2298 Ms. Pat Kurkul, Regional Office Director Mr. Mike Ludwig	Connecticut Department of Environmental Protection 79 Elm Street Hartford, CT 06106 Mr. Art Rocque Jr., Commissioner Mr. George Wisker
New York State Department of Environmental Conservation 625 Broadway Albany, NY 12233 Ms. Erin Crotty, Commissioner	Eastern Pequot Tribe 391 Norwich-Westerly Road P.O. Box 208 North Stonington, CT 06359 Ms. Marsha Flowers, Chairwoman Mr. Tobias Glaza, Land Management Coordinator
Narragansett Indian Tribe P.O. Box 268 Charlestown, RI 02813 Mr. Matthew Thomas, Chief Mr. John Brown, Councilman	

7.7 List of Federal and State Agencies Coordinated With During Development of this EIS

Federal	
U.S. Fish and Wildlife Service Regional Office 5 300 Westgate Center Drive Hadley, MA 01035-9589 Ms. Mamic Parker, Regional Director	U.S. Fish and Wildlife Service 3817 Luker Road Courtland, NY 13045 (607) 753-9334 Mr. David Stillwell, Regional Coordinator
U.S. Fish and Wildlife Service P.O. Box 608 Islip, NY 11751-0608 Mr. Steven Mars	U.S. Fish and Wildlife Service Route 1A Shoreline Plaza P.O. Box 307 Charlestown, RI 02813 (401) 364-9124 Mr. Greg Manesto
NMFS Northeast Regional Office One Blackburn Drive Gloucester, MA 1930-2298 Ms. Pat Kurkul, Regional Office Director	NMFS Milford Lab 212 Roger Ave. Milford, CT 06460 Mr. Mike Ludwig
Tribes	
Eastern Pequot Tribe 391 Norwich-Westerly Road P.O. Box 208 North Stonington, CT 06359 Ms. Marsha Flowers, Chairwoman Mr. Tobias Glaza, Land Management Coordinator	Mashantucket Pequot Tribal Nation Tribal Office Indiantown Road - P.O. Box 3060 Mashantucket, CT 06339-3060 Mr. Kenneth Reels, Chairman Mr. Michael Boland, Director of Natural Resources Protection
Mohegan Tribe P.O. Box 488 Uncasville, CT 06382 Mr. Mark Brown, Tribal Chairman Dr. Norman Richards	Narragansett Indian Tribe P.O. Box 268 Charlestown, RI 02813 Mr. Matthew Thomas, Chief Mr. John Brown, Councilman
Paucatuck Eastern Pequot Tribal Office 393 Gold Star Highway Groton, CT 06340 Mr. James A. Cunha, Jr. Chief	
States	
Connecticut Department of Environmental Protection 79 Elm Street Hartford, CT 06106 Mr. Art Rocque Jr., Commissioner Mr. George Wisker	New York State Department of Environmental Conservation 625 Broadway Albany, NY 12233 Ms. Erin Crotty, Commissioner

New York State Department of Environmental Conservation 205 Bellmeade East Setauket, NY 11733 Ms. Karen Chytello	New York Department of State 41 State Street Albany, NY 12231 Mr. Randy A. Daniels, Secretary of State Mr. Rod McNeil
NY State Parks, Recreation, and Historic Preservation Bureau of Field Services Peebles Island, P.O. Box 189 Waterford, NY 12188-0189 Ms. Ruth L. Pierpont, Director	Office of CT State Archaeology University of Connecticut U-214 Storrs, CT 06269-4214 Dr. Nicholas Bellantoni, State Archaeologist
Office of the State Historic Preservation Officer 59 South Prospect Street Hartford, CT 06106 Mr. John W. Shannahan, SHPO	
Other Federal Agencies	
U.S. Coast Guard Academy 15 Mohegan Avenue New London, CT 06320-4195 (860) 444-8301 (860) 444-8546 (fax) Mr. Schwaab	U.S. Coast Guard First District 408 Atlantic Avenue Boston, MA 02210-3350 RADM Vivien Crea, Commander
USCG Group/MSO L.I.S. 120 Woodward Avenue New Haven, CT 06512 (203) 468-4470 (203) 468-4406 Commanding Officer	Navel Submarine Base New London Environmental Department Building 166, Box 39 Route 12 Groton, CT 06349 Mr. Richard Conant, Commanding Officer
U. S. Department of the Navy Engineering Field Activity North East 10 Industrial Highway Mail 82 Lester, PA 19113-2090 Ms. Nancy Kuntzleman	U.S. Coast Guard Station Jones Beach Freeport, NY 11520 Mr. Thomas Botcenhart

