7.0 DISPOSAL SITE IMPACTS

A detailed evaluation of the environmental and human resource impacts and benefits associated with the designation of the aquatic disposal sites is presented in this section. Where impacts or benefits associated with the disposal of dredged sediment are common to both candidate sites, they are referred to collectively. Where such impacts or benefits vary among the two candidate sites, they are discussed individually. In addition, at the end of each subsection, a summary of the impacts that would or would not occur as a result of the no action alternative is also presented.

As discussed in Section 11.0 of this DEIR, the planned operation and management of any disposal site that is designated will have a bearing on the temporal and spatial aspects of impact. Currently, it is envisioned that either of the two disposal sites would be open once each year (i.e., during the open dredging window) over a period of 20 years. The dredging window, as specified by DCR and DEP in consultation with DMF, is typically from late fall to early spring in New England waters and is designed to avoid the sensitive life stages of important fish and shellfish species (see Section 11.0). Therefore, placement of dredged material within the sites would likely occur within a period of less than six months in each year. This period would be the time when *temporary* impacts are expected to occur, with recovery of bottom communities anticipated within 6 months to 2 years following the cessation of disposal activities. As described in Section 11.0, the disposal site will be monitored periodically to verify that recovery occurs as predicted and to allow early detection and mitigation of any potential *longer-term* impacts.

The expected impacts of dredged material disposal at one of the candidate sites in Buzzards Bay were evaluated based upon the following: site-specific information gathered during the DMMP process; previous studies of New Bedford/Fairhaven Harbor and the Buzzards Bay region; studies conducted at other New England ports (e.g. Boston, Salem and Gloucester Harbors) and disposal sites, and laboratory studies of the effects of dredging and related activities. It is recognized that additional site-specific information may be recommended by the MEPA process and subsequent Federal and state permitting.

Potential impacts at the candidate sites are evaluated in the following subsections:

Section 7.1: A discussion on potential short-term and long-term impacts to bathymetry associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to bathymetry of the area associated with selection of the no-action alternative.

Section 7.2: A discussion on potential short-term and long-term impacts to sediment quality associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to sediment quality associated with the no-action alternative.

Section 7.3: A discussion on potential short-term and long-term impacts to water quality (i.e., in terms of total suspended solids, dissolved oxygen, and contaminants) associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to water quality associated with selection of the no-action alternative.

Section 7.4: A discussion on potential short-term and long-term impacts to the benthic communities associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to benthic communities associated with the selection of the no-action alternative.

Section 7.5: A discussion on potential short-term and long-term impacts to the finfish and shellfish communities associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to finfish and shellfish communities associated with selection of the no-action alternative.

Section 7.6: A discussion of the anticipated short-term and long-term impacts to the essential fish habitat (EFH) of federally-managed species associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to EFH associated with selection of the no-action alternative.

Section 7.7: A discussion on potential impacts to rare and endangered species, to ensure compliance with state and federal regulations focused on protection of these important species relative to disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to rare and endangered species associated with selection of the no-action alternative.

Section 7.8: A discussion on potential impacts to wildlife (i.e., marine mammals and avifauna) associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to wildlife associated with selection of the no-action alternative.

Section 7.9: A discussion on potential impacts to the wetlands associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to wetlands associated with selection of the no-action alternative.

Section 7.10: A discussion of the potential impacts to existing commercial and recreational fishing activities, particularly in relation to the candidate sites. Specifically, impacts to commercial and recreational finfishing, shellfishing and lobstering patterns, practices, and seasonality will be covered. A discussion of the anticipated short- and long-term changes to commercial and recreational fishing activities associated with selection of the no-action alternative.

Section 7.11: A discussion on potential impacts to historic and archeological resources associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to historic and archeological resources associated with selection of the no-action alternative.

Section 7.12: A discussion on potential impacts to navigation and shipping associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated short- and long-term changes to navigation and shipping associated with selection of the no-action alternative.

Section 7.13: A discussion on potential impacts to land use and special area designations, including the Cape and Islands Ocean Sanctuary, associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically, at the two candidate disposal sites. A discussion of the anticipated changes to land use and special area designations associated with selection of the no-action alternative.

Section 7.14: A discussion on potential impacts to air quality and noise associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated changes to air quality and noise associated with selection of the no-action alternative.

Section 7.15: A discussion on potential impacts to the recreational resources other than fishing, shellfishing, and lobstering associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically, at the two candidate disposal sites. A discussion of the anticipated changes to recreational resources other than fishing, shellfishing, and lobstering associated with selection of the no-action alternative.

Section 7.16: A discussion on potential impacts to the economic environment associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated changes to the economic environment associated with selection of the no-action alternative.

Section 7.17: A discussion on potential environmental justice issues associated with the disposal of clean dredged sediment at aquatic disposal sites in general and specifically at the two candidate disposal sites. A discussion of the anticipated changes to environmental justice issues associated with selection of the no-action alternative.

7.1 Bathymetry

A series of sediment transport and fate simulations were performed to estimate effects in the water column and on the substrate resulting from disposal activities at either candidate site (Maguire 2004a and b). Specifically, this involved utilization of the multiple-dump fate (MDFATE) model developed by the USACE Engineer Research and Development Center (ERDC) to predict the changes in seafloor topography (i.e., bathymetry) resulting from disposal of dredged material at in open-water disposal sites. This model is typically used in planning disposal activities at sites that are already designated to determine the most efficient disposal scheme. After dredged material is released from a barge or scow at the water's surface, MDFATE simulates its convective descent through the water column, its dynamic collapse upon contact with the bottom, and its long-term passive diffusion on the seafloor. The MDFATE model output consists of a bathymetric grid defining the predicted height and spread of the dredged material deposit or “mound” that is typically created on the seafloor after simulation of the three processes listed above.

The estimated annual volume of dredged material used as input to the MDFATE model was 106,000 cy; this value was derived by dividing the projected total volume of 2.1 million cy for the Buzzards Bay region (as described in Section 2.5) evenly over the 20-year projection period. Separate model runs were used to simulate the deposition of this one-year volume of dredged material at each of the two candidate sites. For each model run, it was assumed that the disposal activity would consist of a total of 53 individual barge releases of 2,000 cy each. The release locations were clustered around the center of each disposal site to simulate likely disposal directed to a fixed buoy for a single disposal season. The substrate at each site was defined as a flat plane, with water depths of 12.8 meters (42 feet) at site 1 and 14 meters (46 feet) at site 2.

The results are plotted in a grid displaying the thickness and spread of the dredged material deposited on the bottom following the multiple releases. Information on current speed, current direction, water chemistry, and disposal site bathymetry were taken from the results of the reports summarized in Section 4 of this DEIR. Wind data to estimate wind waves were obtained from the NOAA BUZM3 data station, as described in Section 4.3. Historical data from the time period February 2001 to May 2001 were used for inputs to the model runs.

Barges were assumed to be moving at a rate of 6 feet per second (6.6 kilometers per hour or 3.5 knots) upon release of the sediment. Typical barge dimensions of 200 feet in length, 50 feet beam, and a 17 feet draft were assumed. As previously indicated, the MDFATE simulations were based on 53 individual split-hull barge releases of 2,000 cy each, for a total disposal volume of 106,000 cy. The individual barge release locations were randomly distributed within a 100 meters radius circle at the center of each of the disposal sites. Table 7-1 summarizes the input parameters and assumptions used for the MDFATE simulations.

Sediment to be dredged is typically analyzed beforehand to determine its grain size distribution (i.e., relative amounts of different-size particles or “grains”, such as gravel, sand, silt, and clay, that together made up the sediment). To use such information as part of the input to the MDFATE model, the total volume of sediment in each grain size class, with the addition of larger, cohesive blocks or “clumps” of sediment, must be calculated. This is calculated using the average wet bulk density (mass of sediment per unit of bulk volume), moisture content, and sand, silt, and clay fraction values. Typical values for dredged material are provided in Table 7-1 (USACE-NAE 1998).

Table 7-1. MDFATE input parameters and assumptions (the latter denoted by *).

Total Barge Volume		g/cc to lbs/ft^3 conversion	
Solids Volume	70%	Sediment moisture content	100%
Water Volume (free water)	30%	Average specific gravity of sediment*	2.67
Bulk Density*	1.443*	Sand fraction*	0.12
Clump Fraction	0.7	Silt fraction*	0.59
Non-clump fraction	0.3	Clay fraction*	0.29

* Value from USACE 1998.

The estimated grain size distribution in Table 7-1 is similar to the average measured values in the deeper portions of candidate sites 1 (58% to 93% silt and clay) and 2 (61% to 69% silt and clay; as discussed in Section 4.2 of this DEIR). The volumetric solids fractions of the dredged material were calculated as follows:

Unit weight - the weight of 1 cubic feet (ft^3) of dredge material derived by converting the wet bulk density from the sediment cores in units of grams per cubic centimeter (g/cm^3) to English units of pounds per cubic foot (lb/ft^3).

Unit weight = 1.443 g/cm^3 x 62.4 lb/ft^3
= 90.04 lb

Dry weight of solids - the weight of solids in 1 unit weight of dredged material

Dry weight of solids = 90.04 / (1 + sediment moisture content)
= 90.04 / 2.00
= 45.02 lb

Volume of solids - the volume of solids in unit volume

Volume of solids = dry wt of solids / (unit wt of water x S.G.)
= 45.02 / (62.4 x 2.67)
= 0.27 ft^3

Solids fraction of dredged material = 0.27

Mechanical dredging of sediments typically involves the use of a large "clamshell" bucket that is lowered to the bottom by crane to dig or scoop out individual volumes of sediment that are then transferred to a barge. This is the most common dredging practice in New England, and, in many areas where the sediment is naturally cohesive (i.e., tending to stick together), mechanical dredging results in the dredged material retaining its cohesiveness and thus remaining in the form of blocks or "clumps" throughout the dredging and disposal process. Upon release from a barge, these clumps will sink much faster than the finer-grained material comprising loose or "unconsolidated" sediment. For the purpose of the MDFATE model runs, it was assumed that 70% of the solids would be in the form of large coherent blocks or clumps. These clumps were assumed to be comprised of sand, silt and clay particles in proportion to the average amount of each size reported in Table 7-2 (USACE 1998).

The volume fractions for sand, silt, and clay not contained in clumps (i.e., the non-clump fraction) was calculated by multiplying the size fraction by the solids fraction of the bulk material, and then multiplying the resulting value by the fraction not contained in clumps (Table 7-2a). Likewise, the volume fraction for clumped material was calculated by multiplying the size fraction by the solids fraction of the bulk material by the clumps fraction (Table 7-2b). The resulting MDFATE material characterization is summarized in the model input form shown in Figure 7-1. Values for specific gravity and void ratio are identical to those used in similar MDFATE model runs performed by USACE experts for Providence River and Harbor Dredging study in Rhode Island (USACE 1998). Critical shear stresses are typical values for each size class.

Table 7-2 (a and b). Clumped and non-clumped material volume fractions.

a. Non-Clumped Material					
Sediment Size	**% Present in Sediment**	**Size Fraction**	**Solids Fraction**	**Fraction not in Clumps**	**Volume Fraction**
Sand	12.0%	0.12	0.27	0.3	0.00972
Silt	59.0%	0.59	0.27	0.3	0.04779
Clay	29.0%	0.29	0.27	0.3	0.02349
b. Clumped Material					
Sediment Size	**% Present in Sediment**	**Size Fraction**	**Solids Fraction**	**Clumps Fraction**	**Volume Fraction**
Sand	12.0%	0.12	0.27	0.7	0.02268
Silt	59.0%	0.59	0.27	0.7	0.11151
Clay	29.0%	0.29	0.27	0.7	0.05481
TOTAL Clumps Volume Fraction					**0.189**

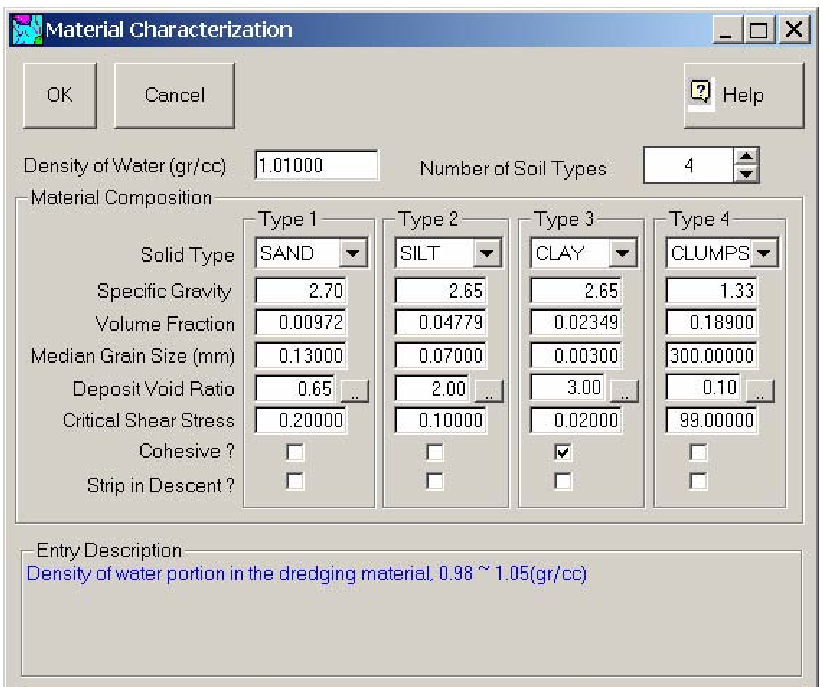

Figure 7-1. MDFATE model material characterization values used for the 106,000 cy disposal at candidate sites 1 and 2.

7.1.1 MDFATE Model Results

Depth-difference plots were created by the model using pre- and post-disposal bathymetry to give an indication of the accumulation of dredged material for site 1 (Figure 7-2) and site 2 (Figure 7-3). Table 7-3 summarizes the MDFATE results for sites 1 and 2. The computed mound at site 1 covered 14.2 acres (0.06 square kilometers (km^2)), which corresponds to a circular area with a diameter of roughly 270 meters. Given the initial model depth of 12.8 meters for a flat bottom at site 1, the maximum mound height of 2.07 meters would result in a final water depth of 10.7 meters. The computed mound at site 2 covered 14.1 acres (0.06 km^2), which corresponds to a circular area with a diameter of roughly 270 meters. The initial water depth used for site 2 was 14 meters, and the maximum mound height of 2.4 meters would result in a final water depth of 11.6 meters. Total estimated fill capacities for candidate sites 1 and 2 were estimated in Section 4.1 within a range between 33 feet (10 meters) and 41 feet (12.5 meters). The mound apex in each case, corresponding to these minimum final water depths, consists of a relatively limited area at the mound center (Figures 7-2 and 7-3). Substantially thinner layers of dredged material (less than or equal to the 3 to 4 feet accumulation category in Figures 7-2 and 7-3) comprise more than half the total areas of each mound, corresponding to changes in water depth of roughly 1 meters or less.

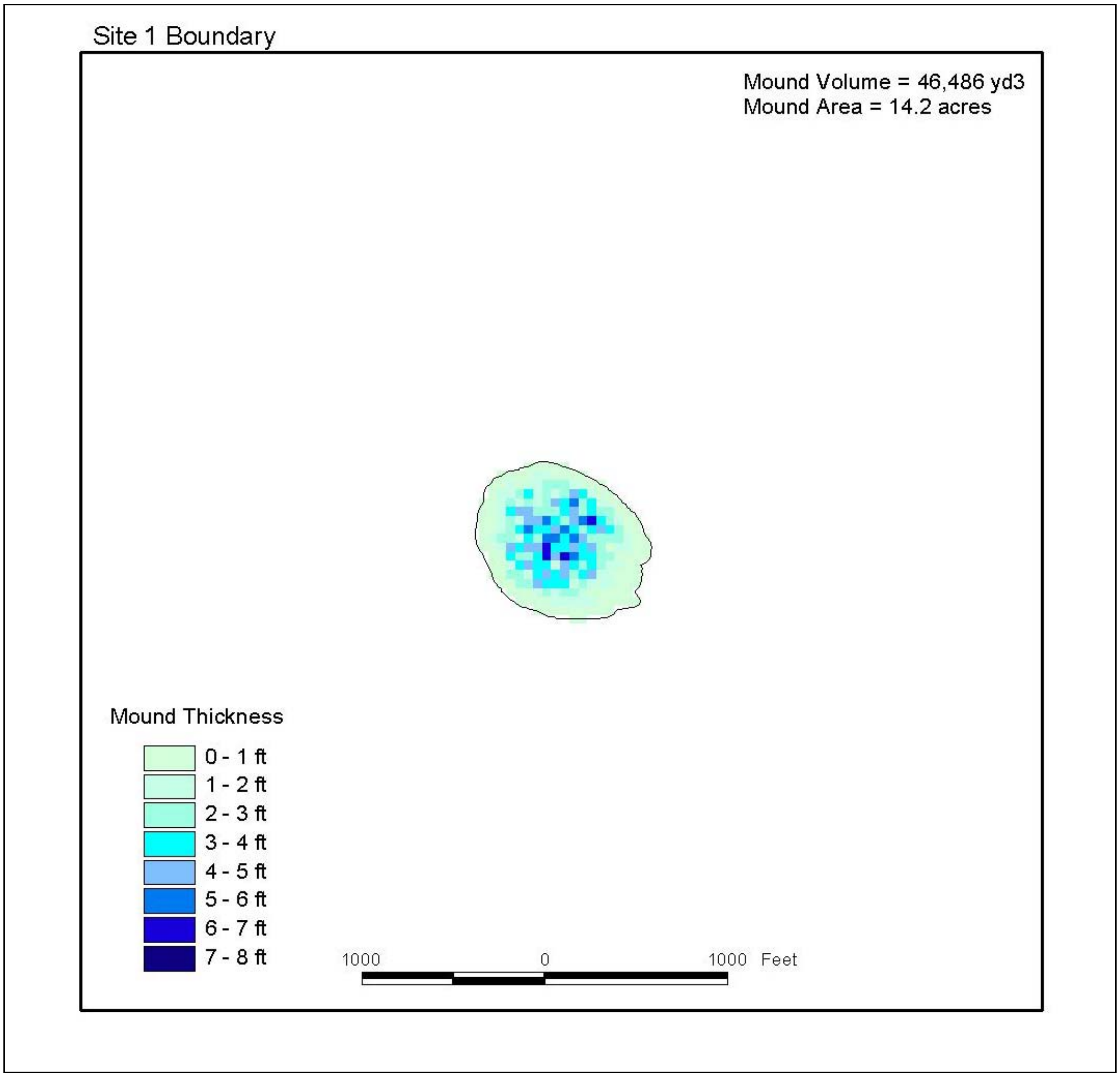

Figure 7-2. MDFATE output showing the mound resulting from 53 barge loads of 2,000 cy each disposed of at the center of candidate site 1.

Values are sediment thickness of the deposited dredged material. The inner black rectangle represents the boundary of site 1; the contour line outlines the mound footprint and represents a thickness of 3 centimeters (0.1 feet).

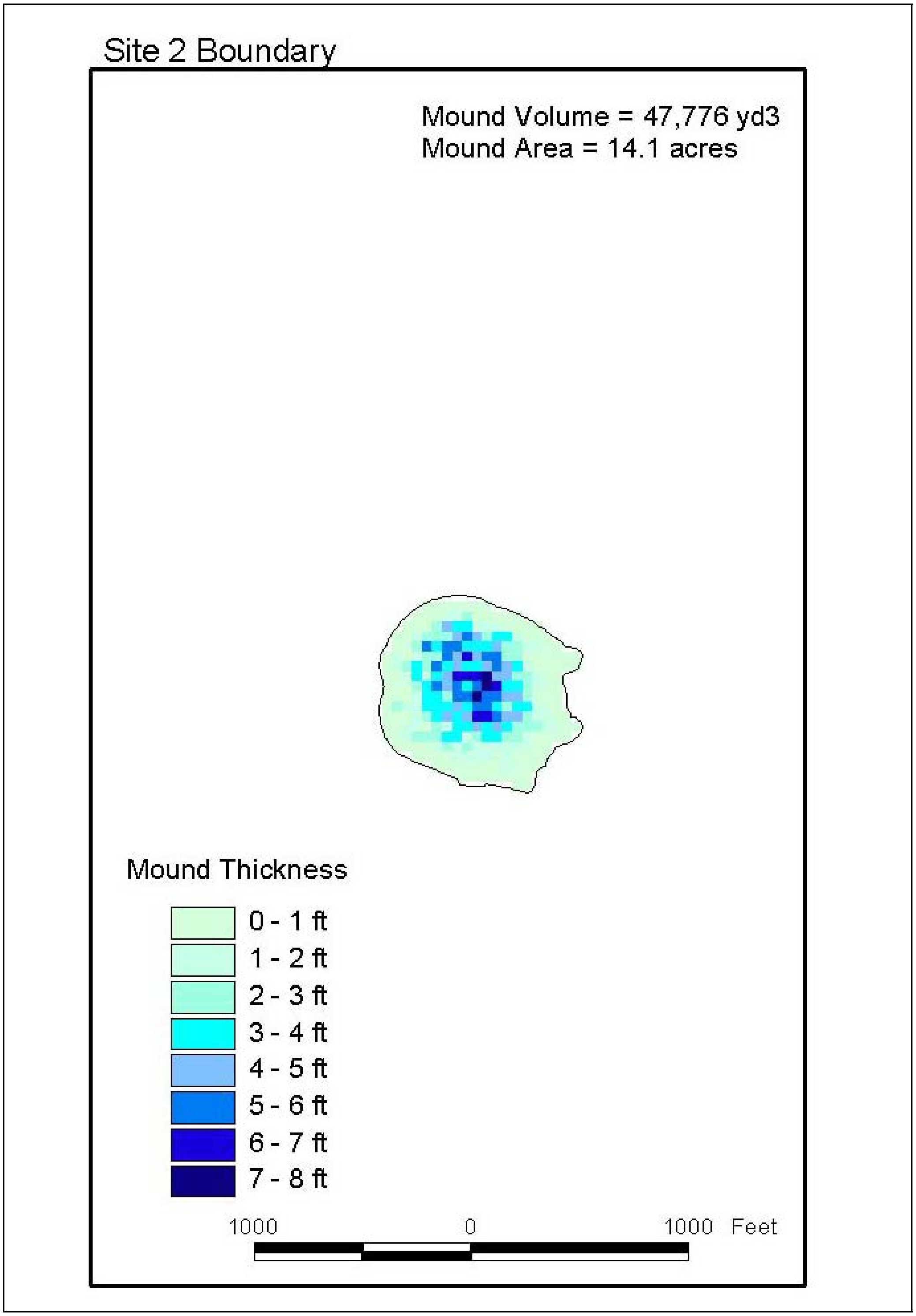

Figure 7-3. MDFATE output showing the mound resulting from 53 barge loads of 2000 cy each disposed of at the center of candidate site 2.

