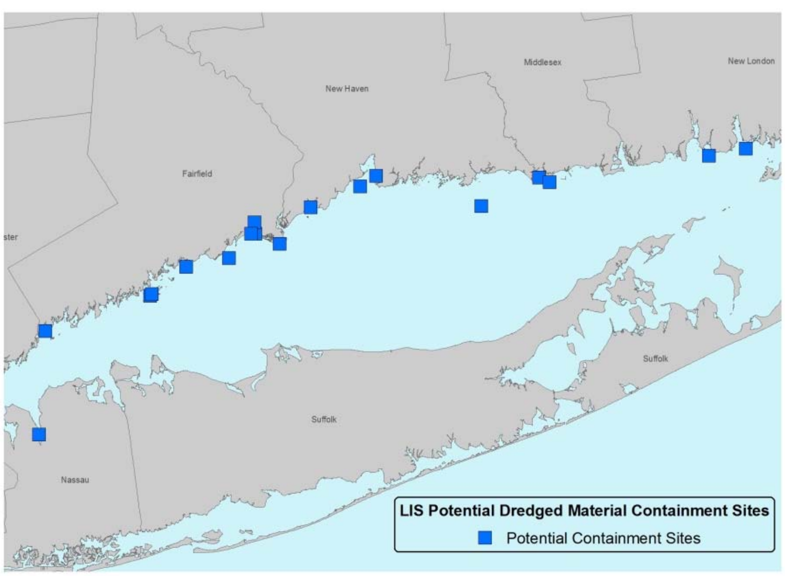
# FINAL

# Long Island Sound
# Dredged Material Management Plan (LIS DMMP)
# Investigation of Potential Containment Sites for Placement of Dredged Materials

**Contract No. W912WJ-09-D-0001-0040**





Prepared For:
United States Army Corps of Engineers
New England District
696 Virginia Road
Concord, MA 01742

Prepared By:
Woods Hole Group, Inc.
81 Technology Park Drive
East Falmouth, MA 02536



November 2012

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**Prepared by:**
Woods Hole Group
81 Technology Park Drive
East Falmouth MA  02536
(508) 540-8080

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# EXECUTIVE SUMMARY

This report provides an evaluation of dredged material containment site alternatives in Long Island Sound (LIS) for placement of dredged materials. The types of containment facilities considered include Confined Aquatic Disposal (CAD) cells, shoreline Confined Disposal Facilities (CDFs), and island CDFs. The work was prepared within the larger context of the ongoing Long Island Sound Dredged Material Management Plan (LIS DMMP), which includes reports that evaluate dredged material placement at nearshore berms (Woods Hole Group, 2012), upland, beneficial use, and sediment dewatering sites (Battelle, 2009; Woods Hole Group, 2010), as well as small site alternatives for potential non-federal projects (Battelle, 2011).

This report includes a general description of dredged material containment methods, a summary of previously developed or proposed containment projects in LIS and elsewhere, a site-by-site assessment of candidate sites in the LIS study area, and an estimated capacity for dredged material at each site. Preliminary engineering designs are also discussed, as well as a summary of potential impacts. The summaries include site-specific evaluation matrices that provide qualitative descriptions of potential impacts from construction or maintenance of the candidate containment facilities. Potential impacts to local environmental, cultural, and physical resources and marine infrastructure are addressed.

This report derives preliminary design criteria for the containment site alternatives (CAD and CDF) primarily from previous feasibility analyses. When previous designs were not available for CDFs, this report uses site-specific average depth and dike elevation (derived from adjacent upland for shoreline CDFs, or tidal information for marsh and island CDFs) along with standard engineering assumptions (dike crest width of 12 feet and slope of 1.5:1 H:V) to formulate a preliminary design and volume estimate. Total capacity of the containment alternatives evaluated here is 175,264,000 cubic yards (cy) with most of that volume in either island CDFs (88,770,000 cy) or shoreline CDFs (83,600,000 cy). Total CAD capacity is 2,894,000 cy. The range of estimated volumes in the individual containment sites is 270,000 to 58,250,000 cy. Containment sites can accommodate a wide range of sediments, including the finer grain sizes more likely to be found in harbors and navigation channels.

The evaluation of potential impacts suggests the following:

- Potential impacts to shipwrecks, Federal and State listed species habitat, shellfish, federally managed species habitat, birds, marine mammals, recreational areas, and sediments are frequently or always encountered at containment site alternatives.
- Potential impacts to archaeological resources, terrestrial wildlife, commercial and industrial facilities, aquaculture sites, and existing dredged material disposal sites are rarely or never encountered at containment site alternatives;

Comparison of impacts at the containment site alternatives reveals areas with the least potential to adversely impact the surrounding resources. The impact matrices are also useful in identifying relative differences between the LIS sites evaluated. Site-specific assessments would be completed prior to construction of any CAD or CDF, to further define the extent and magnitude of impacts to particular resources.

# 1.0 INTRODUCTION

In June 2005, the Environmental Protection Agency (EPA) designated two open water dredged material disposal sites in LIS to provide long-term, environmentally acceptable disposal options for potential use by Federal, State, municipal, and private entities that dredge channels, harbors, marinas and other aquatic areas in LIS. The Designation Rule (40 CFR 228.15(b)(4)) anticipated the development of a regional Dredged Material Management Plan (DMMP) for LIS and identified a timeline for completion of the DMMP or the use of the sites under the designation rule would be suspended. The rule also specified that the timeline could be extended under identified circumstances. Subsequent to the publication of the Designation Rule, EPA, the U.S. Army Corps of Engineers (Corps), and appropriate Federal and State resource agencies agreed to partner in the development of a LIS DMMP. The process was initiated in 2007, and when completed, the LIS DMMP will include an in-depth analysis of all potential dredged material management alternatives including open-water placement, beneficial use, confined aquatic placement, upland placement, and innovative treatment technologies. Dredging proponents may use this plan in developing alternatives analyses for dredging in LIS.

The LIS DMMP will assess potential dredged material management options. Prior studies for the DMMP have documented options for dewatering, upland disposal, and various beneficial uses such as beach nourishment, wetlands restoration, etc. This study builds on prior work to assess containment options including confined aquatic disposal (CAD) cells, shoreline Confined Disposal Facility (CDF) sites, and island CDF sites.

This report includes a general description of dredged material containment methods, a summary of previously developed or proposed containment projects in LIS and elsewhere, a site-by-site assessment of candidate sites in the LIS study area, and an estimated capacity for dredged material at each site. Preliminary engineering designs are also discussed, as well as a summary of potential impacts. The summaries include site-specific evaluation matrices that provide qualitative descriptions of potential impacts from construction or maintenance of the candidate containment facilities. Potential impacts to local environmental, cultural, and physical resources and marine infrastructure are addressed.

The study area includes the waters and adjacent coastal zone from Throgs Neck in the west to Montauk Point and Watch Hill Point in the east including the waters of Long Island Sound, Fisher’s Island Sound, Peconic Bay, Gardiners Bay and western Block Island Sound and tributaries to these waters (Figure 1).

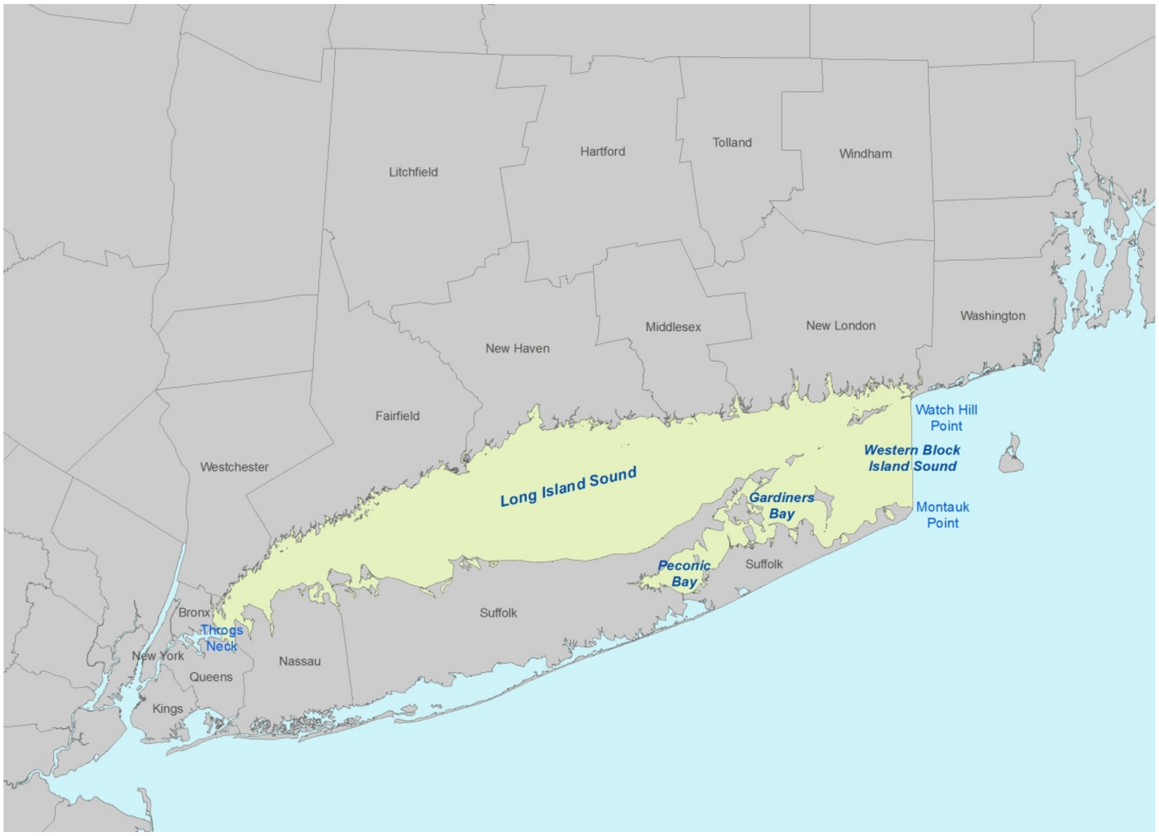


**Figure 1.** **Study area for LIS DMMP.**

# 2.0 BACKGROUND INFORMATION AND CANDIDATE SITES

This section provides a review of documents previously developed in support of the LIS DMMP and discusses current methods for design and construction of containment sites. Following the review of design and construction methods is a survey of four existing island CDF projects. This survey includes summaries of design, construction, environmental aspects and economic profiles for each island CDF project. A summary of Federal regulations governing the transport and disposal of dredged material in LIS, and the role of state agencies in regulatory oversight, is provided. Finally, a list of candidate containment sites reviewed under this study is presented.

## 2.1 REVIEW OF BACKGROUND DOCUMENTS

The USACE has prepared several documents relevant to dredged material management options in LIS. The documents reviewed during the preparation of this report include:

- *LIS DMMP Phase I and Phase II Literature Review Updates.* The Phase I and Phase II literature review updates include a database and written report on data sources relevant to LIS dredging and dredged material disposal. The database and report provided several information sources that were used to evaluate potential impacts associated with containment sites (Woods Hole Group, 2009, 2010b).
- *1979-1985 Long Island Sound Study of Dredged Material Containment.* These documents include a list of potential dredged material containment sites throughout Long Island Sound evaluated during the 1980s, including design specifications for some candidate sites selected through the feasibility process. The documents provided an initial list of candidate containment sites included in this assessment (USACE, 1979, 1980, 1981, 1983, 1985a).
- *2010 Federal-State Regulatory Update*. This document summarizes regulations relevant to dredged material management in Long Island Sound. The document provided background for discussions with State and Federal Agency representatives regarding the acceptability and regulatory issues related to the construction of dredged material management sites in Long Island Sound (USACE, 2011).

## 2.2 CONTAINMENT SITE METHODS

This report addresses three types of containment site technologies: CAD cells, shoreline CDFs, and island CDFs. The following describes the construction methods of, and engineering constraints on, each of these containment site technologies.

The descriptions are based on the design and operation assumptions provided by the Corps and other publications (NRC 1997; Palermo 1997, 1996a, 1996b, 1996c; USACE 1996) unless otherwise indicated.

### *2.2.1 Confined Aquatic Disposal*

CAD cells are existing sea floor depressions and borrow pits or newly-excavated pits that can be filled with dredged materials.

**Construction Methods**

There are generally three categories of such pits (NYNJ, 1999):

- Existing pits such as borrow pits whose capacity is limited by their existing size;
- Newly excavated pits which require the excavation of a volume of material equal to or greater by 25% than the intended capacity of the pit; and,
- In channel pits which are excavated within the confines of a channel or berthing area below its authorized depth. This option minimizes impacts to undisturbed areas by utilizing previously excavated sites. It also has the potential to optimize dredging operations and lessen costs by reducing the transport distances of dredged material.

CAD cells can be filled via surface release or other controlled means (e.g., hydraulic offload or submerged diffuser). Lateral containment (i.e., the sides of the depressions) is used to restrict movement of sediment from the CAD, and a coarse-grained cap layer can also be used to control resuspension and restrict movement of sediment from the CAD. CAD cells are generally constructed in water depths of 5 to 100 feet (average 25 feet) in areas of low to moderate energy. The preferred foundation type is stiff clay; however, CAD cells have been constructed successfully in sandy substrates. The construction sequence usually involves multiple cells that are filled, capped if necessary, and closed in sequence within a single CAD footprint. The final cap, if specified, is usually clean sand whose thickness is site dependent (Palermo et al., 1998).

**Engineering Considerations**

CAD cells are generally constructed in environments where hydrodynamic characteristics (i.e., limited wave action and wave-induced currents) do not enhance dispersion of dredged material during placement. Water depth is also an important siting factor. A water depth greater than 100 feet complicates excavation activities and results in increased dispersion during placement. However, water depths less than 15 feet can restrict barge access. The stability and quality of the sediment bed are also important siting factors. The thickness of the sediment cap (where necessary), the equipment and dredging techniques selected, and the disposal schedule with respect to tidal currents determine the success of the disposal alternative.

Potential impacts of CAD operations (e.g., dredging, filling, and capping) on the surrounding habitat are another important consideration. The CAD pit alters existing sea floor habitat, and has the potential to permanently change habitat if the CAD is capped with sediment that differs from the in situ material. Because operations at the CAD pit are below the sea floor elevation, modification of wave energy regimes is limited, as compared to a structure rising above mean high water.

### *2.2.2 Nearshore Confined Disposal*

Nearshore CDFs are constructed in shallow coastal water adjacent to land (e.g., peninsulas) and use confinement, retention dikes or other structures to isolate the dredged material from the surrounding water. One or more dikes are constructed to enclose the near-shore CDF. In many cases, one of the sides is land. The dikes are constructed to an elevation above mean high water to allow ponding of water and retention of dredged material. Direct interchange between CDF water and surrounding water is restricted. However, clarified effluent is released from CDFs following settling of solids via a system of weirs or pipes. Upon closure of the CDF, a clean cap of sediment is typically placed on the surface of the dredged materials.

**Construction Methods**

Nearshore CDFs may be built of materials such as armored stone/sand, steel sheet pile or geotextiles, and the dike is designed to withstand storm forces, waves, winds and wakes that it would typically be exposed to. The land created from this process can then be used for a variety of purposes including wetland and upland habitat creation, commercial development (typically Port related), or recreational uses (NYNJ, 1999).

Nearshore CDF operations begin at the dredging site where a clamshell or hopper dredge loads a barge with dredged material. The dredged material is offloaded at the CDF by hydraulic piping that extends over the dike wall. Smaller volumes of dredged material can be offloaded using a clamshell. In cases where the dredged sediments contain contaminants, the filling sequence should be carefully controlled to minimize the potential for contaminant release from the CDF. Dredged sediments with comparatively lower potential for adverse impact are typically placed in the CDF during the initial stages of filling. The cleaner materials at the bottom of the CDF act as an ad hoc liner to retard and attenuate leachate from subsequent placement of the more contaminated materials. Many CDFs receive a final cap of clean sediments.

**Engineering Considerations**

A number of factors are important in locating an appropriate site for a nearshore CDF. In most cases the construction is limited by water depth because it can be difficult to construct dikes in deep water for the containment of large volumes of sediment. The quality of the site is an important siting factor. For example, the relative depth to firm foundation strata or rock layers influences the excavation depth and, therefore, the volume capacity of the CDF. Bottom sediment properties are a significant siting factor because the bottom sediment properties influence the dike height and thus the volume capacity of the CDF. For solid dike construction, sandy sediments are preferred because they have high shear strengths. However, fine-grained sediments are preferred as underlying layers because they are more resistant to movement of contaminants into groundwater. Also, these fine-grained sediments may compact under the load of the fill, thus increasing the storage capacity of the CDF over time. Palermo (1996c) states that it is likely that the more desirable shear strength characteristics of sandy sediments would outweigh the permeability and consolidation advantages of fine-grained sediments. The extent of in-place contamination is an important siting factor with implications for dike construction and excavation of material to create storage. If a nearshore CDF is constructed in an area of contaminated sediments, these sediments may be resuspended during construction activities, but they will also be removed or covered by the CDF, thus minimizing transport of existing contamination and eliminating potential exposure. Areas of low sediment activity (i.e., with a lack of significant bedforms) are preferred because potential impacts of nearshore CDFs are presumably greater in areas where sediments are moving in response to tidal, wave, and storm energies. Physical parameters and design features are also important considerations in selecting a site for a nearshore CDF. The hydrodynamics (i.e., direction of prevailing currents) is an important siting consideration. If constructed within an intertidal area, nearshore CDFs can cause hydrodynamic changes (e.g., impacts on tidal ranges, wave/current action, shore erosion, sedimentation, circulation/DO and other water quality parameters). Proximity to potential exposure zones, such as bathing beaches, environmentally sensitive areas, wetlands, or water intakes are also important considerations when estimating exposure to environmental and human receptors.

Potential impacts of CDF operations (e.g., dredging, filling, and capping) on the surrounding habitat are another important consideration. The nearshore CDF eliminates some portion of intertidal and subtidal habitat; however, depending on the design elevation of the final site, new coastal wetland and species specific habitat can be created. Interactions between the dike structures and coastal processes can adversely impact nearby wetland communities, although design features can be incorporated to minimize these impacts.

NYNJ (1999) summarizes considerations that should be addressed in planning nearshore CDFs. These include: permanent loss of nearshore aquatic habitat and associated species; effect of effluent on adjacent water quality; groundwater contamination; human and ecological risk associated with contaminant uptake; prehistoric archaeological sites; nearshore cultural resources (piers, waterfront structures).

### *2.2.3 Island Confined Disposal*

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

#### Construction Methods

Island CDFs are constructed so that retaining dikes completely enclose the facility, isolating the dredged material from adjacent water during placement. The dikes are constructed to an elevation above the mean high water elevation to allow ponding of water and retention of dredged material. Direct interchange between the CDF and surrounding water is generally restricted; however, some island CDFs have been designed to create shallow wetland habitats that flood as a result of daily tidal action. Effluent is released from CDFs following settling of solids via a system of weirs or pipes. Upon closure of the island, a clean cap of sediment is typically placed on the surface of the dredged materials.

Island CDF operations begin at the dredging site where a clamshell or hopper dredge loads a barge with dredged material. The dredged material is offloaded at the CDF by hydraulic piping that extends over the dike wall. Smaller volumes of dredged material can be offloaded using a clamshell. After the island CDF or one of its internal divisions is filled, a final cap is typically placed over the dredged material. Depending on the nature of the dredged material and the intended use of the CDF, capping may not be necessary. Dredged sediments with comparatively lower potential for adverse impact are typically placed in the island CDF during the initial stages of filling. The cleaner materials at the bottom of the CDF act as an ad hoc liner to retard and attenuate leachate from subsequent placement of the more contaminated materials. Many island CDFs receive a final cap of clean sediment depending on the intended final use.

**Engineering Considerations**

Potential sites for an island CDF are generally between 1 and 5 miles from shore. Water depth greatly influences construction costs for islands and water depths no greater than 100 feet are necessary for dike construction. Water depths of 25 feet or shallower are preferable so that conventional approaches can be used for construction. Properties of bottom sediment influence the dike height and thus the volume capacity of the CDF. For solid dike construction, sandy sediments are preferred because they have high shear strengths. However, fine-grained sediments are preferred as underlying layers because they consolidate under load of the fill, thus increasing the storage capacity of the CDF over time. It is likely that the more desirable shear strength characteristics of sandy sediments would outweigh the permeability and consolidation advantages of fine-grained sediments. The relative depth to firm foundation strata or rock layers is a siting consideration because this depth influences the excavation depth and hence the volume capacity of the CDF. The extent of in-place contamination is also an important siting factor with implications regarding dike construction and excavation. If an island CDF is constructed in an area of contaminated sediments, these sediments may either be removed or covered by the CDF. The covering of these sediments will presumably have a net positive environmental impact. Physical parameters and design features are also important considerations in selecting a site for an island CDF. Surface area and aspect ratio (ratio of possible length to width) are critical design features because these parameters control the potential capacity of the CDF. A circular or near-circular shape is preferred because this geometry provides the highest surface area per unit of dike length. Areas of low sediment activity (i.e., with a lack of significant bedforms) are preferable because potential impacts of island CDFs are presumably greater in areas where sediments are moving in response to tidal, wave, and storm energies. Hydrodynamics (i.e., direction of prevailing currents) and proximity to potential exposure zones, e.g., bathing beaches, environmentally sensitive areas such as wetlands, or water intakes are also important siting factors when evaluating impacts to human and ecological receptors.

Potential impacts of island CDF operations (e.g., dredging, filling, and capping) on the surrounding habitat are another important consideration. If transportation distance is limited between the dredge site and the island CDF, overall habitat influences can be moderated. The island CDF eliminates sea floor habitat, but can also create new shallow water wetland and/or terrestrial habitat. Finally, construction activities and the island itself can impact hydrodynamic processes such as shoreline erosion, wave/current action, sedimentation and circulation that in turn influence the extent of the intertidal zone, dissolved oxygen, and other water quality parameters.

NYNJ, (1999) summarizes considerations that should be addressed in planning island CDF sites. These include permanent loss of benthic and associated species; permanent loss of water column habitat; effluent discharge to water column; effect on shoreline due to changes in wave energy and/or approach; hazards to navigation; and, prehistoric resources.

## 2.3 REVIEW OF EXISTING ISLAND CDFS

The following summarizes the development of four existing island CDFs, based on the available literature:

- Hart Miller Island, Chesapeake Bay
- Poplar Island, Chesapeake Bay
- Craney Island, Norfolk Harbor
- Pier 400 & Pier T, Port of Los Angeles

These sites are large-capacity placement areas for dredged material. They are large, capital-intensive projects that take a great deal of time and resources to construct and manage. Development requires Federal, State and Port Authority partnerships and cost sharing. A significant revenue stream is necessary for sponsoring port authorities and agencies to participate in such projects.