CHAPTER 8 - REFERENCES

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CHAPTER 9 - LIST OF PREPARERS

Joel Banslaben: Researcher, Battelle
Education: M.P.A. in Environmental Policy from Columbia University; B.A. in Biology from Colorado College.
Experience: As a Policy Analyst for Battelle, Mr. Banslaben is responsible for policy analysis and stakeholder communications. Mr. Banslaben's recent efforts have included the development of a socio-economic resource assessment for the Rhode Island Region Long-Term Dredged Material Disposal Site Environmental Impact Statement and the formulation of an Environmental Feasibility Study for the Beneficial Use of Dredged Bedrock in the New York/New Jersey Harbor.
Role in Preparing the EIS: Mr. Banslaben assisted with the evaluation of socioeconomic resources including: commercial and recreational fishing; shipping and navigation; recreational uses; energy resources; archaeological and cultural resources; and parks and areas of special concern.

Nancy Bonnevie: Principal Research Scientist, Battelle
Education: B.S. in Biology from Bates College
Experience: Ms. Bonnevie has more than twelve years of experience in conducting environmental assessments. An environmental scientist specializing in aquatic ecology and sediment quality evaluations, she has effectively managed teams on tasks ranging from preliminary site characterizations to multi-tasked field sampling programs, ecological risk evaluations and environmental impact statements.
Role in Preparing the EIS: Ms. Bonnevie acted as the Battelle Task Manager for the biological resources sections of the document and assisted with overall direction of technical staff. In addition, she prepared the risk evaluation, oversaw the preparation of the SMMPs, and provided technical and editorial review of the document.

Jean Brochi: Biologist, USEPA
Education: B.S. Biology from Suffolk University
Experience: Over 7 years experience in environmental science which includes three positions such as Regional Ocean Dumping Coordinator, New Hampshire Estuary Program Manager, LIS Environmental Impact Statement Program Manager. Experience includes contracts and grant management, quality assurance reviews and development, ecological and human health risk assessments, regional indicator monitoring development and development of comprehensive management plans.
Role in Preparing the EIS: Ms. Brochi acted as the EPA Program Manager for the Long Island Sound study effort. In addition to providing technical review, she contributed to the preparation and editing of various portions of the DEIS including the Introduction, Purpose and Need, and No Action, as well as air quality and the risk evaluation.

Rosanna Buhl: Program Quality Assurance, Battelle
Education: Coursework at Bridgewater State College; Quality Assurance education through the Center for Professional Development and ASQ.
Experience: As Quality Systems Manager for Battelle's Duxbury Operations, Ms. Buhl is responsible for overseeing all site quality assurance activities, verifying that technical activities are conducted in compliance with the site Quality Management Plan (QMP), and managing the technical activities of the Quality Assurance Office. ASQ Certified Quality Auditor, 1996 – present.
Role in Preparing the EIS: Ms. Buhl oversaw the audit of DEIS tables, figures, and text to verify that the data presented in the EIS accurately and completely represents the source data.

Drew Carey: Principal Scientist, CoastalVision
Education: Ph.D. in Geology and Marine Biology from the University of St. Andrews, Scotland; B.Sc. in Geology and Biological Oceanography from The Evergreen State College
Experience: Dr. Carey is a marine environmental scientist with over twenty year's experience in benthic ecology, sedimentology, environmental monitoring, and marine policy. He is an internationally recognized expert in monitoring the environmental impacts of dredged material disposal and disposal site selection. CoastalVision has established projects compiling data for coastal management in Narragansett Bay, Long Island Sound and Massachusetts waters.
Role in Preparing the EIS: Dr. Carey led the assessment of fish resources in Long Island Sound based on existing inshore trawl data (Appendix H-6) and participated in the design of sampling plans for chemical, biological, and physical measurements. In addition, he supported the site screening efforts, GIS and document database development, and design of workshops for public outreach.