Values are sediment thickness of the deposited dredged material. The inner black rectangle represents the boundary of site 2, and the contour line outlines the mound footprint and represents a thickness of 3 centimeters (0.1 feet).

Table 7-3. MDFATE results summary.

	Mound Volume	Maximum Mound Height	Area Covered
Candidate site 1	46,486 cy	6.8 feet (2.07 meters)	14.2 acres
Candidate site 2	47,757 cy	7.8 feet (2.4 meters)	14.1 acres

7.1.2 Discussion

MDFATE predicts that annual disposal activities at each candidate disposal site would result in the formation of a relatively small mound, given the range of sizes of discrete disposal mounds typically created at other open-water dredged material disposal sites in New England (SAIC 1996). Additionally, the predicted mound heights appear reasonable for mounds approximately 250 meters in diameter, based on actual monitoring results at other New England sites (SAIC 1996). Therefore, the final water depths calculated using the predicted mound height (10.7 meters for site 1 and 11.6 meters for site 2) can be used as an indication of the final water depths for a single disposal mound at each site after a year of disposal activities (given 53 disposals of 2,000 cy), prior to any consolidation of the mound. The predicted, final water depths fall approximately between the two long-term target depths of 10 meters and 12 meters used in estimating the potential capacity of each site (Section 4.1). Mound consolidation (i.e., compaction due gravitational settling and associated loss of entrained water) is likely to occur during the first few years following disposal (Brandes et al. 1991). This is not factored into the MDFATE mound results. The degree of consolidation depends on a number of factors, including the particle size distribution and initial water content of the disposed sediment. Because historical dredging records indicate that most of the material dredged in Buzzards Bay consists of sandy material (Section 2.2), which is less likely than finer-grained material to consolidate after disposal, ignoring potential consolidation effects provides a conservative evaluation of likely mound heights.

7.1.2.1 Candidate Site 1

The MDFATE model runs with an assumed flat bottom instead of the gently sloping bottom (deepening to the southeast) in site 1 and the trough feature that is present in site 2. The apex of the estimated mound at site 1 had a depth of 10.7 meters, created on a bottom with an initial depth of 12.8 meters. Based on the evaluation of grain size data for site 1 (Section 4.2), there is an increased sand component in the sediments, indicative of some minor winnowing of finer grain sizes, at shallower depths less than about 12 meters. This suggests that coarser material could be deposited to create mounds with final water depths shallower than 12 meters, but that fine-grained material may be more suitable for target final depths (i.e., top of mound) deeper than 12 meters to avoid any minor off-site transport as a result of winnowing.

7.1.2.2 Candidate Site 2

The apex of the mound estimated for site 2 had a depth of 11.6 meters, created on a bottom with an initial depth of 14 meters. Grain size information (Section 4.2) indicates that winnowing of fines may be occurring to depths of 13 meters at site 2. This suggests that target water depths for coarser material could be shallower than 13 meters, and fine-grained deposits may be more suitable for target depths greater than 13 meters.

7.1.2.3 Summary of Bathymetry

The implications of these considerations of mound height and water depths, based on a single disposal year, are that it may be desirable to direct material to different locations within either of the candidate sites rather than focusing all disposal activity in the center of each site. This is consistent with the SMMP described in Section 11.0 and with the management approach typically employed at other open-water disposal sites in use in Massachusetts (i.e., CCDS and MBDS) and Rhode Island (proposed Federal-designated Site "W"). This management approach is successful partly because the creation of discrete mounds facilitates monitoring of material from a variety of sources. Directing material to various locations within the designated disposal site would form a series of smaller mounds with less marked relief than the single, central mound predicted by the MDFATE Model. As an illustrative example, Figure 7-4 depicts the bathymetry of the MBDS and shows five distinct disposal mounds (denoted as A through E) that have been created within the confines of this disposal site.

Additionally, it may be optimal to direct disposal of sandier material to shallower portions of either candidate site that currently have a comparable grain size distribution, while finer-grained sediments could be directed primarily to deeper water portions of either site, to minimize the potential for erosion by currents. Alternatively, disposal activities could be sequenced such that the final surface layers on a particular mound consist of coarser material, if warranted, based on estimates of the final water depth over the mound.

Winnowing of fines is a routine occurrence at open-water disposal mounds in many locations, and does not necessarily imply lack of long-term stability of the mound or substantial loss of material from the mound (SAIC 2001a). While management strategies will seek to minimize potential mound erosion, the overall goal is to contain the material in stable features on the seafloor. Small-scale winnowing of the surface sediments may still occur, typically resulting in an armored mound surface of coarser sediments or shell hash, and will have negligible impacts on the overall goal of a stable disposal mound.

Given the long-term stability of dredged material mounds on the bottom at other disposal sites throughout New England, changes in bathymetry that are likely to persist over time are anticipated to occur from use of either of the candidate sites in Buzzards Bay. Short-term impacts will consist of the creation of individual mounds that match existing sediment characteristics to the most practicable extent. Mound stability over time will be evaluated through periodic monitoring surveys, as described in Section 11. Long-term monitoring of open-water disposal sites in New England, including the BBDS, indicate that disposal mounds present persistent, stable features on the substrate even after prolonged periods of time (SAIC 1996) and passage of major storm events (SAIC 1988b; SAIC 1989a; SAIC 1989b). Minimum target water depths for mound formation can be determined based on the distribution of grain sizes with water depth at each site. Small-scale, localized changes may occur in tidal current strength and direction based on the presence of disposal mounds and/or filling portions of the trough around Gifford Ledge in site 2. However, based on the size of the typical disposal mounds and their broad, relatively flat configuration within a depositional environment, such effects will be minimal and highly localized, and therefore will not have substantial effects on erosion or other sediment transport processes in the surrounding area.

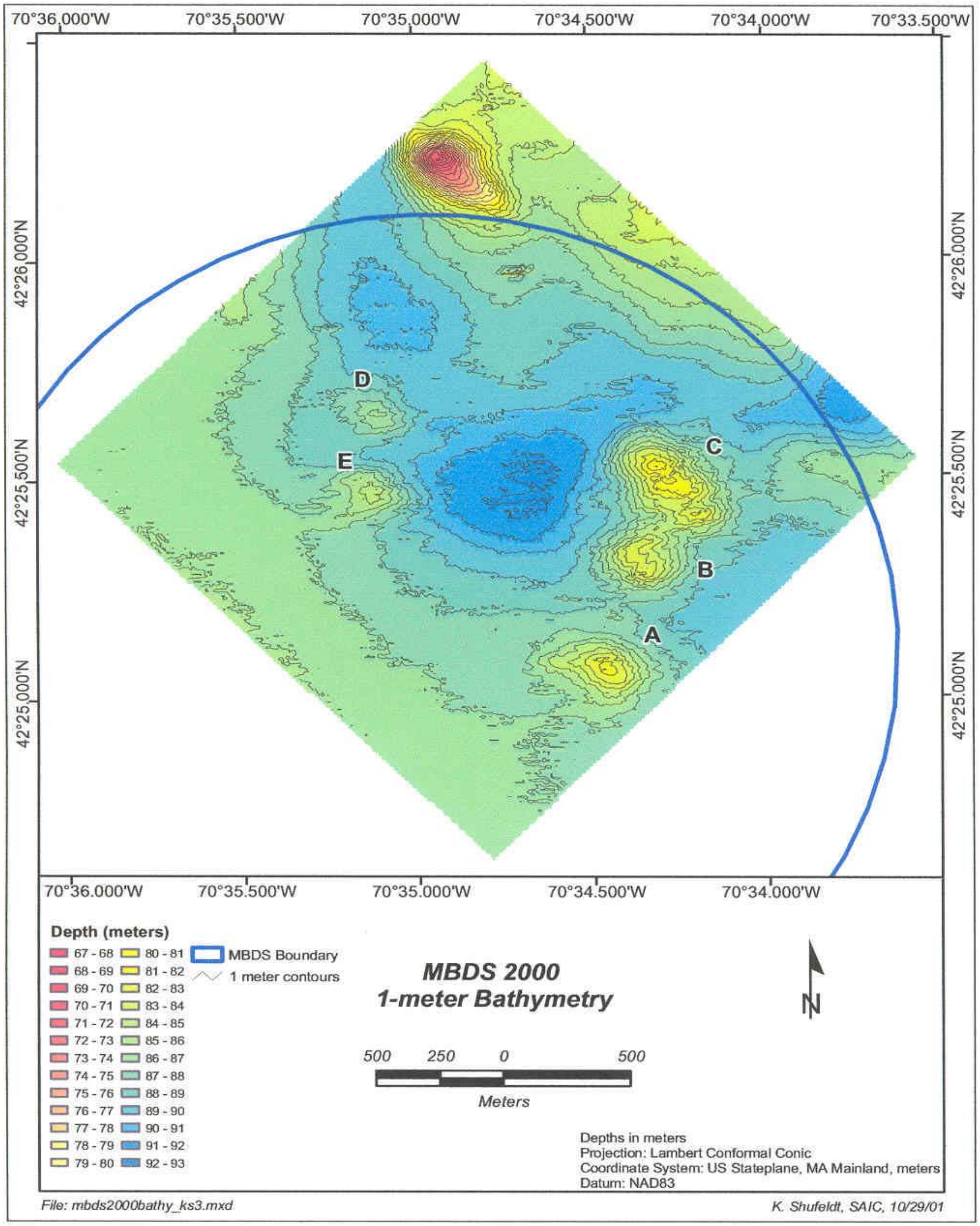

Figure 7-4. Bathymetric contour chart of the 2,400 by 2,400 meter survey area showing five disposal mounds within the confines of Massachusetts Bay Disposal Site, 1.0 meter contour interval (Adapted from SAIC, 2002).

7.1.3 No-Action

The existing bathymetry of the proposed candidate disposal sites, as characterized through past and contemporary survey efforts, is expected to remain largely unchanged with election of the no-action alternative.

7.2 Sediment Quality

7.2.1 Evidence for Likely Effects Based on Existing Conditions

In addition to changes in bathymetry, the dredged material placed at the site will likely consist of sediments with grain size distributions and organic contents that differ to varying degrees from those of the existing substrate. As discussed in Section 4.2, the existing sediments at candidate sites 1 and 2 ranged from predominantly silt and clay (approximately 60 to 90%) in the deeper portions of each site to a predominance of sand with 15 to 34% fines in the shallower portions of each site. Total organic content ranged from 0.5% to 3.4%, with the higher concentrations associated with finer grain sizes. While historical records indicate that the majority of material dredged in the Buzzards Bay region consisted of sand (93%, Section 2.1), there is the potential for a wide variety of grain sizes to be deposited at the site, from coarse sand and gravel to very fine silts and clays with relatively high organic content.

Stability of disposal mounds is partly a function of the grain size of the material; potential implications of changes in grain size at the candidate disposal sites are discussed in Section 7.1. Effects of changes in grain size and TOC on the benthic community are discussed in Section 7.4. This section of the DEIR focuses on potential changes in sediment chemistry from disposal activities at the candidate disposal sites.

Despite evidence of historical dredged material disposal in the vicinity, the surface sediments at sites 1 and 2 were found to have negligible concentrations of chemical contaminants (Section 4.2). Sediment chemistry within each site was determined to be comparable to ambient sediments outside the disposal sites. Minor increased concentrations of some analytes were associated with finer grain sizes and increased TOC and did not show any spatial trends in relation to CLDS and/or historic disposal activities (i.e., northern portion of site 1, and the northern portion and trough area of site 2). Detected contaminant concentrations did not exceed the USACE/EPA minimum sediment guidelines (SAIC 1996) or conservative ecological benchmarks. There were no significant differences between sandier and finer-grained sediments within the sites or with results from nearby reference areas. These sediment chemistry analyses provide useful information on the lack of substantive sediment chemistry effects from historical disposal activities in the vicinity of the CLDS.

7.2.2 Regulatory Evaluation of Sediment Chemistry

Federal review of dredging projects includes evaluation of sediment chemistry to ensure that increases in chemical contamination at the disposal site are unlikely and/or will have negligible adverse effects on the aquatic environment. The DEP requires that applicants sample and test the material intended to be permitted for dredging, in accordance with procedures specified in the Regional Implementation Manual (RIM) for the Evaluation of Dredged Material Proposed for Disposal in New England Waters, (EPA/USACE-NAE 2004). The RIM, consistent with the nationally based Inland Testing Manual, provides specific testing and evaluation methods for dredged material disposal projects within the New England area. Updates and/or revisions will take precedence at the time of notification by the appropriate agencies.

To determine the suitability of dredged sediment proposed for open-water disposal, the sediment is subject to a tiered testing program approved by the USACE and the EPA. The first tier (Tier I testing) relies on existing data and/or analysis of physical sediment characteristics (e.g., grain size, organic carbon content, etc.). The second tier (Tier II testing) involves project-specific chemical characterization of the material via bulk chemistry and elutriate testing for a suite of inorganic (e.g., heavy metals) and organic (e.g., pesticides, PAHs and PCBs) chemical contaminants. Tier III testing includes an assessment of the sediment's acute toxicity, and a determination of the material's potential for bioaccumulation. Tier IV testing involves further quantifying potential impact to biota via ecological risk assessment following EPA protocol. The material is subject to each progressive step in the tiers only as far as is needed to make an evaluation of the material's suitability for open-water disposal (Fredette et al. 1992).

For instance, if Tier II testing reveals that chemicals are present at extremely elevated (i.e., hazardous) concentrations, then the material will be precluded from open-water disposal on that basis, and the next tier of testing is unnecessary. In contrast, material dredged from areas known to be pristine or otherwise located far from the industrial or urban influences might be classified as suitable for open-water disposal on the basis of Tier I testing only.

Dredged material in New England typically emanates from channels and harbors that have experienced some level of past or on-going human influence. Such sediments do not typically contain contaminants at levels considered hazardous, but nonetheless they are commonly subjected to both Tier I and Tier II (chemical) testing. If, after Tier II testing, the material is found to have concentrations of contaminants at background levels or below the levels known to cause adverse ecological effects, then Tier III biological testing may not be required. Biological testing typically is required if the material exhibits contaminants at concentrations that are significantly elevated above background and/or at levels that may cause adverse ecological effects.

Dredged material generated by various Federal, public, and private dredging projects throughout the Buzzards Bay region will be subject to the tiered testing approach prior to authorization for open-water disposal at the BBDS. As indicated, sediments generated from most sites undergo physical and chemical testing at a minimum. Areas for which existing data are more than 3 years old may also need to be retested. The MADEP is the state agency responsible for reviewing dredging permit applications concurrently with the USACE. The Department also maintains records of sediment sampling results for state waters.

7.2.3 Site Monitoring to Evaluate Long-Term Impacts to Sediment Chemistry

Long-term monitoring of the site (Section 11) will involve using a tiered approach based on that developed and utilized successfully for over 25 years in New England by the NAE's DAMOS program (SAIC 1994; Fredette and French 2003). One of the goals of the monitoring program is to ensure that disposal activities do not have significant negative environmental impacts, including effects on the sediment characteristics and potential for bioaccumulation of contaminants by aquatic species. The first tier of post-disposal monitoring includes collection of grab samples to evaluate grain size and sediment chemistry. Monitoring will be conducted both at the disposal sites and nearby reference areas to identify conditions specifically attributable to dredged material disposal and identify whether additional monitoring surveys or management measures are required. Tier II testing includes additional sediment chemical and toxicity tests; collection of benthic organisms to analyze for contaminant body burdens; and surveys to provide more detailed information on sediment stability and hydrodynamics. Monitoring at the existing open-water disposal sites in New England has demonstrated that low-levels of chemical contaminants in dredged material placed at open-water sites are generally not transported off-site and do not accumulate in the tissues of resident organisms (SAIC 1996).

Section 11 describes the detailed baseline, during-disposal, and one-year, two-year, and five-year post-disposal monitoring that will be required at BBDS to ensure that expected environmental conditions are maintained (e.g., stable disposal mounds and chemical concentrations comparable to pre-disposal and/or reference concentrations).

7.2.4 No Action

Selection of the no-action alternative will result in no significant changes to the existing sediment chemistry at the candidate disposal sites. The negligible concentration of contaminants detected in the sediments at sites 1 and 2 will continue to be comparable to ambient sediments outside the disposal sites. Minor increased concentrations of some analytes in comparison to the reference areas may occur due to continued ambient accumulation of finer grain sizes and increased TOC within the deeper portions of the sites (i.e., northern portion of site 1, and northern portion and trough area of site 2). However these anticipated contaminant concentrations will not be expected to exceed the USACE/EPA minimum sediment guidelines (SAIC 1996) or other conservative ecological benchmarks under present conditions.

7.3 Water Quality

The primary concern with respect to water quality impacts at the disposal site is increased turbidity during disposal activities. Following release from a disposal barge, most of the suitable dredged material will fall to the seafloor immediately. However, the non-clumping, extremely fine-grained components become entrained in the water column. Currents may transport this component as a plume of more turbid water that eventually returns to background turbidity levels through particle settling and dilution with surrounding water. Typically, the volume of sediment that becomes entrained in this way is a very small percentage of the total volume of material, on the order of <1% to 5% (USACE 2001). The variation within this range is a function of environmental factors, including water depth, material type, and current velocity.

The predictive modeling performed as part of the Environmental Impact Statement for the Boston Harbor Navigation Improvement Project assumed a 2% to 5% loss of the mass of material to entrainment during disposal from split hulled scows (ENSR 2002). For the season-long disposal activities modeled with MDFATE for each candidate site (Section 7.1 above), a loss to entrainment of 5% (the maximum of the reported range above) of the total, annual disposal volume of 106,000 cy would be 5,300 cy or 143,100 ft^3.

Some negative effects of increased turbidity are decreased light penetration, interference with sensitive life stages of biota in the water column, and interference with the feeding activities of filter feeders. The characteristics and behavior of the turbidity plume resulting from each dredged material disposal event at candidate disposal sites 1 and 2 were simulated using both the short-term fate (STFATE) and long-term fate (LTFATE) models developed by the USACE (Maguire 2004a and b). Based on the modeling results, the potential short-term and long-term impacts of increased turbidity on living resources within and near the candidate disposal sites are evaluated below.

7.3.1 Total Suspended Solids (TSS)

The STFATE model simulations were used to characterize the a real extent and duration of increases in total suspended solids above background concentrations and evaluate these increases relative to state water quality standards. Background TSS concentration in Buzzards Bay were determined using data from the EPA's EMAP program. Seven sites in the Bay were sampled at various times over the period 1990 through 1993 for a variety of water quality parameters, including collection of surface water samples for determination of TSS concentration using the filtering method (Figure 7-5). Sampling was conducted in late July or August of each year, and typically consisted of sample collection at one or two stations having different depths. The results in Table 7-4 indicate an overall range of TSS concentrations of 2.7 mg/L to 24.3 mg/L at the seven stations.

There are no indications from the data of any trends based on water depth, and the spatial and temporal coverage of the stations acts to provide a range of typical values for surface TSS concentrations throughout Buzzards Bay. In general, shallower areas close to shore would be expected to have higher TSS concentrations on average, due to greater sediment re-suspension caused by wave and current effects on the substrate and inputs of freshwater runoff from land. Seasonal variability in primary productivity will affect TSS concentrations in surface waters throughout the Bay as well. These factors can contribute to variability in TSS concentrations on a variety of time-scales ranging from hourly (e.g., tidal cycle fluctuations in water depth and current speed) to seasonal (e.g., freshwater runoff and primary productivity cycles).