These projects also provide ancillary services related to their ultimate uses, such as provision of wildlife habitat or industrial facilities. Specifically, Hart-Miller and Poplar Islands provide wildlife habitat and recreation areas, while Craney Island and the Port of Los Angeles projects are commercial marine terminals.

### *2.3.1 Hart-Miller Island*

Hart-Miller Island is a 1,140 acre dredged material containment site east of Baltimore, MD. The constructed site connects two separate natural islands, Hart and Miller. The islands are part of a historic island chain at the mouth of the Back River in Baltimore County, MD. Severe erosion had reduced the size of the islands and the dredged material placement was originally aimed at reinforcing the island remnants. The project was proposed in 1970 and after six years of studies and public meetings it was approved. Construction began in 1981.

The project was designed to receive dredged sediments from Baltimore Harbor and other nearby channels. It is divided into two subcontainment cells (Figure 2.2-1), a north cell of approximately 800 acres and south cell of approximately 300 acres. Dikes were constructed in lifts, and were ultimately raised to a height of 48 feet, but they will be lowered once the material settles. The south cell on the island was completed first and is currently managed as a wildlife reserve; the north cell was closed to new material in 2009 and will be a wildlife management area as well. The site has accepted approximately 100 million cubic yards of dredged material. The island received material from harbor dredging as well as chromium-contaminated material from a remediation site at Allied Signal Corporation.

**Figure 2.2-1. Hart-Miller Island Containment Cells – Chesapeake Bay.**

### Construction

Construction of Hart-Miller Island began by building a dike connecting the remnants of Hart and Miller Islands and encompassing an open-water area of approximately 1,100 acres. The dike was constructed of sandy sediments excavated from the proposed interior of the facility. The eastern or Bay side of the dike was reinforced with filter cloth and rip-rap to protect the dike from erosion. Completed in 1983, the dike is approximately 29,000 feet long and is divided into North and South Cells by a 4,300 foot interior cross-dike. Placement of dredged material within Hart-Miller Island began with dike completion in the early 1980's and continued through 2009.

### Environmental Aspects

Hart-Miller Island supports many species, especially during migration (shorebirds) and in winter (waterfowl). Bird monitoring studies indicate 282 species of birds have been observed on or in the vicinity of Hart-Miller Island (Erwin and Beck, 2007). For nesting species, populations have been established but the results have been mixed. While State species of concern such as Least and Common Terns have nested in the area, bird predators (red fox, raccoon, great horned owls, and peregrine falcons) have kept populations depressed.

An extensive monitoring program was required by the Clean Water Act. Under section 404, permits for dredged material disposal can be rescinded if it is determined that discharge of such materials will have an unacceptable adverse impact on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. This federal mandate, along with a special condition of the MD State Wetlands License 72-127(R), required a long-term compliance monitoring program for Hart-Miller Island. Results from the monitoring are used to detect changes from baseline environmental conditions and to guide decisions regarding possible operational changes and remedial actions.

The monitoring program has evolved over the years in response to changes in technology and sampling protocols. For example analytical methods to detect trace metal burdens in sediments and benthic macroinvertebrates changed as improved technologies with lower detection limits and greater sensitivity were developed. Fish and crab population studies were discontinued after Year 5 due to the ineffectiveness of the information as a compliance monitoring tool. Beach erosion studies were discontinued in Year 13 after beach nourishment and breakwater stabilization occurred. The current monitoring includes sediment chemistry (metals), sediment toxicity (benthic tissue concentrations of metals and organics in the brackish-water clam, *Rangia cuneata*) and benthic community studies (macroinvertebrate assemblages).

**Other Issues**

World War II vintage ordnance was found on a debris barge after dredging, and had to be detonated on the island. Subsequently dredged material was sorted on the island to identify and remove ordnance, and any ordnance identified was detonated in a safety zone around the work area. Part of the island is used as a public beach so the identification of ordnance in the dredged material requires vigilance to provide public protection.

**Economics**

Hart-Miller Island project costs were estimated at $667 million in 2007 (Erwin and Beck, 2007). The non-Federal cost-share partner for this project is the Maryland Port Administration DMMP. The cost to place material at Hart-Miller Island was about $3 per cubic yard, compared with about $9-11 per cubic yard at other placement sites, making it an economical alternative. Some areas on the island are now used for boating and beaching. Several acres were designated as a State Park. Maryland Department of Natural Resources has management responsibility for the island.

### *2.3.2 Poplar Island*

Like Hart-Miller, the Poplar Island project consisted of reconstructing a severely eroded island as an environmental restoration project. Information on the project can be obtained from Derrick et al. (unspecified date). The island was about 1,100 acres in the mid-1800s but had eroded down to about 1 acre by the 1990s. The Island was rebuilt using uncontaminated dredged material from the Baltimore Harbor and Channels Federal navigation projects. The rebuilding of the island involved placing, shaping and planting approximately 68 million cubic yards of dredged material to create 1,715 acres of wetland, upland, and open water habitat (Figure 2.2-2).

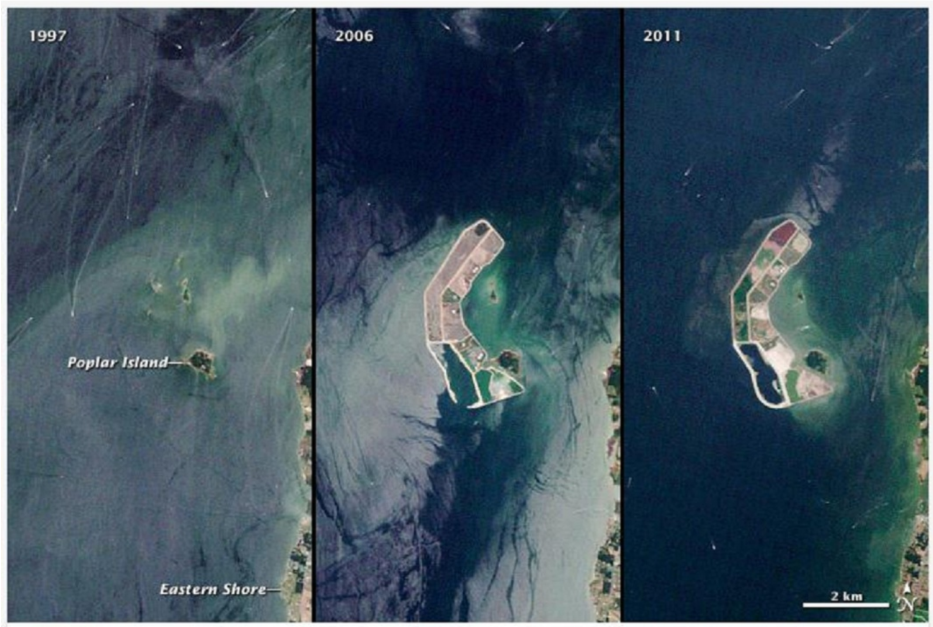


**Figure 2.2-2. Poplar Island footprint, 1997, 2006, and 2011.**

## Construction

Construction began with containment dikes, which were built in phases. The first phase involved enclosing a 640 acre area and a breakwater between the dike and Coaches Island to protect Poplar Harbor. The second phase involved the construction of dikes to enclose the remaining 500 acres. The third phase involved incrementally raising the dikes in the upland areas from an initial elevation of 10 feet Mean Lower Low Water (MLLW) to an elevation of just over 20 feet MLLW. A new expansion project will raise the upland dikes to 25 feet MLLW. Construction-related challenges included construction of a solid dike over soft foundation soils (Century Engineering, 2012).

The material for the project originated from maintenance dredging of the approach channels to Baltimore Harbor. As the cells of the project are filled, these cells are planted to create wetland habitat. Created wetlands include approximately 80% low marsh and 20% high marsh. Small upland islands, ponds and dendrite guts will be created to increase habitat diversity within marsh areas. Habitat diversity will also be increased in the upland by constructing small ponds and providing both forested an open scrub/shrub areas.

Currently a northeasterly expansion of the island is planned (USACE, 2011c; USACE 2012a). The expansion plans include a 5 foot vertical extension of the existing upland cell dikes and a 575 acre lateral expansion of the island. Plans include creation of 270 acres of upland habitat, 165 acres of tidal wetland, and 140 acres of open water embayment. The expansion will extend the placement life of the project until 2029 with a capacity of 68 million cubic yards of material.

**Environmental Aspects**

As the project was developed, a series of discussions with various wildlife protection groups and other stakeholders led to the development of a set of priority resources that should be considered for restoration. These included waterbird species, wetlands, submerged aquatic vegetation, marsh fishes, and diamondback terrapins. When construction began all of the mobile species relocated to other areas due to noise and human activity. However, many species subsequently returned to the area. Nuisance species including predators, gulls, mute swans and Canada geese also colonized the area, and predator control programs now include shooting adults (gulls and geese) or oiling/addling eggs (swans, gulls). This is generally done by US Department of Agriculture Wildlife Services personnel.

**Economics**

The Poplar Island project was funded as a cost-share project with the Maryland Port Administration. The total project cost is estimated at 667 million (USACE 2012a).

### *2.3.3 Craney Island*

The Craney Island Dredged Material Management Area (Craney Island) is a man-made 2,500 acre dredged material placement site at the confluence of the Elizabeth and James Rivers in Portsmouth, Virginia. Information on the site is available from Craney Island Design Partners (2008), and the Port of Virginia and USACE (2012). Craney Island is one of the earlier dredged material containment islands. It was authorized by Congress in 1946 and construction was completed in 1958. The site receives navigation related dredged material from private and public dredging projects bounded by the Hampton Roads Bridge Tunnel on the west, to the James River on the north, and the entire Elizabeth and Nanesmond Rivers. A current expansion project (the Eastward Expansion project) has 40 million cubic yards additional capacity.

Although it was originally designed for a 20-year life span, the life of the facility was doubled using engineering and management techniques. However, in the early 1990's the Corps recognized that other options were needed for long-term disposal of dredged material in Norfolk Harbor. At the same time, the Virginia Port Authority recognized that a fourth State-owned marine terminal would be required to meet long-term cargo handling needs in Hampton Roads. The result was a plan to use dredged material to expand Craney Island to the east, and to provide a new marine terminal.

In accordance with the National Environmental Policy Act (NEPA), the Corps evaluated a total of 51 alternatives for dredged material placement and a total of 25 port alternatives for container handling capacity. An eastward expansion emerged as the best solution to increase the capacity of Craney Island for dredged material and also provide an area to construct the fourth marine terminal.

The final Feasibility Study for the project recommended an eastward expansion of Craney Island, with a future project planned to strengthen the western dikes. The Virginia Port Authority (VPA) and the Corps are cost-sharing and constructing the

Eastward Expansion project. The western dike strengthening project is not required until about 2025 and will be delayed until an undefined date.

The Eastward Expansion project will extend the footprint of the existing site and provide a marine terminal for cargo vessels (Figure 2.2-3). Expansion cell dikes are being constructed from the existing eastern dike into the Elizabeth River, and the cell will be filled with dredged material. A deep water channel (50 foot depth) and berthing area will be dredged to allow access for deep draft ships. Dredged material from channel development will be used for both dike construction and filling the expansion cells. The project is expected to provide approximately 580 acres of waterfront property for the container terminal.

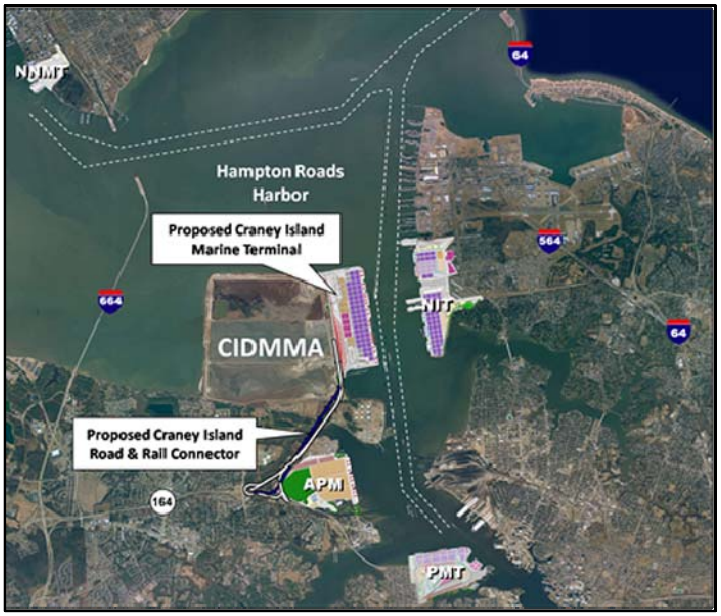


**Figure 2.2-3. Craney Island eastward expansion project schematic.**

## Construction

The first phase of the expansion project began in Fall 2010 and is in progress. This phase entails building cross dikes, and the first tasks included constructing sand lifts and installing prefabricated wick drains to strengthen and consolidate the sand.

Approximately 1.2 million cubic yards was brought to the site from the Atlantic Ocean Channel. Material for the dikes was brought to Craney Island by the Liberty Island hopper dredge, which has a capacity of more than 5,000 cubic yards. The contractor designed a project-specific spill barge (Figures 2.2-4 and 2.2-5) that connects to the Liberty Island dredge by a pipe, and works like a sprinkler to disperse the pumped material along the alignment of the dikes. The spill barge is intended to allow even layers of material to be placed efficiently. At present the material has been placed and wick drains are being installed to allow the soft subsurface clays to consolidate and strengthen.

The project also included demolition of a section of existing rock jetty that forms the northern boundary of the Craney Island re-handling basin. This will allow for future access channels to the Craney Island Marine Terminal.

**Figure 2.2-4. Spill barge designed for the Craney Island project.**

**Figure 2.2-5. Spill barge dispersing material along the footprint of the cross dikes.**

**Economics**

The Eastern Expansion Project is expected to generate $6 billion in National Economic Development benefits over the 50-year life of the project.

### *2.3.4 Pier 400 and Pier T Port of Los Angeles*

The Port of Los Angeles Containment Island projects at Pier 400 and Pier T entailed:

- Constructing over 7 miles of containment structures
- Dredging and placing more than 50 million cubic yards of material to create a new 545 acre landfill.
- Deepening navigation channels including 7 miles of new navigation channels along with two turning basins

- Providing wave and storm surge protection for Pier 300
- Creating a new 166 acre submerged shallow water habitat (least tern feeding grounds) to compensate for habitat lost during project construction
- Improving transportation infrastructure.

**Construction**

Construction began in 1994 and was completed six years later at a cost of approximately $400 million. Dikes were constructed around the perimeter of the disposal area with open areas to allow vessel traffic. Sediments were then placed into the fill area, initially via bottom dump barge and then hydraulically as the fill area became too shallow to allow access via barge. As the sediment accumulated in the fill area, the dike walls were increased in height until they broke the surface of the water. Weirs were then used to drain the remaining water from the fill area. After de-watering, the fill areas were covered with asphalt and developed to support various port facilities.

The pier now has berths for liquid bulk carriers, a tank farm, and marine oil terminals. Container terminals and rail lines are provided on the site and they connect to an access corridor by bridge.

Unique aspects of this project included building retention structures in challenging geotechnical conditions. Because of the project location in a seismically active area with potential for shifting soils, geotechnical information was used with a subsurface GIS to characterize site conditions. The analysis included a seismic risk assessment and a set of site specific performance criteria under assumptions of extreme environmental conditions.

Construction was done in phases to accommodate environmental and institutional requirements, and to allow navigation around the project area. In addition the project had to be coordinated with other Port of Los Angeles projects either impacting or relying on the Pier 400 project.

Dikes were constructed of quarried rock that was placed in multiple lifts to the full height of the fill embankment. A containment structure was also constructed to create a shallow-water habitat mitigation area known as the Cabrillo Shallow Water Habitat area. Navigation channels along the west side of the future pier were dredged to a depth of -63 feet MLLW to allow navigation. Berth areas were deepened to -50 or -72 feet MLLW for the container and dry bulk wharves, respectively.

Current dredging-related use of the site includes placement of material from the Port of Los Angeles deepening project, The Federal portion of the port deepening project has been completed (USACE, 2012b). Ongoing work by non-Federal project partners includes continued deepening of the channel and project close-out (USACE, 2012b).

As a major container and commodities terminal, Port 400's ongoing use also includes heavy industrial use. The Port is expected to expand over the years, while mitigation-related habitat enhancement and monitoring continues (Shibao, 2012).

**Environment**

The construction was found to cause unavoidable significant impacts to the following:

- Air Quality (construction, greenhouse gasses, criteria pollutants)
- Biological Resources (Least terns)
- Geology (seismic)
- Noise (construction)
- Water Quality (discharges)
- Recreation (possible spills)
- Hazards (possible spills)

Impact mitigation projects were implemented to offset these unavoidable impacts. These included creation of a 166 acre shallow water habitat at the Cabrillo habitat area to compensate for impacts on California least tern habitat. Other major mitigation projects included inlet opening and land restoration at the Batiquitos Lagoon and at the Bolsa Chica wetlands area (Shibao, 2012).

**Economics**

The Pier 400 and Pier T projects were integral components of the Port of Los Angeles deepening project, a cost-share between USACE and the Port of Los Angeles. Total project costs are approximately $222,000,000, with almost three quarters of the project funded by the Port of Los Angeles (USACE, 2012b). Pier 400 is one of the largest container-handling ports in the world, and is expected to generate 59,000 jobs and add $3.4 billion to the economy over the next 25 years (Shibao, 2012).

## 2.4 REGULATORY OVERSIGHT OF DREDGED MATERIAL CONTAINMENT IN LONG ISLAND SOUND

This section describes Federal and State laws and regulations including the Marine Protection, Research, and Sanctuaries Act (MPRSA), the Clean Water Act (CWA), the Ambro Amendment, and their relevance to potential dredged material management in LIS. The legislation described here governs the transportation and disposal of dredged material in Long Island Sound.

### *2.4.1 Federal Regulations*

Proposed discharges of dredged or fill material are subject to regulations including the CWA, MPRSA, and Section 10 of the Rivers and Harbors Act. Projects conducted in inland waters are evaluated under the CWA and may be subject to Section 10 of the Rivers and Harbors Act if the project occurs in navigable waters. Dredged material disposal projects conducted beyond the baseline of the territorial sea are evaluated under the MPRSA, and also may be subject to section 10 of the Rivers and Harbors Act. Dredged material disposal projects that involve a beneficial use (e.g., beach nourishment, feeder berms) or fill (e.g., island creation) within the territorial sea are evaluated under the CWA and the Rivers and Harbors Act.

MPRSA was enacted by Congress in 1972 to address ocean disposal of material that could degrade or endanger human health or the environment. The act states that disposal of material in ocean waters must not "unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities. All dredged material being transported beyond the baseline of the territorial sea for disposal must be evaluated under MPRSA".

The baseline of the territorial sea is generally the mean lower low water line along the coast (i.e. the tidal datum MLLW on NOAA charts), but may extend as a straight line across the mouth of rivers and bays if the coast is deeply indented (Articles 9 and 10, United Nations Convention on Law of the Sea, UNCLOS).

This designation, particularly the straight lines at river mouths and embayments, can leave significant areas of coastal waters landward of the baseline. This is the case for Long Island Sound, where the baseline cuts across Block Island Sound from the mainland near the CT/RI border to the eastern tip of Long Island at Montauk. Therefore, the entire area within LIS falls landward of the baseline, and disposal of dredged material would not be expected to fall under the MPRSA, but rather would fall under the CWA.

However, the transport and disposal of certain specified dredged material in LIS is subject to the provisions of MPRSA, because the Statute was amended in 1980 to include Section 106(f), termed the Ambro Amendment. The Ambro Amendment requires "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" to be subject to the requirements of MPRSA.

MPRSA provides for a permitting process to control placement of dredged material in ocean waters. Section 103 authorizes the Secretary of the Army (through the Army Corps of Engineers) to issue permits for the transportation and placement of dredged material in the territorial sea and ocean waters. This transportation and dredged material placement activity must meet criteria established by the EPA (40 CFR 227 & 228) which ensure the material poses no unacceptable risk to human health or the environment. The regulations also prohibit disposal of certain materials from ocean disposal, including radioactive waste, metals and other hazardous compounds in concentrations other than trace amounts, as well as persistent materials that may float or remain in suspension.

The procedures for evaluating dredged material for placement in ocean waters are contained in the Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual (EPA/COE-503/8-91/001). The manual contains technical guidance for determining the suitability of dredged material for ocean disposal through chemical, physical, and biological evaluations.

The Corps is the lead Federal agency for issuing permits under MPRSA for placement of dredged material. The permits are subject to EPA concurrence. MPRSA also authorizes EPA to designate long-term dredged material disposal sites, and requires that these sites have Site Monitoring and Management Plans to determine whether disposal projects have significant adverse effects.

In summary, the Ambro Amendment requires that all Federal projects and any non-Federal applicant project exceeding 25,000 cubic yards proposed for open water placement within Long Island Sound comply with the requirements of MPRSA. According to a recent Corps review of regulations (USACE, 2011), MPRSA is not applicable to island CDFs, shoreline CDFs or harbor CADs. Any CAD cells sited outside of harbors in the open waters of Long Island Sound would be considered open water placement and, therefore, subject to MPRSA. Development such a CAD cell would be contingent on being "selected" by the Corps as an alternative site, meeting the criteria for determining the material poses no unacceptable risk to human health or the environment, and obtaining review and concurrence from EPA. If developed, such a Corps-selected site would be limited to a five-year period of use (with potential for a five-year extension).

### *2.4.2 Regulatory Oversight at the State Level*

The following summary of state regulatory oversight relies on the recent report, "Federal, State, and Local Regulations and Programs Applicable to Dredged Material" (USACE, 2011) and subsequent contacts with regulatory agency leads in Connecticut, New York, and Rhode Island to discuss regulatory requirements associated with the construction and maintenance of containment sites. While the three states differ somewhat with respect to the regulatory review process, all three state agencies are concerned with potential impacts to coastal habitat and water quality, and are charged with reviewing project plans to ensure compliance with regulations related to dredging and dredged material management.

#### ***2.4.2.1 Connecticut***

The Connecticut Department of Energy and Environmental Protection (DEEP) Office of Long Island Sound Programs manages and regulates dredging and dredged material placement projects. The agency also manages the Coastal Zone Management Program, Structures and Dredging Program, Tidal Wetlands Act permitting program. It also issues Water Quality Certificates under the CWA. In general, when reviewing projects involving dredging and placement of dredged material, CT DEEP looks for compliance with the CWA and other regulations. To do this, they evaluate environmental conditions on and adjacent to the site, and evaluate likely impacts associated with construction and maintenance of the facility. When an applicant proposes a nearshore berm project to the State, the proponents must provide:

- Analysis of disposal alternatives that would avoid the use of the marine environment completely, or that would minimize impacts on the coastal/marine environment (this ensures compliance with the CWA, which indicates that if lower-impact alternatives are available these should be used).
- Sediment quality information including sediment type, bathymetry, and contaminant status. This information is used to evaluate sediment quality and the potential for problems with dewatering of CDFs and CAD cells if the sediment is contaminated.
- Documentation of physical, biological, and socioeconomic characteristics of the areas adjacent to the proposed site to evaluate potential for problems associated

with construction or failure of a site such as an island CDF or CAD cell. Socioeconomic characteristics include land use in the vicinity of the project, including parks and protected habitats, as well as open space and recreation areas.