Valerie Cullinan, Ph.D.: Research Scientist, Battelle Marine Science Laboratory
Education: Ph.D. and M.S. in Biometry from Cornell University, B.S. in Zoology from Ohio State University.
Experience: Dr. Cullinan has over 16 years of experience in the statistical design, analysis, and interpretation of results from multidisciplinary experimental research. This research has focused on marine and freshwater environmental issues, particularly relative to dredged material disposal, environmental assessments, shellfish and fisheries studies, toxicity testing programs, and protocol development.
Role in Preparing the EIS: Dr. Cullinan conducted the statistical analysis of the benthic infaunal data for Bridgeport and Milford. She also assisted with the data interpretation and preparation of the summary report (Appendix H-2).

Paul Dragos: Senior Research Scientist, Battelle
Education: M.C.E. in Coastal Engineering from the University of Delaware; B.S. in Civil Engineering from the University of Delaware
Experience: Mr. Dragos is a physical oceanographer/coastal engineer with 22 years experience in estuarine and coastal ocean hydrodynamic measurement, data analysis, and interpretation in problems associated with water quality issues and coastal engineering works. He has lead research projects in the sediment transport, circulation, mixing, dilution, and transport of contaminants in various bays, harbors and estuaries throughout the U.S. and

particularly in the Northeast including the New York Bight, New York Harbor, Massachusetts Bay, and Long Island Sound. His experience includes field and modeling studies of ocean outfall monitoring, transport and fate of contaminants associated with dredged material, oil production, and sewage sludge, hydrodynamic measurement, and coastal engineering. These studies have contributed to numerous environmental assessment projects and provide Mr. Dragos with an extensive knowledge of transport and fate in marine water quality issues.
Role in Preparing the EIS: Mr. Dragos prepared the sections of the DEIS pertaining to physical oceanography. This included the analysis of available wind, wave and current data and the running of the STFATE numerical model of disposal plume behavior and the LTFATE model of sediment resuspension and transport.

Karen Foster: Program Manager/Fisheries Biologist
Education: M.S. in Oceanography from the University of Rhode Island; B.S. in Biology from the University of Connecticut
Experience: Ms. Foster specializes in fishery resource and environmental impact projects. She has more than 15 years of experience in fishery resource assessment and monitoring. Ms. Foster has used this expertise in preparing Environmental Impact Statements, conducting field studies to evaluate the feasibility of using artificial reefs as mitigation for habitat loss due to dredged material disposal, and preparing National Environmental Policy Act Section 7 biological assessments to identify impacts to threatened and endangered species. Before joining Battelle in 1989, Ms. Foster served as a Fishery Biologist with the National Marine Fisheries Service (NMFS) for 13 years.
Role in Preparing the EIS: Ms. Foster served as the Task Manager for the Socioeconomic section of the DEIS. She also is Program Manager of the Battelle contract under which this work is being conducted.

Thomas J. Fredette: Biologist, New England District, US Army Corps of Engineers
Education: Ph.D. The College of William & Mary, Virginia Institute of Marine Science; M.A. The College of William & Mary, Virginia Institute of Marine Science; B.S. University of Massachusetts, North Dartmouth.
Experience: Dr. Fredette has more than 20 years experience in marine science, focusing on benthic ecology, marine environmental monitoring, dredged material management, and contaminated sediment management.
Role in Preparing the EIS: Mr. Fredette acted as a technical and regulatory reviewer for the DEIS.

Mark L. Habel: Geologist, Navigation Section, Planning Branch, New England District, US Army Corps of Engineers
Education: J.D. Suffolk University Law School, B.S. in Geology, Northeastern University
Experience: Over 22 years experience in coastal geology, navigation project design, evaluation and construction, civil works planning and feasibility studies, and project management.
Role in Preparing the EIS: Mr. Habel acted as the Corps of Engineers Project Manager for the Long Island Sound study effort. He contributed to the preparation and editing of the Introduction, Purpose and Need, No Action and Alternatives sections of the DEIS.