A comparison of the maximum reported, non-storm condition, background TSS values for various Eastern seaboard sites was provided in the EIS for the Providence River and Harbor Maintenance Dredging Project (USACE-NAE 2001). Reported values were 7 mg/L in Narragansett Bay, 14 mg/L in the Providence River, 4 mg/L in Rhode Island Sound, 25 mg/L in New Haven Harbor, and 40 mg/L on average in various mid-Atlantic estuaries. The Buzzards Bay TSS values based on the EMAP monitoring results fall within the range of representative "background" levels for New England and mid-Atlantic estuaries.

As noted in Section 7.1, dredged material released from a scow undergoes three phases: (1) convective descent, (2) dynamic collapse, and (3) passive transport and dispersion (USACE-NAE 2001). Passive transport and dispersion refer to the action of the ambient currents on particles that have become entrained in the water column during the descent and collapse of the material. Most water-column entrainment of particles occurs during dynamic collapse, and it is the action of ambient hydrodynamic conditions that can transport them beyond the boundaries of a disposal site. Plumes of suspended material that are carried away from the disposal site by ambient currents become less concentrated over time due to settling of particles to the substrate, and dilution with surrounding water.

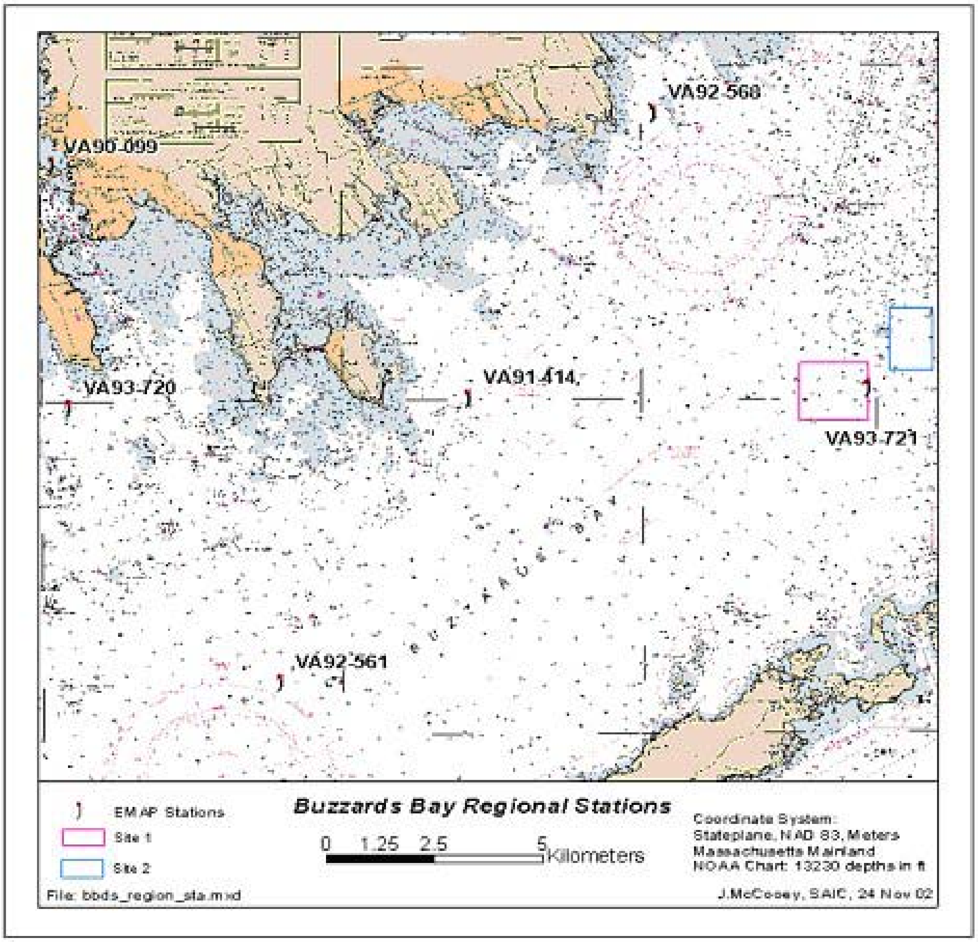

Figure 7-5. Six stations in Buzzards Bay where TSS concentrations in the water column were determined by the EPA's EMAP program over the period 1990 through 1993. A seventh station (VA91-413) located in the Westport River is not shown.

Table 7-4. TSS concentrations (mg/L) for Buzzards Bay stations from the EPA EMAP Program.

EMAP Station [1]	Lat./Long. Decimal Degrees Location	Water Depth	Sampling Date	TSS (mg/L)
VA90-099	41.643 / -70.912 (Northwestern part of Bay – New Bedford Harbor Estuary)	9.4 meters	15 Aug 1990	5.4
VA91-413	41.53 / -71.094 (Westport River Estuary)	3 meters	9 Aug 1991	20
VA91-414	41.584 / -70.797 (Western Bay, 7.5 km west of site 1, 2 km from shore)	12 meters	28 Jul 1991	24.3
VA92-561	41.513 / -70.85 (Middle of Bay entrance)	17 meters	16 Aug 1992	16
VA92-568	41.655 / -70.745 (Buzzards Bay)	6.8 meters	16 Aug 1992	21
VA93-720	41.582 / -70.908 (Buzzards Bay)	6.5 meters	16 Aug 1993	2.7
VA93-721	41.586 / -70.686 (East boundary of site 1)	14.6 meters	20 Aug 1993	3.2

[1] Refer to Figure 7-5 for EMAP station locations.

7.3.2 STFATE Model Results

The STFATE model simulates the convective descent and dynamic collapse of discrete discharges of dredged material from barges and hopper dredges in open water. This model is commonly used to comply with regulations that require evaluation of potential water column impacts during disposal. The model output consists of sediment particle concentrations in the water column in the hours immediately following release of the dredged material.

Like the MDFATE model runs described previously, the input used in the STFATE simulations consisted of a single 2,000 cy load of dredged material released from a split-hull barge in the center of each of the two candidate disposal sites. Model inputs were determined using data from similar dredging studies and determining the most applicable parameters for conditions in Buzzards Bay. The model was used to simulate the concentration of suspended silt and clay at three depths in the water column, at one-hour intervals, for a total time period of four hours following disposal. The Providence River Dredging Project modeling had demonstrated that, following disposal of dredged material volumes much larger than those that would be released in Buzzards Bay, total suspended solids (TSS) concentrations would return to background levels within such a four-hour period. The STFATE model results are presented as maximum silt and clay concentrations for each hourly interval at candidate sites 1 and 2. The output includes silt and clay concentrations only because the model predicts that the larger sand particles and clumps would be deposited on the bottom in less than 1 hour and would not be transported outside the confines of the disposal site.

Site 1 simulations were performed on a flat grid with a 12 meters (40 feet) depth. Site 2 simulations used a flat grid with a depth of 13.7 meters (45 feet). Both STFATE simulations used a mean background current of 7 cm/s (0.23 feet per second (feet/s)) at a direction of 25º (relative to true north), which is consistent with a typical, maximum flood current velocity in the vicinity of the sites (as discussed in Section 4.3). A TSS concentration of 2 mg/L, the lower end of the ambient background concentration range, was used as the background concentration for the modeling. Table 7-5 provides a listing of STFATE input parameters used.

Table 7-5. STFATE simulation parameters.

Volume (cy)	Barge Length (feet)	Barge Beam (feet)	Barge Draft (feet)
2000	200	50	17

7.3.2.1 Candidate Site 1 Results

The map in Figure 7-6 shows the horizontal extent of the silt and clay particle cloud (i.e., “turbidity plume”) from a 2,000 cy release at site 1. The TSS concentration exceeds the range of recorded background values for the Bay (2.7 mg/L to 24.3 mg/L) until the third hour following disposal. Four hours following disposal, the centroid of the cloud would have traveled approximately 3,350 feet (1,021 meters) from the release point and would have a concentration of 2.64 mg/L clay and 7.17 mg/L silt. Added together, this value represents a disposal-induced TSS concentration of 9.81 mg/L, a value that exceeds the lower end value of the bay’s TSS background concentration of 2 mg/L, but is less than the higher end value (24.3 mg/L) in the background concentration range. The centroid would have traveled approximately 530 feet (160 meters) beyond the boundary of site 1. The extent of the cloud associated with this centroid is delimited in Figure 7-6. The boundary of the cloud, delimited to the contour where the cloud approaches the 2 mg/L background concentration, had traveled approximately 4,858 feet (480 meters) from the disposal point, and 2,112 feet (644 meters) beyond the boundary of site 1 (Maguire 2004a).

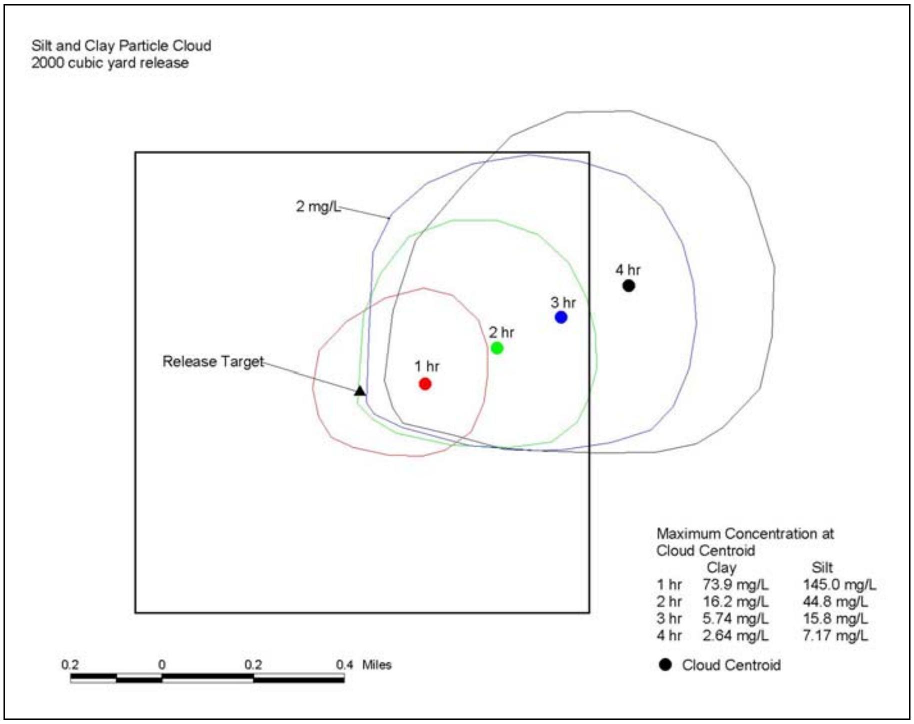

Figure 7-6. Maximum accumulated silt and clay particle concentrations over a 4-hour period resulting from a 2,000 cy release from a split-hull barge at Candidate site 1.

Contours represent a 2 mg/L concentration, the lower limit of the range of TSS background in the bay. The centroid of the particle cloud at each time interval is shown as a small dot. The heavy black box is the boundary of Candidate site 1. The TSS concentration is 2mg/L at the outer contour line in the figure.

A plot of the maximum silt and clay concentrations (above the background level of 2 mg/L) at each 1-hour time step for the 2,000 cy release at site 1 is presented in Figure 7-7. The results show high initial concentrations with a rapid decrease in silt and clay concentrations to values less than 10 mg/L above background. The maximum concentrations plotted in Figure 7-7 correspond to the particle cloud centroids for the same time period that are depicted in Figure 7-6.

7.3.2.2 Candidate Site 2 Results

The model results for site 2 were very similar to those for site 1. The map in Figure 7-8 shows the horizontal extent of the silt and clay particle cloud from the 2,000 cy release at the center of site 2. The accumulated TSS concentration approaches the recorded range of values for the Bay (2.7 mg/L to 24.3 mg/L) at the third hour following disposal. Four hours following disposal, the centroid of the cloud would have traveled approximately 3,350 feet (1,021 meters) from the release point and would have a concentration above background of 2.52 mg/L clay and 7.03 mg/L silt. Added together, this value represents a disposal-induced TSS concentration of 9.55 mg/L, a value that exceeds the lower end value of the TSS background concentration of 2 mg/L (Maguire 2004a).

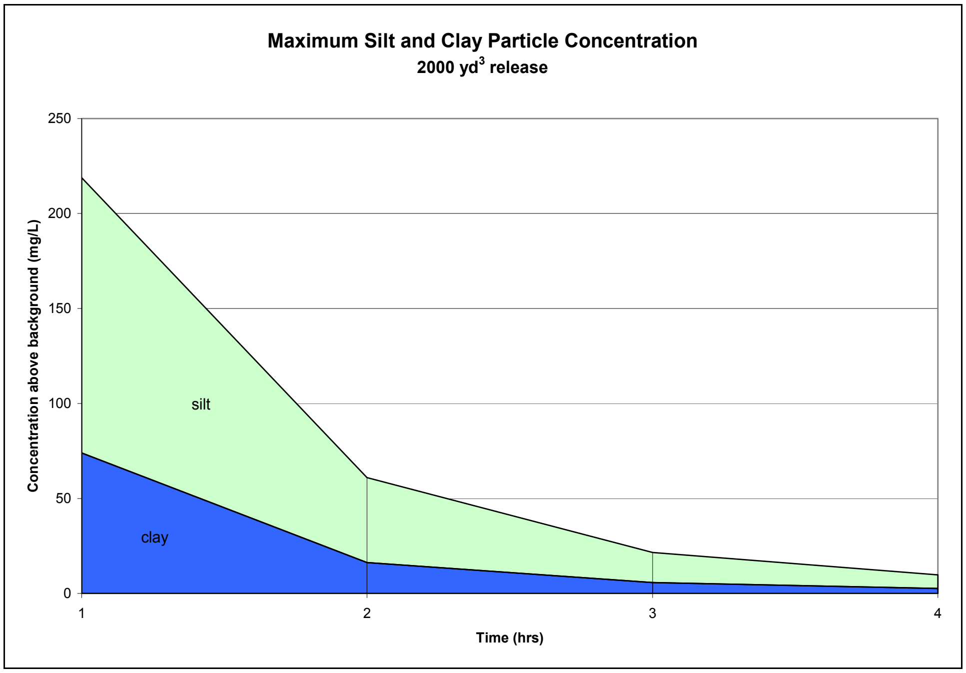

Figure 7-7. Maximum accumulated silt and clay concentration within the sediment particle cloud from 1 to 4 hours following release of 2,000 cy of dredged material at candidate site 1.

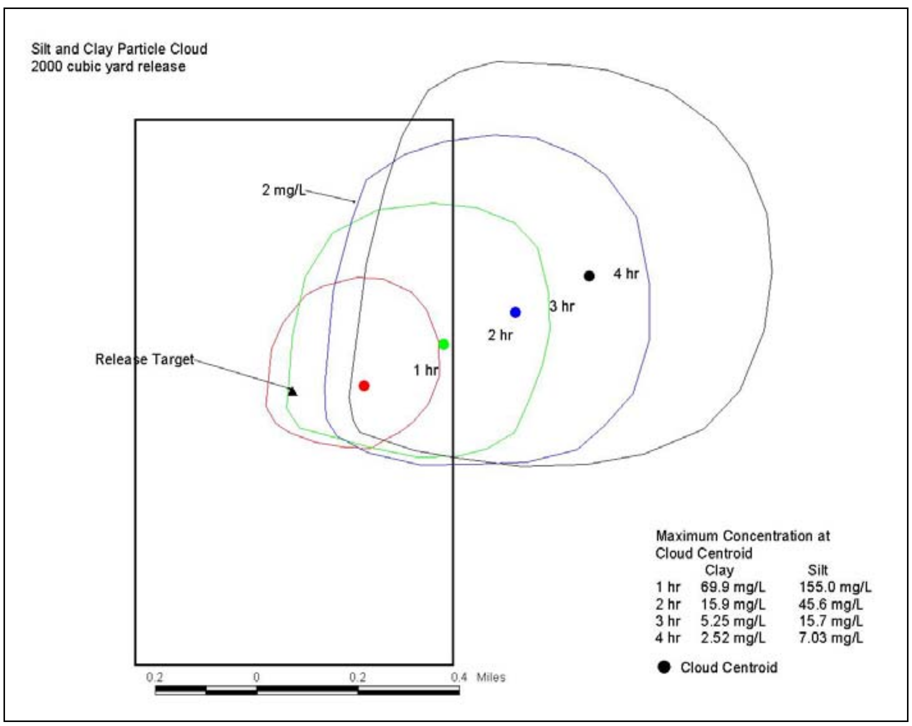

Figure 7-8. Maximum accumulated silt and clay particle concentrations over a 4-hour period resulting from a 2,000 cy release from a split-hull barge at candidate site 2.

Contours represent a 2 mg/L concentration, the lower limit of the range of TSS background in the bay. The centroid of the particle cloud at each time interval is shown as a small dot. The heavy black box is the boundary of candidate site 2. The TSS concentration is 2mg/L at the outer contour line in the figure.

After 4 hours, the centroid would have traveled approximately 3,274 feet (998 meters) beyond the disposal point, or 1,584 feet (483 meters) beyond the boundary of site 2. The extent of the cloud is delimited in Figure 7-8 as the 2 mg/L contour, which was used as the background concentration, which had traveled approximately 5,280 feet (1,609 meters) from the disposal point and 3,432 feet (1,046 meters) beyond the boundary of site 2. Figure 7-9 is a plot of the maximum silt and clay concentration at each 1-hour time step for the 2,000 cy release at site 2. The results show high initial concentrations with a rapid decrease in silt and clay concentrations to values less than 10 mg/L above background.

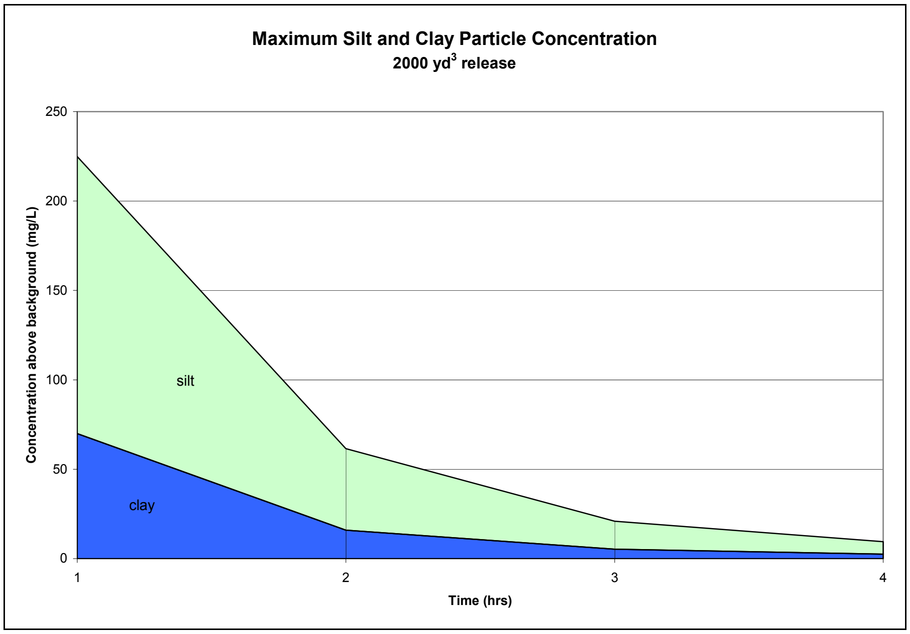

Figure 7-9. Maximum accumulated silt and clay concentration within the sediment particle cloud from 1 to 4 hours following release of 2,000 cy of dredged material at site 2.

Values are mg/L of silt and clay above the background concentration of 2 mg/L, the lower limit of the range of TSS background in the bay. Maximum concentrations plotted here correspond to the particle cloud centroids for the same time period shown in Figure 7-8.

7.3.2.3 Discussion

Based on the results of modeling, increases in total suspended solids from disposal events will exceed the very conservative, pre-disposal background concentrations by minor amounts, less than a total of 10 mg/L, within 4 hours of disposal. Given the range of concentrations recorded for various North Atlantic estuaries presented above (7 to 40 mg/L for harbors and estuaries), and for specific stations in Buzzards Bay (2.7 to 24.3 mg/L), the modeled TSS values on the order of 10 to 15 mg/L occurring 4 hours after disposal are well within the normal range of expected variability. Fluctuations due to algal blooms, changes in runoff volume, spring and neap tidal current strength, current velocity fluctuations throughout a tidal cycle, and sediment re-suspension caused by wind waves can produce dramatic differences in TSS concentrations at a site over varying time scales (Levinton 1982). Seasonal differences (i.e., spring versus fall) in TSS concentrations spanning an order of magnitude were measured by Pilson and Hunt (1989) for Rhode Island Sound, Narragansett Bay, and the Providence River.

Only a single tidal current speed was used for input to the model, which consisted in this case of the average tidal current speed for the sites determined in Section 4.3. However, tidal current strength and direction can vary throughout the tidal cycle, from zero to the maximum for each tide stage, as the tide switches direction from flood to ebb over roughly six hours. While very rare conditions and superposition of wind waves alter the magnitude and direction of transport from the disposal site, transport of the plume will still be controlled primarily by the ebb and flood of the tidal current. Therefore, the model predictions using a constant, uni-directional current throughout the entire 4-hour period of the model provide very conservative estimate of the plume transport distance expected at each site. Modeling of plume transport conditions under minimum and maximum tidal current conditions typically occurs during the permitting process. Very rare conditions are not modeled because dredged material disposal will not be allowed during extreme hydrographic conditions. In addition, adherence to procedures specified in the SMMP (Section 11.0) will further limit TSS impacts.