- Hydrologic modeling to evaluate transfer of placed material offsite, and to evaluate potential changes in hydrological characteristics or stability/erosion of CDFs or CAD cells.

With this information the CT DEEP makes a determination of compliance with regulations and issues permits for the construction, maintenance, and stipulates if monitoring is required. In addition, under the Interstate Consistency agreement, CT DEEP provides coastal zone review for projects occurring within NY state waters if the project occurs seaward of the 20 foot contour line.

#### *2.4.2.2 New York*

The Department of Environmental Conservation (NYSDEC) and the Department of State (NYDOS) are responsible for ensuring regulatory compliance for dredging and fill projects in the coastal zone.

NYSDEC is the lead agency in charge of reviewing projects for compliance with the Federal Clean Water Act. The agency issues Section 401 Water Quality Certificates for proposed dredged material disposal and fill projects in the coastal zone.

NYDOS reviews dredged material and fill projects for Coastal Zone Management Program Consistency, ensuring that Federal actions within the coastal zone (including direct actions, site selection and designation, permitting, or rulemaking) are carried out in a manner consistent with the enforceable policies of approved State management programs. Enforceable coastal policies include those in the State Coastal Management Program, the LIS Coastal Management Program, and any Local Waterfront Revitalization Program[1]. Additionally, under the Interstate Consistency agreement, NYDOS provides consistency review for projects occurring within Connecticut state waters if the project occurs seaward of the 20 foot contour line.

Coastal policies applicable to dredged material disposal projects include consideration of fish and wildlife, flooding and erosion, historic, cultural, and scenic resources, air and water resources, facilitating water dependent uses, revitalizing underutilized waterfronts, and wetlands. The 44 policies are provided in the New York State Coastal Management Program and Final Environmental Impact Statement, available online (NYS, 2010). Consultation with NYDOS indicates that the State favors beneficial reuse, particularly nearshore placement, over many other placement options. It is a goal of the New York

[1] A Local Waterfront Revitalization Program (LWRP) is both a plan and a program. The term refers to both a planning document prepared by a community, as well as the program established to implement the plan. The Program may be comprehensive and address all issues that affect a community's entire waterfront or it may address the most critical issues facing a significant portion of its waterfront. As a planning document, a LWRP is a land and water use plan and strategy for a community's natural, public, working, or developed waterfront through which critical issues are addressed. In partnership with the Division of Coastal Resources, a municipality develops community consensus regarding the future of its waterfront and refines State waterfront policies to reflect local conditions and circumstances. Once approved by the New York Secretary of State, the Local Program serves to coordinate State and federal actions needed to assist the community achieve its vision. LWRPs occur in the following towns and villages: Bayville, East Hampton, Greenport, Head of Harbor/Nissequog Village, Lloyd Harbor, Ocean Beach, Sag Harbor, Southold, Smithtown, Mamaronek, Port Chester, and Rye.

Coastal Management Program to preserve natural coastal processes and to keep material within the littoral system.

#### *2.4.2.3 Rhode Island*

The Rhode Island Coastal Resources Management Council (RICRMC) is the lead agency for regulating dredging in tidal waters. RICRMC is the initial and primary point of contact for dredging activities in coastal waters. The agency integrates and coordinates the plans and policies of other state agencies as they pertain to dredging in order to develop comprehensive dredging programs. The State of Rhode Island Coastal Resources Management Program document (the "Red Book") describes these policies, along with the authority and duties of the RICMC in enforcing them.

The RICRMC must coordinate with the RI Department of Environmental Management (RIDEM) for reviewing and permitting projects in the coastal zone. The RIDEM issues Water Quality Certification for placement of dredged material, while RICRMC is authorized to issue, modify or deny permits for dredging, filling, or alteration of coastal wetlands and directly related areas. If dredged material disposal is involved, project applicants are required to obtain a Section 401Water Quality Certification from RIDEM before the RICRMC can consider granting approval for the project.

For placement of dredged material along shorelines or in State waters, a Council Assent or Federal Consistency Determination is required from RICRMC. RICRMC aims to ensure that placement projects are consistent with State interests and policies, and it works with other State agencies and Federal agencies to coordinate dredged material placement projects.

In 2010 RIDEM updated its "Rules and Regulations for Dredging and Management of Dredged Material" regulation (regulation DEM-OWR-DR-02-03). This set of regulations ensures that dredging and material management is conducted so as to protect groundwater, surface water quality, fish and wildlife, and habitat resources while streamlining the permitting process. The regulations provide guidance on in-water placement of dredged material. In-water placement is prohibited unless there is no practicable alternative to the proposed project that would have less adverse environmental impact. In addition, the placement activity must not cause violations of water quality standards or contribute to significant degradation of waters of the State. Lastly, appropriate steps must be taken to minimize any potential adverse impacts.

The RICRMC's priorities in dredged material placement are generally to promote beneficial uses of dredged material. Depending on the nature and characteristics of the material and on reasonable costs, the agency's priorities are:

- Beneficial use including beach nourishment, habitat restoration or creation in the coastal zone;
- Beneficial use in upland areas, including daily cover for landfills and general fill used by the RI Department of Transportation;
- Offshore in open water for large volumes, provided that environmental impacts are minimized;

- Innovative nearshore placement methods, including wetland or shellfish habitat creation and beach nourishment.

### 2.5 IDENTIFICATION OF POTENTIAL LIS CONTAINMENT SITES

In consultation with the Corps project team (memoranda dated October 4, 2011 and April 2, 2012), Woods Hole Group developed the list of containment sites to investigate for this report by comparing the list of thirteen (13) previously identified potential LIS dredged material containment sites provided in the Scope of Work to information on these and other sites in the 1979-1985 Long Island Sound Study of Dredged Material Containment documents (the containment documents). These documents included:

- Reconnaissance Report (USACE, 1979);
- Interim Siting Analysis (USACE, 1980);
- Addendum – Extension of Siting Analysis (USACE, 1981);
- Island / Shoal Screening Report (USACE, 1983); and
- Feasibility Report (USACE, 1985a).

Figure 2.3-1 shows the process for developing a final list of containment site alternatives for consideration from among the originally specified 13 sites (Scope of Work), the list of screened-in or deferred sites from the Feasibility Report (USACE, 1985a), and Corps project team knowledge. That screening returned 5 containment site alternatives that were not on the original list of 13 sites derived from the Scope of Work, and 2 potential containment sites on the original list where two alternatives had been considered.

The final list of 18 containment sites included:

- Eleven of the 13 site alternatives specified in the initial scope of work (2 of the 13 are not containment sites and were dropped);
- Three additional site alternatives from the USACE Feasibility Report (USACE, 1985a) because those three sites were not on the original list from the Scope of Work and not rejected in the Feasibility Report;
- Two additional site alternatives from Corps project team input; and
- Two additional alternatives at existing potential sites from Corps project team input.

The distribution of containment site alternatives throughout the LIS study area is illustrated in Figure 2.3-2. Figures 2.3-3 to 2.3-17 (derived from either USACE, 1981; USACE, 1983; USACE, 1985a; USACE, 2009; or USACE, 2011b) identify and locate the final list of 18 containment site alternatives.

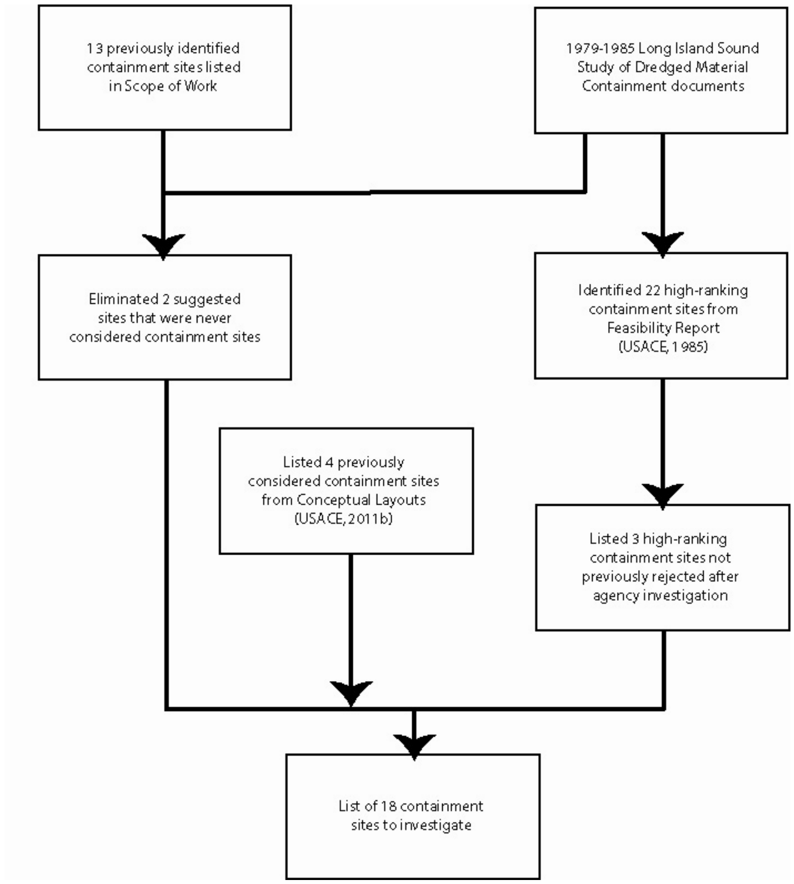


**Figure 2.3-1. Procedure for identification of potential containment sites.**

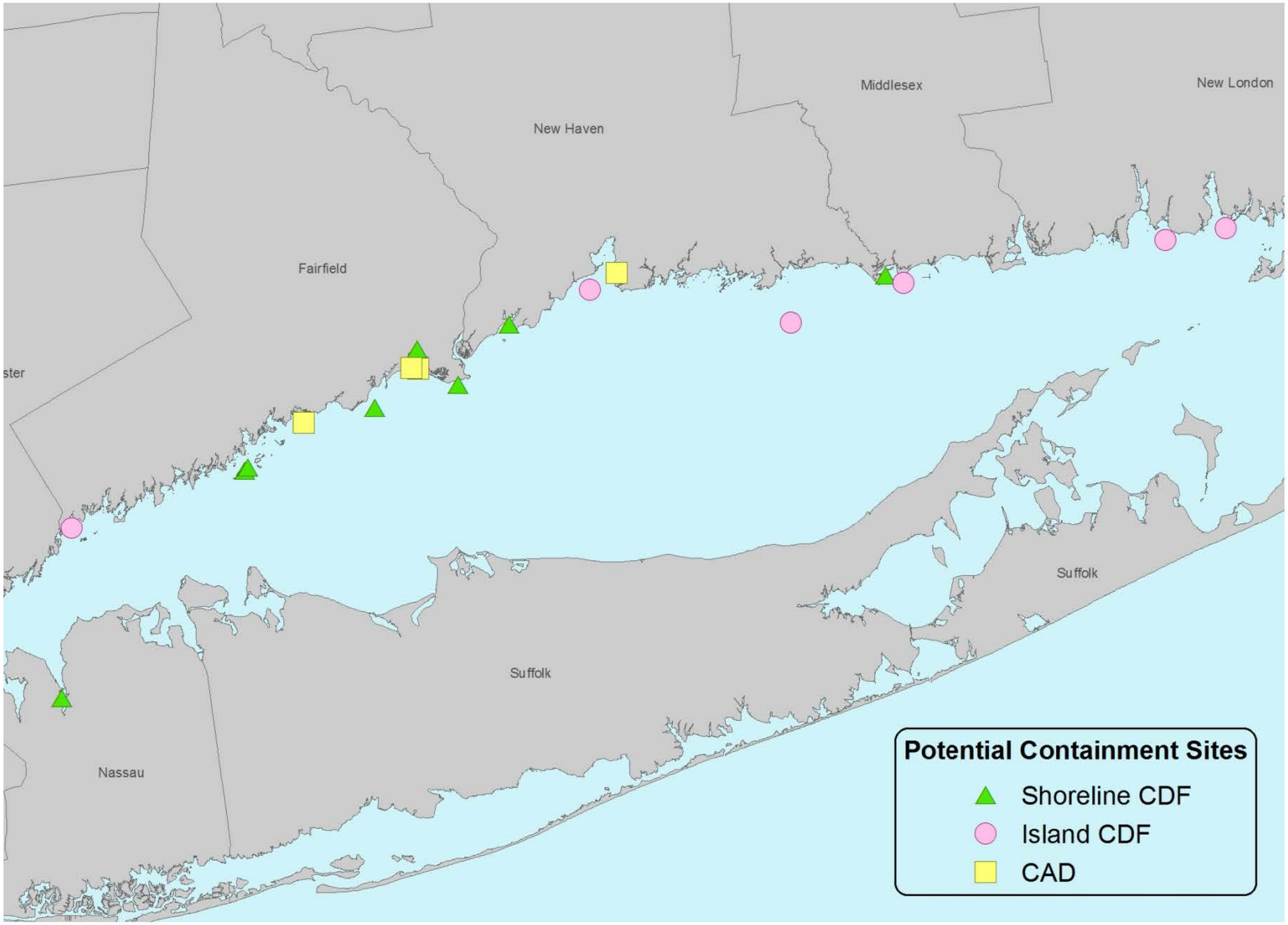


**Figure 2.3-2. Distribution of containment site alternatives throughout the LIS DMMP study area.**

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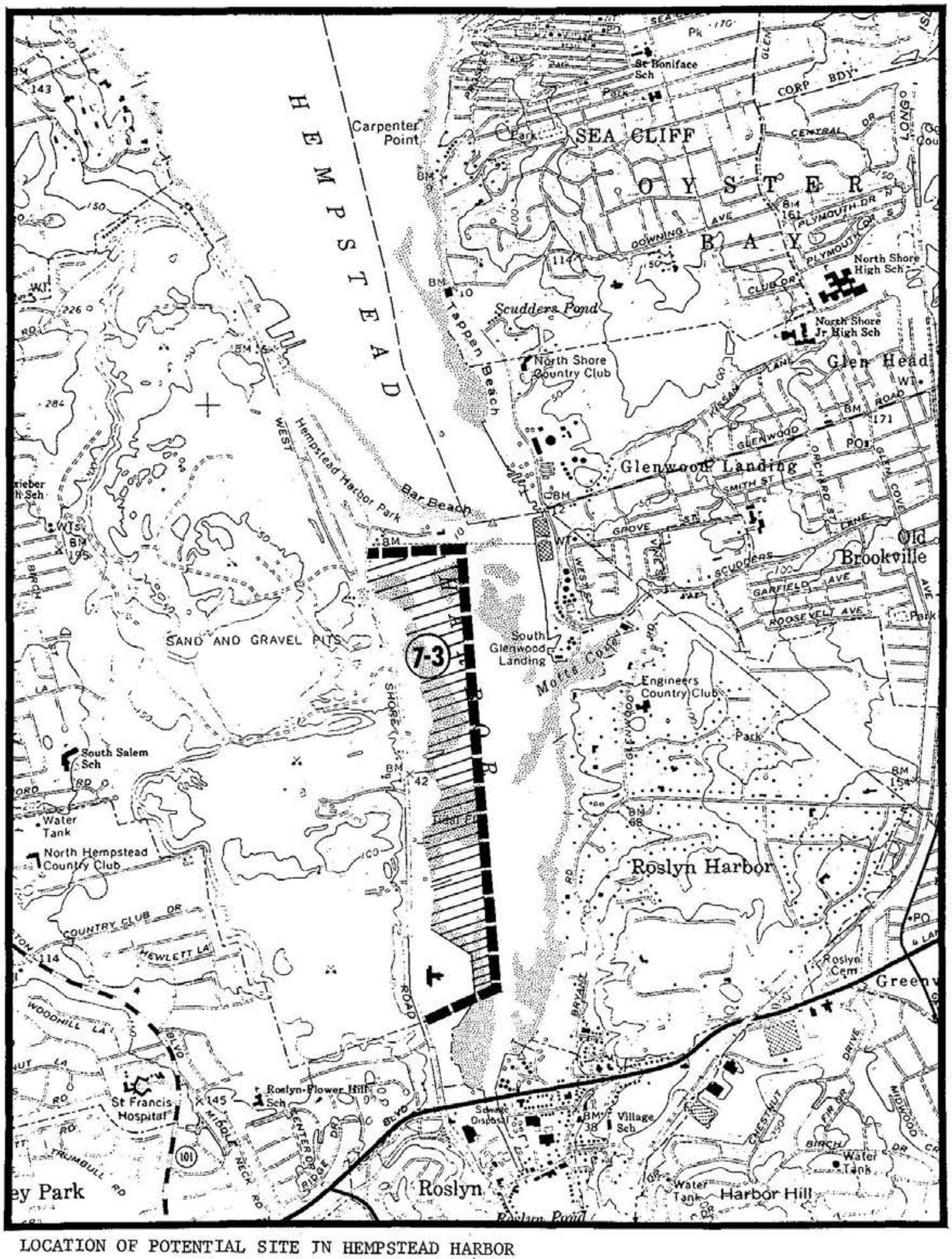


**Figure 2.3-3. Containment Site Alternative A. Hempstead Harbor.**

A shoreline CDF occupying the southwestern shoreline of Hempstead Harbor near Port Washington, NY and Glenwood Landing, NY.

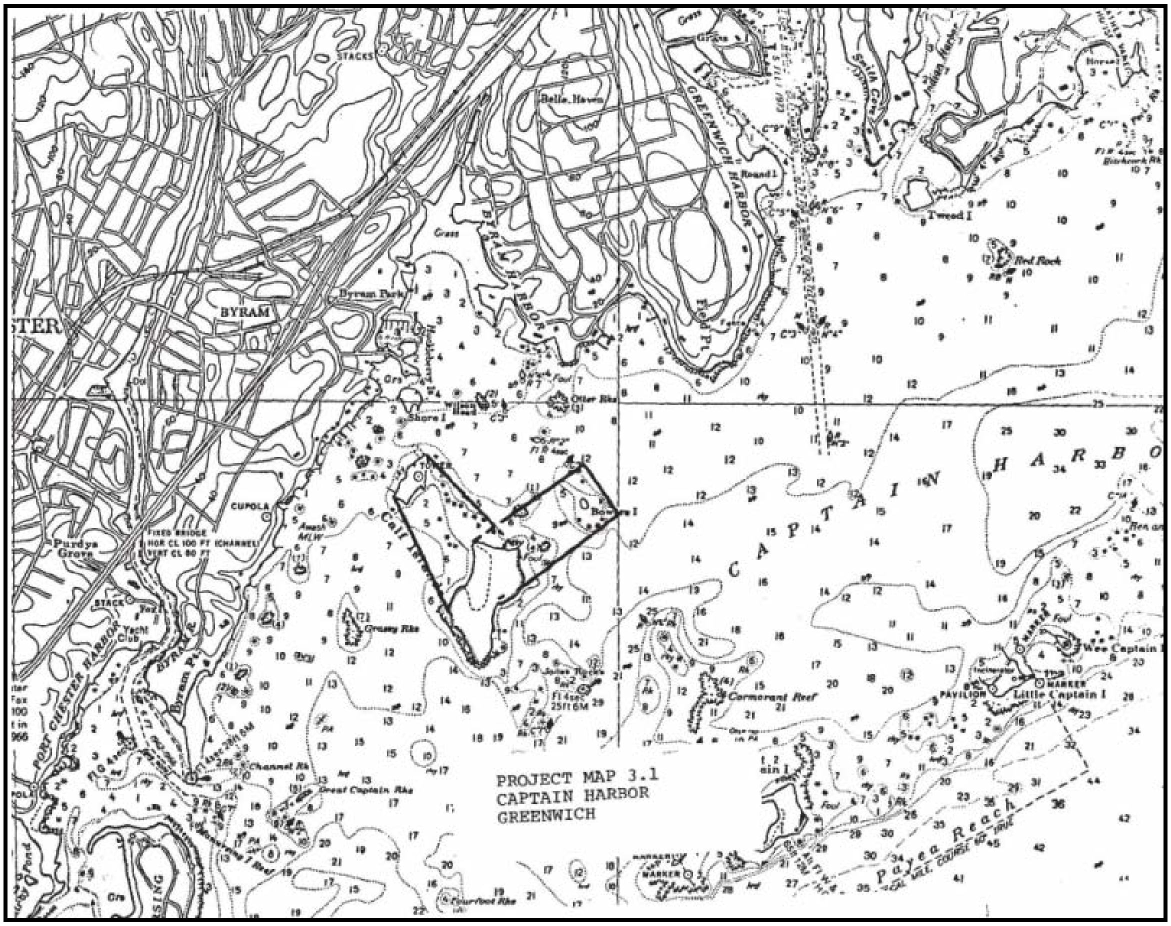


**Figure 2.3-4. Containment Site Alternative B. Greenwich Captain Harbor.**

An island CDF occupying the area between either the Calf Island or between the southern Calf Islands and Bowers Island in Captain Harbor near Greenwich, CT.