Susan E. Holtham: Environmental Resource Specialist, New England District, US Army Corps of Engineers
Education: B.S. in Biology from Northeastern University; A.A. in Liberal Arts from Colby-Sawyer College
Experience: Ms. Holtham has over 20 years experience in managing and preparing NEPA documents for Corps of Engineers civil and military projects, including Environmental Impact Statements for the Base Realignment and Closure program, Environmental Assessments for the U.S. Army Reserve and National Guard, and EIS's associated with Corps of Engineers regulatory program permit actions.
Role in Preparing the EIS: Ms. Holtham assisted in overall project management of the preparation of the DEIS.

Christopher High: Chemist, New England District, US Army Corps of Engineers
Education: M.S. in Biochemistry from Brandeis University; B.S. Biochemistry from Florida State University
Experience: Over 8 years experience as a technical specialist responsible for development and preparation of NEPA documents for the Corps of Engineers civil and military projects. Tasks managed in support of NEPA documents included quality assurance reviews of analytical work (data and reports) conducted by outside contract labs and cost, budget, and schedule preparation.
Role in Preparing the EIS: Mr. High assisted the USACE project manager by serving as a technical lead for the DEIS. Duties included determining the appropriate level of field studies conducted in support of the DEIS, technical review of reports prepared in support of the DEIS, and review of the DEIS for technical accuracy.

Carlton Hunt: Research Leader, Battelle
Education: Ph.D. in Chemical/Geochemical Oceanography from the University of Connecticut; M.S. in Chemical Oceanography from the University of Connecticut; B.A. in Chemistry from Doane College
Experience: Dr. Hunt is a chemical oceanographer with broad experience in estuarine and coastal marine ecosystems. During the past 25 years, he has conducted and supervised projects involving the transport, fate, effects, and bioaccumulation of contaminants and water quality impacts of nutrients in diverse coastal systems including Long Island Sound, Narragansett Bay, Massachusetts Bay, New York Harbor, and New York Bight, and the Northwest Atlantic Ocean. His experience includes studies of the transport and fate of contaminants associated with soils, sediments, urban runoff, sewage sludge, sewage effluents and industrial wastes in the marine environment. He has supported the preparation of EISs that support dredged material site designations in the New York Bight and offshore of Rhode Island and southeastern Massachusetts.
Role in Preparing the EIS: Dr. Hunt served in a technical advisory role for the preparation of the DEIS, providing technical review and comments on drafts of the document. In addition, he prepared sections of the DEIS related to the general impacts of dredged material disposal in the coastal environment, lead the alternatives screening effort, facilitated discussions among agencies and provided public briefing support at the workgroup discussions.

Roy Kropp: Senior Research Scientist, Battelle
Education: Ph.D. in Zoology from the University of Maryland; M.S. in Biology from the University of Guam; B.S. in Zoology from the San Diego State University
Experience: Dr. Kropp is a specialist in benthic marine ecology, toxicology, and the systematics of crustaceans and mollusks with 19 years of experience. He has served as the principal investigator for or participated in marine environmental surveys in the tropical and boreal Pacific, off California, the Gulf of Mexico, along the Atlantic Coast of the United States, and in the Mediterranean. Currently, Dr. Kropp is the Senior Scientist for Benthic Biology for the Massachusetts Water Resources Authority Monitoring Program. Since matriculating to the Marine Sciences Laboratory from Battelle's Duxbury facility, Dr. Kropp has directed several toxicological studies involving the testing of marine and freshwater species. He was the technical project manager for the preparation of the Final Environmental Impact Statement being prepared for the Providence River dredging project by the US Army Corps of Engineers.
Role in Preparing the EIS: Dr. Kropp prepared the affected environment and impact text for benthic infauna, plankton, and shellfish sections of the DEIS. He prepared supporting technical reports for the Bridgeport and Milford Alternative sites (*e.g.*, sediment quality triad, toxicology, benthic infauna). Dr. Kropp also provided technical review and comments on drafts of the document.