The model showed that the centroid of the turbidity cloud would be transported beyond the boundary of each site, but not until the TSS concentrations were relatively low. The cloud was transported over a longer distance in 4 hours at site 2 compared to site 1, and the magnitude of the transport beyond the boundary was also greater for site 2 due to its configuration (i.e., shorter distance from the center to the site boundary).

The limits of the turbidity cloud, defined by the background concentration of 2 mg/L, also extended beyond the site boundary in each case, traveling a slightly greater distance at site 2, and a greater distance beyond the site 2 boundary (as with the cloud centroid) due to the site configuration (i.e., site 2 is narrower than site 1 in relation to the prevailing current flow). However, in both cases, impacts beyond the site boundaries consist of low to negligible increased turbidity with respect to background concentrations. The most significant impacts occur in the immediate vicinity of the disposal location (within roughly 800 feet or 245 meters, contained within the site boundary under average current velocity), for a short duration of time (one hour) following disposal.

The draft site monitoring plan (Section 11) requires the use scows or barges designed for rapid bottom release of the dredged material, to increase the likelihood that released sediments will reach the bottom as a relatively coherent mass. This will minimize the development of a suspended sediment plume during the descent of the material through the water column and also reduce the spread of sediment on the seafloor following impact. Additionally, time-of-year restrictions will be used to limit the impacts of dredging and disposal activities, notably water column turbidity impacts on sensitive stages of marine life (e.g., planktonic and larval stages).

Specific conditions can also be imposed on disposal activities on a project-specific basis, including specifications on the location and timing of disposal events to control both the location of the deposit and likely water column impacts.

7.3.3 LTFATE Modeling Results

The objective of the LTFATE model simulations conducted as part of the detailed hydrodynamic study (Maguire 2004b) was to determine the long-term stability of dredged material placed on the bottom at candidate sites 1 and 2. The LTFATE model was developed by the USACE to simulate the potential erosion, transport, and off-site deposition of bottom sediments under average or storm-induced wave and current conditions. The model calculates the bottom shear stress imposed by combined currents and waves over the sediment bed and simulates bed load sediment transport. The LTFATE model generates output showing the thickness of sediment erosion and deposition over the bed.

Results of the hydrodynamic modeling showed that tidal currents at the candidate disposal sites are not sufficient to initiate sediment transport, thus it is assumed that any erosion of dredge material at the sites would occur during storm events. Wave height data were combined with spring tide currents from the hydrodynamic model to drive the LTFATE analysis. Sediment properties and the geometry of the dredge material mounds used in the LTFATE simulations were taken from the MDFATE modeling effort described above (Maguire 2004a). Average depths at site 1 and 2 were taken as 45.9 feet and 42.7 feet, respectively.

7.3.3.1 LTFATE Results

LTFATE simulations were completed for dredge material mounds placed at sites 1 and 2 in Buzzards Bay. The LTFATE calculations were driven by combined waves and currents from simulated Hurricane Bob storm conditions as described in Section 4.3 of this report. Results of the simulations show that no sediment movement occurs inside the boundaries of either site under the simulated storm waves and currents (Maguire 2004b).

These results can be put into perspective by considering what conditions are necessary to generate sediment erosion and transport at the sites. The combinations of bottom current speed and wave height necessary for sediment motion are shown in Figure 7-10. Curves defining the threshold at which sediment motion occurs for water depths of 33 feet (10 meters) and 46 feet (14 meters) were calculated using a USACE model (Gailani et al. 1999) and assuming a 0.1 mm median grain size (i.e., very fine sand) for the sediment. Total estimated fill capacities for candidate sites 1 and 2 were estimated in Section 4-1 for a range of 33 feet (10 meters) to 41 feet (12.5 meters). Combinations of current speed and wave height plotting to the right of a given curve in Figure 7-10 will result in the erosion and transport of sediment at the depth corresponding to that curve. Wave heights and bottom currents typical of the candidate disposal sites, defined as synthetic wave heights corresponding to wind speeds of up to 34 mph (i.e., the 95^{th} percentile wind speed recorded at BUZM3) and bottom current speeds up to the maximum modeled value over a spring-neap cycle, are shown for further perspective in Figure 7-10. Wave heights and current speeds actually experienced in Buzzards Bay during a Category 2 storm (Hurricane Bob) fall well within the region of no sediment motion, with substantial increases in current speed or wave height needed to generate sediment movement. The 46 feet water depth adopted for the plot represents the depth of site 1, the deeper of the two candidate sites. The 33 feet water depth curve shown in the plot is provided as a conservative boundary for comparison, since the wave heights and current speeds necessary to erode and transport sediment decrease with decreasing water depth.

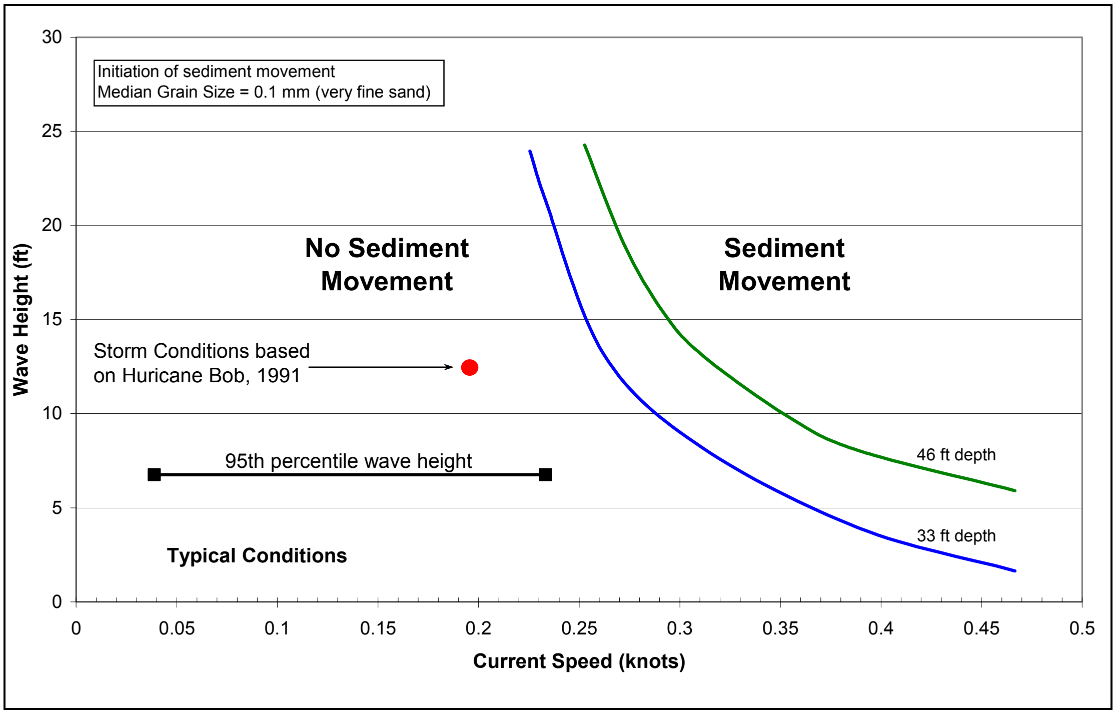

Figure 7-10. Environmental (i.e., wave and current) conditions necessary for sediment movement. Curves defining the boundary between motion and no motion environments were calculated for water depths of 33 feet (blue) and 46 feet (green) using a U.S. Army Corps of Engineers model (Gailani, et al 1999), assuming a 0.1 mm median grain size (very fine sand) for the sediment. The typical range of conditions at the proposed candidate disposal sites is shown for perspective. The 95th percentile wave height at the BUZM3 station and maximum current speed and wave height from the simulated Hurricane Bob storm are also shown.

7.3.4 LTFATE Modeling Conclusions

In summary, the LTFATE modeling study was undertaken to assess the long term stability of sediment disposed at two candidate disposal sites in Buzzards Bay. A multiphase approach was taken to accomplish this task. First, a field program was undertaken to characterize flow near the proposed candidate disposal sites, then an analysis of historical records was performed to determine representative storm conditions at the sites. Finally, a computer modeling study was conducted to evaluate the long-term mound stability. The LTFATE model simulations found that no sediment transport occurs over the long-term at the candidate sites, even under the most extreme conditions (Hurricane Bob) on record for the Bay in the last 18 years (Maguire 2004b).

7.3.5 Evaluation of Increased TSS With Respect to State Water Quality Standards

Under the CWA, the DEP is charged with protecting public health and the quality and value of surface waters in the state. The objectives of the Act are to restore and maintain the chemical, physical and biological integrity of the surface waters of the Commonwealth, including tidal waters. To meet these requirements, the DEP has developed the Massachusetts Surface Water Quality Standards, which provide surface water designations (class) based on existing water quality and uses, and the minimum standards to maintain existing uses. The Surface Water Quality Standards are applied to dredging and dredged material disposal projects through the 401 Water Quality Certification regulatory processes administered by DEP.

The Massachusetts Surface Water Discharge Permit Program requirements are defined at 315 CMR 3.00. The provisions of 314 CMR 3.00 not only reflect the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §26 through 53 but also implement those provisions of 33 U.S.C 1251 *et. seq.* and regulations adopted thereunder necessary for the Department to assume delegation from the EPA to implement the National Pollutant Discharge Elimination System (NPDES) permit program within the Commonwealth. Massachusetts Surface Water Discharge Permit Conditions are listed at 315 CMR 3.10 (3) Water quality based effluent limitations. At a minimum, all permits shall contain limitations adequate to assure the attainment and maintenance of the water quality of the receiving waters as assigned in the Massachusetts Surface Water Quality Standards, 314 CMR 4.00. The Massachusetts Surface Water Quality Standards are defined at 314 CMR 4.00; the Anti-degradation Provisions are provided at 314 CMR 4.04, and surface water classifications are provided at 314 CMR 4.05. The following summary identifies the standards relevant to turbidity increases at the candidate disposal sites.

The waters in the vicinity of the candidate disposal sites are classified as Class SA, which meet the designation of *excellent* aquatic habitat. Class SA waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation by humans. In approved areas, such waters shall be suitable for shellfish harvesting without depuration (Open Shellfish Areas). These waters shall have excellent aesthetic value. The minimum standards related to solids require that Class SA waters be maintained free from floating, suspended and settleable solids in concentrations or combinations that would impair the assigned uses, or that would cause aesthetically objectionable conditions, or that would impair the benthic biota or degrade the chemical composition of the bottom. Additionally, color and turbidity in Class SA waters is to be maintained in concentrations or combinations that are not aesthetically objectionable and will not impair any assigned uses of this class.

Pursuant to 314 CMR 4.06(1)(d)(4), open and restricted shellfishing areas are subject to more stringent regulation in accordance with the rules and regulations of the Massachusetts Division of Marine Fisheries pursuant to M.G.L. c. 130, § 75. Buzzards Bay in the vicinity of the BBDS is classified as an approved shellfishing area, and shellfishing activities are subject to applicable shellfish harvest regulations.

In addition to requirements for maintenance of existing Class SA uses, any future dredged material disposal activities at either candidate site are subject to the Anti-degradation Provisions of the regulations, which include the following:

(1) Protection of Existing Uses. In all cases existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.

Based on the STFATE modeling results, the estimated increases in turbidity above background concentrations following a disposal event at either candidate site are minor compared to the natural variability in turbidity experienced in a relatively shallow estuary like Buzzards Bay. Elevated TSS concentrations will be limited to a small area in the immediate vicinity of the disposal location and will be of relatively short duration. As such, existing uses of the water column over either candidate site will not be adversely affected, including its utilization as habitat for aquatic species and other wildlife, its value for primary and secondary contact recreation, and its aesthetics. Water column effects related to disposal activities will temporarily impair the benthic biota within the disposal site (see Section 7.4). Since the site would be designated only for clean material, no degradation of the chemical composition of the bottom is expected (see Sections 7.3 and 7.4).

(2) Protection of High Quality and Other Significant Resource Waters. Certain waters shall be designated for protection under this provision in 314 CMR 4.06(2) and 4.06(3). These include water bodies where current water quality exceeds minimum levels necessary to support the national goal uses, low flow waters, and other waters whose character cannot be adequately described or protected by traditional criteria.

Buzzards Bay is not currently classified as a High Quality Water or a Significant Resource Water (MassGIS 2003).

(3) Protection of Outstanding Resource Waters. Certain waters shall be designated for protection under this provision in 314 CMR 4.06(3) including Public Water Supplies (314 CMR 4.06(1)(d)1.). These waters constitute an outstanding resource as determined by their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained.

Buzzards Bay is not currently designated as an Outstanding Resource Water (MassGIS, 2003).

Additional minimum water quality criteria that are applicable to all surface waters include the following:

(a) Aesthetics - All surface waters shall be free from pollutants in concentrations or combinations that settle to form objectionable deposits; float as debris, scum or other matter to form nuisances; produce objectionable odor, color, taste or turbidity; or produce undesirable or nuisance species of aquatic life.

Objectionable odor, color, and taste of the water column within the disposal site would occur as a result of the disposal of clean dredged material (see Section 7.12). Temporary increases in turbidity will occur within and proximal to the disposal site during dredged material disposal, however, this is a short-term impact, and suspended sediment concentrations will return to ambient concentrations within four hours of a disposal event (Section 7.2). Designation of the disposal site to receive only material generated within Buzzards Bay communities and the Cape Cod Canal will act to the control the spread of nuisance marine species.

(b) Bottom Pollutants or Alterations - All surface waters shall be free from pollutants in concentrations or combinations or from alterations that adversely affect the physical or chemical nature of the bottom, interfere with the propagation of fish or shellfish, or adversely affect populations of non-mobile or sessile benthic organisms.

No chemical pollutant impacts would occur since the material permitted to be disposed at the designated site will consist of clean dredged material. Dredged material proposed for open-water disposal at the BBDS is subject to regulatory evaluation of sediment chemistry (Section 7.2.2), and the TSS concentration of the water column will be monitored during the disposal of approved material (Section 7.2.1).

(c) Nutrients - Shall not exceed the site-specific limits necessary to control accelerated or cultural eutrophication (also, see 314 CMR 4.04(5)).

The clean dredged material to be placed at the candidate sites is not anticipated to constitute a substantial or concentrated source of nutrients. Provisions can be added to the site management plan to prevent materials suspected or confirmed by analytical testing to constitute a concentrated source of nutrients from being disposed at the candidate sites without prior treatment.

(d) Radioactivity - All surface waters shall be free from radioactive substances in concentrations or combinations that would be harmful to human, animal or aquatic life or the most sensitive designated use; result in radionuclides in aquatic life exceeding the recommended limits for consumption by humans; or exceed Massachusetts Drinking Water Regulations as set forth in 310 CMR 22.09.

Clean dredged sediments from Buzzards Bay are not expected to constitute a source of radioactive contaminants, since no likely source of radioactive contamination (e.g., nuclear powered vessels or nuclear power plants) are known to exist within in the Bay.

(e) Toxic Pollutants - All surface waters shall be free from pollutants in concentrations or combinations that are toxic to humans, aquatic life or wildlife.

Clean dredged material will not constitute a source of toxic pollutants (see [b] above).

7.3.6 Dissolved Oxygen

In addition to turbidity impacts discussed above, open-water disposal of sediments may result in water column impacts, such as localized decreases in DO concentrations. Concern with the effects of disposal activities on DO is based on the utilization of oxygen as organic material in the sediment is metabolized by microbial activity. However, evidence from prior dredging projects suggests that impacts to water quality resulting from clean dredged material disposal are short-term (USACE-NAE 1996b; USACE 2001). Estimates of the likely magnitude of the water column effects during disposal indicate negligible, short-term decreases in DO due to the material settling through the water column.

At the New London Disposal Site (NLDS) located in the open waters of eastern Long Island Sound, DO levels in the water column were found to return to pre-release concentrations from 15 minutes to 2 hours after a disposal event (U.S. Navy 1979). NOAA (1977) reported that the DO content in the bottom waters at the NLDS dropped to approximately 48% of saturation and returned to ambient (84%) within 40 minutes, and that surface and middle waters exhibited little change. Therefore, it is likely that short-term negative impacts on water-column DO from disposal events would be greatest near the substrate.

Lee et al. (1977) reported that the greatest drop in DO in a Galveston, Texas disposal project was 1.7 mg/L, but at no time did the level drop below 5.0 mg/L (the concentration at which many marine organisms become stressed). Therefore, the short-term decrease of DO in the water column, at the scale and magnitude measured for other projects, is not expected to result in any adverse impacts (e.g., mortality or impairment) to mobile marine organisms.

Effects of open-water disposal on water-column DO concentrations were estimated for the Providence River dredging project using procedures developed by the USACE ERDC (USACE 2001). The estimates assumed a relatively large amount of material being released (4,000 cy and 6,000 cy disposal barges), relatively high total organic carbon content in the sediments (3.5%), and conservative assumptions about TSS distributions and duration following release from the barge. Results indicated maximum changes in water-column DO concentrations of 0.4 to 0.6 mg/L. These values represent minor changes in concentration and effects, and changes corresponding to use of a smaller disposal barge and material with less organic carbon content would be even less dramatic. Similarly, effects on DO at the outer margins of the turbidity plume would be negligible.

Water quality monitoring of unsuitable (i.e., contaminated) dredged material at the Conley Terminal CAD site in Boston Harbor showed no apparent difference in DO concentrations between the reference and down current sample sites. DO concentrations varied only slightly (by tenths of a mg/L) and were not consistently higher or lower at the reference station (USACE 2001). These values from the Providence River and Boston Harbor examples indicate temporary minor changes in DO concentrations and subsequent limited effects on marine biota.

The area of Buzzards Bay containing the candidate disposal sites is classified as Type SA surface water, which shall not have a DO concentration of less than 6.0 mg/L. The lowest DO values in this area would be expected during the warmer summer and early fall months, when water temperatures are highest and the potential exists for stable thermal stratification of the water column. The highest DO values for this area occur during winter when the environmental window period is most likely to be permitted (opened). NPDES requirements for DO as documented in the Massachusetts Surface Quality Standards for Coastal and Marine Class SA waters at 314 CMR 4.05(4)(a)(1)(a) state that DO "*shall not be less than 6.0mg/l unless background conditions are lower; and (b) natural seasonal and daily variations above this level shall be maintained.*" Overall, the DO changes associated with disposal of limited volumes of dredged material at either candidate site are expected to be insignificant.

7.3.7 Contaminants

Water-column concerns are related to the potential release of contaminants from sediment pore waters during the descent phase of dredged material disposal. The likely presence of sediment contaminants, and actual measured concentrations of chemicals of concern, is evaluated for each distinct dredging project through the regulatory process (see Section 10). The STFATE model can be utilized to determine appropriate mixing zones and ensure that water quality criteria beyond the site boundary are not exceeded during disposal (e.g., exceedance of water quality criteria is only allowed within a specified time period following disposal and within a specified distance from the disposal point). Based on the determination by the Commonwealth that only clean material is to be placed at the BBDS, concentrations of any detectable chemical constituents would be below the criteria set for open-water disposal. NPDES requirements for DO as documented in the Massachusetts Surface Quality Standards for Coastal and Marine Class SA waters at 314 CMR 4.05(4)(7) maintain that these Class SA waters shall be free from oil, grease, and petrochemicals. Therefore, it is anticipated that water column impacts from chemical constituents in the dredged material will not be a significant concern. Potential impacts will be evaluated on a case-by-case basis using the sediment chemistry testing results, the application of the STFATE model, and other appropriate evaluation techniques.

7.3.8 No Action

If the candidate disposal sites 1 and 2 situated in the Class SA water resource of Buzzards Bay are not used for disposal of clean uncontaminated dredged material, existing water quality and sediment transport conditions at or near the sites will remain unchanged. In the long-term, impacts to TSS, DO, and contaminants from disposal will be equivalent to the no-action alternative results.

7.4 Benthic Communities

Potential impacts from disposal to benthic communities at the candidate disposal sites include direct impacts (physical disruption/smothering of the organisms inhabiting the substrate of the disposal area) and changes in benthic habitat characteristics (e.g., grain size, total organic carbon content, dissolved oxygen).

As described in Section 5.1, based on the results of the SPI surveys (Maguire 2001c) and benthic community characterizations (Maguire 2001d), both candidate disposal sites were characterized by relatively abundant and diverse benthic infaunal communities, indicative of a seafloor environment with a low frequency and/or intensity of disturbance (e.g., from physical disruption, chemical stressors, etc.). Populations of both surface-dwelling, opportunistic polychaetes (Stage I) and deeper-dwelling, subsurface deposit-feeding taxa (Stage III) were widespread across candidate sites 1 and 2. Overall, benthic habitat conditions in and around candidate sites 1 and 2 reflected healthy sediment aeration and the presence of a diverse and abundant benthic community.