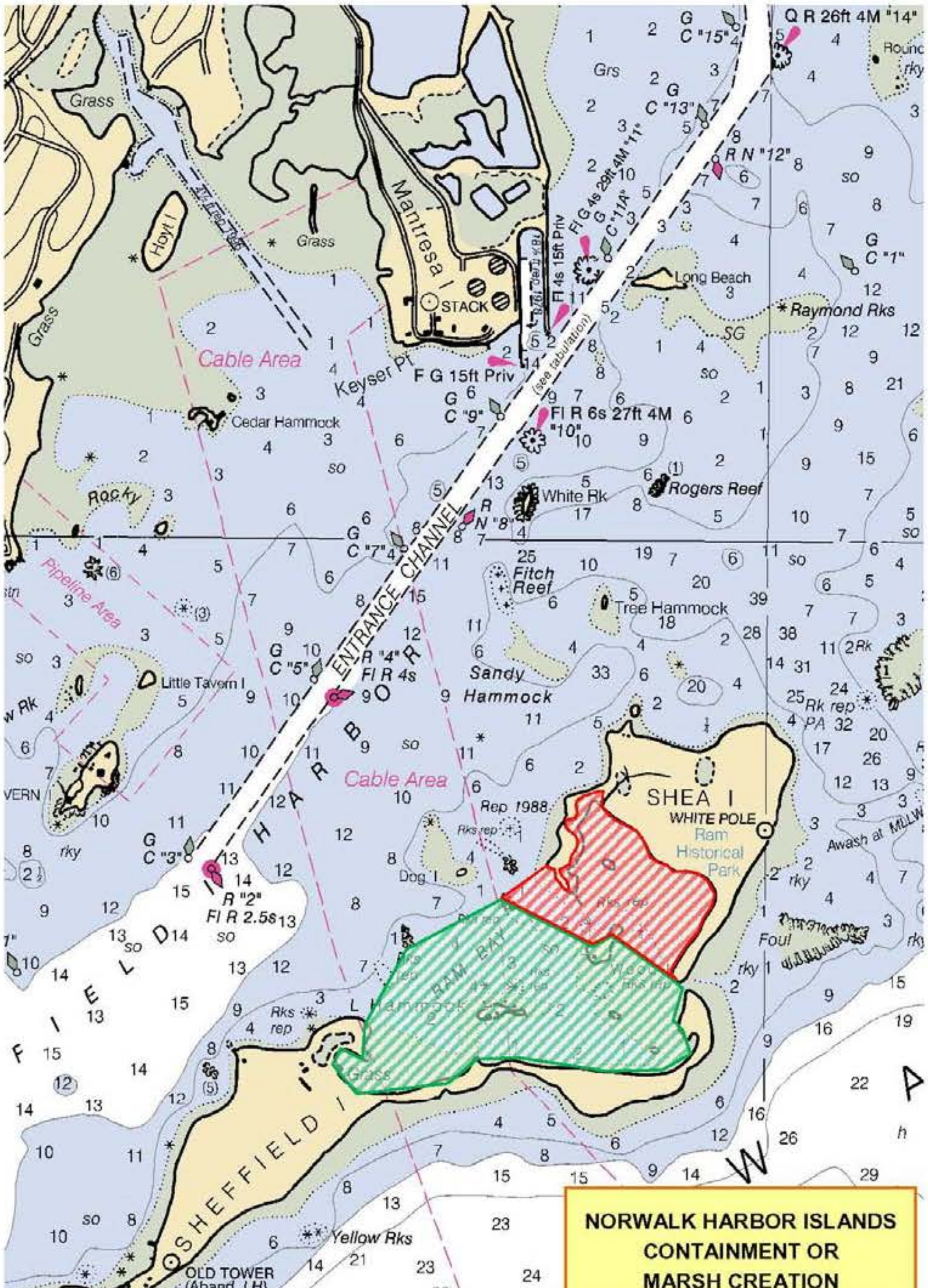


**Figure 2.3-5. Containment Site Alternatives C and D. Norwalk Outer Harbor Islands.**

A shoreline CDF to create salt marsh habitat occupying Ram Bay between Shea Island and Sheffield Island and a shoreline CDF occupying the southwestern shoreline of Shea Island in Sheffield Island Harbor near Norwalk, CT.

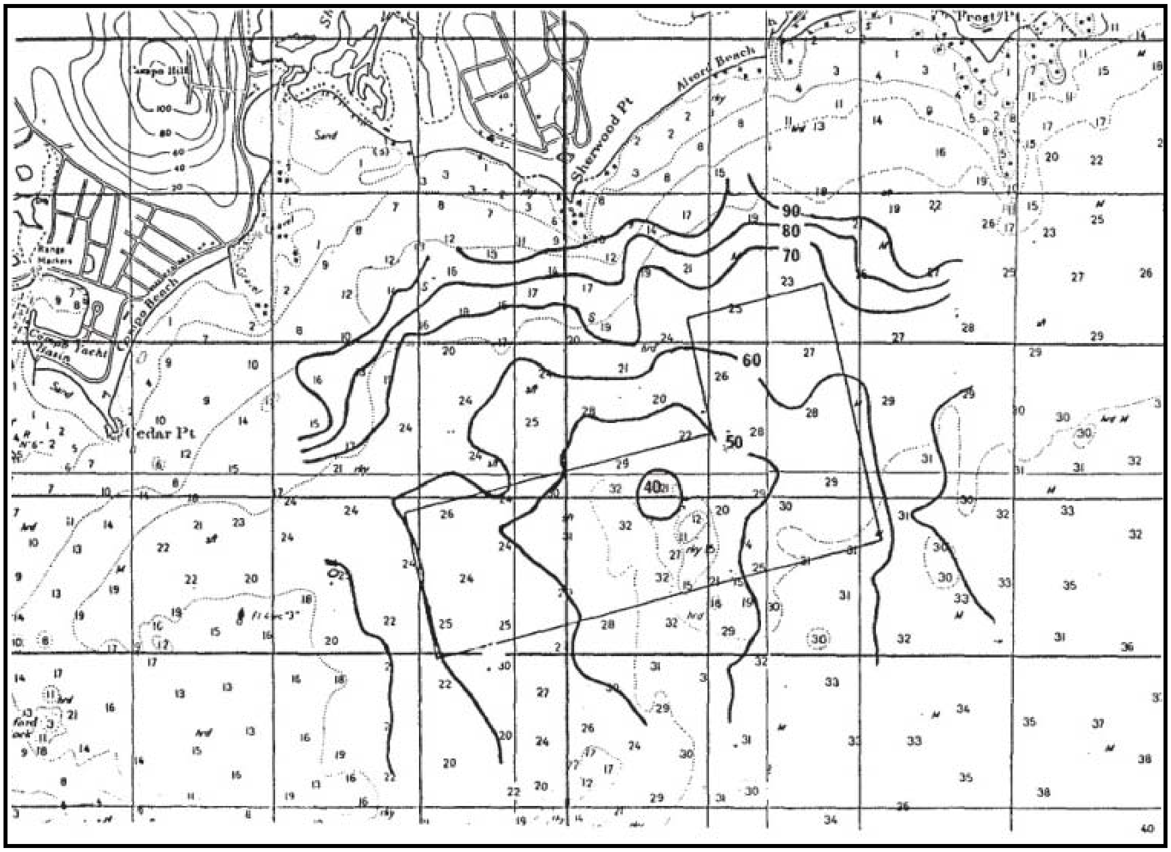


**Figure 2.3-6. Containment Site Alternative E. Sherwood Island Borrow Pit.**

A CAD[2] occupying a former borrow pit approximately ½ mile offshore of Sherwood Island State Park near Westport, CT.

[2] A CAD outside of a harbor in LIS is subject to MPRSA. Development of this containment site alternative would be contingent on being "selected" by the Corps, meeting the criteria for determining the material poses no unacceptable risk to human health or the environment, and obtaining concurrence from EPA.

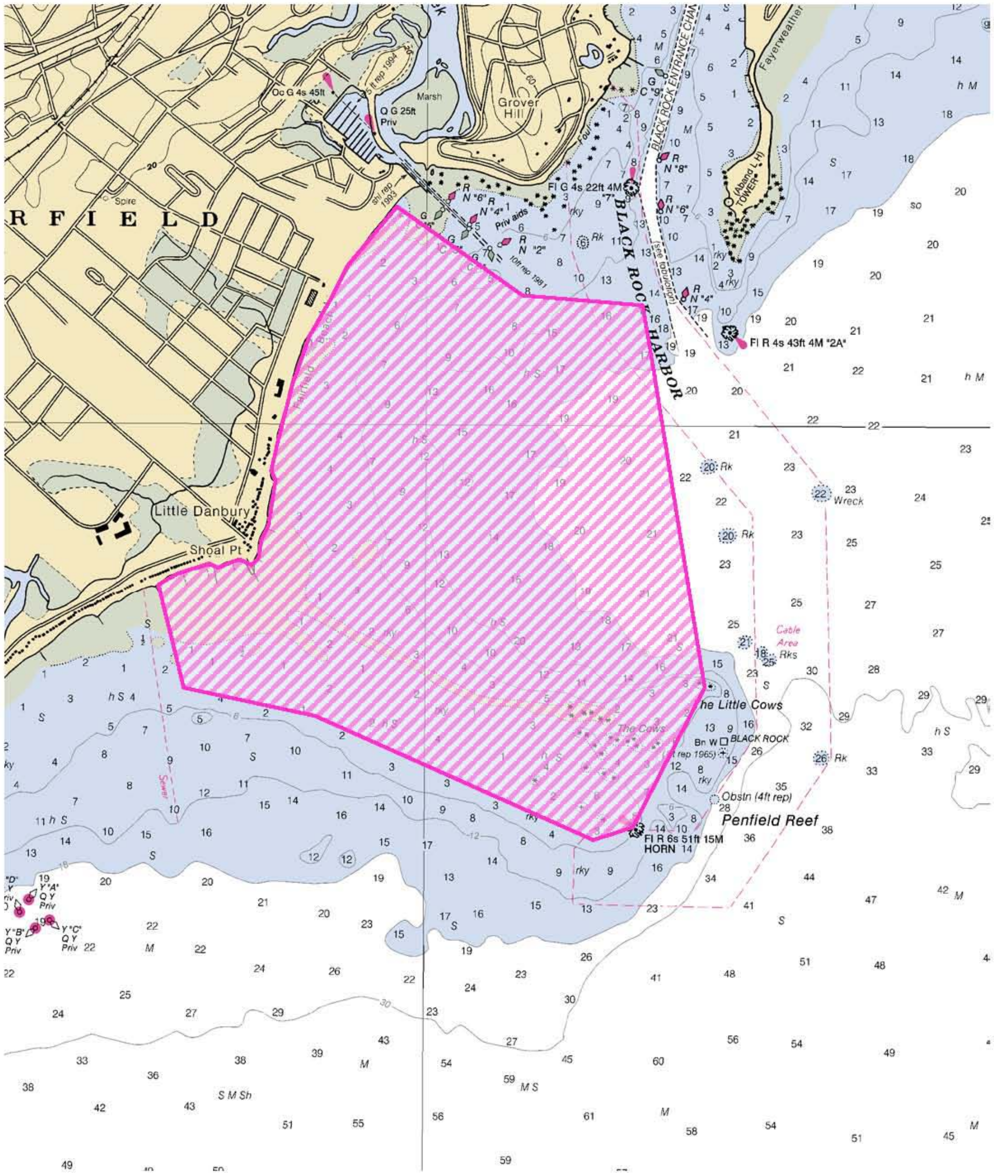


**Figure 2.3-7. Containment Site Alternative F. Penfield Reef.**

A shoreline CDF occupying the area around Penfield Reef adjacent to the shoreline of Fairfield, CT near Wakeman Island.

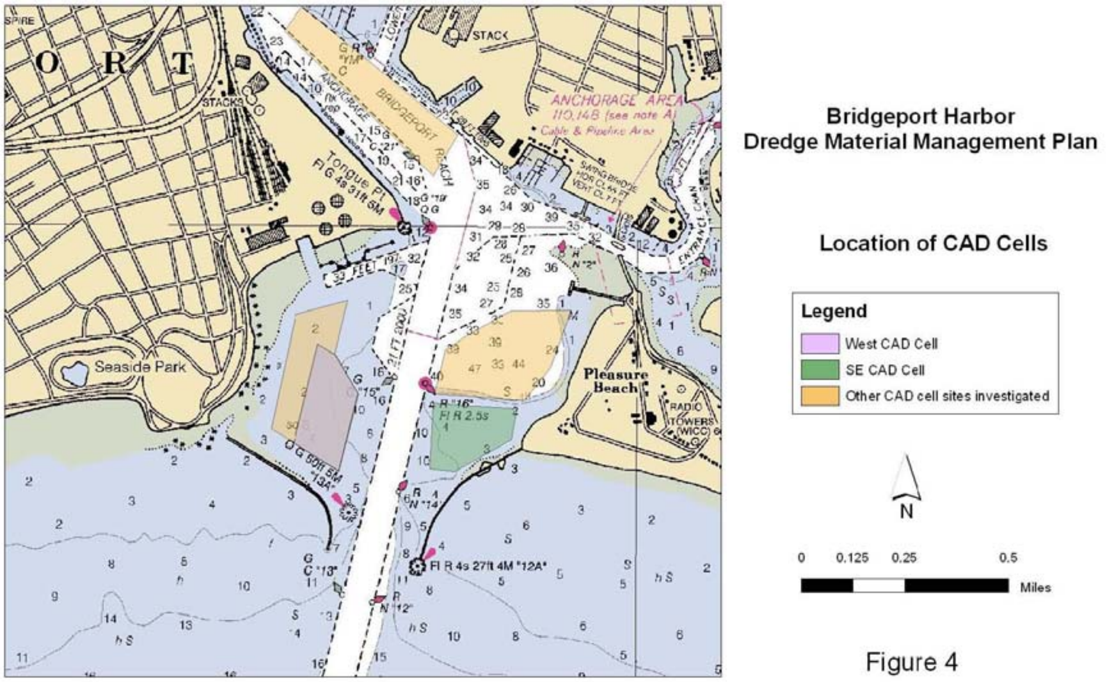


**Figure 2.3-8. Containment Site Alternatives G and H. Bridgeport Outer Harbor.**

A CAD occupying the area behind the western jetty of Bridgeport Harbor and a CAD occupying the area behind the eastern jetty of Bridgeport Harbor in Bridgeport, CT.


**Figure 2.3-9. Containment Site Alternative I. Bridgeport Yellow Mill Channel.**

A shoreline CDF occupying the northern half of the Yellow Mill Channel to the I-95 bridge in the city of Bridgeport, CT.

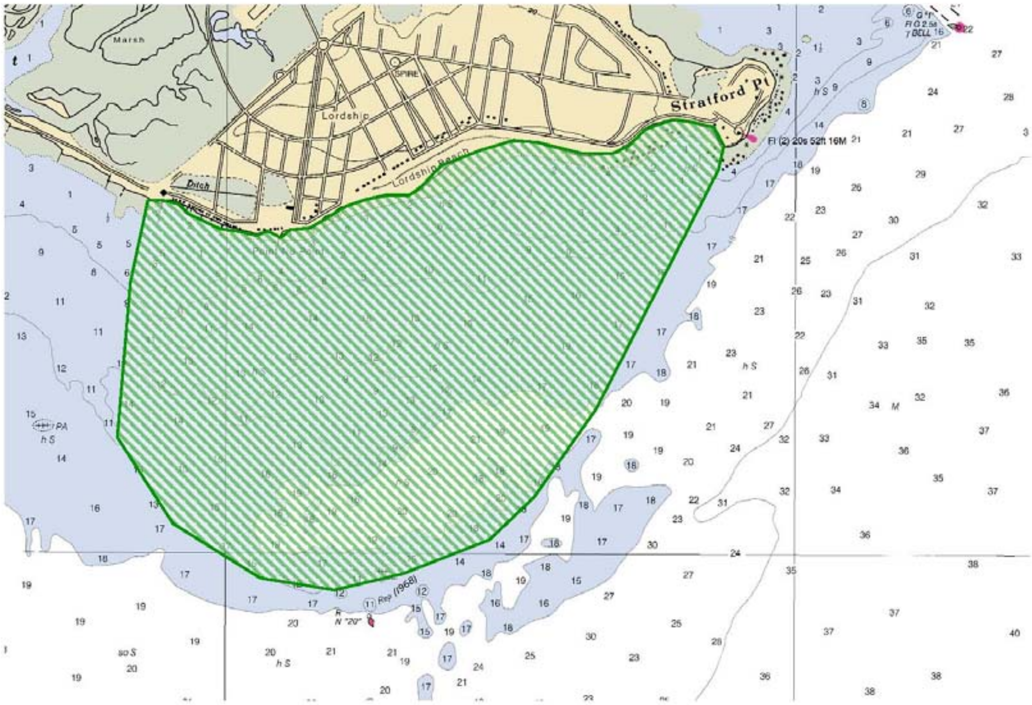


**Figure 2.3-10. Containment Site Alternative J. Stratford Point.**

A shoreline CDF occupying the area south of Stratford Point and Lordship west to Lewis Gut in Stratford, CT.

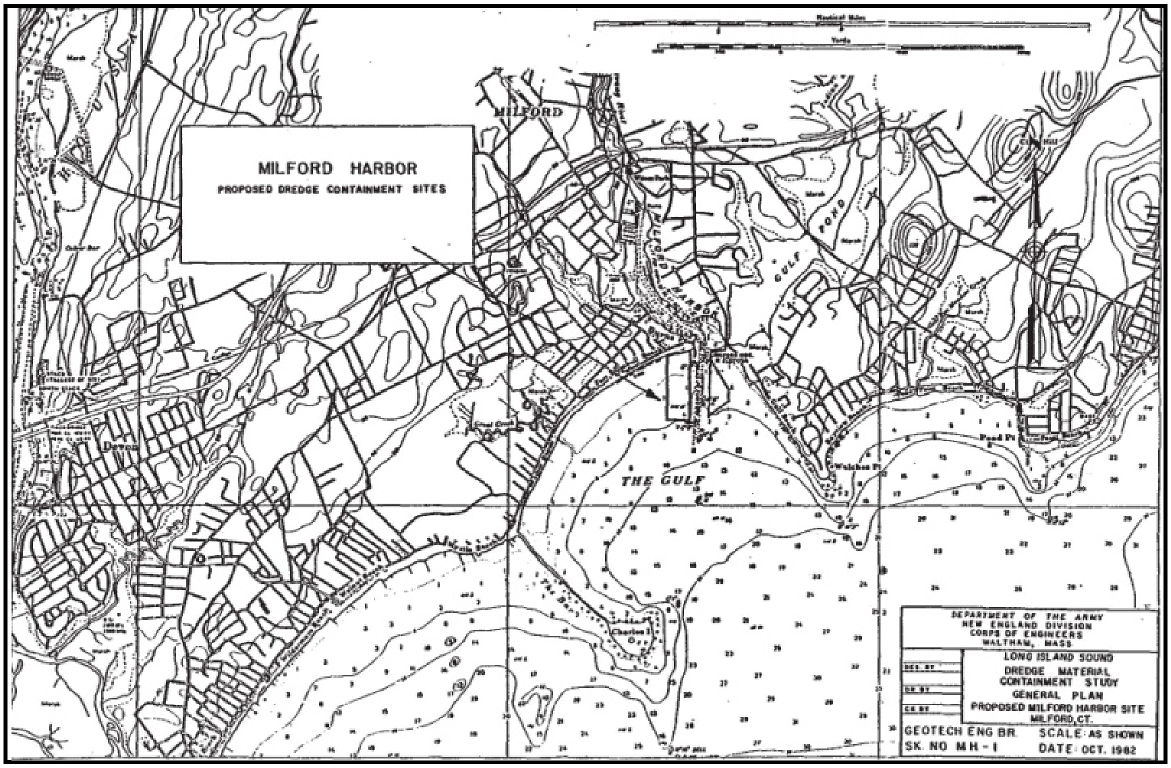


**Figure 2.3-11. Containment Site Alternative K. Milford Harbor.**

A shoreline CDF occupying the area outside the eastern jetty of Milford Harbor and adjacent to Gulf Beach near Milford, CT.

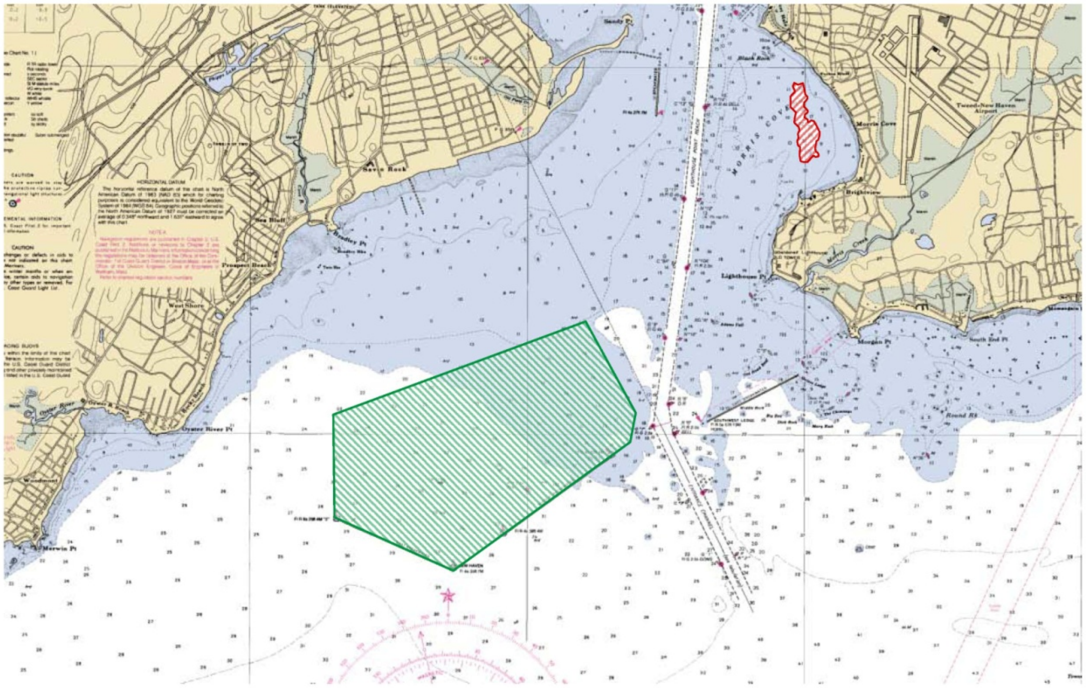

**Figure 2.3-12. Containment Site Alternatives L and M. New Haven Breakwaters and Morris Cove.**

An island CDF occupying the area behind the west and middle breakwaters in the southwestern portion of New Haven Harbor and a CAD in Morris Cove in New Haven, CT.

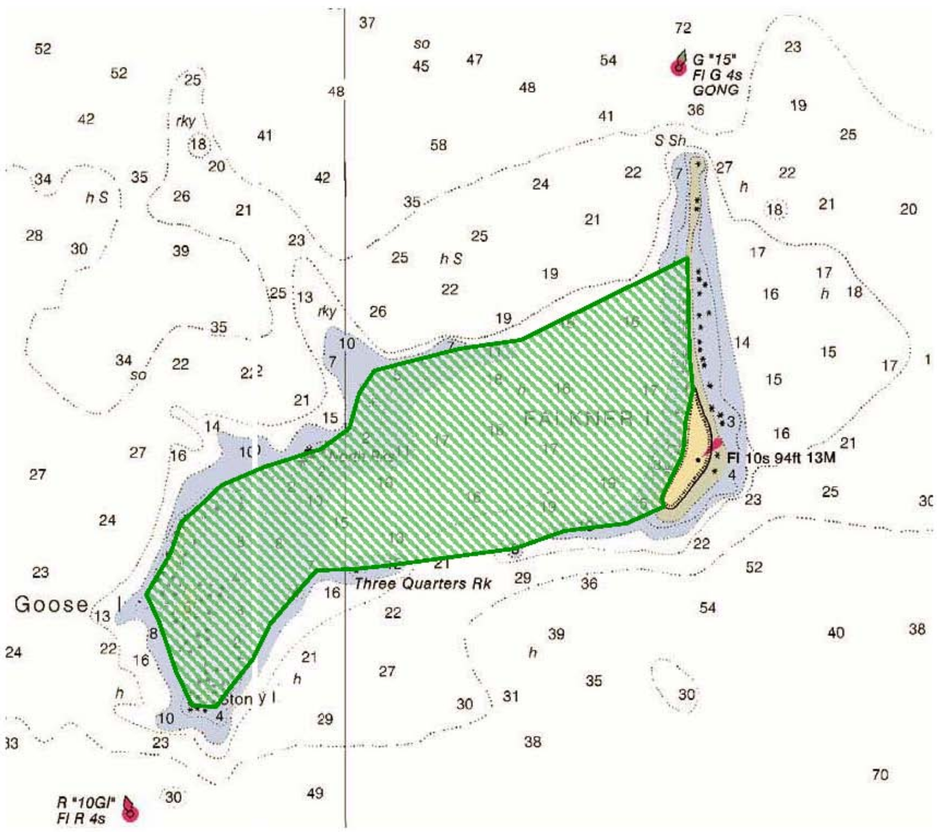


**Figure 2.3-13. Containment Site Alternative N. Falkner Island.**

An island CDF occupying the area between Goose Island and Falkner Island approximately 4 miles south of Guilford Harbor near Guilford, CT.