Lisa Lefkovitz: Principal Research Scientist, Battelle
Education: M.S. in Water Chemistry from the University of Wisconsin; B.S. in Chemistry from Case Western Reserve University
Experience: Ms. Lefkovitz is an environmental chemist with more than 15 years of experience related to evaluation of chemical contaminants in the marine environment. Ms. Lefkovitz is currently managing the Rhode Island Region Long Term Dredged Material Disposal Study project which includes preparation of an EIS for the Corps in support of designating a new offshore dredged material disposal location in Rhode Island Sound. As part of the LIS EIS, Ms. Lefkovitz managed all activities related to chemical analysis and reporting of contaminants in tissues collected within Long Island Sound. She also prepared the general and site specific affected environment sections describing the results of the tissue chemical analyses.
Role in Preparing the EIS: Ms. Lefkovitz served as task manager for all chemical analyses of tissue samples for the Long Island Sound Study Effort. She reviewed data quality and prepared final reports containing the results of all analyses. Ms. Lefkovitz also prepared the sections of the DEIS summarizing contaminants in tissues in Long Island Sound.

Lynn McLeod: Research Scientist, Battelle
Education: B.S. (Honors) in Environmental Science from Marist College; A.S. (Honors) in Environmental Science from Southern Vermont College
Experience: Over 14 years experience in environmental science, including work in biological and environmental assessments, environmental impact statements, monitoring plan development, chemical analysis, data management, quality assurance, and large-scale document production. Ms. McLeod was a task manager on the Providence River and Harbor Maintenance Dredging Project Final EIS and assisted in the preparation of the Historic Area Remediation Site Supplemental EIS.

Role in Preparing the EIS: Ms. McLeod authored the ZSF and site screening descriptions, as well as the birds, mammals, and endangered species sections. She also authored portions of the SMMPs. She served as Battelle's deputy project manager and directed editing and production.

Derek Michelin: Research Scientist, Battelle
Education: M.S. in Ocean Engineering from the University of New Hampshire; B.S. in Mechanical Engineering from the University of New Hampshire
Experience: Mr. Michelin has 5 years experience in engineering and at-sea deployment of moorings and mechanical systems for operation in the ocean environment software development as well as experience in signal processing, database development and GIS mapping. Mr. Michelin has participated in the development of rapid current oil containment devices as well as offshore aquaculture equipment. His engineering experience also includes the development of in situ sampling devices and sample processing systems. His programming experience includes the development of software with the ability to non-invasively measure the motion of objects as well as more specialized software for use in assessing oil boom failure.
Role in Preparing the EIS: Mr. Michelin gathered input data for and ran the erosion models STFATE and LTFATE.

Grace Neff: Quality Auditor, Battelle
Education: Ph.D. in Organic Chemistry from the University of Illinois; B.S. from the University of Illinois College of Pharmacy
Experience: Dr. Neff has approximately 18 years of experience in the field of environmental chemistry. Her background includes the synthesis of organic compounds, the analysis of marine samples for pollutants and managing environmental research projects. She was involved in developing detection and quantification methods for several phthalate pollutants. Dr. Neff joined the Quality Assurance Unit at Battelle in 1993 and participates in the auditing of environmental data. Her responsibilities include conducting statistical random data audits to determine the accuracy and completeness of raw vs. reported data and for reporting the results of audits in written reports to management.
Role in Preparing the EIS: Dr. Neff aided in the verification of data tables used in the DEIS as well as the concurrence of tabular data and text. She also assisted in the literature search for the DEIS.

Marcos (Marc) Paiva: Archaeologist, New England District, US Army Corps of Engineers
Education: PhD candidate in Anthropology, Brandeis University; M.A. in History/Historical Archaeology, University of Massachusetts at Boston; B.A. in History, University of Massachusetts at Dartmouth.
Experience: Mr. Paiva has twelve years of experience in cultural resource management including archaeology, architecture, and history. He is involved in reviewing and managing cultural resource management contracts, agency compliance for cultural resources, providing input to Environmental Assessments and Environmental Impact Statements as well as producing specific archaeological reports and cultural resource management plans for Corps

facilities and reservoirs. He also acts as the Corps District Tribal Coordinator responsible for insuring proper consultation with New England Federally Recognized Tribes.
Role in Preparing the EIS: Mr. Paiva was responsible for the historic and archaeological resources section of the DEIS and assisted with appropriate coordination with regulatory agencies and others.