Subtle differences in benthic habitat characteristics, such as a greater percentage of Stage III organisms at candidate site 1 compared to candidate site 2, and determinations of a moderate degree of physical disturbance at some of the shallower stations, were most likely due to slightly greater hydrodynamic forcing mechanisms and slightly coarser grain size. Overall, the similarities observed in habitat parameters and dominant taxa suggest that the benthic communities at candidate sites 1 and 2 would respond similarly to dredged material disposal.

Both sites exhibited typical estuarine benthic communities, dominated by small-bodied, surface-dwelling, "Stage I" polychaetes (e.g., *Mediomastus ambiseta*, *Prionospio perkinsii, Caraziella hobsonae*) known to have high population turnover rates and therefore wide spatial and temporal variance. The prevalence of such opportunistic species in the vicinity of both candidate disposal sites ensures rapid recolonization of disposal mounds, as indicated by previous disposal site monitoring efforts (SAIC 1991).

Much is known about the response of benthic communities to dredged material disposal from the NAE's DAMOS, which has involved monitoring of post-disposal recovery of disposal mounds at nine regional and numerous project-specific open-water disposal sites throughout New England waters since 1977 (Fredette and French 2004). The program developed and continues to utilize a tiered monitoring protocol to assess conditions at each disposal site following disposal activities, to ensure that the sites return to pre-disposal, ambient conditions (SAIC 1994). As part of the tiered monitoring plan, recolonization over the surface of a dredged material mound by benthic invertebrates is evaluated through time relative to both nearby reference areas and a well-documented model of benthic infaunal succession.

Based on this model and long-term monitoring results obtained at open-water disposal sites throughout New England waters (SAIC 1996), it is anticipated that deposits of dredged material placed on the seafloor at either candidate site will recolonize with benthic organisms within several weeks to several months (in the absence of further physical disturbance). The initial recolonizing community is likely to include high numbers of several of the dominant opportunistic taxa found in the present study. Pioneering assemblages (Stage I assemblages) usually consist of dense aggregations of near-surface living, tube-dwelling polychaetes (Rhoads and Germano 1982; Santos and Simon 1980a). In the absence of further disturbance, these early successional assemblages are eventually replaced by infaunal deposit feeders, designated as Stage II taxa. Typical Stage II species are shallow-dwelling bivalves and tubicolous amphipods (Santos and Simon 1980a and b).

Stage III taxa, in turn, represent higher-order successional stages typically found in low-disturbance regimes. These invertebrates are infaunal, and many feed at depth in a head-down orientation. Complete recovery of a Stage III community (to levels comparable to the ambient seafloor) is a longer-term process that may require a year or more, depending on the grain size, total organic carbon content, oxygenation of the bottom waters, disposal mound thickness, and other characteristics of the dredged material (Rhoads and Germano 1986).

Stage III species are capable of burrowing upward through relatively thin dredged material deposits and can thereby immediately recolonize thin deposits and/or the outer apron region of disposal mounds (SAIC 1994). Dredged material deposits greater than about 20 to 30 centimeters in thickness require Stage III recolonization by larval recruitment, which generally requires two to three years following disposal.

Results of DAMOS monitoring conducted at the BBDS when it was actively used for dredged material disposal indicated that species richness of the benthic communities within both the disposal site and nearby reference areas was comparable to other benthic communities observed in soft-bottom, shallow water environments in the region (e.g., Cape Cod Bay and Massachusetts Bay). In addition, benthic invertebrate faunal densities at the disposal mound stations were similar those at the reference stations. The results of the benthic invertebrate community sampling were in good agreement with several parameters (e.g., RPD depths, successional stages, and OSI values) determined through analysis of SPI images. Therefore, there was no evidence of adverse effects on the benthic community attributable to disposal activities at the BBDS (SAIC 1991).

7.4.1 Summary of Potential Effects from Disposal on the Benthic Community

7.4.1.1 Physical Effects

The physical effects of disposal of clean dredged material on the substrate include relatively minor changes in water depth, on the order of 2 to 2.5 meters (Section 7.1) that should not affect the distribution of subtidal benthic invertebrate species currently inhabiting the candidate disposal sites. Disposal operations can be expected to consist of a predominance of fine-grained silts and clays (Section 2.3) but may also include rock, coarse sand and gravel, and sandy material. Coarse sand and gravel provides less suitable substrate for deposit feeders, and disposal of this type of material would have the most dramatic effects on the benthic community composition at both candidate disposal sites because existing substrate at both sites is predominantly soft mud. While coarse sand and gravel habitat occurs in the vicinity of the two candidate sites, it represents a very small percentage the existing substrate within each one (Section 4.2). Disposal of sandy material in the deeper-water basin areas of candidate sites 1 and 2 would likely result in minor shifts in the relative abundance of dominant species, as suggested by minor differences in the existing species distribution between the shallower and deeper portions of each site (Section 5.1.3). One of the main differences observed from the SPI surveys was a lack of Stage III organisms at the sandier stations, as these organisms favor soft-bottom substrates. However, these differences (i.e., in abundance of Stage III organisms at finer-grained and sandier locations throughout each candidate site) are relatively minor and lead to the conclusion that disposal of a range of dredged material types (from fine-grained sediments to sand) will not appreciably alter the benthic community composition at the disposal sites.

This prediction is supported by monitoring of previous disposal activities in the vicinity, at the historical BBDS, which indicated negligible effects of disposal activities on the overall character and composition of the benthic community (SAIC 1991).

7.4.1.2 Effects of Increased Organic Content Carbon of Sediments

Fine-grained material deposited at the sites is likely to have a broad range of TOC concentrations. The TOC concentrations in the existing sediments at the site indicate minor variability associated with changes in grain size, and range overall between 0.5% and 2.3% at site 1 and 0.2% to 3.4% at site 2 (Section 4.2). TOC concentrations for fine-grained dredged sediments would not likely exceed 3% (personal communication, P. Nimeskern, USACE-NAE), which is comparable to the range of values measured in sediments at candidate sites 1 and 2. Concentrations higher than that would be unlikely but could occur. Increased TOC in sediment provides a food source for deposit feeders, and also increases the chemical and biological oxygen demand. Recently deposited dredged material often supports higher population densities of recolonizing benthic organisms by providing a concentrated food source within a competition-free space, relative to ambient sediments (SAIC 1994; Morris and Tufts 1997).

While higher nutrients and organic carbon content generally have a stimulatory effect on benthic communities, it is also possible for dredged material to be over-enriched with respect to these parameters. Elevated sediment oxygen demand associated with microbial decomposition of high concentrations of organic matter can make an area of seafloor more susceptible to disturbance during periods of time when bottom water dissolved oxygen concentrations are low (seasonal hypoxic events). As oxygen levels in overlying waters decrease, the benthic community becomes stressed and less able to maintain an aerobic sedimentary environment (Diaz and Rosenberg 1995; Ritter and Montagna 1999). Microbial-mediated oxidation of organic matter will continue in the sediment until the supply of molecular oxygen is exhausted, causing a rapid decrease in RPD depths that is often observed in sediment-profile images as a redox rebound layer.

Long-term monitoring of disposal mounds having elevated organic content in the sediments is expected to show cyclical recovery and decline of benthic habitat conditions and presence of Stage III deposit feeders, which often may be linked to the onset and severity of seasonal hypoxia in the near-bottom waters of a region (Morris and Tufts 1997). Due to the high oxygen demand of the sediments, the resident benthic community is more susceptible to hypoxia-induced stress and the development of a stable benthic infaunal population may be delayed.

Given the expected comparability in TOC concentrations between the dredged material and the ambient sediments at both candidate disposal sites, and the relative lack of stratified water column conditions that increase the likelihood for low DO in the bottom waters, these TOC-related effects on benthic community recovery are less likely at the BBDS. The SMMP (Section 11) includes provisions to determine if these effects are occurring.

7.4.1.3 Contaminant Content of Sediment Effects

The testing protocols and the SMMP are both designed to ensure that only suitable dredged material is placed at the BBDS. The testing protocols require representative sampling and analysis of the entire volume of sediment to be dredged. In the event that trace concentrations of chemical contaminants are detected, a suitability determination will be made by several cooperating Federal and state agencies to ensure that these these chemicals do not significantly exceed background concentrations in ambient sediment outside of the candidate disposal sites and/or will not results in adverse biological effects (Section 7.3).

7.4.1.4 Summary of Biological Effects

Placement of suitable dredged material at the candidate sites may result in the following main impacts to benthic communities: mortality through burial, physical disruption, possible increases in the food supply, minor reduction of DO concentrations, and negligible influences from toxic contaminants.

Both the sandy and muddy sediments that are typical of dredging projects in the Buzzards Bay region will support rapid recolonization by Stage I organisms. Changes in sediment grain size from the existing muddy sediments to coarser sands, gravel or rock deposits may hamper the rate of recolonization by some organisms. In the deeper, depositional basin areas of the two candidate sites, finer silty or muddy sediments will eventually cover coarser sands and gravel. In the short term, surviving organisms may be slightly stressed from temporary DO reductions. Since only suitable dredged material will be permitted for disposal, elevated chemical contamination is not a concern. Stage I benthic organisms are expected to recolonize new dredged material deposits within several weeks to months in the absence of further disturbance.

Benthic organisms buried by more than 20 to 30 centimeters of dredged material will likely be killed. Upward burrowing of buried organisms in dredged material layers less than 20 to 30 centimeters thick will allow relatively rapid recolonization of the thinner flanks or apron regions of disposal mounds. New deposits of sandier Bay-area dredged material may result in minor shifts in the relative abundance of some resident benthic species. Recolonizing organisms may benefit from enhanced food availability due to elevated levels of TOC in the disposed sediment. Temporary reductions in DO concentrations are likely have minimal stress effects. In areas of the candidate sites where Stage III benthic organisms are unable to survive by burrowing up through the new deposits, recolonization through larval recruitment from the periphery is expected to require two to three years.

7.4.2 Comparison of Potential Effects at Candidate Sites 1 and 2

The character of the benthic community and benthic habitat conditions are very similar at candidate sites 1 and 2, and, therefore, differences in potential effects on this community at each site are relatively minor. The potential to change the character of the benthic community depends largely on the grain size and organic carbon content of the material comprising the surface sediments of the disposal mounds. Formation of disposal mounds with fine-grained, organically enriched sediments in areas that currently have coarser-grained substrate may stimulate benthic productivity, increasing species richness and abundance of opportunistic invertebrates. Conversely, formation of disposal mounds with coarse sand and gravel in areas that currently have finer-grained substrate may decrease species richness and the prevalence of advanced successional stages (e.g., deep-dwelling deposit feeders). In general, given that candidate site 2 has somewhat coarser sediments, the positive effects of organic enrichment would be most pronounced at candidate site 2, and the potential negative effects of coarse-grained deposits would be most pronounced at candidate site 1. Within each disposal site, it will be possible to target disposal of dredged material to areas with the most compatible existing grain size, to minimize potential changes.

The existing differences in benthic community composition are minor, and the differences in potential impacts from disposal activities are expected to be similarly minor. Other factors, such as potential for erosion of disposal mounds, navigation concerns, and proximity to commercial fishing areas, provide more substantive differences between the two candidate sites than the comparisons of benthic community effects.

7.4.3 No-Action Alternative

The results of the benthic invertebrate community characterization sampling indicate that the benthic communities at candidate sites 1 and 2 and nearby reference areas are dominated by opportunistic taxa, mainly polycheates (e.g., *Mediomastus ambiseta*, *Prionospio perkinsii*, and *Aricidea catherinae*), the nemertean (*Carinomella lactea*), the bivalve mollusk *Macoma tenta*, the gastropod mollusk *Cylichna oryzna*, and various nematodes and ostracods. These results represent current conditions at the sites and most likely reflect the nature of the net depositional environment, past disturbance, regional source populations of invertebrates, and other site-specific factors. Through selection of the no-action alternative, the benthic invertebrate communities within the candidate disposal sites are expected to remain similar to those found in the November 2000 baseline characterization survey (Maguire 2001d).

7.4.4 Site Monitoring to Evaluate Long-Term Impacts to the Benthic Community

Long-term monitoring of the site (Section 11.0) includes the tiered monitoring approach utilized by the NAE's DAMOS program (SAIC 1994). One of the goals of the monitoring program is to ensure that disposal activities are not having significant negative environmental impacts, including effects on the character and condition of the benthic community. The first tier of post-disposal monitoring includes collection of grab samples to evaluate grain size and sediment chemistry, and SPI surveys to assess benthic recolonization (e.g., successional stages and benthic habitat characteristics). Monitoring will be conducted at the disposal sites and nearby reference areas to document conditions that could be attributed to dredged material disposal, and identify whether additional monitoring surveys or management measures are required. Tier II testing may include additional sediment chemical and toxicity tests, collection of benthic organisms to analyze for contaminant body burdens, and/or surveys to provide more detailed information on sediment stability and hydrodynamics.

The tiered monitoring program describes the detailed baseline, during-disposal, and one-year, two-year, and five-year post-disposal monitoring that will be required at BBDS to ensure that expected environmental conditions are maintained (e.g., stable disposal mounds, recolonization by benthic communities comparable to pre-disposal conditions and reference areas).

7.5 Impact to Finfish, Megainvertebrates and Shellfish

Section 5.0 provides substantial information on fishery resources throughout Buzzards Bay and in the vicinity of the candidate disposal sites (see Figures 5-30 through 5-33). The following section presents a summary of the relevant issues related to potential impacts to fishery resources (finfish, megainvertebrates and shellfish) from dredged material disposal activities.

Dredging and dredged material disposal, if not conducted with adequate planning and proper engineering controls, may adversely effect finfish and megainvertebrates both directly and indirectly. Direct impacts are those that occur as a result of physical contact with the dredged material during various phases of disposal (i.e., convective descent, dynamic collapse, passive diffusion). Indirect impacts are those that affect any of the various aspects of the organism's ecology including energy flow, biotic interactions, and habitat. The extent of the effect depends on hydrologic processes, sediment texture and composition, chemical content of the sediment and pore water matrices, the behavior or life stage of the receptor species, and the time of year that dredging-related activities occur.

7.5.1 Direct Impact

7.5.1.1 Burial

Demersal or low-mobility biota, and organisms with demersal or low mobility life stages (e.g., larvae suspended in the water column or newly-settled larvae in the benthos) would be most susceptible to direct burial of dredged sediment. Species and life stages of species with low mobility are more susceptible to burial by the descending sediment plume (convective descent) than species with greater mobility, since burial results when the released dredged material descends upon the biota faster than the biota can avoid the descending plume. It is primarily the egg, embryonic, and larval stages of finfish that are most susceptible to mortality and injury (Blaxter 1969, 1974; McGurk 1986; Black et al. 1988; Chambers et al. 1988). Managing disposal activities to avoid and/or minimize impacts to these sensitive stages consists of a determination of whether they are likely to occur in the vicinity of the dredging and/or disposal sites, and prohibitions on dredging and disposal activities during the time of year when they are most likely to be present and/or abundant in either the water column (pelagic), or on the bottom (demersal).

7.5.1.2 Toxicological/Physiological Effects

Direct effects caused by disposal of the dredged material include behavioral impairment (e.g., inhibition of migration patterns), physical impairment (e.g., turbidity-induced clogged gills resulting in suffocation or abrasion of sensitive epithelial tissue), and potential acute and chronic effects (e.g., growth, reproduction, and behavior) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen 1996) or chemical contaminants. Some physical impairment of resident fish species within Buzzards Bay would be expected. Being highly mobile, pelagic fish are more likely to avoid the turbidity plume and temporarily leave that portion of the bay in which the sediment plume occurs. Anadromous fish might be susceptible to temporary impact by the sediment plume if they happen to pass through it to freshwater spawning areas.

Based on the determination that the BBDS will be used for disposal of suitable dredged material, chemical concentrations at the disposal sites should remain comparable to existing conditions and/or reference areas, and therefore acute and chronic effects to aquatic organisms should not occur. Therefore, potential acute and chronic effects to finfish and shellfish associated with disposal activities largely relate to contact with turbidity plumes (disposal-induced elevated concentrations of total suspended solids). The severity of ill effect due to exposure of marine fish to suspended solids is not only a function of suspended solid concentration but also of the duration of exposure (Newcome and Jensen 1996), with the latter function argued as the more important of the two (USACE 2001).

The impact to finfish and megainvertebrates of Buzzards Bay due to exposure of elevated concentrations of suspended solids produced during disposal of dredged material at the candidate sites will be limited due to spatial, temporal, and regulatory constraints. The relatively small area of the candidate disposal sites in relation to the total area of the Bay is illustrative of the limited spatial scale of the temporary impacts associated with dredged material disposal at the candidate sites. The temporal restrictions will be imposed by establishing a closed disposal window during particular seasons. Additional restrictions may be incorporated into the disposal site monitoring and management plan and during the permitting process (regulatory restriction) on a project-by-project basis. The various spatial, temporal, and regulatory restrictions act in concert to ensure that disposal of dredged material and the resultant turbidity plumes generated by such activity would have as minimal an effect on fisheries resources (i.e., finfish, shellfish, megainvertebrates) as is practicable.

7.5.2 Indirect Impact

Dredged material disposal, if implemented without the proper controls and planning, can affect various attributes of the ecosystem, including energy flow, habitat structure, and biotic interactions.

7.5.2.1 Effect on Energy Flow

Food sources enter the Buzzards Bay ecosystem via inputs of organic material (detrital pathway) and via primary productivity by phytoplankton, algae, and emergent and submerged aquatic vegetation. Phytoplankton productivity is a major source of primary food energy for temperate zone estuaries (Day et al. 1989). These organisms have metabolic pathways that convert light energy into biological energy with the resultant fixation of carbon dioxide and the production of oxygen and carbohydrates. Phytoplankton production typically exhibits spring and fall maxima. These seasonal patterns are usually a result of various environmental factors including salinity, turbidity, nutrients, turbulence, and depth. However, the highest rates typically occur during annual water temperature maxima.

Energy from phytoplankton production is transported to primary consumers such as zooplankton and benthic marine invertebrates. These primary consumers, in turn, provide prey for secondary consumers and higher trophic level organisms. Disruption in seasonal patterns of salinity, turbidity, nutrients, turbulence, and depth can impact phytoplankton productivity and, therefore, the flow of energy from primary producers to higher trophic level consumers. Many organisms have evolved migration patterns and spawning activity to coincide or correspond with increased inputs of energy into the system. Disruption in these energy flow patterns might, therefore, disrupt these aspects of the organism's life cycle. During the likely open dredge material disposal window of November through March, the water column above the disposal sites and throughout much of Buzzards Bay will be well-mixed by wind and tidal currents. Under these typical winter season conditions, phytoplankton production rates would be low and light-limited. Disposal activity at the candidate sites will not coincide with seasonal peak phytoplankton production and therefore will have little effect on the primary productivity of the system.

The abundance and local distribution of prey species for biota may directly or indirectly be effected by dredged material disposal. Many of the finfish species identified within the candidate disposal sites prey on benthic organisms living in or on the sediment. Direct impact to these prey species will occur via burial at the point of disposal. Indirect impact may occur as a result of the temporary changes in water quality discussed in Section 7.3: elevated TSS concentrations (which may result in a temporary, local depletion of DO) and the release of hydrogen sulfide (which may discourage or prevent successful settlement of many sessile, benthic invertebrate prey species). A loss of prey (e.g., lower trophic level) species will temporarily degrade the habitat value of higher trophic level biota inhabiting the area of the candidate sites by depleting the food sources of those organisms. The major prey items of each of the most abundant finfish, shellfish and mobile megainvertebrates are discussed in Section 7.5.3.

The anticipated impact to prey species is considered temporary, as the benthic community will eventually return to pre-impact conditions via recolonization over time. The return to pre-impact conditions will not occur immediately, but rather in phases as various invertebrates re-colonize disturbance areas in successive stages over a temporal scale. Re-colonization of dredged material disposal areas typically follows successive and progressive steps that are ecologically analogous to the re-vegetation and re-colonization successional phases of catastrophically disturbed terrestrial systems (e.g., burned areas, etc.).

Opportunistic organisms with high reproductive rates typically characterize the initial communities that form on dredged material deposits. Slower growing specialists with lower reproductive rates and narrower niche requirements eventually replace these organisms. Eventually, over time, the community on the re-colonized surface will approach pre-disturbance levels of diversity (Kaplan et al. 1975; Rhoads and Germano 1982, 1986; Zajac and Whitlach 1982; Gallagher and Keay 1998; Van Dolah et al. 1984). Therefore, the anticipated impact to prey species that occur within the area of the candidate disposal sites is considered temporary in an ecological context, as the benthic community will return to pre-impact conditions over time, following cessation of disposal.

Additionally, food supply can be enhanced at disposal mounds: the increased organic content of some dredged material relative to the ambient sediments can result in greater densities of early colonizing opportunists, which can settle in large numbers in organically enriched sediment (Gallagher and Keay 1998; Rhoads et al. 1978). Since demersal finfish can exploit aggregations of resources (McCall 1977), this induced abundance of recently colonized organisms can provide a ready food source.