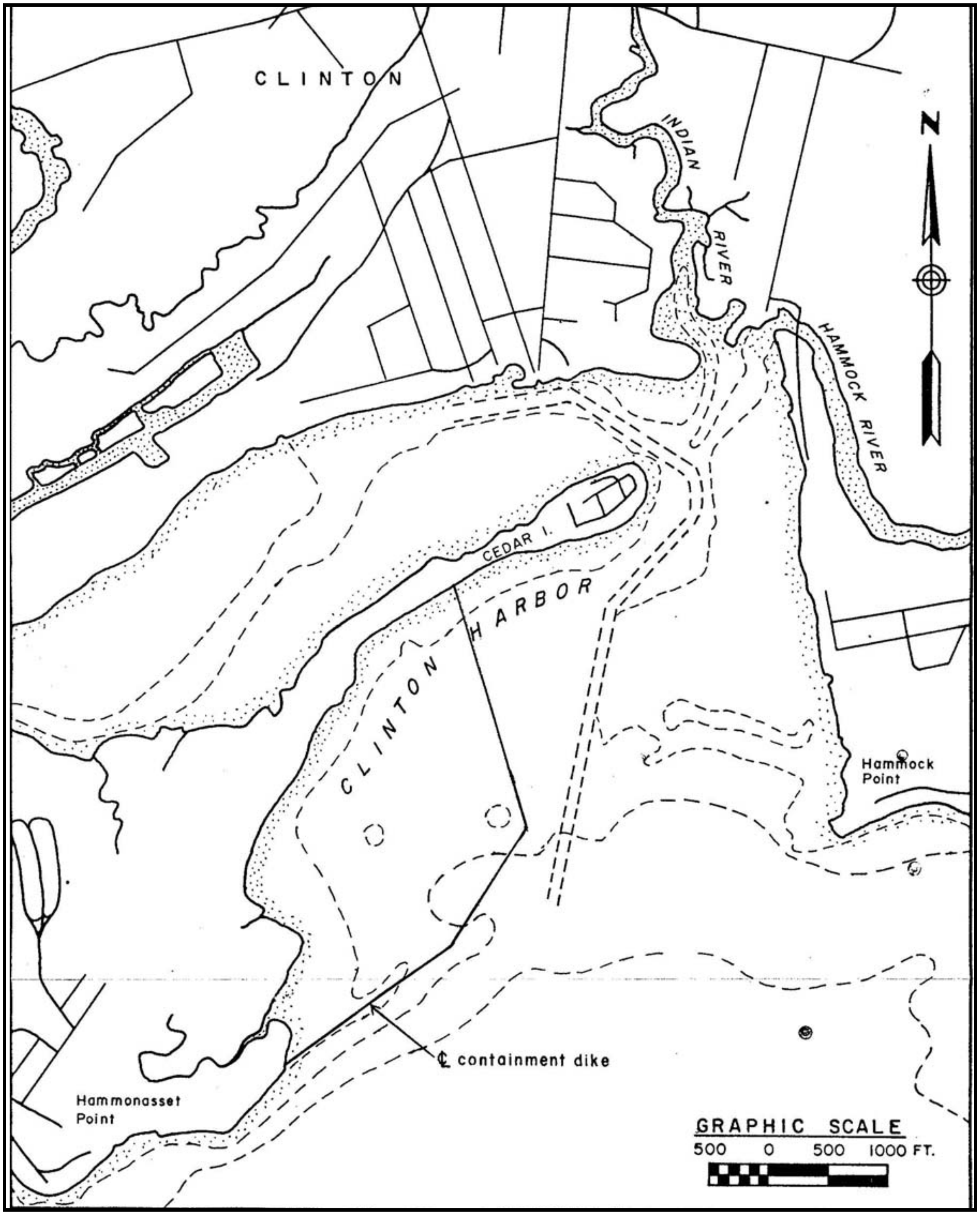


**Figure 2.3-14. Containment Site Alternative O. Clinton Harbor.**

A shoreline CDF to create salt marsh habitat occupying the area east of Willard Island and southwest of Cedar Island in Clinton Harbor near Clinton, CT.

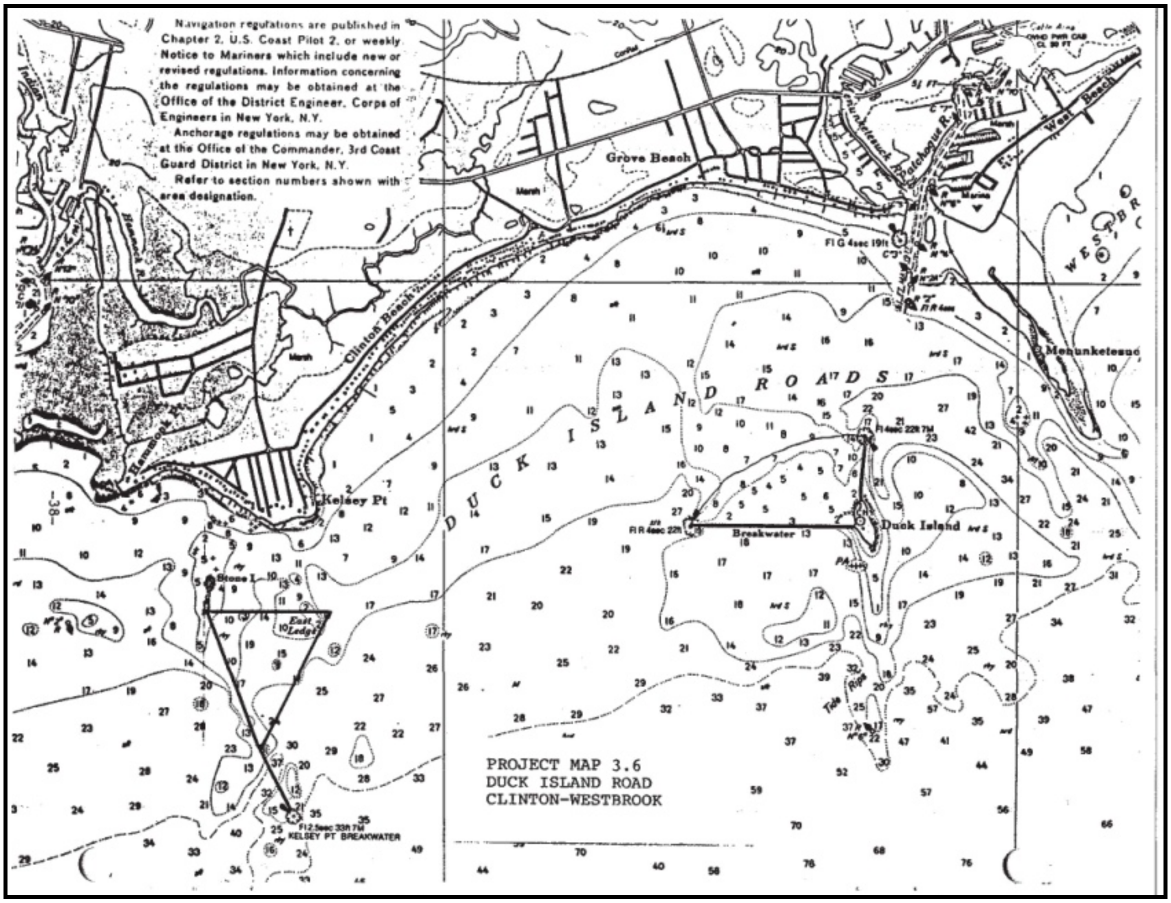


**Figure 2.3-15. Containment Site Alternative P. Duck Island Roads.**

An island CDF occupying the area adjacent to Kelsey Point Breakwater between Clinton Harbor and Duck Island Roads approximately ¼ mile south of Kelsey Point near Clinton, CT.

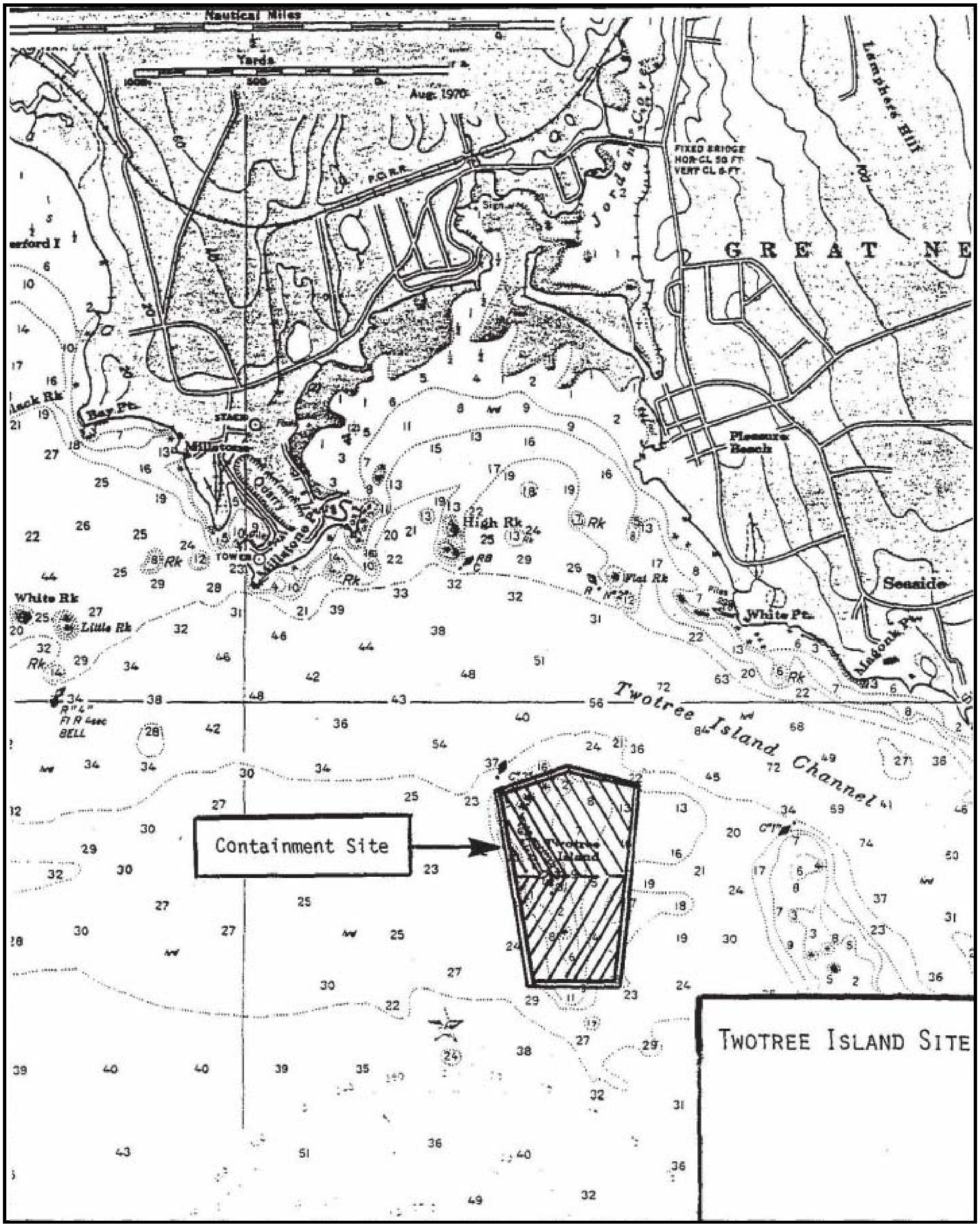


**Figure 2.3-16. Containment Site Alternative Q. Twotree Island.**

An island CDF occupying the area around Twotree Island approximately ¾ mile southeast of the Millstone Power Plant near Waterford, CT.

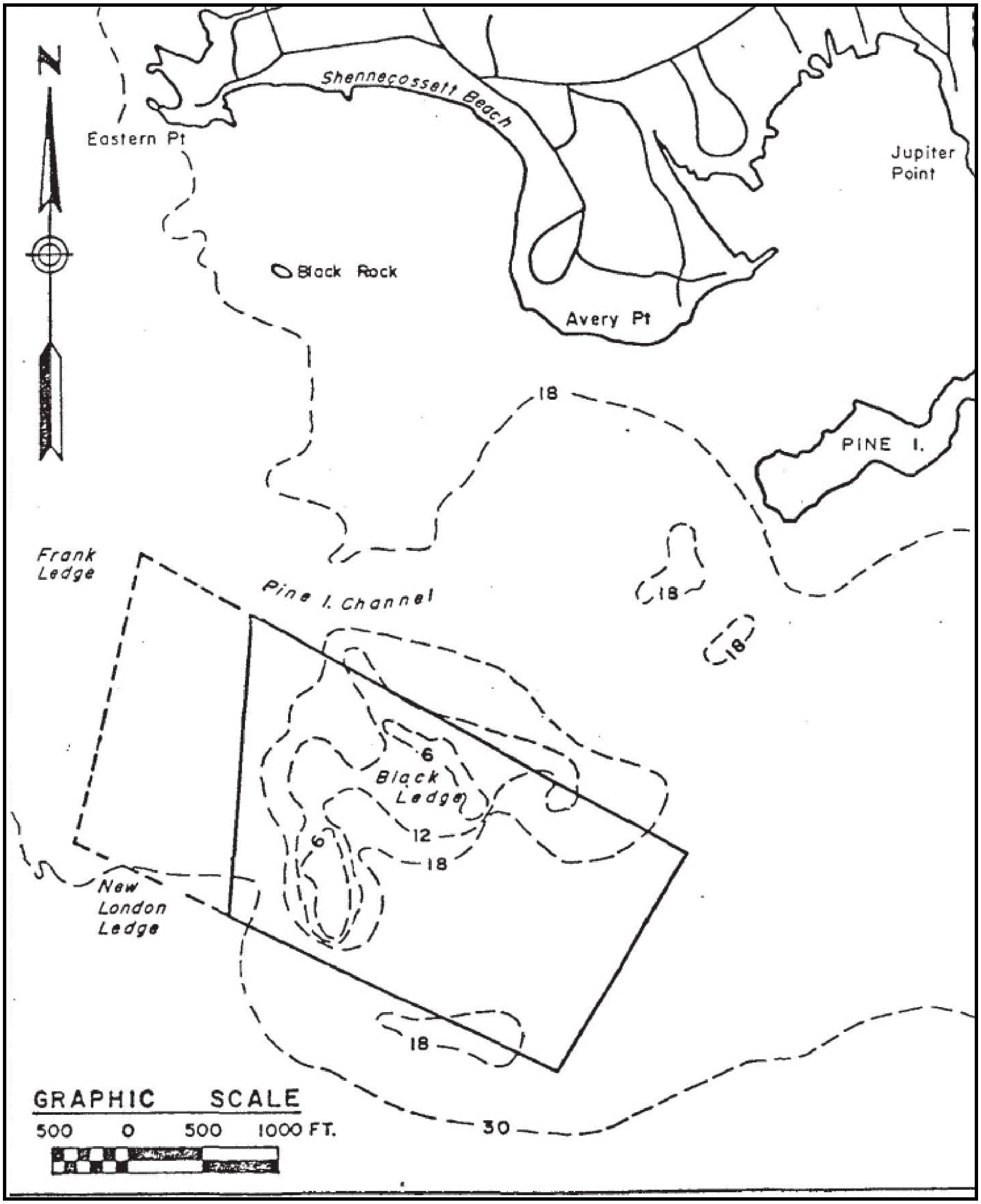


**Figure 2.3-17. Containment Site Alternative R. Groton Black Ledge.**

An island CDF occupying the area around Black Ledge at the mouth of New London Harbor approximately ½ mile southwest of Avery Point near Groton, CT.

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# 3.0 SITE INVESTIGATIONS

## 3.1 INTRODUCTION

The objectives of this section are to evaluate each of the 18 containment site alternatives based on: (1) a narrative description, including appropriate exhibits of each site, and (2) an estimate of site capacity.

This evaluation included three general tasks to meet these objectives:

1) Evaluate preliminary engineering design;
2) Obtain basemaps, physical, environmental, and cultural data for each site;
3) Prepare containment site alternative summaries

Tasks 2 and 3 constituted an evaluation of each potential containment site in terms of the location and the resources that may be affected during either site construction or operation. This evaluation took the form of site-specific evaluation matrices that compared the resources that come under the influence of a potential site against the potential impacts that might accrue to each resource from site construction or operation. The matrices were populated by qualitative characterizations of the impacts and a descriptive assessment of their probability of occurrence in each resource area. Figure 3.1-1 shows how these matrices were developed and applied.

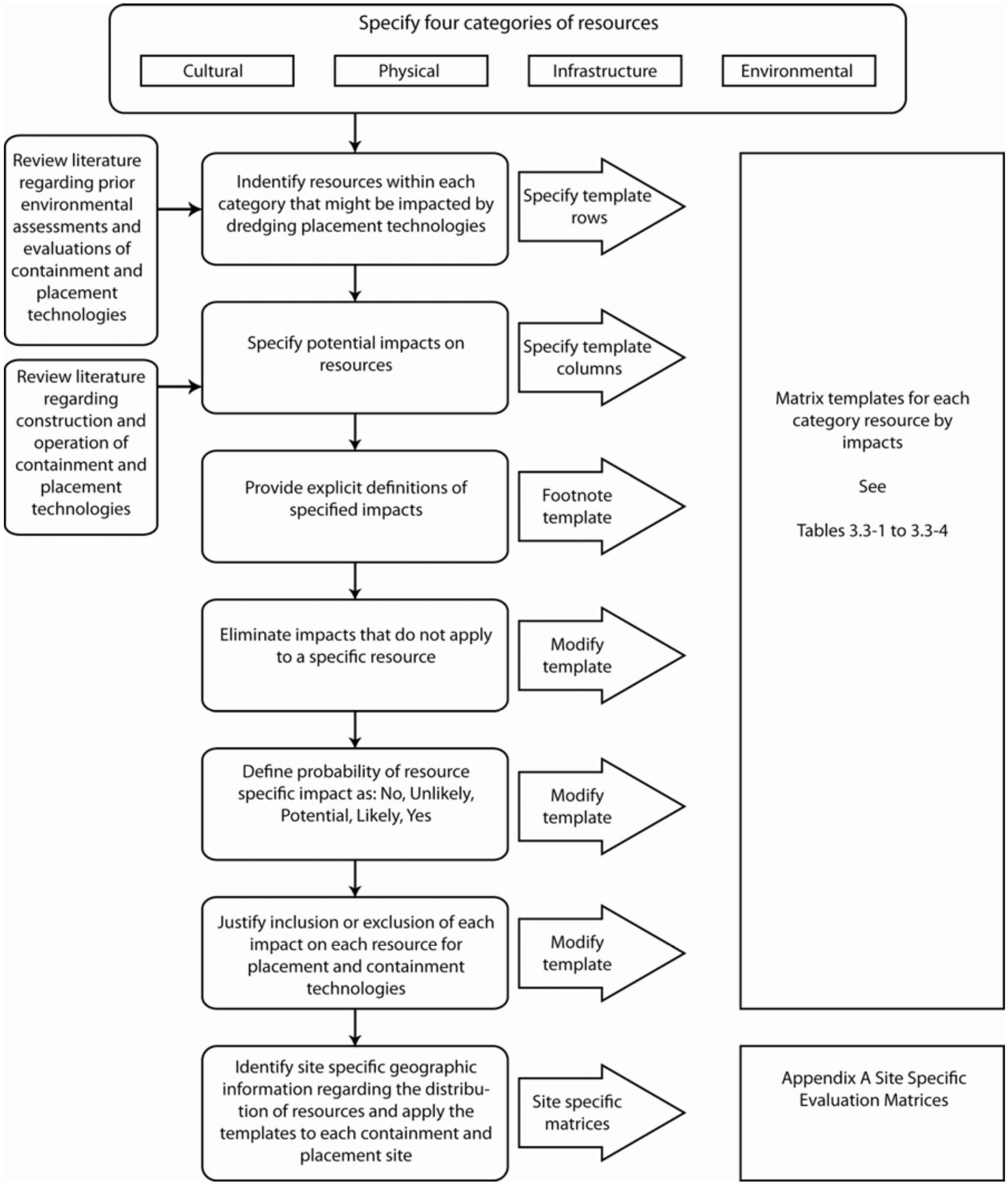


**Figure 3.1-1. Development and application of evaluation matrices.**

### 3.2 PRELIMINARY ENGINEERING DESIGN

Woods Hole Group reviewed the containment documents and other materials provided by the Corps Project Team to summarize the design specifications of each containment site alternative. The primary documents that contributed to our understanding of the potential containment sites were:

- Long Island Sound Studies Dredged Material Containment Facilities Feasibility Report (USACE, 1985a)
- Long Island Sound Studies Dredged Material Containment Supplemental Data – Volumes 1-5 (USACE, 1985b)
- Draft Dredged Material Management Plan – Bridgeport Harbor, Bridgeport, CT (USACE, 2009)

Some potential containment sites reported in these documents and all potential sites included in the Corps Conceptual Layouts (USACE, 2011b) had no previous preliminary engineering design or capacity estimates. For these sites, Woods Hole Group derived preliminary engineering designs and capacity estimates from existing design criteria and/or engineering assumptions.

It was not necessary to make assumptions for CAD cell alternatives, since the Corps had previously calculated the capacities of all four potential CAD cells.

Although location and footprint were always provided, a number of assumptions were required to complete first order designs of some shoreline CDFs and island CDFs. The primary engineering assumptions and design criteria are described below.

- Water Depth – first order volumetric calculations rely on the assumption of a flat bottom at a site-specific average water depth. GIS analysis of LIS bathymetric data (converted contours to TIN surface, then to raster GRID) enabled the calculation of a spatially weighted average depth at each site. The calculation could not be made in very shallow areas where bathymetric contours were not available; for these sites it was necessary to estimate the average depth from interpretation of the NOAA chart.