Ann Rodney: Environmental Protection Specialist, USEPA
Experience: 15 years experience with U.S. EPA, including work with special projects in the Regional Administrators office, public relations with the Superfund program, Boston Harbor Residuals Environmental Impact Statement, Mass. Bay Disposal Site Environmental Impact Statement, National Estuary Programs, administration of Section 312 of the Clean Water Act.
Role in Preparing the EIS: Ms. Rodney participated in the development and implementation of all aspects of the public outreach program, including the review and writing of documents.

Erika Schaub: Researcher, Battelle
Education: M.E.Sc. in Conservation Science from Yale School of Forestry and Environmental Studies; B.S. in Biology, Minor in Mathematical Sciences from Loyola College, MD
Experience: Ms. Schaub has worked in the environmental field for the past four years and has experience in preparing EIS/EA's for The Wilderness Society.
Role in Preparing the EIS: Ms. Schaub assisted with the preparation of the military usage and mineral/energy development sections in the socioeconomic portion of the DEIS.

Bill Steinhauer: Senior Environmental Chemist, Battelle
Education: M.S. in Chemistry from Northwestern University; B.S. in Chemistry from Lake Forest College
Experience: Mr. Steinhauer has more than 25 years experience in environmental chemistry and coastal marine monitoring, including 18 years with Battelle. During this period, he has conducted and supervised research projects involving the transport, fate, effects, and bioaccumulation of contaminants, and is a recognized expert in the fate and effects of organic contaminants in the environment. Mr. Steinhauer's laboratory and management experience includes methods development and analysis of trace levels of petroleum- and combustion-related hydrocarbon contaminants in the environment. He is the author of many environmental reports and scientific papers, including those relating to assessments of contaminated sediment, dredged material testing, municipal and industrial discharges into the coastal zone, and oil spills, as well as methods papers and contaminant residence time studies.
Role in Preparing the EIS: Mr. Steinhauer acted as task manager for the environmental, geophysical, and archeological assessments at the Milford and Bridgeport historical sites and assisted in the preparation of several project-related reports and fact sheets. Mr. Steinhauer also prepared the sections on water quality in DEIS.

Tracy Stenner: Project Manager, Battelle
Education: M.S. in Marine Ecology from Northeastern University; B.S. in Biology from Emory University
Experience: Ms. Stenner has 17 years of project management and environmental science and engineering experience working with public and private sector clients. Her project management experience has focused largely on the preparation of National Environmental Policy Act (NEPA) documents – Environmental Assessments (EAs), Environmental Impact Statements (EISs), and Findings of No Significant Impact (FNSIs) – and the preparation of associated technical reports (e.g., biological assessments, essential fish habitat assessments, and coastal consistency documentation). She has also managed a variety of multidisciplinary environmental and engineering projects for other government clients.
Role in Preparing the EIS: Ms. Stenner served as the Project Manager, as well as one of the authors and technical reviewers. Ms. Stenner leads Battelle's contributions to this DEIS Project and coordinates with USACE and USEPA project leads.

Patty White: Senior Research Scientist, Battelle
Education: M.S. in Geology from the University of Washington, Seattle, WA; B.S. in Geology from Kent State University, Kent, OH
Experience: Ms. White has 18 years of experience as a geologist and has focused for the past 10 years on sediment quality assessment. Ms. White has served as a project geologist for dredged material disposal studies and has participated in multidisciplinary sediment studies that include site characterization, ecological and human health risk assessments, and feasibility studies.
Role in Preparing the EIS: Ms. White contributed to the sections of the DEIS that addressed geological setting, geomorphology and sediment quality.

Corey Wisneski: Research Associate, Battelle
Education: M.E.M. in Coastal and Watershed Systems from Yale School of Forestry and Environmental Studies; B.A. in Anthropology from Boston University
Experience: Ms. Wisneski has two years experience with researching and writing Environmental Impact Statements. In addition, she has experience addressing habitat and predator issues associated with a threatened species and has participated in the creation of reports for ballast water testing methods, combined sewer overflows, and estuarine environmental indicators.
Role in Preparing the EIS: Ms. Wisneski contributed to the affected environment and environmental consequences sections of the EIS, as well as assisting with the fisheries and avian sections.

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