7.5.2.2 Effects on Biotic Interactions

Indirect effects on fisheries resources due to dredging and dredge material disposal occur through disruption of the biotic interactions that govern the fish community (i.e., predator-prey relationships and any of the various symbiotic relationships). Predator-prey relationships can be locally disrupted by direct impact to the prey organism's population. Prey species are effected by burial of organisms during disposal, impact to propagule settlement or success rate (either through removal of suitable substrate or via release of hydrogen sulfide), destruction of prey species habitat, or other impacts to predator or prey species fecundity, survivorship, recruitment, or colonization rates. The degree or complexity of symbiotic interactions among many fish species is not completely understood; therefore impacts to one species may have unknown or currently unobserved impacts to others.

Additionally, animals that have been stressed and weakened by the various negative impacts associated with dredging and dredge material disposal are more susceptible to parasitism, disease, predation, intense competition, or other stresses. The loss of one species in an obligatory mutualistic relationship will result in the demise of the other. Finally, the transfer of sediment from location to another may aid in the spread of non-native species. However, since the material to be disposed at the candidate disposal sites will be generated from within the Buzzards Bay region, no inter-basin transfer of non-native nuisance species is anticipated.

7.5.2.3 Effects on Habitat Suitability

Habitat structural attributes vary with water depth, current, and tidal velocity; basin size and shape; and the diversity or complexity of substrate types. Examples of the diverse habitat types or physical structures typically found in marine and estuarine environments include, but are not limited to: depressions, sediment wave ripples, woody debris, submerged aquatic vegetation, shell beds, rock or cobble reefs, boulder fields and wrecks. Potential dredging and dredge material disposal activities alter these structural attributes resulting in dramatic change or homogenization of habitat structure by decreasing the stability of the substrate, creating a more uniform water depth, reducing habitat heterogeneity, reducing habitat area, and decreasing availability of cover.

Water Column

The release and convective descent of dredged material can result in physical, chemical and biological impacts to the water column. These impacts will be temporary and disappear relatively soon following the cessation of disposal. They include changes in turbidity, pH, and DO that will be limited in spatial extent (Refer to Section 7.2). However, using proper controls, these impacts will be minimized and no appreciable or permanent long-term changes to the salinity regime, tidal cycle, or current patterns will occur.

Benthic Substrate

Dredge material disposal may diminish benthic habitat attributes by changing the substrate composition (rendering the formerly suitable benthic substrate unsuitable for certain benthic organisms) or disrupting existing ecological processes or interactions between resident benthic and water column communities (Refer to Sections 7.4, 7.5.2.2).

Changes to the bathymetry of the disposal site will occur. The final elevation of the sediment surface at the disposal site will increase relative to the existing sediment elevation. Changes in the biotic and abiotic composition of the sediment surface within the candidate disposal sites are also anticipated. Disposal of dredged material within the candidate sites will temporarily eliminate existing biogenic structure such as algal mats, worm tubes, shell beds, etc. Changes to the abiotic composition of the benthos occur through a potential homogenization of sediment type in comparison to existing conditions. Sediment texture undergoes a series of changes. Existing sediments become covered by unconsolidated material that changes the existing surficial topography and microhabitat. The seafloor within the disposal site slowly begins to accumulate a layer of smaller fraction sediment such as silts, clays, and organic matter, forming a veneer.

Resultant impact to the biota that inhabit these areas or exploit these structures will vary based on the mobility, life history, and behavior of each particular species. For instance, sessile and slow moving invertebrate species and taxa are buried during sediment disposal at the candidate sites, eliminating potential feeding or spawning areas, or otherwise changing the specific habitat attributes favored by the species that use the area. In contrast, highly mobile species and taxa such as adult pelagic fish would likely avoid these disturbance areas and temporarily seek out other suitable areas of the Bay that are not disturbed.

However, since the candidate disposal sites lie within topographic depressions that appear to favor the long-term accumulation and retention of fine-grained (i.e., muddy) sediments, natural sedimentation will eventually create a return to the physical composition of the benthic surface similar to other recessed areas of the benthoscape within the area. Natural recolonization and succession will eventually restore the biogenic structure.

7.5.3 Summary of Direct and Indirect Impacts to Specific Finfish, Megainvertebrates, and Shellfish

This section summarizes the direct and indirect impact to specific finfish, megainvertebrates and shellfish of the project area and adjacent waters. Species found by Camisa and Wilbur (2002) to be numerically dominant or have substantial biomass contributions to the fish community sampled at the candidate disposal sites are discussed first in Section 7.5.3.1. The impact to any additional abundant or notable species identified within the northern deep and northern shallow water stratums of Buzzards Bay based on the trawl data set analysis provided by Maguire (2002a) are discussed in Sections 7.5.3.2 and 7.5.3.3, respectively. A cumulative list of these abundant species and their respective prey is provided in Table 7-6.

7.5.3.1 Abundant or Notable Candidate Disposal Site Species

Scup

Peak biomass for this species occurs in June, due to an inshore movement of adult fish that suggests the candidate disposal sites may have some role in the spawning of this species. Peak abundance in the Bay occurs from July to September and reflects the contribution from YOY. By fall, scup begin to migrate to deeper coastal waters, where they over-winter until returning to the Bay in the spring. With an open dredge material disposal window (i.e., disposal allowed) from November through March (Section 5.3), direct impacts to scup will be avoided. Therefore, resident scup populations are unlikely to be directly impacted by sediment disposal at either candidate disposal site. However, resident scup may be indirectly impacted by altered nursery and spawning habitat (see Sections 7.5.4 and 7.5.5, respectively).

Butterfish

This species frequents sandy substrate areas of the shallow Bay in the spring, and then migrates to deeper water in the fall. Camisa and Wilbur (2002) found butterfish to reside within and around the candidate disposal sites from the end of May to mid-December. Cross et al (1999) report that Massachusetts trawl data suggest that juvenile butterfish may remain as residents within Buzzards Bay in the winter. However, Camisa and Wilbur (2002) did not find butterfish in the Bay any later than mid-December, and abundance decreased markedly from October catches, especially for juveniles. Therefore, resident butterfish populations are unlikely to be directly impacted by sediment disposal at either candidate disposal site, given the likely time-of-year restrictions that will be established for the BBDS. However, resident butterfish may be indirectly impacted by altered nursery and spawning habitat (see Sections 7.5.4 and 7.5.5).

Long-finned Squid

This species is widespread throughout Buzzards Bay, and among the most numerically abundant megainvertebrate species within the candidate disposal sites. It migrates to deeper water in the fall. Camisa and Wilbur (2002) found long-finned squid within and around the candidate disposal sites from mid-May until the end of December at candidate site 1 and from mid-May to October at candidate site 2. Therefore, it is not likely to be substantially effected by disposal activities at either site, given the likely seasonal restrictions that will be established for the

Table 7-6. Abundant or notable fisheries resources at the candidate disposal sites and their respective prey.

Species	Life Stage	Likely Prey Species in Project Area	Source
Alewife (*Alosa pseudoharengus*)	Larva	Yolk sacks, plankton	Bigelow and Schroeder 1953
	Juvenile	Copepods, amphipods, shrimps;	
	Adult	Copepods, amphipods, shrimps; also small fish and fish eggs	
Atlantic butterfish (*Peprillus triacanthus*)	Larva	Undetermined	Cross et al. 1999
	Juvenile	Copepods, squid, amphipods, decapods, coelenterates, polychaetes, small fish, ctenophores	
	Adult	Copepods, squid, amphipods, decapods, coelenterates, polychaetes, small fish, ctenophores	
Atlantic mackerel (*Scomber scombrus*)	Larva	Copepods, fish larvae: yellowtail flounder, silver hake, redfish	Studholme et al. 1999
	Juvenile	Small crustaceans, such as copepods, euphausiids, amphipods, mysid, shrimp, and decapod larvae	
	Adult	Similar to juvenile but with selection of larger fish such as, euphausiid, pandalid, and crangonid shrimp	
Atlantic sea herring (*Clupea harengus*)	Juvenile	Selective opportunistic feeders, mostly copepods	Reid et al. 1999
	Adult	Euphausiid, chaetognaths, and copepods	
Bay anchovy *(Anchoa mitchilli)*	Larva	Yolk sack	www.chesbay.org
	Juvenile	Plankton	
	Adults	Plankton	
Black sea bass (*Centropristus striata*)	Larva	Zooplankton	Steimle et al. 1999a
	Juvenile	Small epibenthic invertebrates such as crustaceans	
	Adult	Benthic, near-bottom invertebrates, and small fish	
Blueback herring (*Alosa aestivalis*)	Larva	Plankton, chiefly copepods	Bigelow and Schroeder 1953
	Juvenile	Copepods and pelagic shrimp	
	Adult	Pelagic shrimp, sand lance and small fry of other fish species	
Bluefish (*Pomatomus saltatrix*)	Juvenile	Crustaceans, fish, and polychaetes	Fahay et al. 1999b
	Adult	Sight feed on other fish such as silversides, spot, and weakfish. Also eat shrimp, crabs, and worms	
Little skate (*Raja erinacea*)	Juvenile	Crabs, shrimps, worms, amphipods, ascidians, bivalves, squid, small fish (lance, alewives, herring, cunner, silverside, tomcod, silver hake)	Bigelow and Schroeder 1953
	Adult	Crabs, shrimps, worms, amphipods, ascidians, bivalves, squid, small fish (lance, alewives, herring, cunner, silverside, tomcod, silver hake)	
Long-finned squid (*Loligo pealei*)	Juvenile	Plankton, copepods, euphausiids, arrow worms, crabs, polychaetes, shrimp	Cargnelli et al. 1999b
	Adult	Clupeids, myctophids, squid larvae/juveniles, silver hake, mackerel, herring, menhaden, sand lance, bay anchovy, menhaden, weakfish, silversides	
Scup (*Stenotomus chrysops*)	Larva	Zooplankton	Steimle et al. 1999b
	Juvenile	Small benthic invertebrates, fish eggs and larvae	
	Adult	Benthic and near bottom invertebrates and small fish	
Summer flounder (*Paralichthys dentatus*)	Larva	Polychaete tentacles, harpactacoid copepods, and clams siphons	Packer et al. 1999
	Juvenile	Crustaceans, polychaetes, and invertebrate parts	
	Adult	Invertebrates, shrimp, weakfish, mysids, anchovies, squid, Atlantic silversides, herring, and hermit crabs	
Tautog *(Tautoga onitis)*	Larva	No data reported – small motile crustaceans speculated	Steimle and Shaheen 1996
	Juvenile	Pycnogonids, razor clam, decapods, amphipods, copepods, polychaetes, isopods	
	Adult	Bivalve and univalve mollusks, barnacles, crabs, sand dollars, scallops, amphipods, shrimp, isopods, lobster	
Weakfish *(Cynoscion regalis)*	Juvenile	Crabs and shrimp	Bowman et al. 2000
	Adult	Herrings, anchovies	
Windowpane (*Scophthalmus aquosus*)	Larva	Copepods and other zooplankton	Chang et al. 1999
	Juvenile	Polychaetes and small crustaceans such as mysids	
	Adult	Polychaetes, mysids, decapods, shrimp, hake, and tomcod	
Winter flounder (*Pseudopleuronectes americanus*)	Larva	Nauplii, invertebrate eggs, protozoans, polychaetes	Pereira et al. 1999
	Juvenile	Sand dollar, bivalve siphons, polychaetes, amphipods,	
	Adult	Amphipods, polychaetes, bivalves or siphons, capelin eggs, crustaceans	

BBDS. However, resident long-finned squid may be indirectly effected by altered nursery and spawning habitat (see Sections 7.5.4 and 7.5.5).

Bay Anchovy

Bay anchovy were found to occur within and proximal to the candidate sites from late June to early October, with a peak abundance occurring in mid-September (Camisa and Wilbur 2002). They were collected from each of the seven trawl sampling locations within the study area. However, they were not a significant part of the total abundance or biomass of the finfish community at each trawl sampling location due largely to the disproportionate contributions of scup and butterfish. Among the seven stations, bay anchovy were most abundant at trawl station 5 (769 individuals captured), where it was the third most abundant finfish species collected, yet comprised only 4.1% of the total abundance.

Based on the seasonal data provided by Camisa and Wilbur (2002), bay anchovy would not be resident within or proximal to the disposal site during the open dredge material disposal window from late-fall through mid-winter, and therefore would not be directly effected by dredged material disposal.

Bay anchovy are apparently not dependent upon any single type of benthic substrate, as they have been collected over a variety of bottoms including vegetated areas, soft mud, sand, silt and oyster bars (Munroe 2002). Due to their preference for plankton in the water column as their major food source, they are unlikely to be indirectly impacted by the loss of localized benthic invertebrate communities that may be covered during the disposal of dredged material.

Black Sea Bass

Black sea bass were found to be numerically abundant within or adjacent to the candidate disposal sites (trawl Stations 3 and 7) and provided a substantial contribution (20.6%) to the biomass of the catch taken at trawl Station 3. They move into coastal waters in southern New England during the first or second week of May and typically leave during late October and early November (Klein-MacPhee 2002a). This seasonal occurrence pattern was consistent with the findings of Camisa and Wilbur (2002), who caught black sea bass in trawls collected from within and adjacent to the candidate disposal sites from mid-May to mid-November. They found peak abundance to occur during August (352 individuals captured). Spawning is reported to occur in coastal Southern New England waters from summer through fall (Steimle et al. 1999a). Therefore, the anticipated dredged material disposal season would not coincide with the peak occurrence of black sea bass within or adjacent to the candidate disposal sites, and little direct impact to this species would occur. It is assumed that any individuals remaining in the area would flee the disturbance caused by the dredged material disposal.

Black sea bass are most abundant over hard bottom areas such as boulders, reefs, wrecks and around pilings of wharves, in waters at depths of less than 36 meters. In these locations they feed on a variety of crustaceans, fishes, mollusks and worms (Klein-MacPhee 2002a). Side-scan sonar and underwater video data collected from the fisheries trawl sampling lanes revealed that the majority of the bottom substrate within the candidate disposal sites consisted of soft mud, with limited areas of harder mud/sand bottom and few areas of boulders, rocks, and reefs (Maguire 2002d). Therefore, minimal indirect impact to this species due to loss of preferred habitat is anticipated.

Alewife

During the 13-month trawl survey, Camisa and Wilbur (2002) found alewife within the area of the disposal sites from late July to early October, with peak abundance (205 individuals captured) occurring in mid-September. They were absent from trawls collected from March to July 2001 and then from mid-October 2001 to March 2002, with the exception of one sampling date in mid-December, when 20 individuals were caught.

Based on the seasonal sampling data provided by Camisa and Wilbur (2002), the occurrence of this species within the candidate disposal sites is unlikely to coincide with disposal activities during the open dredge material disposal window from late-fall through mid-winter. Therefore direct impact to this fishery is not anticipated.

Alewife are known to feed either selectively on zooplankton snatched from the water column or non-selectively by filtering planktonic organisms using their gill rakers (Munroe 2002). Due to their dependency on plankton in the water column as their major food source, they are unlikely to be indirectly impacted by the temporary loss of localized benthic invertebrate communities that may be covered during the disposal of dredged material.

Weakfish

Weakfish were found within the disposal site and vicinity from late July to mid-September, with peak abundance occurring in early September. They are absent from the candidate disposal sites during fall, winter, and spring months. Among all seven trawl sampling stations, weakfish were found to be most abundant at Station 6 (within candidate site 2), where they made a substantial contribution to the total biomass.

Weakfish feed on a variety of prey species including shrimp, squid, ampipods and annelid worms. However, the chief component of their diet is other fish. Being pursuit predators of other fish, they are highly mobile and are likely to avoid direct impact from disposal activities by fleeing the area.

Weakfish have been reported to prey on a variety of fish species, especially those that are locally abundant (Klein-MacPhee 2002b). Within Buzzards Bay, these would likely include scup and butterfish, since both reach their peak abundance during the summer months (which is when weakfish appear within the region). Foraging on scup and butterfish, this species is likely not to be indirectly impacted by the loss of benthic invertebrates covered by dredged material at the candidate disposal sites.

Little Skate

Little skate was consistently found to be among the top five most numerically abundant species at each trawl sampling location during the Camisa and Wilbur (2002) study. However, due to the high numerical contributions of scup, butterfish, bay anchovy, and others, it was not among the top 3 species whose numerical contributions combined formed 95% of the total abundance.

Little skate inhabit offshore waters in the summer and move into the Bay during winter and spring. They are widespread throughout the Bay but reach greatest abundance within its southern half (Maguire 2002a). Little skate feed on invertebrates in sand, pebble, and mud substrates. Therefore, the candidate disposal sites provide suitable feeding areas. Camisa and Wilbur (2002) found little skate within the candidate disposal sites from early March through mid-June. As a demersal species inhabiting the bottom substrate, adults and young are susceptible to direct impact by burial or by physiological stress from increased suspended sediment generated during disposal activities.

Their eggs develop inside a tough leathery capsule, or egg case, which provides protection against abrasion from coarse bottom sediments. Little skate eggs that are indirectly impacted and not buried are likely to survive due to the durability of their casing. However, larvae hatching from eggs that are directly impacted by burial would likely not survive. Indirect impact to skate due to burial of feeding habitat is expected. Individuals frequenting the area would likely need to find alternative foraging areas in the vicinity. After cessation of dredged material disposal, recolonization of the affected seafloor habitat by benthic organisms would occur, and little skate would return to feed (Section 7.1.1.4).

Summer Flounder

A demersal species, summer flounder are present within the sandy mud substrate of both candidate disposal sites. This species moves to offshore waters in fall and early winter for spawning. Camisa and Wilbur (2002) found this species within and proximal to the disposal sites from mid-May to October-November. Therefore, adults are not likely to be exposed to dredged sediment disposal. As off-shore spawners, summer flounder eggs and larvae are unlikely to be directly effected by disposal activity within the Bay, nor will spawning grounds be effected by a change in habitat attributes (Refer to Sections 7.5.5). Juveniles may inhabit the Bay year-round. However, they prefer creeks, eelgrass beds, surf zones, and similar near-shore habitats like those that occur along the shoreline areas located east of sites 1 and 2 (Refer to Section 7.5.4). Therefore, impact to juvenile summer flounder populations will be minimal.

Smooth Dogfish

The smooth dogfish is a small coastal shark common to southern New England estuaries during the warmer months. Camisa and Wilbur (2002) caught smooth dogfish in trawls collected within and adjacent to the candidate disposal sites from May to mid-October, with peak numbers occurring during June and July tows. These small sharks frequent shallow water and muddy or sandy bottoms, where they feed on crustaceans and other invertebrates. Spawning occurs in coastal waters from May through July over most of the range and therefore would not coincide with the anticipated dredged material disposal season.

Spiny Dogfish

The spiny dogfish is another small coastal shark common to southern New England estuaries during the warmer months. Camisa and Wilbur (2002) caught this dogfish species from trawl Station 2 located within candidate site 1. At this trawl location, the biomass contribution of spiny dogfish (37.2%) exceeded that of any other single-species contribution. It was also detected at trawl Station 5 located to the east of candidate site 1. Like its conspecific, the smooth dogfish, Camisa and Wilbur (2002) found that spiny dogfish occur within and adjacent to the candidate disposal sites from May to mid-October, with peak numbers occurring during June and July tows. These small sharks frequent shallow water and muddy or sandy bottoms, where they feed on crustaceans and other invertebrates. Spawning occurs in coastal waters from May through July over most of the range and therefore would not coincide with the anticipated dredged material disposal season.

Winter Flounder

Camisa and Wilbur (2002) found winter flounder to occur at generally low abundance within and proximal to the disposal sites throughout the year. Abundance for this species was greatest from mid-March to mid-July, peaking during early April (58 individuals caught during the April 3 sampling date). By late July through December, abundance decreased substantially. The most winter flounder were detected at trawl survey Station 4 (which lies within candidate site 2), trawl Station 5, and trawl Station 7.

Since the site-specific trawl data revealed this species to be present within the candidate disposal sites year-round, some direct impact to individuals of this species is anticipated. Spawning within the region usually occurs in February and March, lasting into early spring, therefore direct impact to spawning individuals at the candidate disposal sites is not anticipated with an open disposal window from late fall through mid-winter.

The diet of the winter flounder is primarily comprised of worms, bivalves, crustaceans, snails, and mollusks (Pereira et al. 1999). Various species from these taxonomic groups were detected within the candidate disposal sites. To the extent that these organisms will be covered by the disposal of dredged sediment at the candidate disposal sites, winter flounder would be indirectly impacted due to the temporary loss of a food source. As these organisms begin to recolonize the disposal site, the food source they represent to winter flounder would return.

Striped Searobin

Striped searobin was found to occur within and proximal to the disposal sites from mid-May to mid-October, with a peak abundance occurring in June (Camisa and Wilbur 2002). This species was collected from each of the seven trawl sampling locations within the study area. However, it was not a significant part of the total abundance or biomass of the finfish community at each trawl sampling location, due largely to the disproportionate contributions of scup and butterfish.

Based on the seasonal data provided by Camisa and Wilbur (2002), the striped sea robin would not be resident within or proximal to the disposal area during the open dredged material disposal window from late-fall through mid-winter, and therefore it would not be directly affected.
Striped searobin are bottom or near-bottom feeders, where they consume a variety of prey including crustaceans, amphipods, mysid and crangon shrimp, annelids, cumaceans, crabs and megalops larvae, as well as a variety of mollusks, fish, and their eggs (Klein-MacPhee and McBride 2002). Disposal of dredged material at either of the two candidate sites would likely represent a localized and temporary loss of forage area for this species, until the surface of the disposal mounds were recolonized by benthic fauna.