- Dike Height – first order volumetric assumptions rely on an assumption of dike height (elevation above Mean Low Water) when this design criteria was not specified in previous documents or could not be inferred from the upland elevation or from an existing breakwater cross section. Dike height assumptions depend on type of containment facility, physical setting, and aesthetic concerns. Some island CDF alternative conceptual designs specified low dike elevations, citing vista concerns from local residents. For these site alternatives, the dike height assumption is equivalent to the elevation of the annual tidal flood (USACE, 1988), a conservative proxy for the elevation resistant to most normal waves and tides while still preserving a scenic vista. Other island CDF alternative conceptual designs specified high dike elevations to be resistant to wave forces at an exposed location. For these site alternatives, the dike height assumption is equivalent to the elevation of the 100-year tidal flood (USACE, 1988) plus storm wave calculated using a standard wave break depth factor of 0.78. Shoreline CDF alternatives designed as marsh creation projects must be filled to an elevation that facilitates the establishment and maintenance of tidal marsh vegetation. Herbich's (2000) Handbook of Dredging Engineering suggests salt marshes are generally most productive in the upper third of the tidal range. Therefore, the assumed dike height in these cases is equivalent to the median elevation of the upper third of diurnal tidal range. This approach assumes that grading and/or distributed filling will create both low and high marsh habitats below and above this elevation.

- Dike Crest - first order volumetric assumptions rely on a conservative assumption of dike crest width of 12 feet.

- Dike Side Slopes - first order volumetric assumptions rely on an assumption of 1.5 to 1 (H to V) dike slope.

Table 3.2-1 summarizes the containment site footprints and capacities based on the literature and preceding assumptions.

**Table 3.2-1. Summary of Containment Site Designs.**

| Site ID | Type | Site Name | Footprint (acres) | Capacity (cy) |
|---|---|---|---|---|
| A | Shoreline CDF | Hempstead Harbor | 116 | 3,500,000 |
| B | Island CDF | Greenwich Captain Harbor* | 49 | 830,000 |
| C | Shoreline CDF | Norwalk Outer Harbor Islands – Marsh* | 78 | 930,000 |
| D | Shoreline CDF | Norwalk Outer Harbor Islands – Shore* | 33 | 400,000 |
| E | CAD | Sherwood Island Borrow Pit | 100 | 750,000 |
| F | Shoreline CDF | Penfield Reef* | 1035 | 38,550,000 |
| G | CAD | Bridgeport Outer Harbor West | 14 | 469,000 |
| H | CAD | Bridgeport Outer Harbor Southeast | 16 | 1,065,000 |
| I | Shoreline CDF | Bridgeport Yellow Mill Channel | 16 | 300,000 |
| J | Shoreline CDF | Stratford Point* | 1090 | 38,950,000 |
| K | Shoreline CDF | Milford Harbor | 11 | 270,000 |
| L | Island CDF | New Haven Breakwaters* | 1150 | 58,250,000 |
| M | CAD | Morris Cove | 30 | 610,000 |
| N | Island CDF | Falkner Island* | 240 | 17,180,000 |
| O | Shoreline CDF | Clinton Harbor | 100 | 700,000 |
| P | Island CDF | Duck Island Roads* | 48 | 1,610,000 |
| Q | Island CDF | Twotree Island | 80 | 3,400,000 |
| R | Island CDF | Groton Black Ledge | 125 | 7,500,000 |

* estimated using specifications from the containment documents

### *3.2.1 Hempstead Harbor*

The Hempstead Harbor containment site alternative (Figure 2.3-3) is a potential shoreline CDF occupying the southwestern shoreline of Hempstead Harbor near Port Washington, NY and Glenwood Landing, NY. It would extend along the western shoreline of Hempstead Harbor (south of Hempstead Harbor Park) approximately 333 yards. The project area overlaps the former operating area of the Colonial Sand and Stone mining company. Construction methods are not specified in the historical documents, but review of site screening data sheets suggests that the containment facility would be constructed by:

1) tying an approximately 2,450 yards long by ten feet high (above MLLW) rock retaining dike to the adjacent shoreline, and
2) filling the site with dredged material from a barge.

The footprint of the potential containment facility is 116 acres. Its design volume is approximately 3,500,000 cubic yards. Further details on the Hempstead Harbor design are available in the Extension of Siting Analysis contained within the Supplemental Data – Volume 1 (USACE, 1985b).

### *3.2.2 Greenwich Captain Harbor*

The Greenwich Captain Harbor containment site alternative (Figure 2.3-4) is a potential island CDF occupying either the area between the Calf Islands or between the southern Calf Island and Bowers Island in Captain Harbor near Greenwich, CT approximately 1 mile northeast of Byram Point at the mouth of Byram Harbor. The project area connects either the existing Calf Islands or the southern Calf Islands with Bowers Island. Construction methods are not specified in the historical documents, but review of site screening documentation suggests that the containment facility would be constructed by:

1) building rock retaining dikes around an area approximately 400 yards by 600 yards to a height not much above sea level (vista concerns) in 0 to 9 feet of water between the islands, and
2) filling the area between the chosen islands with dredged material from regional dredging projects (Port Chester, Greenwich, and Cos Cob harbors).

The footprint of the potential containment facility is 49 acres. Its design volume is not available in the historical documents, but was calculated[3] at approximately 830,000 cubic yards. Further details on the Greenwich Captain Harbor design are available in the Island/Shoal Screening Report contained within the Supplemental Data – Volume 1 (USACE, 1985b).

[3] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Greenwich Captain Harbor included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 12 feet (dike elevation built to +9 feet MLW annual tidal flood for vista concerns in 3 foot average depth).

### *3.2.3 Norwalk Outer Harbor Islands Marsh*

The Norwalk Outer Harbor Islands Marsh containment site alternative (Figure 2.3-5) is a potential shoreline CDF approximately 1 mile south of Manresa Island in Norwalk, CT. It is designed to create salt marsh habitat in Ram Bay between Shea Island and Sheffield Island. The Corps Conceptual Layouts (2011b) do not specify the design, but review of the literature suggests that the containment facility would be constructed by:

1) tying an approximately 567 yard long by 6.2 foot high (above MLW) rock retaining dike to the adjacent shoreline in 0 to 4 feet of water across Ram Bay,
2) constructing a weir to control circulation in and out of the facility,
3) filling the site directly with dredged material from regional dredging projects (Greenwich, Stamford, Norwalk, Bridgeport and/or Saugatuck) to an average elevation of +6.2 feet MLW, and
4) planting with *Spartina alterniflora*.

The footprint of the potential containment facility is 78 acres. Its design volume is not available in the historical documents, but was calculated[4] at approximately 930,000 cubic yards. Previous studies in support of other designs for the Norwalk Outer Harbor Islands are available in the Island/Shoal Screening Report contained within the Supplemental Data – Volume 1 (USACE, 1985b).

### *3.2.4 Norwalk Outer Harbor Islands Shore*

The Norwalk Outer Harbor Islands Shore containment site alternative (Figure 2.3-5) is a potential shoreline CDF approximately 1 mile south of Manresa Island in Norwalk, CT CDF occupying the area southwest of Shea Island. The project extends across the cove on the southwest side of Shea Island, through Wood Island. USACE Conceptual Layouts (2011b) do not specify the design, but review of the literature suggests that the containment facility would be constructed by:

1) building a 760 yard rock retaining dike to a height not much above sea level (vista concerns) in 0 to 3 feet of water in Ram Bay, and
2) filling the area with dredged material from regional dredging projects (Greenwich, Stamford, Norwalk, Bridgeport and/or Saugatuck).

The footprint of the potential containment facility is 33 acres. Its design volume is not available in the historical documents, but was calculated[5] at approximately 400,000 cubic

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[4] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Norwalk Outer Harbor Islands Marsh included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 8.2 feet (dike elevation built to +6.2 feet MLW median of upper third of diurnal tidal range at NOAA Station 8468799 Long Neck Point in 3 foot average depth).

[5] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Norwalk Outer Harbor Islands Shore included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 9.3 feet (dike elevation built to +8.3 feet MLW annual tidal flood for vista concerns in 1 foot average depth).

yards. Previous studies in support of other designs for the Norwalk Outer Harbor Islands are available in the Island/Shoal Screening Report contained within the Supplemental Data – Volume 1 (USACE, 1985b).

### *3.2.5 Sherwood Island Borrow Pit*

The Sherwood Island Borrow Pit containment site alternative (Figure 2.3-6) is a potential CAD facility approximately one-half mile offshore of Sherwood Island State Park, Westport, CT. The existing borrow pit is approximately 30 feet deeper than the surrounding area, which has average depths of -20 feet MLW. The containment facility (subject to regulation under MPRSA) would be constructed by:

1) filling the borrow pit to -30 feet MLW from a bottom dump barge with dredged material from Westport/Saugatuck River, Southport Harbor, and other regional projects, and
2) capping the fill material (the historical investigations of this site do not specify whether the cap will raise the elevation of the CAD to be more consistent with surrounding depths or whether the cap is included in the design that raises the CAD to -30 feet MLW).

The footprint of the potential containment facility is approximately 100 acres. Its design volume is approximately 750,000 cubic yards. Further details on the Sherwood Island Borrow Pit design are available in the Feasibility Report (USACE, 1985a).

### *3.2.6 Penfield Reef*

The Penfield Reef containment site alternative (Figure 2.3-7) is a potential shoreline CDF extending approximately 1.25 miles southeast around Penfield Reef from Shoal Point in Fairfield, CT. Penfield Reef is currently a small island and a submerged ridge with elevations between +0.2 and -10.8 feet MLW, but historical records indicate it was once a barrier beach providing protection to landward areas. USACE Conceptual Layouts (2011b) do not specify the design, but review of the literature suggests that the containment facility would be constructed by:

1) tying a 6,867 yard long rock retaining dike of height +13.5 feet MLW in 0 to 23 feet of water to the adjacent shoreline,
2) filling the site with dredged material from Black Rock Harbor (via hydraulic dredge) or other regional projects such as Westport Harbor/Saugatuck River, Southport, Bridgeport, or Housatonic River (using booster pump or mechanical dredging with bucket/scow), and
3) optionally place a reservoir of clean sand outside the diked area to serve as a sacrificial sandbar similar to the historical landform.

The footprint of the potential containment facility is 1035 acres. Its design volume is not available in the historical documents, but was calculated[6] at approximately 38,550,000

[6] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Penfield Reef included: dike side

cubic yards. Previous studies in support of other designs for the Penfield Reef are available in the Feasibility Report (USACE, 1985a).

### 3.2.7 Bridgeport Outer Harbor West

The Bridgeport Outer Harbor West site alternative (Figure 2.3-8) is a potential CAD west of the Bridgeport Harbor Channel and north (harbor side) of the western jetty in Bridgeport, CT. The Bridgeport Outer Harbor West CAD is not located at an existing depression or borrow pit, and would need to be excavated. The containment facility would be constructed by:

1) in approximately 15 feet of water, excavating existing harbor sediments to bedrock (down to 25 to 60 feet below MLLW) with walls at a 3:1 (horizontal:vertical) slope,
2) filling the site with dredged material from Bridgeport Harbor by scow, and
3) capping the fill material at -10 to -7 feet MLLW.

The footprint of the potential containment facility is approximately 14 acres. Its design volume is 469,000 cubic yards. Further details on the Bridgeport Outer Harbor West design are available in the Bridgeport Harbor DMMP (USACE, 2009).

### 3.2.8 Bridgeport Outer Harbor Southeast

The Bridgeport Outer Harbor Southeast site alternative (Figure 2.3-8) is a potential CAD east of the Bridgeport Harbor Channel and north (harbor side) of the eastern jetty in Bridgeport, CT. The Bridgeport Outer Harbor Southeast CAD is not located at an existing depression or borrow pit, and would need to be excavated. The containment facility would be constructed by:

1) in relatively shallow water, excavating existing harbor sediments to bedrock (down 90 feet below MLLW) with walls at a 3:1 (horizontal:vertical) slope,
2) filling the site with dredged material from Bridgeport Harbor by scow, and
3) capping the fill material at -10 to -7 feet MLLW.

The footprint of the potential containment facility is approximately 16 acres. Its design volume is 1,065,000 cubic yards. Further details on the Bridgeport Outer Harbor Southeast design are available in the Bridgeport Harbor DMMP (USACE, 2009).

### 3.2.9 Bridgeport Yellow Mill Channel

The Bridgeport Yellow Mill Channel containment site alternative (Figure 2.3-9) is a potential shoreline CDF filling the northern reach of the Yellow Mill Channel between the railroad corridor and I-95 in the city of Bridgeport, CT. The project area is an

slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 23.4 feet (dike elevation built to +13.5 feet MLW from previous designs in 9.9 foot average depth).

industrial channel adjacent to Bridgeport Harbor and abutting an elementary school and two parks. The containment facility would be constructed by:

1) closing off the tidal portions of the channel with a 167 yard long rock retaining dike of height +15 feet MLW at the southern end in up to 20 feet of water,
2) constructing freshwater drainage through the facility,
3) filling the site with dredged material from Bridgeport Harbor (likely via hydraulic dredge), and,
4) capping the area for upland development.

The footprint of the potential containment facility is 16 acres. Its design volume is approximately 300,000 cubic yards. Further details on the Bridgeport Yellow Mill Channel design are available in the Engineering Reports contained within the Supplemental Data – Volume 2 (USACE, 1985b).

### *3.2.10 Stratford Point*

The Stratford Point containment site alternative (Figure 2.3-10) is a potential shoreline CDF occupying the area south of Stratford Point and Lordship west to Lewis Gut in Stratford, CT. The Corps Conceptual Layouts (2011b) do not specify the design, but review of the literature suggests that the containment facility would be constructed by:

1) tying a 6,167 yard long rock retaining dike of height +10 feet MLW in 0 to 30 feet of water to the adjacent shoreline, and
2) filling the site with dredged material from unspecified harbors.

The footprint of the potential containment facility is 1,090 acres. Its design volume is not available in the historical documents, but was calculated[7] at approximately 38,950,000 cubic yards. Previous investigations of this site were not encountered in the literature.

### *3.2.11 Milford Harbor*

The Milford Harbor containment site alternative (Figure 2.3-11) is a potential shoreline CDF occupying the area outside the eastern jetty of Milford Harbor and adjacent to Gulf Beach adjacent to the entrance channel to Milford Harbor in Milford, CT and anchored to the outside of the eastern Jetty. The Milford Harbor project was originally proposed for the western jetty, but was later altered to take advantage of littoral drift to feed Gulf Beach. The containment facility would be constructed by:

1) tying a 1,100 yard long rock retaining dike of height +9.5 feet MLW in 0 to 14 feet of water to the adjacent shoreline and jetty, and
2) filling the site with dredged material from Milford Harbor (via hydraulic dredge).

[7] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Stratford Point included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 22.6 feet (dike elevation built to +10 feet MLW equivalent to adjacent upland in 12.6 foot average depth).

The footprint of the potential containment facility is approximately 11 acres. Its design volume is approximately 270,000 cubic yards. Further details on the Milford Harbor design are available in the Feasibility Report (USACE, 1985a).

#### *3.2.12 New Haven Breakwaters*

The New Haven Breakwaters containment site alternative (Figure 2.3-12) is a potential island CDF occupying the area behind the west and middle breakwaters in the southwestern portion of New Haven Harbor adjacent to the entrance channel to the harbor in New Haven, CT and anchored to the two breakwaters west of the channel. The Corps Conceptual Layouts (2011b) do not specify the design, but review of the literature suggests that the containment facility would be constructed by:

1) tying 9,410 yards of rock retaining dikes in 13 to 26 feet of water north of and between the existing breakwaters, and
2) filling the site with dredged material from unspecified harbors.

The footprint of the potential containment facility is approximately 1,150 acres. Its design volume is not available in the historical documents, but was calculated[8] to be at least 58,250,000 cubic yards. Previous studies in support of other designs for the New Haven Breakwaters are available in the Addendum to the Interim Report contained within the Supplemental Data (USACE, 1985b).

#### *3.2.13 Morris Cove*

The Morris Cove containment site alternative (Figure 2.3-12) is a potential CAD facility occupying a former borrow pit offshore of Fort Nathan Hale Park and Pardee Parkway in outer New Haven Harbor. The existing borrow pit from the construction of Interstate Highway 95 is approximately 217 yards wide and 817 yards long with depths ranging from 9.8 to 29.5 feet below MLW. Some open water disposal occurred at the site (18,574 cubic yards in 2000), but significant capacity remains. The containment facility would be constructed by:

1) filling the borrow pit to -11.5 feet MLLW from a dump scow with dredged material from Bridgeport Harbor, and
2) capping the fill material.

The footprint of the potential containment facility is approximately 30 acres. Its design volume is approximately 610,000 cubic yards. Further details on the Morris Cove design are available in the Bridgeport Harbor DMMP (USACE, 2009).

[8] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for New Haven Breakwaters included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 32.6 feet (dike elevation built to +12 feet MLW equivalent to current breakwater in 20.6 foot average depth).

### *3.2.14 Falkner Island*

The Falkner Island containment site alternative (Figure 2.3-13) is a potential island CDF approximately 4 miles south of Guilford Harbor, CT connecting Falkner Island to Goose Island. USACE Conceptual Layouts (2011b) do not specify the design, but review of site screening documentation suggests that the containment facility would be constructed by:

1) building a 5,000 yard rock retaining dike to a height higher than nearshore facilities (wave protection and visibility for navigation) in up to 32 feet of water between Goose Island and Falkner Island, and
2) filling the area with dredged material from regional dredging projects (New Haven, Branford, Stony Creek, Guilford, and/or Clinton harbors).

The footprint of the potential containment facility is 240 acres. Its design volume is not available in the historical documents, but was calculated[9] at approximately 17,180,000 cubic yards. Previous studies in support of other designs for Falkner Island are available in the Island/Shoal Screening Report contained within the Supplemental Data – Volume 1 (USACE, 1985b).

### *3.2.15 Clinton Harbor*

The Clinton Harbor containment site alternative (Figure 2.3-14) is a potential shoreline CDF that would create a salt marsh habitat adjacent to the Clinton Harbor federal navigation channel along the southern shoreline of Cedar Island and the eastern shoreline of Willard Island (Hammonasset Beach State Park). The containment facility would be constructed by:

1) tying a 1,600 yard long rock retaining dike of height +6 feet MLW in 0 to 12 feet of water to the adjacent shorelines,
2) constructing a 50 foot wide weir to control circulation in and out of the facility,
3) filling the site directly with dredged material from Clinton Harbor via hydraulic pumping to elevations varying from below MLW to +7 feet MLW, and
4) planting with *Spartina alterniflora*.

The footprint of the potential containment facility is 100 acres, of which 68 acres would be created tidal wetlands. Its design volume is approximately 700,000 cubic yards. Further details on the Clinton Harbor design are available in the Feasibility Report (USACE, 1985a).

[9] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Falkner Goose Island included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 54.5 feet (dike elevation built to +36.2 feet MLW equivalent to elevation of 100-year tidal flood plus storm wave calculated using wave break depth factor in 18.3 foot average depth).

### *3.2.16 Duck Island Roads*

The Duck Island Roads containment site alternative (Figure 2.3-15) is a potential island CDF approximately 0.25 mile south of Kelsey Point in Clinton, CT and bounded by the southern tip of Stone Island, East Ledge, and the Kelsey Point Breakwater. The project is a triangle shaped area approximately 700 yards on each side. Construction methods are not specified in the historical documents, but review of site screening documentation suggests that the containment facility would be constructed by:

1) tying a 1,400 yard long rock retaining dike at a height not much above sea level (vista concerns) in 8 to 30 feet of water to the eastern side of the breakwater, and
2) filling the area with dredged material from regional dredging projects (Clinton, Guilford, Westbroook, and/or Old Saybrook harbors).

The footprint of the potential containment facility is approximately 48 acres. Its design volume is not available in the historical documents, but was calculated[10] at approximately 1,610,000 cubic yards. Further details on the Duck Island Roads design are available in the Island/Shoal Screening Report contained within the Supplemental Data – Volume 1 (USACE, 1985b).

### *3.2.17 Twotree Island*

The Two Tree Island containment site alternative (Figure 2.3-16) is a potential island CDF approximately 0.75 mile southeast of Millstone Power Plant in Waterford, CT surrounding the existing Twotree Island. Construction methods are not specified in the historical documents, but review of site screening documentation suggests that the containment facility would be constructed by:

1) building a 2,567 yard long rock retaining dike at a height of +20 feet MLW in 10 to 15 feet of water around the existing island, and
2) filling the area with dredged material from unspecified dredging projects.

The footprint of the potential containment facility is 80 acres. Its design volume is 3,400,000 cubic yards. Further details on the Twotree Island design are available in the Feasibility Report (USACE, 1985a).

### *3.2.18 Groton Black Ledge*

The Groton Black Ledge containment site alternative (Figure 2.3-17) is a potential island CDF adjacent to the New London Harbor navigation channel approximately 1 mile seaward of the entrance to New London Harbor and south of Avery Point in Groton, CT. Black Ledge is an existing rocky shoal primarily occupying the area within the 18 foot

[10] Calculations assume reasonable volume can be determined assuming a flat bottom and an estimate of average depth throughout the disposal area. Design assumptions for Duck Island Road included: dike side slope of 1.5:1 (horizontal:vertical), dike crest width of 12 feet, average dike height above bottom of 25.4 feet (dike elevation built to +6.5 feet MLW annual tidal flood for vista concerns in 18.9 foot average depth).

isobath, with depths ranging from 10 to 30 feet MLW and a small portion (20 square yards) exposed over most of the tidal cycle. The island would be constructed by:

1) building 3,083 yard long rock retaining dike of height +13.5 feet MLW in 5 to 35 feet of water around the shoal,
2) building two internal dikes,
3) filling the three interior cells with dredged material (in stages with wetland establishment between fill events) from regional dredging projects (primarily Thames River, but also Niantic Bay/Harbor, Mystic River, Stonington Harbor, or Pawcatuck River) via bottom dump barge (to -10 MLW) and by crane from floating barge,
4) and capping with 2 feet of fill.

The footprint of the potential containment facility is 125 acres. Its design volume is approximately 7,500,000 cubic yards. Further details on the Groton Black Ledge design are available in the Feasibility Report (USACE, 1985a).

## 3.3 GEOSPATIAL DATA

Potential impacts from development of the nearshore placement sites were evaluated using geospatial data rendered in a series of thematic working maps. The working maps were organized into the following four resource categories: cultural, environmental, infrastructure and physical.

### *3.3.1 Cultural*

Cultural resources refer to anthropogenic remains or constructs that have historical or archaeological significance.

A report by Public Archaeological Laboratory (PAL, 2010) provided a cultural resources inventory for historic properties including archaeological sites and sensitivity of 57 coastal communities in the study area along the shoreline of Long Island Sound. The inventory included areas underwater within one-half mile of the shoreline and inland for a distance of no greater than 10 miles. Volume II Appendix A of the report provided a GIS database of these resources.