Cunner

Cunner prefer near-shore habitat areas, including eelgrass or seaweed beds, rocky substrate, and man-made structures like pilings and wharves (Munroe 2002). They most likely retreat from these shallow water areas as water temperatures cool. Therefore, some cunner may seek out deeper water habitats with the onset of winter. Cunner were caught by Camisa and Wilbur (2002) within the candidate disposal sites and proximity, generally from January through April. Since cunner are closely associated with structure, fewer diposal-related impacts to this species would be anticipated at candidate site 1 than 2, since the latter lies adjacent to the western end of Gifford Ledge. Gifford Ledge is an area containing cobble or rock substrate, which may provide suitable habitat for cunner.

7.5.3.2 Abundant or Notable Northern Deep-Stratum Species

In the analysis of the long-term dataset from trawl surveys conducted over the period 1978 to 2000, Maguire (2002a) found distinct seasonal patterns (i.e., spring versus fall) in the abundance of finfish species within the northern, deep-water stratum (i.e., the 9120 stratum) of Buzzards Bay. This stratum is a physiographic subregion of the bay that includes the disposal sites. The seasonal assemblages are discussed below.

Spring Assemblage

Striped anchovy and Atlantic sea herring were found to be two numerically abundant species that concentrate in the spring within the northern, deep-water stratum of the Bay, proximal to the candidate disposal site. Other notable species (i.e., species with substantial biomass contributions) identified within the northern, deep-water stratum of the Bay in spring include black sea bass, tautog, and windowpane (Maguire 2002a). Striped anchovy and black sea bass were discussed in Section 7.5.3.1 above. The remaining species are discussed below.

<u>Atlantic Sea Herring:</u> Atlantic sea herring adults are found in open waters and bottom habitats. They generally prefer water temperatures below 10^{o} C (50° F), inhabit water depths from 20 to 130 meters (66 to 427 feet), and prefer salinities above 28 ppt. Atlantic herring adults use bottom habitats with gravel, sand, cobble or shell fragment and patches of aquatic macrophytes for spawning. However, spawning typically occurs outside of Buzzards Bay from July through November in well-mixed water, at depths between 20 and 80 meters (66 and 263 feet), in salinities ranging from 32 to 33 ppt, and in water with tidal currents between 1.5 and 3.0 knots

(NEFMC 1998). This species enters the Bay as migratory juveniles inhabiting the upper water column.

Camisa and Wilbur (2002) found Atlantic herring to occur within and proximal to the disposal sites during the winter and early spring (late January to April), with peak abundance (200 individuals caught) during April. They found sea herring to be absent in trawl samples collected during the late spring, throughout the summer, and during fall. Although not a significant part of the biomass or abundance of the finfish community, they were collected from each of the seven trawl sampling locations within and adjacent to the candidate disposal sites. Despite the known occurrence of Atlantic sea herring within and adjacent to the candidate disposal sites during the latter part of the open dredge material disposal window, no direct impacts to this species are anticipated. This is due to their fast swimming ability, which would allow them to flee rapidly the disturbance caused by the disposal scows and the descending sediment.

As facultative zooplanktivorous filter feeders (Munroe 2002), this species is not a direct benthic forager and therefore would not be indirectly impacted by the loss of benthic invertebrates covered by disposed dredged material. Due to its high mobility, seasonal occurrence, and preference for inhabiting the upper water column, little impact to this species due to dredged material disposal at the candidate sites is anticipated.

Tautog: This species occurs most abundantly in the shallow areas of the Bay from May through October. It spawns in spring in eelgrass beds. Tautog feed on invertebrates within or proximal to rocky habitats (Bigelow and Schroeder 1953), while juveniles are reported to frequent patches of drift algae (Able et al. 2002) in addition to eelgrass beds. Adults are likely to visit the candidate disposal sites as transient feeders, particularly in the vicinity of Gifford Ledge (site 2). The analysis of trawl data from 1978 to 2000 (Maguire 2002a) revealed that tautog were abundant and had substantial biomass contributions to the data set represented by data points to the northwest, west, and southwest of the candidate disposal sites. A data point coincident with candidate site 1 also revealed moderate biomass concentrations from tautog in the spring.

With respect to tautog, the analysis of the trawl data from 1978 to 2000 (Maguire 2002a) was consistent with the findings of Camisa and Wilbur (2002) during their 13-month trawl investigation. They found tautog among the top eight (4^{th}) species contributing 95% of the finfish biomass at trawl Station 1, located near the candidate disposal sites to the west. They found tautog to be present in trawls collected during every month but December and March.

These studies suggest that some individuals may be present within the vicinity of the candidate disposal sites and therefore be susceptible to direct impacts from disposal activities. Impacts to spawning would be avoided by seasonal limitations of disposal activities (Refer to Section 7.5.5).

Windowpane*:* A DMF trawl data location coincident with candidate site 1 revealed a high catch per unit effort and spring biomass for this species relative to other locations within the northern, deep-stratum (Maguire 2002a). In the long-term DMF fall surveys, windowpane catch per unit effort and biomass at this same data location was zero. The windowpane has a preference for colder waters. Adults inhabit sandy and muddy substrates in waters less than 15 meters in depth during the spring, and less than 30 meters depth in winter. They are typically collected from waters ranging in temperature from 0 to 26.8° C. Their preference for cooler water is reflected in their seasonal occurrence patterns in New England waters. The windowpane can be found in nearshore waters during the early and late months of the year when the water temperatures are cold. They were caught in trawls by Camisa and Wilbur (2002) from April to July, with peak occurrence (15 individuals captured) during a June sampling run. Windowpane were also caught again later in the season from October to March of the following year. No windowpane were caught during the months of warmest water temperature, as this species most likely seeks out cooler, deeper waters during the summer. Some individuals may be present within the vicinity of the candidate disposal sites and therefore be susceptible to direct impacts from disposal activities.

Fall Assemblage

Blueback herring, bluefish, northern searobin, weakfish, and striped anchovy were reported to be relatively abundant in the northern, deep-water stratum of the fall bay-wide trawl surveys from 1978 to 2000 (Maguire 2002a). These species generally reach peak abundance in late summer or early fall and will not be as abundant in the bay during the open dredged material disposal window from late-fall through mid-winter.

<u>Blueback herring:</u> Blueback herring are resident anadromous fish species known to move through Buzzards Bay each season while in transit to and from the various freshwater streams within the Buzzards Bay drainage basin. In the 1978 to 2000 dataset, one data point representing a relatively high catch per unit effort in the fall was located at the western edge of the former Cleveland Ledge Disposal Site, which is proximal to the candidate disposal sites (Maguire 2002a).

Camisa and Wilbur (2002) found this species to occur at all trawl stations located within and proximal to the candidate disposal sites from late May to mid-July. Peak abundance occurred in late June (247 individuals captured). From early August to mid-September, only one to three individuals were caught per tow at all seven stations combined. They were collected from each of the seven trawl sampling locations within the study area. Among the seven stations, blueback herring were most abundant at Station 5. However, they were not a significant part of the total abundance or biomass of the finfish community here or within the project area as a whole, due to the proportionately larger contributions to biomass and abundance provided by scup and other species.

Based on the seasonal sampling data provided by Camisa and Wilbur (2002), the occurrence of this species within the candidate disposal sites is unlikely to coincide with disposal activities during the open dredge material disposal window from late-fall through mid-winter. Therefore, direct impact to this fishery is not anticipated.

As a particulate-feeding planktivore, blueback herring are known to feed selectively on zooplankton (ctenophores, copepods, amphipods, mysids and other shrimps) snatched by sight from the water column (Munroe 2002). Due to their dependency on plankton in the water column as their major food source, they are unlikely to be indirectly impacted by the loss of localized benthic invertebrate communities that may be covered during the disposal of dredged material.

Bluefish: Bluefish spawn offshore, and both adults and juveniles enter Buzzards Bay waters from July through September, with peak densities typically occurring in August. The analysis of trawl data from 1978 to 2000 (Maguire 2002a) revealed a high fall catch per unit effort and significant biomass contributions to the dataset from a data point to the west of the candidate disposal sites. Camisa and Wilbur (2002) found bluefish to be most abundant during trawl sampling in September. They found the highest bluefish abundance and biomass contributions at trawl Station 4 located within candidate site 1. However, due to their seasonal occurrence and high mobility, impacts to bluefish from dredged material disposal are not anticipated.

Northern searobin: Northern searobin are benthic marine, adventitious, summer visitors to Massachusetts bays (Avayzian et al. 1992). They typically frequent smooth hard bottom and are found less often on mud or about rocks (Bigelow and Schroeder 1953). This species begins leaving coastal areas in October with the onset of colder water temperatures. In the analysis of trawl data from 1978 to 2000, Maguire (2002a) found northern searobin to be relatively abundant to the west of the candidate disposal sites.

Camisa and Wilbur (2002) collected no northern searobins during their trawl survey after mid-November. Therefore, the peak season for northern searobin occurrence will have passed before the anticipated start of the dredged material disposal season. As a result, direct impact to this species is not anticipated. However, indirect impact could occur at the candidate disposal sites due to changes in substrate composition if mud is deposited over the smooth hard sand bottom areas preferred by the northern searobin.

Weakfish: Weakfish are essentially summer residents in shallow (e.g., less than 20 meters) coastal waters. The analysis of trawl data from 1978 to 2000 revealed one data point coincident with the southeast corner of candidate site 2, where fall CPUE of weakfish was substantially higher than other areas of the Bay (Maguire 2002a). This is likely due to weakfish exploiting food sources associated with the shallows of Gifford Ledge.

Within candidate site 2, Camisa and Wilbur (2002) found weakfish to be the fourth numerically abundant fish out of a total of 51 species collected in trawls from that location. The total number of weakfish (563) collected during the 13-month trawl survey was dwarfed by the high numerical abundance of scup (16,102) and butterfish (6,756), which collectively comprised 95% of the total abundance of finfish at candidate site 2 (i.e., Station 6) during the 13-month survey (Camisa and Wilbur 2002). However, weakfish were among the top ten species (4th) that comprised 95% of the total biomass collected at candidate site 2 (i.e., Station 6) during the 13-month survey. Their abundance and biomass contributions are impressive, given the fact they were only collected from mid-August to mid-September during the 13-month survey. Given their high mobility and their limited seasonal occurrence within the Bay outside of the anticipated open dredged material disposal window, no direct impacts to this species are anticipated.

Weakfish are opportunistic feeders. Adults can be found near the surface (i.e., depths less than 30 feet) of the southern New England coast, where they feed on small menhaden (Bigelow and

Shroeder 1953). Young weakfish are more dependent on bottom-associated prey like shrimp and other small crustaceans (Bigelow and Shroeder 1953). Since weakfish prefer shallow water habitats and exploit fairly mobile prey, impacts to their foraging habits from dredged material disposal at either candidate site are expected to be limited. However, since this species has been demonstrated to be most abundant within proximity of Gifford Ledge, selection of candidate site 1 over candidate site 2 may be preferable to avoid and/or minimize potential impacts.

Striped Anchovy: The striped anchovy spawns in nearshore waters during the summer months, after which it moves to deeper water in the winter. The analysis of trawl data from 1978 to 2000 (Maguire 2002a) revealed large concentrations of striped anchovy in the Bay in fall within the northern deep sub-stratum. These concentrations occurred to the southeast and proximal to the candidate disposal sites. Camisa and Wilbur (2002) reported few catches of this species (i.e., only one individual caught during a June trawl and two during October trawls). Therefore, it is anticipated that this species would not be prevalent in the Bay during the anticipated disposal season in late autumn and early winter.

7.5.3.3 Abundant Northern, Shallow-Stratum Species

Species identified as abundant in the shallow-water stratum of the northern reach of the Bay based on the long-term trawl data analysis (Maguire 2002a) were also abundant in the deeper water proximal to the BBDS, based on the site-specific trawl surveys conducted by Camisa and Wilbur (2002; see Section 5.2.2). These species include black sea bass, bay anchovy, bluefish, butterfish, long-finned squid, northern sea robin, scup, summer flounder, tautog, windowpane and winter flounder.

7.5.3.4 No-Action Alternative

Through selection of the no-action alternative, any finfish, shellfish, and megainvertebrate species that may exploit the area of the candidate disposal sites in late fall and early winter will not be subjected to potential direct impact by dredged material disposal. Species that depend on the existing benthic environment would not be indirectly impacted by the temporary loss of habitat attributes that may serve to make either candidate site attractive as a nursery or spawning area (see Sections 7.5.4 and 7.5.5). Likewise, the water column above both sites will continue to support pelagic species (such as juvenile Atlantic mackerel and long-finned squid) that are found in the bay waters during late fall and through the winter.

7.5.4 Impact to Nursery Potential

7.5.4.1 Candidate Disposal Sites

Use of Buzzards Bay waters as a nursery for marine fish was confirmed for many species by the capture of juvenile fish in the trawl surveys, including YOY and 1+ year juveniles (see Section 5.2.5). In the DMF long-term dataset, trawls from the deep-water regions of the northern part of the Bay yielded the most abundant catches of juveniles of the following species: YOY bluefish in the fall, spring post-larval Atlantic herring, spring juvenile scup, and fall juvenile winter flounder (Maguire 2002a). The more recent 13-month trawl survey that focused specifically on candidate sites 1 and 2 demonstrated that both areas have high nursery potential for juvenile fish, especially scup, Atlantic butterfish, long-finned squid, Atlantic herring, bay anchovy, black sea bass, blueback herring, northern searobin, and weakfish (Camisa and Wilbur 2002).

Candidate site 2 has a greater heterogeneity of substrate types. This site is in close proximity to Gifford Ledge and the historical disposal mound, two prominent topographic features that provide habitat heterogeneity. Although still some distance from nearby shoreline resource areas, candidate site 2 is also in closer proximity to eelgrass beds and salt marsh habitat areas along the West Falmouth shoreline - two additional habitat types that have high nursery potential. Both sites are characterized by small-scale biogenic features (i.e., microtopography) that contribute to nursery potential by providing cover to larval fish and juvenile megainvertebrates. These features include shell beds, macroalgal mats, worm tubes, feeding mounds and depressions, and other features. While the differences between candidate sites 1 and 2 cannot be quantified with the available data, it appears that the more diverse habitat at candidate site 2 provides nursery areas for additional finfish species. In addition, since it is closer to nearby eelgrass bed nursery areas along the shoreline, candidate site 2 may be utilized more extensively as a feeding area for certain fish species, like cunner, that migrate from the eelgrass nursery areas to deeper water for feeding. The trawl survey results for candidate site 1 also provided substantial evidence of the use of this area by YOY fishes, suggesting that suitable nursery habitat exists at this location.

Therefore, disposal of dredged material at either candidate disposal site would have a temporary direct impact upon the nursery potential of these sites, due to the loss in diversity of substrate composition and the burial of biogenic structures such as algal mats, shell beds, and invertebrate castings.

7.5.4.2 No-Action Alternative

With the selection of the no-action alternative, the areas within the candidate disposal sites that were identified as having high nursery potential for juvenile fish would continue to possess their attractive habitat attributes, especially for those species with demersal- or near-bottom-dwelling larval and juvenile stages such as scup, long-finned squid, black sea bass, and northern searobin.

7.5.5 Impact to Spawning

The presence of mature adults and their known preferred substrate types, as well as the presence of prolific, healthy benthic invertebrate populations representing a significant food source, together support the characterization of the candidate disposal sites as potential spawning habitat for various fish species (see Section 5.2.6). As discussed in Section 7.5.1, the species with the greatest potential to spawn within the area of the candidate disposal sites are black sea bass, butterfish, long-finned squid, scup, tautog, windowpane, and winter flounder. Of these species, winter flounder have the highest susceptibility to the various direct and indirect impacts associated with dredged material disposal, since they have a benthic egg stage (see Section 7.5.1).

7.5.5.1 Direct Impact

Avoiding impacts to the larvae and eggs of various spawning fish species forms the basis for the restrictions on dredging and disposal activities from mid-January or February through May in much of New England, depending on the resident spawning fisheries resources within any given area. The remaining species spawn later in the spring or during summer months, with black sea bass spawning as late as the end of October. Therefore, direct impact to spawning times of all these species will be avoided by establishing a closed dredge material disposal window (i.e., no dredge material disposal allowed) from April through October.

7.5.5.2 Indirect Impact

Indirect impact to spawning could occur through changes to the benthoscape, as many fish species favor various substrate types for spawning. For each fisheries resource identified as having the potential to spawn within the candidate disposal sites, a discussion of potential indirect impacts to their spawning potential is provided below. The relative importance of each site to these fisheries resources is identified.

Black Sea Bass

Steimle et al. (1999a) report that black sea bass spawn over sand bottoms broken by ledges in water depths at 20 to 50 meters (Table 5-11, Section 5.2.6). This habitat feature was identified within candidate site 2 (Maguire 2001c and 2002d). Therefore, candidate site 2 was considered to contain suitable spawning habitat for black sea bass (see Section 7.5.5), assuming season and temperature requirements are present. However, the disposal of the estimated 20-year volume of dredged material could render the site unfavorable for black sea bass, due to a change in water depth from an average of 14 meters to an average of 11.6 meters. In addition, should the predominantly sand substrate areas in the vicinity of Gifford Ledge be buried with silty dredged material, the favored substrate for potential spawning black sea bass would be eliminated.

Butterfish

Butterfish have no known substrate requirements for spawning (Cross et al. 1999). They spawn within the water column at a depth of 0 to 4 meters, and therefore their spawning habitat would not be susceptible to impacts from dredge material disposal.

Long-finned Squid

Long-finned squid spawn at depths of less than 50 meters. Their demersal eggs attach to rocks and small boulders on sandy/muddy bottoms and on aquatic vegetation such as *Fucus* sp., *Ulva*, *Laminaria*, and *Porphyra* (Cargnelli et al. 1999). The presence of red algal mats within the disposal sites was detected in the side-scan sonar surveys (Maguire 2002d). Therefore, there may be some limited potential for indirect impacts to long-finned squid spawning, since dredged material could bury some of the benthic structures to which long-finned squid eggs attach. As a result, until certain aquatic vegetation reappears, the relatively limited amount of area within each candidate site affected by disposal would likely not provide habitat attributes suitable for spawning of this species.

Scup

Scup spawn over weedy and sandy areas at depths of less than 10 meters (Steimle et al. 1999b). Most of the area within the candidate disposal sites therefore may be too deep for scup to spawn. However, the shallower and sandier areas at the northern end of site 1 may provide some potential spawning habitat. Changes to bathymetry at this location would not alter the scup spawning depth requirement. However, should predominantly silty material be deposited at this location, the marginal spawning habitat could be rendered unsuitable until winnowing by tidal currents over time removed fines and thus re-armored the benthoscape by exposing sand and shell fragments.

Tautog

Tautog spawn over hard bottom sites, however, the greatest abundance of eggs are found in eelgrass vegetated sites (Steimle and Shaheen 1999). In addition, many viable eggs have been found to be buoyant. Spawning occurs within these habitats at depths of 25 to 35 meters. Since the distribution of hard bottom substrate is limited, and eelgrass beds do not occur, candidate site 1 is likely unsuitable spawning habitat for tautog. However, limited areas of candidate site 2 (i.e., in the vicinity of harder bottom substrate areas in the southwest corner) may offer marginal spawning habitat. The predicted change in bathymetry at candidate site 2 due to dredged material disposal and the resultant burial of hard substrate would further reduce the suitability of candidate site 2 as tautog spawning habitat.

Windowpane

Windopane spawn on or near the bottom over sand substrates in waters less than 30 meters depth (Chang et al 1999), but adult fish are also known to inhabit muddier habitat in the Gulf of Maine (Bigelow and Schroeder 1953). A change in bathymetry following dredged material disposal at the candidate sites will not indirectly impact windowpane in the long-term. However, temporary indirect impacts could affect windowpane should predominantly sandy substrate areas be covered with silty dredged material at either site. Winnowing of the sediment surface by tidal current action atop disposal mounds in shallower areas may re-armor these areas by exposing sands over time.

Winter Flounder

Winter flounder are known to spawn over a variety of substrates, including sand, muddy sand, mud, and gravel. Sand is the most-common spawning habitat, especially for inshore populations at depths of two to five meters (Periera et al 1999). Therefore, the anticipated changes to the bathymetry and substrate composition at the candidate disposal sites would not render the existing habitat unsuitable for winter flounder spawning.

Although they were not represented as one of the dominant species in terms of number or biomass in the vicinity of the candidate disposal sites (based on the site-specific trawl surveys summarized in Section 5.2.2), winter flounder constitute an economically important fishery species in the area. They are bottom spawners with demersal eggs that stick to benthic substrates, rendering them susceptible to burial from dredged material disposal. In Buzzards Bay, they spawn from mid-February through April in Massachusetts waters, and the eggs hatch in about 15 to 18 days (Bigelow and Schroeder 1953). Juveniles exhibit strong site fidelity, not straying too far from their spawning grounds. By fall, adults return to spawning areas, where they remain during the winter unless forced to retreat to deeper water due to extreme winter conditions (e.g., cold temperatures, ice, etc.).