#### ***3.3.1.1 Shipwrecks***

The “Underwater Cultural Resources Inventory” shapefile included in Volume II Appendix A of the Cultural Resources Inventory (PAL, 2010) documented 847 known maritime resources and submerged sites (i.e. shipwrecks) within the study area. Available information included the name and date of the shipwreck, the information source, and the National Register status (listed or not listed).

#### ***3.3.1.2 Historic Districts***

The “Historic Aboveground Cultural Resources” geodatabase included in Volume II Appendix A of the Cultural Resources Inventory (PAL, 2010) documented the locations of all 321 recorded aboveground and belowground terrestrial historic properties within the project study area. According to the Advisory Council on Historic Preservation

(ACHP), historic properties are defined as those "districts, sites, buildings, structures, and objects" listed or eligible for listing in the National Register of Historic Places. Available information included the state inventory number, resource name, location, property type, and National Register status (listed or eligible).

#### *3.3.1.3 Archaeological Sites*

The "Terrestrial Archaeology Cultural Resources" geodatabase included in Volume II Appendix A of the Cultural Resources Inventory (PAL, 2010) documented the locations (generalized for confidentiality purposes) of all 202 known terrestrial archaeological sites within the project study area. Available information included the state inventory number, name, location, site type, contents/function, temporal affiliation, National Register status (where known), and source of information.

### *3.3.2 Environmental*

Environmental resources refer to flora and fauna that inhabit the coastal and marine environment, as well as any management areas established to protect these natural resources.

#### *3.3.2.1 Wetlands*

Each state in the study area has developed information on wetlands using different methods and varying definitions. These data were aggregated to make the representation of wetlands more consistent among the states.

The New York State Department of Environmental Conservation (NYSDEC) developed "Tidal Wetlands - NYC and Long Island – 1974" in 2005 and distributes it through the New York State Geographic Information Systems (NYGIS) Clearinghouse (NYSDEC, 2005). These data include New York State tidal wetlands south of the Tappan Zee Bridge, as of 1974. Six wetland types from the New York data layer were used to identify potential impacts from the nearshore berm sites. These wetland types and their respective codes were:

- Coastal Shoals, Bars and Mudflats (SM);
- Formerly Connected (FC);
- Intertidal Marsh (IM);
- Fresh Marsh (FM);
- High Marsh (HM); and
- Dredged Material (DC).

The Connecticut Department of Energy and Environmental Protection (CTDEEP) developed "Tidal Wetlands 1990s" in 1999 (CTDEEP, 1999) and distributes it through the CTDEEP GIS Data website. Wetland mapping for all tidal, coastal and navigable waters, and tidal wetlands were used to identify potential impacts from the nearshore berm sites.

The Rhode Island Department of Environmental Management (RIDEM), Narragansett Bay Estuary Program, and Rhode Island Coastal Resources Management Council

(RICRMC) developed "South Coast Estuarine Habitat; cstlwet" in 2003 (RIDEM, 2003) and distributes it through the Rhode Island Geographic Information System (RIGIS). Four of the original wetland types were used to identify potential impacts from the nearshore berm sites. These wetland types were:

- Brackish Marsh
- Phragmites Marsh
- Salt Marsh
- Scrub Shrub Wetland

#### *3.3.2.2 Federal and State Listed Species*

Each state in the study area has developed natural heritage information on threatened and endangered species. The spatial coverage of this information is usually broad to protect the subject resources from anthropogenic intrusion. Therefore, any intersections with the project area may or may not overlap with actual species use.

The New York Natural Heritage Program (NYNHP) maintains "Biodiversity Databases" which must be requested from the agency. The agency provides the following data layers (NYNHP, 2010):

- records of occurrences of significant natural communities ("nynhp_LongIsland_comms_10" and "nynhp_WestOfSuffolk_comms_10")
- records of element occurrences either last documented before 1980 (historical records), and/or records for which precise or relatively precise locations are not known ("nynhp_LongIsland_potential_10" and "nynhp_WestOfSuffolk_potential_10")
- records of occurrences of rare animals and rare plants last documented since 1980, and for which the locations are precisely or relatively precisely known ("nynhp_LongIsland_species_10" and "nynhp_WestOfSuffolk_species_10")

The CTDEEP maintains the "Natural Diversity Data Base Areas" dataset (CTDEEP, 2011) and distributes it through the CTDEEP GIS Data website. The data layer represents general locations of endangered, threatened and special concern species and significant natural communities. The July 2011 update was utilized to evaluate potential impacts from the nearshore berm sites.

The RIDEM and The Nature Conservancy Natural Heritage Program developed the "Natural Heritage Areas; natHeritage90" in 1990 (RIDEM, 1990) and distribute it through the RIGIS. The data layer represents the estimated habitat and range of rare species and noteworthy natural communities in Rhode Island as of August 1990.

#### *3.3.2.3 Shellfish*

The NOAA National Ocean Service Office of Response and Restoration, along with other federal and state partners, developed the Environmental Sensitivity Index (ESI) for Long Island (NOAA, 2009) and for Rhode Island/Connecticut/New York/New Jersey

(NOAA, 2002), and distribute the data through their ESI website. The ESI toolkit was developed as a reference of resources that are at-risk if an oil spill occurs nearby. It is used by responders to minimize environmental consequences of spills/cleanups, and by planners to identify and protect vulnerable areas. The "Invertebrates" data set contains

> "…sensitive biological resource data for coastal, estuarine, and marine invertebrate species. Vector polygons in this data set represent invertebrate distribution and concentration areas. Species specific abundance, seasonality, status, life history, and source information are stored in relational data tables designed to be used in conjunction with this spatial data layer."

Invertebrate data within the influence of a given nearshore berm site were used to determine potential impacts to sensitive coastal/estuarine/marine invertebrate species.

Shellfish are also included in the NOAA Essential Fish Habitat designations (discussed below). Therefore, shellfish may also appear in the evaluations of impacts on Federally Managed Species.

#### *3.3.2.4 Federally Managed Species (Magnuson-Stevens)*

The NOAA Fisheries Service Habitat Conservation Division manages the Essential Fish Habitat program and developed the Guide to Essential Fish Habitat Designations in the Northeastern United States (NOAA, 1999). The website provides a

> "…geographic species list of Essential Fish Habitat (EFH) designations…pursuant to the Magnuson-Stevens Fishery Conservation and Management Act [and specifies] species and life stages of fish, shellfish, and mollusks for which EFH has been designated in a particular area."

Recorded fish species from each 10' x 10' square that contained a nearshore berm were used to identify potential impacts to EFH.

#### *3.3.2.5 Submerged Aquatic Vegetation*

Information on the locations of submerged aquatic vegetation (i.e. eelgrass and other vegetation) was derived from three resources.

The "Habitats" dataset within the ESI for Long Island (NOAA, 2009) and Rhode Island/Connecticut/New York/New Jersey (NOAA, 2002) contains

> "…sensitive biological resource data for sensitive/rare coastal plants and submerged aquatic vegetation (SAV). Vector polygons in this data set represent sensitive/rare coastal plants recognized by the Natural Heritage Program (NHP) and eelgrass distribution. Species-specific abundance, seasonality, status, life history, and source information are stored in relational data tables…designed to be used in conjunction with this spatial data layer."

Data within the influence of a given nearshore berm site were used to determine potential impacts to sensitive SAV resources.

The U.S. Fish & Wildlife Service, Northeast Region National Wetlands Inventory developed "Connecticut Eelgrass Beds 2006 Poly" in 2006 (USFWS, 2006) and distributes it through the CTDEEP GIS Data website. This data layer is an inventory of delineations of eelgrass beds on the eastern Connecticut shoreline to the Rhode Island border (plus Fisher Island, Plum Island, and the northern shore of Long Island) based on interpretation of 1:20,000 scale Spring 2006 True Color aerial photography. This information was used to identify eelgrass beds in eastern Connecticut (east of Westbrook) and northeastern Long Island, and to evaluate potential impacts from nearshore berm sites. The geographic scope of this dataset is limited and therefore comparable evaluations were not possible at all LIS nearshore berm sites.

The RIDEM and RICRMC developed "South Coast Estuarine Habitat; cstlwet" in 2003 (RIDEM, 2003), and distribute it through the RIGIS. The original dataset presents a variety of coastal wetland habitats. Following the definitions provided in Section 300.18 of the Rhode Island Coastal Resources Management Program (RICRMC, 2010), only the following categories were displayed for the analysis of submerged aquatic vegetation:

- Aquatic Beds (eelgrass)
- Aquatic Beds (not eelgrass)

#### *3.3.2.6 Marine Protected Areas*

The NOAA Ocean and Coastal Resource Management (OCRM) National Marine Protected Areas Center (MPAC) developed the "MPA Inventory Database (3/2011)" dataset in 2011 (NOAA, 2011a) and distributes it through the MPAC website. The data layer inventories existing federal, state and territorial marine protected areas in the United States. The dataset describes six different levels of protection (Uniform Multiple Use, Zoned Multiple Use, Zoned with No Take Areas, No Take, No Impact, and No Access). The marine protected areas within LIS are all either Uniform Multiple Use or Zoned Multiple Use. Also, the data indicate that the Southern Nearshore Trap/Pot (Lobster) Waters MPA is a Uniform Multiple Use protected area occurring throughout LIS managed by the National Marine Fisheries Service through a Programmatic Species Management Plan. Since this management area is theoretically within the zone of influence of all sites in the evaluation, specific mention of the management area was not made in the site evaluation tables.

#### *3.3.2.7 Birds*

The "Birds" dataset within the ESI for Long Island (NOAA, 2009) and Rhode Island/Connecticut/New York/New Jersey (NOAA, 2002) contains

> "…sensitive biological resource data for wading birds, shorebirds, waterfowl, raptors, diving birds, pelagic birds, passerine birds, gulls and terns. Vector polygons in this data set represent locations of bird nesting, foraging, and rafting sites. Species specific abundance, seasonality, status, life history, and source information are stored in relational data tables designed to be used in conjunction with this spatial data layer."

Data within the influence of a given nearshore berm site were used to determine potential impacts to sensitive bird resources.

##### *3.3.2.8 Marine Mammals*

The "Marine Mammals" dataset within the ESI for Long Island (NOAA, 2009) and Rhode Island/Connecticut/New York/New Jersey (NOAA, 2002) contains

> "…sensitive biological resource data for seals, whales, and dolphins. Vector polygons in this data set represent marine mammal distribution and seal haul-out sites. Species-specific abundance, seasonality, status, life history, and source information are stored in relational data tables…designed to be used in conjunction with this spatial data layer."

Data within the influence of a given nearshore berm site were used to determine potential impacts to sensitive marine mammal resources.

##### *3.3.2.9 Terrestrial Wildlife*

The "Terrestrial Mammals" dataset within the ESI for Long Island (NOAA, 2009) and Rhode Island/Connecticut/New York/New Jersey (NOAA, 2002) contains

> "…sensitive biological resource data for small mammal species. Vector polygons in this data set represent terrestrial mammals. Species-specific abundance, seasonality, status, life history, and source information are stored in relational data tables designed to be used in conjunction with this spatial data layer."

Data within the influence of a given nearshore berm site were used to determine potential impacts to sensitive terrestrial wildlife resources.

#### *3.3.3 Infrastructure*

Infrastructure resources refer to built resources that support human activities such as transportation, recreation, and habitation. For this evaluation, only those elements that have direct relevance to the coastal and marine zone (i.e. developed along or in Long Island Sound) were investigated.

##### *3.3.3.1 Mooring Areas*

The United States Coast Guard Districts Operations Systems Center developed "Anchorage Areas" data in 2004 (USCG, 2004) and distributes it through the Marine Cadastre and the Northeast Ocean Data Viewer. The data layer inventories areas designated as special anchorage areas for purposes of 33 U.S.C. §§2030(g) and 2035(j). These data were downloaded from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impacts to designated anchorage areas from the nearshore berm sites.

NOAA nautical charts and current digital orthophotography (via Google Earth) were used to identify other anchorage areas and small recreational mooring fields.

#### *3.3.3.2 Navigation Channels and Shipping*

NOAA nautical charts were used to identify existing navigational channels and to evaluate impacts to navigation from the nearshore berm sites.

The NOAA-NOS Coastal Services Center and The Nature Conservancy developed "AIS Density" data in 2011 (NOAA, 2011b) and distribute it through the Northeast Ocean Data Viewer. The data layer maps patterns of large vessel traffic in the Northeast with a "…density grid based on the vessel point locations derived from the Automatic Identification System database from 2009." These data were downloaded from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impacts to shipping from the nearshore berm sites.

A number of state-generated road and ferry shapefiles were used to identify ferry traffic patterns throughout LIS. The New York State Office of Cyber Security annually releases updated versions of the "NYS Streets" shapefile (NYSOCS, 2011) and distributes it through the NYGIS Clearinghouse. "NYS Streets" is a vector file of public/private streets and ferry crossings compiled from orthoimagery and other sources and attributed with street names and route numbers. The Rhode Island Department of Administration Statewide Planning Program developed "Ferry Routes; Ferry_04" in 2004 (RIDASPP, 2004) and distributes it through the RIGIS. This data set contains established commercial passenger and vehicle water ferry routes for Rhode Island ports and ferry docks. A complimentary shapefile was digitized for Connecticut using the routes and destinations depicted in the New York and Rhode Island datasets as a guide.

#### *3.3.3.3 Ports*

The USACE Navigation Data Center (NDC) periodically develops an inventory of the principal ports of the United States. The shapefile "pports09" is the 2009 data (USACE NDC, 2009) available in the file "ndcgis11shp.zip" through the NDC website. The data includes port names, codes, and tonnage statistics.

#### *3.3.3.4 Coastal Structures*

Current digital orthophotography (via Google Earth) was utilized to identify coastal structures such as groins, breakwaters, jetties, bulkheads, and other shoreline armoring.

#### *3.3.3.5 Cable/Power/Utility Crossings*

Information on submerged cable areas and pipelines was obtained from the following two sources:

The NOAA-NOS Coastal Services Center developed "Submarine_Cable" data in 2011 (NOAA, 2011c) and distributes it through the Marine Cadastre and the Northeast Ocean Data Viewer. The data layer depicts the location of submarine cables as defined by the NOAA Electronic Navigation Charts and the NOAA Raster Nautical Charts. The data were downloaded from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impacts to submarine cables from the nearshore berm sites.

The CTDEEP developed "LIS_CABLES_PIPELINES" in 2002 (updated in 2005) (CTDEEP, 2005) and distributes it through the CT DEEP GIS Data website. The data layer documents the location of submerged cable and/or pipeline areas in LIS, including electric transmission lines, telephone and/or fiber optic cables, natural gas and/or petroleum pipelines.

#### *3.3.3.6 Recreational Areas*

Recreational areas including public beaches, municipal/state parks, and boat launches were identified using the Google Earth Primary Database and current digital orthophotography (also via Google Earth).

Information on recreational boat ramps was obtained from the following three sources:

1) The NYSDEC Bureau of Marine Resources Marine Fishing Access Unit prepared a report in 2009 "BOAT RAMPS LONG ISLAND REGION - A listing of facilities for the launching of trailered boats into the marine waters of Nassau and Suffolk Counties" (NYSDEC, 2009). The boat ramp locations for Long Island towns with shorelines fronting LIS (East Hampton, Southold, Riverhead, Brookhaven, Smithtown, Huntington, Oyster Bay, and North Hempstead) were digitized and used in the evaluation of impacts.
2) The CTDEEP developed "DEP_BOAT_LAUNCH" in 2008 (CTDEEP, 2008) and distributes it through the CT DEEP GIS Data website. The data layer includes all DEP boat launch locations in the State of Connecticut including trailered, car-top and carry-in.
3) The RIDEM developed "Boat Ramps in Rhode Island; s44obr96" in 1996 (RIDEM, 1996) and distributes it through the RIGIS. The data layer inventories "recreational boat launching ramp and marine pump out facilities for fresh and salt water bodies accessible to the public within Rhode Island."

#### *3.3.3.7 Commercial and Industrial Facilities*

The NOAA-NOS Coastal Services Center developed "Regulated_Facilities" data in 2010 (NOAA, 2010a) and distributes it through the Marine Cadastre and the Northeast Ocean Data Viewer. The data layer inventories facilities, sites, or places subject to environmental regulation or of environmental interest to the United States Environmental Protection Agency (USEPA). The data were downloaded from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impacts to regulated facilities from the nearshore berm sites.

#### *3.3.3.8 Aquaculture*

The NOAA-NOS Office of Coast Survey revised "Marine_Farms" data in 2011 (NOAA, 2011d) and distributes it through the NOAA ENC Direct to GIS viewer and the Northeast Ocean Data Viewer. The data layer inventories "aquaculture activities – defined as an assemblage of cages, nets, rafts and floats or posts where fish, including shellfish, are artificially cultivated." The data were downloaded from Database 2 (Ocean Uses) of the

Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impacts to aquaculture sites from the nearshore berm sites.

Additional information on aquaculture and commercial fishing activities were obtained through interpretation of NOAA nautical charts and current digital orthophotography (via Google Earth).

##### *3.3.3.9 Dredged Material Disposal Sites*

The NOAA-NOS Coastal Services Center developed "Disposal_Sites" data in 2010 (NOAA, 2010b) and distributes it through the Marine Cadastre and the Northeast Ocean Data Viewer. The data layer inventories disposal sites for dredged material, defined as finally approved and precise geographical areas within which ocean dumping of wastes is permitted. These data were downloaded from Database 2 (Ocean Uses) of the Northeast Ocean Data Portal's Northeast Ocean Data Files and used to evaluate potential impact to dredged material disposal sites from the nearshore berm sites.

#### *3.3.4 Physical*

Physical resources refer to the geological deposits and coastal processes that are characteristic of LIS.

##### *3.3.4.1 Sediments*

The U.S. Geological Survey (USGS) developed "listex" data in 2000 and distributes it through the USGS website. The data layer "Distribution of Surficial Sediments in Long Island Sound" is available within the USGS report OFR 00-304 (Paskevich and Poppe, 2000) on Long Island Sound seafloor mapping. The data layer contains "a computer generated model of the distribution of surficial sediments in Long Island Sound."

##### *3.3.4.2 Littoral Drift*

Information on the patterns of littoral drift was derived through interpretation of current digital orthophotography (via Google Earth). Sand impoundments against coastal structures such as groins and jetties, and accumulation of sand at the end of spits along undeveloped shorelines, were used as indicators of the direction of alongshore sediment transport.

##### *3.3.4.3 Currents*

Information on tidal currents was determined through evaluation of local bathymetric contours, proximity to tidal inlet and harbor entrances, shoreline orientation, and observed directions of littoral drift. Bathymetric data sources included: (1) the National Geophysical Data Center (NGDC) NOS hydrographic surveys, multibeam bathymetry, and trackline bathymetry, (2) the USGS, and (3) other federal governmental agencies and academic institutions. Proximity to inlet and harbor entrances was evaluated through examination of aerial photography available through Google Earth. Tidal currents were assumed to flood and ebb through the narrowest cross section of the tidal inlets and harbor entrances. Tidal currents were also assumed to flow along the general shoreline morphology as seen on the aerial photography.

#### *3.3.4.4 Waves*

Wave information and approach directions were derived through evaluation of the local bathymetric contours, shoreline orientation, and estimated littoral drift direction. Local bathymetric data were acquired in order to determine nearshore contours throughout the Sound. Bathymetric data sources included: (1) the NGDC NOS hydrographic surveys, multibeam bathymetry, and trackline bathymetry, (2) the USGS, and (3) other federal governmental agencies and academic institutions. Isobaths from the bathymetric data were then utilized, in concert with the shoreline orientation, to estimate the wave approach, potential wave transformations, and determine the dominant direction of wave approach. Average wave approach directions were assumed to align perpendicular to the offshore isobaths, while the more frequently occurring wave direction was estimated based on the shoreline orientation, fetch approaches, and littoral drift direction.

In addition, wave energy at each location was estimated by qualitatively evaluating the overall shoreline exposure, the fetch distances available for wind–generated waves, and the water depths in the vicinity of each site. The wave energy and approach directions were used to estimate impacts on wave transformations caused by the potential nearshore berms and disposal locations.

## 3.4 PROCESS OF IMPACT EVALUATIONS

The geospatial data were organized into four thematic working maps (Cultural, Environmental, Infrastructure, and Physical) as ArcGIS map projects. The footprints for the 18 potential containment facilities were then added to each working map to facilitate the impact analyses. Figures 3.3-1 and 3.3-2 provide examples of these thematic working maps for Infrastructure and Physical resources, respectively.

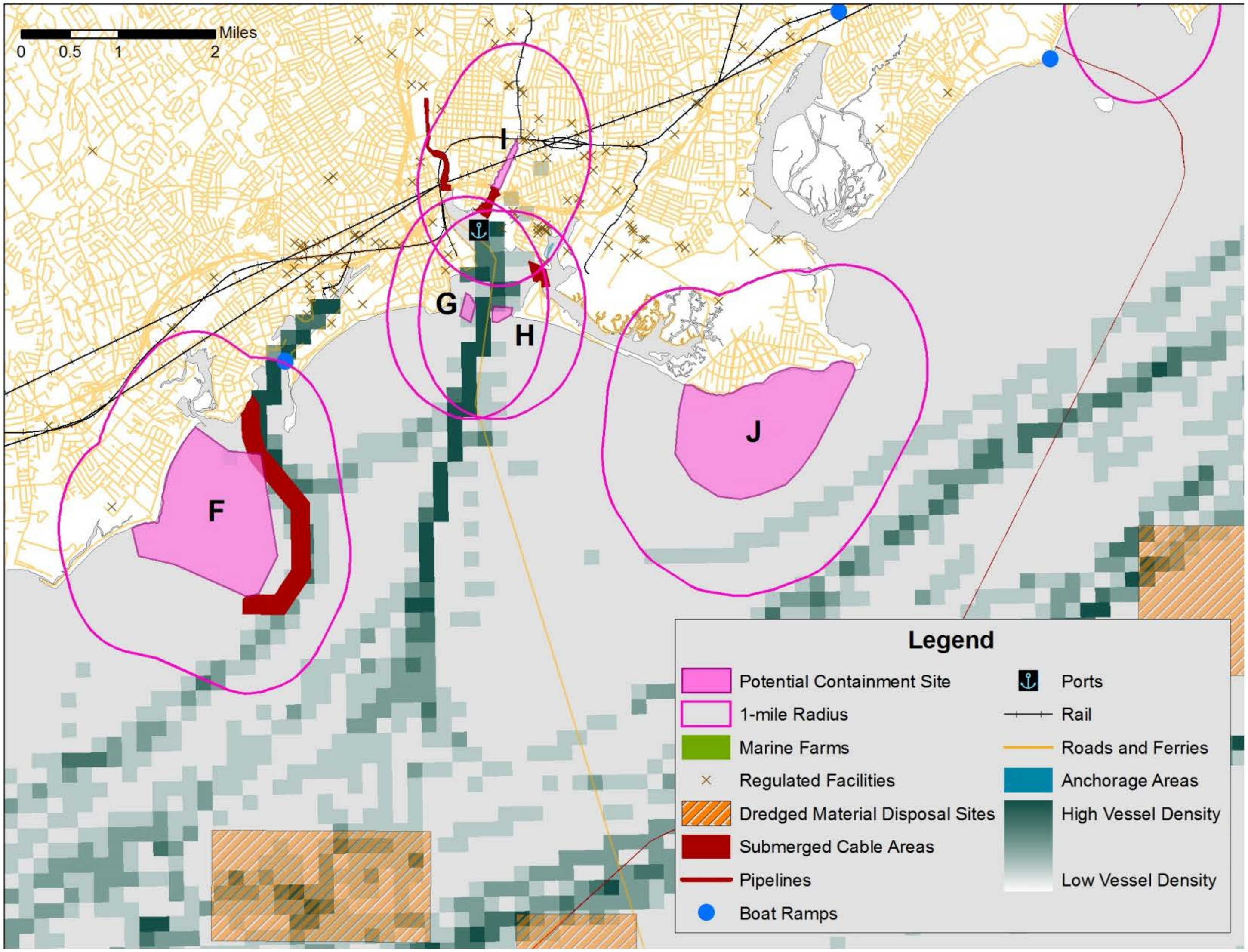


**Figure 3.3-1. Example of infrastructure resources map (Bridgeport vicinity).**

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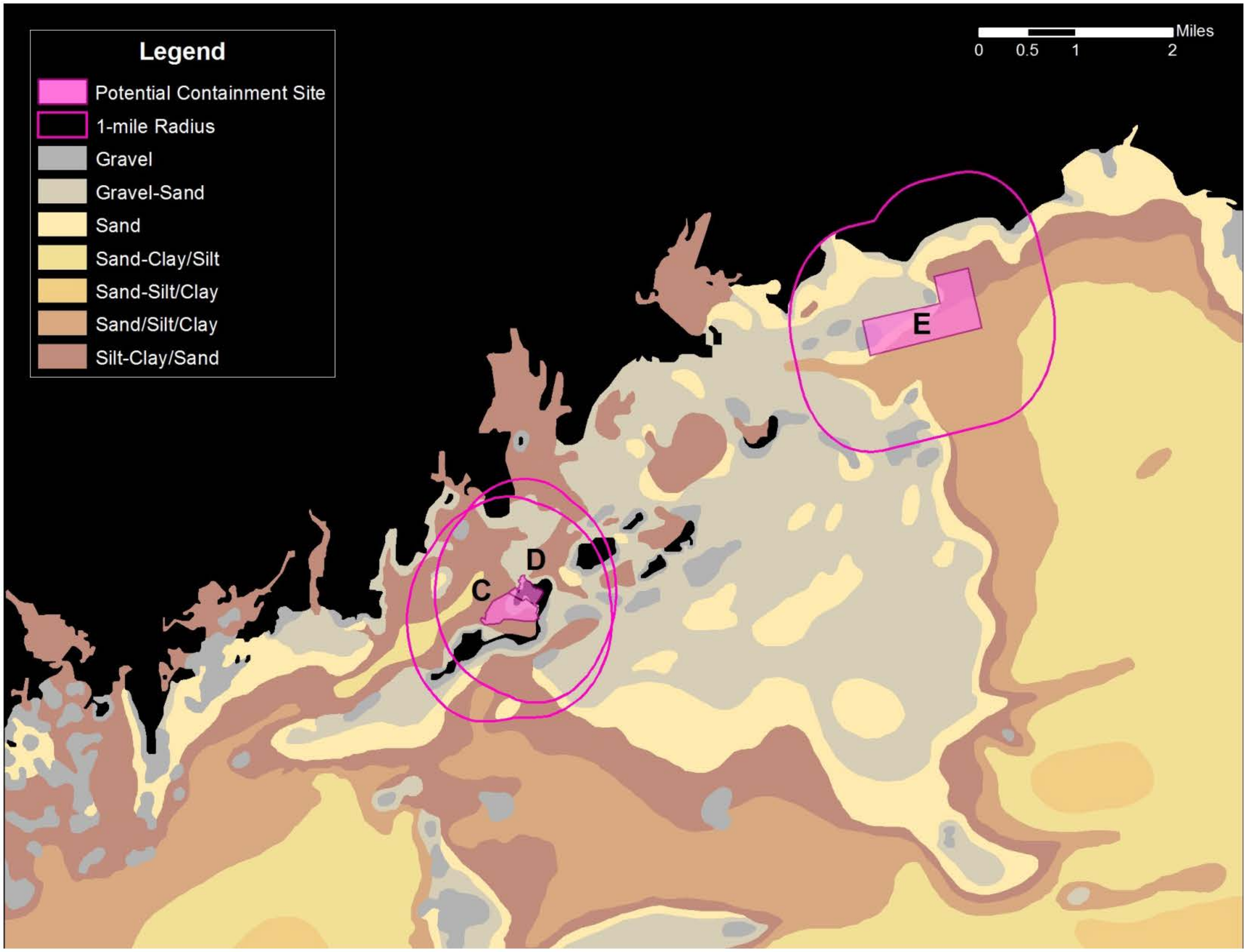


**Figure 3.3-2. Example of physical resources map (Norwalk vicinity).**

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Using the working maps, the resources within a potential zone of influence around each site alternative were identified. A conservative area of interest within a 1-mile radius around each potential containment facility was assumed. Unless best professional judgment indicated (i.e. on the opposite side of a harbor boundary, barrier beach, or island), it was assumed that the resources within this 1-mile radius were within the zone of influence of the site. Figures 3.3.1 and 3.3.2 show the potential zones of influence for containment site alternatives in the Bridgeport and Norwalk areas, respectively.

Potential impacts to resources within the potential zone of influence were evaluated using site-specific impact matrices. Prior to reviewing impacts to individual site alternatives, templates were prepared for each of the four resource categories (cultural, environmental, infrastructure, and physical). The templates and the operational definitions of the impacts are presented below. In each template, “X” indicates that a specific resource could conceivably be impacted in a specific way (i.e. Direct Destruction, Burial, etc.) during or after site development. Given the coarse nature of this screening, potential conflicts will need case-by-case evaluation if a proposal to use a specific site arises. However, the matrices will be useful in evaluating where potential conflicts might exist.

### *3.4.1 Potential Cultural Impacts*

The potential impacts of site alternative development to cultural resources are indicated in Table 3.3-1. For each site evaluation, “X’s” were replaced with either a description of the probability and nature of the impact or a “NA” (if the resource was not within the potential zone of influence of the site).

**Table 3.3-1. Template of Potential Cultural Impacts.**

| Cultural Resources | Direct Destruction | Changes in Local Sedimentation/ Erosion | Burial | Visual Impact |
|---|---|---|---|---|
| Shipwrecks | x | x | x | ---- |
| Historic Districts | x | x | ---- | x |
| Archaeological Sites | x | x | ---- | x |

The operational definitions of the possible impacts to cultural resources are:

- Direct Destruction – Removal or disturbance during construction
- Changes in Local Sedimentation / Erosion – Changes in the rate or pattern of sedimentation or erosion due to facility-related activities (particle settling during dumping, littoral drift following placement, scour due to changes in bathymetry, shoreline erosion due to wave-focusing, run-off during dewatering)
- Burial – Burial of resource by direct placement of material during placement operations
- Visual Impact – Changes in viewshed

### *3.4.2 Potential Environmental Impacts*

The potential impacts of site alternative development to environmental resources are indicated in Table 3.3-2. For each site evaluation, "X's" were replaced with either a description of the probability and nature of the impact or a "NA" (if the resource was not within the potential zone of influence of the site).

**Table 3.3-2. Template of Potential Environmental Impacts.**

| Environmental Resources | Direct Destruction | Burial | Changes in Local Sedimentation / Erosion | Habitat Impairment | Harassment | Water Quality Impairment | Habitat Enhancement |
|---|---|---|---|---|---|---|---|
| Wetlands | x | x | x | x | ---- | x | x |
| Federal & State Listed Species | x | x | ---- | x | x | x | x |
| Shellfish | x | x | ---- | x | ---- | x | x |
| Federally Managed Species (Magnuson-Stevens) | x | x | ---- | x | ---- | x | x |
| SAV | x | x | x | x | ---- | x | x |
| Marine Protected Areas | x | x | x | x | ---- | x | x |
| Birds | ---- | ---- | ---- | x | x | x | x |
| Marine Mammals | x | ---- | ---- | x | x | x | x |
| Terrestrial Wildlife | x | x | ---- | x | x | ---- | x |

The operational definitions of the possible impacts to environmental resources are:

- Direct Destruction – Removal or mortality during construction
- Burial – Burial of resource by direct placement of material during placement operations
- Changes in Local Sedimentation / Erosion – Changes in the rate or pattern of sedimentation or erosion due to facility-related activities (littoral drift following placement, scour due to changes in bathymetry, shoreline erosion due to wave-focusing, run-off during dewatering)
- Habitat Impairment – Loss or change in the extent or quality of habitat due to direct destruction, burial, sedimentation or erosion of critical habitat
- Harassment – Physical disturbance of individual organisms that significantly impairs breeding, feeding, or sheltering (direct strikes, noise and light pollution)
- Water Quality Impairment – Degradation of any parameter outside of its water quality criterion
- Habitat Enhancement – Increase in areal extent of wetland or open space.

### *3.4.3 Potential Infrastructure Impacts*

The potential impacts of site alternative development to infrastructure resources are indicated in Table 3.3-3. For each site evaluation, "X's" were replaced with either a description of the probability and nature of the impact or a "NA" (if the resource was not within the potential zone of influence of the site).

**Table 3.3-3. Template of Potential Infrastructure Impacts.**

| Infrastructure | Direct Interference | Changes in Sedimentation Patterns | Changes in Vessel Traffic Patterns | Burial | Undermining/ Erosion | Visual Impact |
|---|---|---|---|---|---|---|
| Mooring Areas | ---- | x | x | x | ---- | ---- |
| Navigation Channels & Shipping | ---- | x | x | x | ---- | ---- |
| Ports | x | x | x | ---- | ---- | ---- |
| Coastal Structures | x | x | ---- | x | x | ---- |
| Cable/power/utility crossings | x | x | ---- | x | x | ---- |
| Recreational Areas | x | x | x | x | x | x |
| Commercial & Industrial Facilities | x | ---- | ---- | ---- | ---- | ---- |
| Aquaculture | x | x | ---- | x | x | ---- |
| Dredged material Disposal Sites | ---- | x | ---- | ---- | x | ---- |

The operational definitions of the possible impacts to infrastructure resources are:

- Direct Interference – Removal or disturbance during construction
- Changes in Sedimentation Patterns – Changes in the rate or pattern of sedimentation due to facility-related activities (particle settling during dumping, littoral drift following placement)
- Changes in Vessel Traffic Patterns – Changes in typical navigational paths due to facility-related activities (shoreline extension impinging on navigational area, creation of a navigational hazard by creation of island)
- Burial – Burial of resource by direct placement of material during construction
- Undermining / Erosion – Changes in the rate or pattern of erosion due to facility-related activities (scour due to changes in bathymetry, shoreline erosion due to wave-focusing, run-off during dewatering)
- Visual Impact – Changes in viewshed.

### *3.4.4 Potential Physical Impacts*

The potential impacts of site alternative development to physical resources are indicated in Table 3.3-4. For each site evaluation, "X's" were replaced with either a description of the probability and nature of the impact or a "NA" (if the resource was not within the potential zone of influence of the site).

**Table 3.3-4. Template of Potential Physical Impacts.**

| Physical Resources | Change in Grain Size | Change in TOC | Change in Direction, Rate, Amplitude, or Period |
|---|---|---|---|
| Sediments | x | x | ---- |
| Littoral Drift | ---- | ---- | x |
| Currents | ---- | ---- | x |
| Waves | ---- | ---- | x |

The operational definitions of the possible impacts to physical resources are:

- Change in Grain Size – Changes in ambient sediment texture characteristics caused by placement of material.
- Change in TOC – Potential changes in total organic carbon content of ambient sediment caused by placement of material.
- Change in Direction, Rate, Amplitude, or Period – Changes in the nature or intensity of ambient coastal processes caused by the physical presence of a containment or nearshore placement facility.

## 3.5 CONTAINMENT SITE SUMMARIES

Study results suggest that the containment site alternatives may have a number of potential impacts on cultural, environmental, infrastructure, and physical resources.

The CAD cell alternatives (Sherwood Island Borrow Pits, Bridgeport Outer Harbor West, Bridgeport Outer Harbor Southeast, Morris Cove) were associated with the smallest number of potential impacts because the projects would fill existing borrow pits or excavate in already industrialized areas with few sensitive resources, and would not be expected to change currents, waves, littoral drift, or local habitat conditions.

The island CDF alternative at Falkner Island was associated with a similarly small number of potential impacts, primarily because of the project's isolation from other resources and human activity.

The shoreline CDF and closer island CDF alternatives have similar numbers and types of impacts on cultural, environmental, and physical resources. The island CDF alternatives are typically associated with a smaller number of potential impacts on infrastructure resources because they are offshore, away from navigation channels, ports, and cable or power utility crossings.

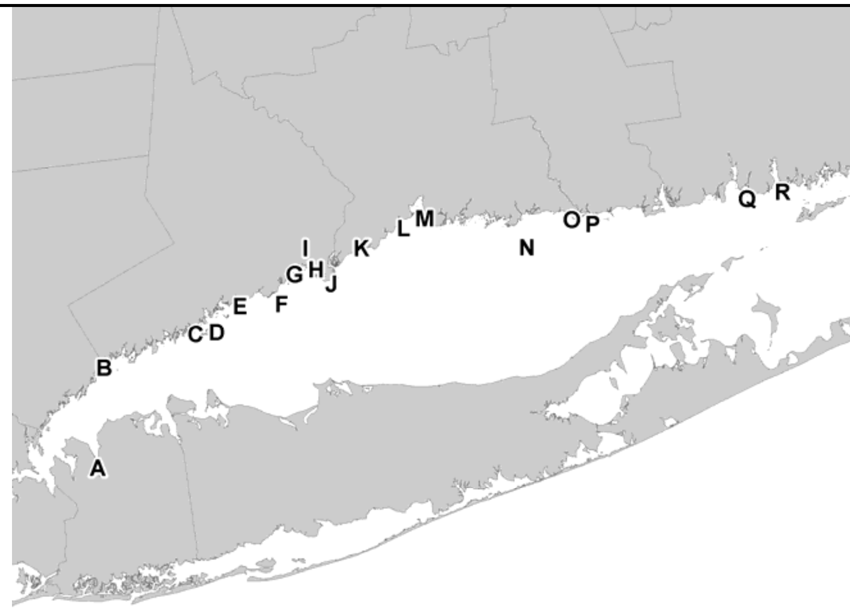
Site summaries showing potential impacts to cultural, environmental, infrastructure, and physical resources from the containment site alternatives are shown in Appendix A. Table 3.4-1 summarizes potential impacts at each of the sites, and suggests:

- The CDF site alternatives (with the exception of Falkner Island) appear to have similar numbers and types of potential impacts on a variety of resources.
- The CAD site alternatives appear to have fewer potential impacts than CDF projects.
- Certain types of impacts are rarely or never expected. These include impacts to archaeological resources, terrestrial wildlife, commercial and industrial facilities, aquaculture sites, and existing dredged material disposal sites.
- Certain types of impacts are frequently or always expected. These include:
    - *Shipwrecks.* The frequency of potential impact is in part a function of the factors considered in siting containment facilities. CDFs and CADs are typically sited in areas that are closer to dredging centers (economic feasibility of material transport) and are typically not located in deep water (engineering feasibility of CDF dike construction or CAD excavation). Because of these factors, containment facilities are typically sited in shallow areas where vessel traffic is common. As a result, these areas also have a greater number of shipwrecks.
    - *Federal and State listed species habitat.* The frequency of potential impact is in part a function of the broad definition of these habitat areas, along with the project locations often along the shoreline and in the nearshore coastal zone where a number of listed species occur. As noted, the extent of impact for any particular site would be evaluated prior to construction with more detailed site-specific information on the occurrence and timing of these species in the area.
    - *Shellfish.* Shellfish are common in the nearshore coastal zone, so many of the project footprints overlap with shellfish habitat. Site-specific information would be required to determine the occurrence of particular shellfish species at the proposed sites. In addition, certain projects could lead to positive impacts on shellfish if the extent of habitat is increased, for instance from the filling of borrow pits.
    - *Federally managed species habitat.* EFH is mapped for every section of LIS and habitat is mapped regionally rather than specifically for any species that could occur in the area. Therefore the projects evaluated always coincide with EFH. For any proposed project, the extent of impact would be evaluated using site specific information on the timing and occurrence of the species in the local EFH block.
    - *Birds.* Birds are common in the nearshore coastal zone, so many of the project footprints overlap with the habitat of various shorebirds and waterfowl. The potential for project-related changes in sedimentation or

erosion along the shoreline led to the indication of potential impact. For any proposed project, the extent of impact would be evaluated using site specific information on the timing and occurrence of the species in the local area, as well as sediment transport evaluations that would indicate the extent of shoreline change expected from the project. In addition, certain projects could lead to positive impacts on birds if the extent of shoreline or wetland is increased, for instance in the case of island CDFs.

- *Marine Mammals.* Marine mammal impacts were always indicated because of the regional representation of marine mammal occurrence throughout LIS, coupled with the potential for harassment (noise, strikes etc) during construction on any project. The extent of impact expected from any proposed project would be evaluated on a site-specific basis.
- *Recreational Areas.* The frequency of potential impact is in part a function of the location of containment facilities. CDFs and CADs are typically sited abutting or adjacent to existing shorelines. These areas are typically developed and, when not occupied by residential or commercial development, often feature beaches and shoreline parks prominently. The extent of impact expected from any proposed project would be evaluated on a site-specific basis. Depending on the design of the facility, some CDFs may ultimately expand recreational areas in a region.
- *Sediments.* Potential impacts on sediments are always indicated because of the nature of containment facility construction. Depending on the type of material used, projects could change the sediment type locally, and they would cause at least a temporary change in sediment topography. The extent of impact expected from any proposed project would be evaluated on a site-specific basis.

**Table 3.4-1. Summary of Impacts for Containment Sites in the LISDMMP Study Area.**




| | Cultural Resources | | | Environmental Resources | | | | | | | | | Infrastructure Resources | | | | | | | | | Physical Resources | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Shipwrecks | Historic Districts | Archaeological Sites | Wetlands | Federal & State Listed Species | Shellfish | Federally Managed Species (Magnuson-Stevens) | SAV | Marine Protected Areas | Birds | Marine Mammals | Terrestrial Wildlife | Mooring Areas | Navigation Channels & Shipping | Ports | Coastal Structures | Cable/power/utility crossings | Recreational Areas | Commercial & Industrial Facilities | Aquaculture | Dredged material Disposal Sites | Sediments | Littoral Drift | Currents | Waves |
| New York | | | | | | | | | | | | | | | | | | | | | | | | | |
| Containment A – Hempstead Harbor | X | X | | X | X | X | X | | | X | X | | | X | | X | | X | | | | X | | X | |
| Connecticut | | | | | | | | | | | | | | | | | | | | | | | | | |
| Containment B – Greenwich Captain Harbor | | | | X | X | X | X | | X | X | X | | X | | | X | | X | | | | X | | X | X |
| Containment C – Norwalk Outer Harbor Islands - Marsh | X | | | X | X | X | X | | X | X | X | | | | | X | X | X | | | | X | | | |
| Containment D – Norwalk Outer Harbor Islands - Shore | X | | | X | X | X | X | | X | X | X | | | | | | | X | | | | X | | | |
| Containment E – Sherwood Island Borrow Pits | X | | | | | X | X | | | | X | | | | | | | X | | | | X | | | |
| Containment F – Penfield Reef | X | X | | X | X | X | X | | | X | X | | | X | | X | X | X | | | | X | X | X | X |
| Containment G – Bridgeport Outer Harbor West | X | | | | X | X | X | | | | X | | | X | X | | | | | | | X | | | |
| Containment H – Bridgeport Outer Harbor Southeast | X | | | | X | X | X | | | | X | | X | X | X | | | X | | | | X | | | |
| Containment I – Bridgeport Yellow Mill Channel | X | X | | | X | X | X | | | X | X | | | X | X | X | X | X | | | | X | | X | X |
| Containment J – Stratford Point | X | | | X | X | X | X | | X | X | X | | | | | X | | | | | | X | X | X | X |
| Containment K – Milford Harbor | X | X | | | X | X | X | | | X | X | | X | X | | X | | X | | | | X | X | X | X |
| Containment L – New Haven Breakwaters | | | | | X | X | X | | | X | X | | | X | X | X | X | X | | | | X | X | X | X |
| Containment M – Morris Cove | X | | | | X | X | X | | | | X | | | X | X | | | X | | | | X | | | |
| Containment N – Falkner Island | X | | | | X | | X | | X | X | X | | | | | | | | | | | X | | | X |
| Containment O – Clinton Harbor | | X | | X | X | X | X | X | | X | X | | | X | | | | X | | | | X | X | X | X |
| Containment P – Duck Island Roads | | X | | | X | | X | | | X | X | | | | | X | | | | | X | X | X | X | X |
| Containment Q – Twotree Island | X | X | | X | X | | X | X | | X | X | | | | | X | | X | | | | X | X | | X |
| Containment R – Groton Black Ledge | X | X | X | | X | | X | X | X | X | X | | | X | | X | X | X | | | | X | X | X | X |

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# 4.0 SUMMARY AND CONCLUSIONS

The assessment of potential impacts demonstrates that for candidate containment sites:

- The total capacity of the containment site alternatives evaluated in this report is 175,264,000 cubic yards. The range of estimated volumes in the individual sites varies from 270,000 to 58,250,000 cubic yards.
- Although MPRSA does not apply to shoreline CDFs, island CDFs or harbor CADs, numerous regulatory hurdles remain. The difficulty of permitting these candidate facilities is largely due to their size and permanence, as well as their potential to receive contaminated dredged materials.
- MPRSA applies to one containment site alternative – a potential CAD cell in the open waters of Long Island Sound.
- Among the containment site alternatives evaluated, potential impacts to archaeological resources, terrestrial wildlife, commercial and industrial facilities, aquaculture sites, and existing dredged material disposal sites are rarely or never encountered.
- Among the containment site alternatives evaluated, potential impacts to shipwrecks, Federal and State listed species habitat, shellfish, Federally managed species habitat, birds, marine mammals, recreational areas, and sediments are frequently or always encountered.

Comparison of potential impacts at the containment site alternatives reveals areas with the least potential to adversely impact the surrounding resources. The impact matrices are also useful in identifying relative differences among the LIS site alternatives evaluated. Site-specific assessments would be completed prior to construction of any CAD or CDF, to further define the extent and magnitude of impacts to particular resources.

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# APPENDIX A CONTAINMENT SITES

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