7.5.5.3 No-Action Alternative

With the selection of the no-action alternative, the areas within the candidate disposal sites that were identified as having high spawning potential for various fisheries resources would continue to possess the habitat attributes that adult fish require for spawning grounds, especially those that are dependent on the existing substrate types and biogenic structure of the disposal sites. These species include, in particular, black sea bass, long-finned squid, scup, and tautog.

7.5.6 Impact to Shellfish

7.5.6.1 Candidate Disposal Sites

Shellfish are sessile or exhibit low mobility and as a result are susceptible to burial by dredged material. They also may be adversely affected by an increase in suspended solid concentrations in the water column.

Burial impacts would be limited to the relatively limited bottom area covered by dredged material under a typical disposal scenario. Shellfish currently of high or potentially high economic importance within or proximal to the candidate disposal sites (i.e., conch, quahog, ocean quahog, Atlantic surf clam) are not rapid colonizers of disturbed areas. Therefore, the return of an established population of harvestable individuals to areas of the candidate disposal sites affected by dredged material disposal may require several years.

Additional impact would be expected from elevated near-bottom turbidity during and immediately after disposal of the material. The short-term elevation in TSS concentrations has the potential to effect sessile filter-feeding shellfish adversely, as the animals ingest the sediment or, more likely, temporarily cease feeding until the plume dissipates. The potential impacts associated with increased turbidity and settling of material within and beyond the disposal sites is expected to be minimal. The area immediately east of Cleveland Ledge has been used on an on-going basis for disposal of material dredged to maintain the Cape Cod Canal; negative effects from the disposal of this relatively sandy material on the scallop or other shellfish industries have not been documented. Turbidity plumes at the proposed BBDS are expected to be of short duration and limited extent beyond the disposal site boundaries (Section 7.2) and will result in only small quantities of sediment settling outside the immediate vicinity of the disposal location (Section 7.1). Therefore, direct impacts to shellfish resources at each of the candidate sites would be limited, and secondary effects to nearby resource areas associated with either site would be negligible. Nevertheless, a conservative recommendation favors candidate site 1 over candidate site 2, based on proximity to the potential scallop sets coincident with and north of the northern edge of the former CLDS.

7.5.6.2 No-Action Alternative

If the no-action alternative is selected, the area of the candidate disposal sites is expected to continue supporting various shellfish resources, including conch, quahog, ocean quahog, and Atlantic surf clam.

7.5.7 Impact to Lobster

7.5.7.1 Candidate Disposal Sites

Potential impacts to lobsters in and near the candidate disposal sites include direct burial and exposure to elevated concentrations of suspended sediment during disposal events. Adult lobsters are somewhat capable of avoiding disturbance areas (e.g., descending sediment clouds) and have the ability to migrate up through sediment deposits if buried (Maurer et al. 1982b; Nichols et al. 1978).

Both adult and juvenile lobsters utilize soft-bottom habitats (Berrill and Stewart 1973, Berrill 1974, Botero and Atema 1982, Normandeau Associates Inc. 2000). However, soft silt/mud substrates like those which characterize most the area encompassed by the two candidate disposal sites, are typically not the preferred habitat for adult lobster (Hudon 1987; Wahle and Steneck 1991). Therefore, lobster density within the disposal sites is expected to be relatively low. The trawl sampling effort at seven locations within and proximal to the candidate disposal sites produced only two lobsters during 20 sample periods spanning 13 consecutive months (Camisa and Wilbur 2002). This suggests that lobster populations are probably not robust throughout the year within or proximal to the candidate disposal sites.

Some commercial lobstering reportedly occurs in the area of candidate site 2 and other regions of the former CLDS in July (Maguire 2002b). Disposal of dredged material in Buzzards Bay would only occur during the open season from November through March, and therefore would not coincide with the summer months of peak commercial lobstering activity (see Section 7.6).

The existing substrate at candidate sites 1 and 2 may provide habitat for juvenile lobsters. Circular openings observed at the sediment surface at candidate site 2 (Station 6) in the video survey were identified as potential juvenile lobster burrows (Maguire 2002d). Because of the presence of lobsters in the area surrounding the candidate disposal sites, individuals would be expected to migrate into areas affected by dredged material disposal. Such movement has been recorded at the New London Disposal Site in eastern Long Island Sound (NOAA 1975) and at the 12-mile Dumpsite in the New York Bight (Wilk et al. 1995). Therefore, long-term impacts to the regional lobster population are predicted to be negligible, as the disposal mounds could provide suitable habitat areas for juvenile lobsters. Secondary effects to adjacent areas consist of short-term and highly localized turbidity impacts (Section 7.2) and the potential for negligible settlement of material beyond the disposal site boundaries (Section 7.1).

7.5.7.2 No-Action Alternative

If the no-action alternative is selected, the area of the candidate disposal sites will continue to provide limited habitat for lobsters, especially at candidate site 2.

7.6 Impact to Essential Fish Habitat and EFH-Designated Species

EFH for 20 Federally-managed species and their various life stages has been designated within the area of Buzzards Bay that includes the candidate disposal sites. However, not all of these species were found within the candidate disposal sites during the DMMP studies. Table 7-7 lists the species and their life stages for which EFH is designated within the project area. The findings of the two DMMP studies are also summarized in Table 7-7 for comparison. The table shows that haddock and American plaice were not collected in either of the candidate disposal sites during the 13-month trawl survey. Haddock juveniles and adults are most likely not present in significant numbers in the northern portion of Buzzards Bay, hence the EFH designation in the vicinity of the disposal sites is only for eggs and larval stages (see Section 5-3). Highly mobile/migratory EFH-designated species such as Atlantic mackerel, king mackerel, Spanish mackerel, cobia, sandbar shark, and bluefin tuna were not collected during 13-month trawl survey (Camisa and Wilbur 2002). However. these fast-moving species that may have easily avoided capture in the otter trawl gear, or else they occur at such low abundance or density within the project area that they were not encountered during sampling.

Various non-designated species that are important prey for EFH-designated species were found to occur within the disposal sites during the 13-month trawl sampling. Examples include menhaden, anchovies, various anadromous fish, and Atlantic silversides. The larvae and young of many EFH-designated species are prey to other EFH-designated species as well (see Table 7-6 and Bowman et al. (2000)).

Disposal of suitable dredged material at either of the candidate sites may cause short-term impacts to both water column (pelagic) and seabed (benthic) habitats and the EFH-designated species that inhabit these zones. However, the impacts from increased turbidity and sediment deposition are anticipated to be negligible in the long-term. Avoidance and minimization of impacts (Section 9.0) and adherence to the SMMP presented in Section 11.0 ensure that the magnitude and extent of any impacts to EFH and designated species at BBDS would be minimal.

Details of the expected impacts to water-column and benthic habitats are discussed throughout this document, specifically within the EFH Assessment (Appendix C) that is summarized below.

7.6.1 Water Column (Pelagic) Habitat Impact

Pelagic species are those species that inhabit the water column, regardless of the bottom structure or habitat type of the sediment surface below. Changes to the water column environment would not impact the salinity or temperature regimes that define the pelagic component of the EFH. However, ephemeral impact to water quality (e.g., impact lasting only hours after an individual disposal event) is anticipated. Contact with released dredged material during the convective descent phase may directly affect pelagic species or certain groundfish with pelagic life stages that inhabit the water column.

Of the 20 species and their life stages for which EFH has been designated within the project area (Table 7-7), the following are considered pelagic species and therefore are primarily associated with the open-water environment: Atlantic sea herring, bluefish, king mackerel, Spanish mackerel, cobia, sandbar shark, and bluefin tuna. Butterfish and long-finned squid are associated with both pelagic and benthic habitat zones. An additional ten of the benthic species are known to have at least one life stage that is pelagic, and therefore susceptible to adverse effects in the water column associated with dredged material disposal.

Table 7-7. EFH species and species life stage designated for EFH quadrant coincident with project area, with comparisons to the findings of two DMMP studies.

EFH Species	Species Life Stage Designated for EFH Quadrant Coincident with the Project Area	Carey and Haley (2002) Spring and Fall Findings (1978-2000)			Camisa and Wilbur (2002) Findings (2001-2002)		
		site 1	site 2	Elsewhere in 9120 N Strata	site 1	site 2	All Stations Combined
Atlantic cod (*Gadus morhua*)	ELJA	Spring, at unspecified location(s) within the Bay			Apr-Jun	Apr-Jun	Mar-Jun
Haddock (*Melanogrammus aeglefinus*)	EL	Not reported			Not reported		
Red hake (*Urophycis chuss*)	LJA	Spring and Fall. Unspecified locations			Not found	Jun, Aug	Apr-Aug, Dec
Winter flounder (*Pseudopleuronectes americanus*)	ELJA	Spring, Fall	Fall	Spring (JA) Fall (JA)	All months	Jan, Apr-Sep	Nov-Aug
Windowpane (*Scophthalmus aquosus*)	ELJA	Spring		Spring Fall	Mar-Jul; Oct-Jan	Jun	Mar-Jul; Oct-Jan
American plaice (*Hippoglossoides platessoides*)	JA	Fall, at unspecified location(s) within the Bay			Not reported		
Atlantic sea herring (*Clupea harengus*)	JA			Spring	Jan-Apr	Dec; Feb-Apr	Dec-Apr
Bluefish (*Pomatomus saltatrix*)	JA	Fall		Spring	May, Jul; Sep-Oct	Jul-Oct	May-Oct
Long finned squid (*Loligo pealei*)	JA	Spring, Fall	Fall	Spring, Fall	May-Dec	May-Oct	May-Dec
Atlantic butterfish (*Peprilus triacanthus*)	ELJA	Fall	Fall	Spring, Fall	May-Dec	May-Dec	May-Dec
Atlantic mackerel (*Scomber scombrus*)	ELJA	Spring, at unspecified location(s) within the Bay			Not Found	Not Found	July
Summer flounder (*Paralichthys dentatus*)	ELJA	Fall	Fall	Spring (JA) Fall (JA)	May-Nov	Apr-Oct	Apr-Nov
Scup (*Stenotomus chrysops*)	ELJA	Spring, Fall	Fall	Spring (A) Fall (JA)	May-Oct	May-Oct	May-Oct
Black sea bass (*Centropristus striata*)	LJA	Spring, FALL	Fall	Spring (A) Fall (J A)	May-Nov	May-Nov	May-Nov
Surf clam (*Spisula solidissima*)	JA	Not reported			Not reported		
King mackerel (*Scomberomorus cavalla*)	ELJA	Not reported			Not reported		
Spanish mackerel (*Scomberomorus maculatus*)	ELJA	Fall, at unspecified location(s) within the Bay			Not reported		
Cobia (*Rachycentron canadum*)	ELJA	Not reported			Not reported		
Sandbar shark (*Charcharinus plumbeus*)	A	Not reported			Not reported		
Bluefin tuna (*Thunnus thynnus*)	J	Not reported			Not reported		

KEY: E = Egg; L = Larva; J = Juvenile; A = Adult

The pelagic species and life stages included in the EFH designation (see Table 7-7) include:

- Atlantic cod – eggs and larvae are pelagic, juvenile and adult life stages are demersal but may follow prey up to the surface (Klein-MacPhee 2002c);
- Haddock – eggs and larvae are pelagic, with juveniles becoming benthic after five to six months (Klein-MacPhee 2002c);
- Red hake – larvae are pelagic for their first months, becoming demersal at a length of 25 to 30 milimeters (Klein-Macphee 2002c);
- Winter flounder – larvae are pelagic, while eggs, juveniles and adults are benthic (Klein-MacPhee 2002d);
- Windowpane – eggs are pelagic, larvae settle to the bottom after obtaining a length of 10 mm (Able and Fahay 1998);
- American plaice – young plaice are pelagic up to the time of metamorphosis, sinking deeper as they grow. Adults may rise off the bottom to feed and are known to move about in the water column (Klein-MacPhee 2002d);
- Butterfish – eggs, larvae, and some juveniles are pelagic (Able and Fahay 1998). Other juveniles and adults occur near the bottom, especially in winter and early spring (Klein-MacPhee 2002e);
- Summer flounder – eggs are pelagic, larvae become benthic even before transformation is complete, although they may still swim up into the water column to take advantage of tidal stream currents for transport (Able and Fahay 1998);
- Scup – eggs and some larvae are pelagic, early juveniles descend to the bottom at 15 to 30 milimeters (Able and Fahay 1998); and,
- Black sea bass – eggs and larvae are pelagic, juveniles demersal (Able and Fahay 1998).

As part of the monitoring studies associated with dredging of the Thames River, with subsequent placement of the sediment at the open-water NLDS in Long Island Sound, chemical measurements suggested that only minor and transient alterations in water column chemistry occurred during hopper discharges of the dredged material. As expected, the redox potential (Eh), pH, turbidity, dissolved oxygen, and suspended solids all showed some seasonal variations, but there were no consistent patterns detected that could be related to the NLDS disposal activities (NOAA 1975; 1977). The dissolved oxygen concentration in near-bottom waters only decreased 30%, returning to pre-discharge levels in less than 40 minutes (NOAA 1975; 1977). The pH was reduced very slightly after a hopper discharge, but returned to pre-discharge values in less than 30 minutes. Surface turbidity in the barge wake quickly disappeared. Suspended solids increased dramatically in near-bottom waters following a hopper discharge, but returned to background values in less than 33 minutes (NOAA 1975). Occasionally there were transient and slight increases in total organic carbon within 1.6 kilometers (1 mile) of the dumping buoy (NOAA 1975). Water column currents appeared to aid in the dissipation of any significant chemical effects.

Given the rapid movement of most of the dredged material to the bottom during the convective descent phase, and the relatively high currents in the water column over the BBDS, the water column effects of hopper discharge would disperse rapidly, and ambient conditions would return soon after cessation of disposal. The average depth of the water column will change somewhat, since material disposed at the BBDS would create mounds that rise from the existing sediment surface. This slight change may render spawning habitat within some areas of the candidate sites less suitable to some EFH-designated species with very specific depth requirements. At the same, the depth change may enhance spawning habitat for other species (see Section 7.5.5).

Other potential water quality impacts include inadvertent discharges of water produced from dewatering of the sediment in the barge during transport, as well as uncontrolled or accidental loss or release of oil or other regulated materials from the barges due to improper equipment operation or malfunctions. Dewatering is likely to occur primarily at the point of dredged sediment generation and will be subject to controls pursuant to state water quality permit conditions, such as the stipulation that all equipment must be functioning properly and maintained in good working condition. All vessels could be required to have in effect a spill prevention and management plan, which would specify actions to be taken to prevent or rectify accidental releases of regulated materials stemming from engine oil leaks, hydraulic hose failures, etc.

Noise generated from vessel operations and activity within a disposal site may cause fish to flee the area. This is an ephemeral impact, since fish would return to the areas soon after vessel operations ceased. Most open-water disposal sites are subject to vessel traffic from a variety of interests, including commercial and recreational fisherman, pleasure craft, etc. The noise disturbance associated with past disposal activity at the BBDS and CLDS has had no reported or detected impacts on the use of this area as a productive habitat by a variety of finfish species, as demonstrated by past observations and the results of the 13-month trawl survey conducted in support of this DEIR (Camisa and Wilbur 2002).

A few of the EFH species are expected to be present within the Bay during the anticipated open dredged material disposal season of November through March. Imposition of a seasonal dredging and dredged material disposal "window" is an example of avoidance mitigation. The sensitive egg and larval life stages of even fewer designated species are present at this time (Figure 5-31). Therefore, temporary impacts to the water column environment due to disposal-induced turbidity would have little impact to most EFH-designated species.

7.6.2 Bottom (Benthic) Habitat Impact

Disposal of sediment at either of the candidate sites may change the physiography (e.g., elevation, particle size, surface roughness, sorting characteristics) of the benthoscape. Suitable dredged material released at the BBDS would be matched with ambient seabed sediment to the extent practicable, as required by the SMMP (Section 11.0). A decrease in immediate habitat heterogeneity would occur by reducing topographical gradients, filling troughs and voids, and covering of hard substrate, biogenic structures, and other features that add to the diversity of habitat type within the benthoscape of the candidate disposal sites (see Section 7.5). EFH-designated species most susceptible to the impacts of these changes include those that feed, spawn or are otherwise dependent on the benthic habitat for all or part of their life cycle.

Of the 20 species and their life stages for which EFH has been designated within the project area (Table 7-7), the following are considered benthic species and therefore, are primarily associated with the habitats of the bottom environment: Atlantic cod, haddock, red hake, winter flounder, windowpane, American plaice, summer flounder, scup and black sea bass. As previously indicated, butterfish and long-finned squid are associated with both pelagic and epibenthic habitat zones. Among the pelagic species for which EFH has been designated coincident with the candidate disposal sites, Atlantic sea herring is one species that has a demersal life stage. The eggs of this species attach to bottom substrate. while larvae and further developed stages are all pelagic (Munroe 2002). However, spawning does not occur within Buzzards Bay and therefore, eggs and larvae are not found there. Hence, the EFH designation in the area only applies to the pelagic juvenile and adult stages.

The Atlantic surf clam is the only sessile invertebrate for which the candidate disposal sites lie within designated EFH. Howes and Goehringer (1996), reporting on recreational and commercial shellfish landings in Buzzards Bay from 1977 to 1990, could find no DMF data for surf clam landings from 1977 to 1982. In 1983, 7,348 kilograms of surf clams were harvested commercially, and none were reported harvested recreationally. In 1984, 44,144 kilograms were harvested commercially, and 1,497 were taken in recreational harvest. From 1985 to 1990, none were reported taken for commercial harvest, while totals reported for recreational harvest fluctuated, ranging from 272 to 1,497 kilograms depending on the year. These statistics show that surf clam landings are highly variable and not a major component of the commercial shellfish industry. This species appears to represent an underexploited shellfish resource within the Bay.

Due to their immobility, direct impact to this resource could occur via burial or from the adverse effects associated with elevated suspended sediment concentrations. However, the disposal sites occupy a relatively small area within the EFH 10 minute by 10 minute grid, and the potential impact would be limited to those individuals within the disposal footprint during any given season. Furthermore, it is possible that this species does not even occur within either of the candidate disposal sites: it was not included on the comprehensive list of species collected in the DMF trawls in Buzzards Bay from 1978 to 2000 (Maguire 2002a) nor was it caught by Camisa and Wilbur (2002) during their 13-month trawl survey of the candidate disposal sites.

Re-colonization of the benthic community will occur through various means. Some benthic infauna can survive burial by dredged material by migrating vertically back up to the surface within hours (Maurer 1982a and b). Other fauna will immigrate from contiguous source areas, or settle as larvae on the new substrate. At the Central Long Island Sound Disposal Site, Rhoads et al. (undated) observed that a sand cap with trace silt was colonized by the same organisms (primarily polychaetes and bivalves) as a nearby site that consisted of a silt cap. Results of ecological monitoring at the NLDS in eastern Long Island Sound under the DAMOS program have demonstrated the success of recolonization of capped disposal mounds by benthic organisms soon after deposition of material. The monitoring revealed that higher-order successional communities were detected on the surface of disposal mounds within three to five years of final capping (SAIC 2001b; Valente and Fredette 2002).

Therefore, the loss of invertebrate infaunal prey will be a minor, temporary, short-term impact until the infaunal community is naturally re-established. The re-colonization of the disturbed areas would likely progress in successive stages, with dominant species varying over time. Although exact community assemblages are hard to predict to species level, the life history attributes and functional organism-sediment relationships are typically predictable (see Pearson and Rosenberg 1978; Rhoads et al. 1978; Rhoads and Germano 1982 and 1986; McCall 1977). The exact species composition of the community is not as important as the sequential appearance of specific functional groups during the process of infaunal succession (Rhoads and Germano 1986).

7.6.3 Mitigation

A discussion of applicable avoidance and minimization strategies is provided in Section 9.0. Avoidance options are the most effective approach to prevent impacts to EFH-designated species and their prey. Avoiding critical times of year (e.g., greatest abundance, biomass, occurrence of sensitive life stages, and spawning of a majority of EFH species) is the most effective technique to limit impacts to this resource. Establishment of an open dredged material disposal window from November to March is important to avoid the occurrence of most EFH species and their sensitive life stages within the candidate disposal sites (see Section 5.3, and the EFH Assessment in Appendix M). Monitoring dredged material releases to control turbidity (Section 11.0) will also be helpful to control or reduce the potential impact of excessive turbidity on EFH-designated species.

7.6.4 No-Action Alternative

Selection of the no-action alternative would result in the candidate disposal sites contining to provide EFH for the appropriate life stages of the designated EFH species known to present.

7.7 Rare and Endangered Species

Use of the candidate disposal sites by rare and endangered species is limited. Such species are more likely to utilize the coastal habitats that occur along the shoreline roughly 2 km to the east of the candidate sites, including sandy beaches, intertidal and shallow subtidal flats, salt marsh complexes, and submerged aquatic vegetation. Changes in bathymetry within either site due to disposal activities will result in only minor, localized effects on circulation and sediment transport (Section 7.1) that should not impact conditions in the nearshore areas to the east.

Water column impacts from increased turbidity during disposal (Section 7.3) will be limited to no more than approximately 1,100 meters beyond the eastern boundary of candidate site 2. Within this distance, which is 340 meters from the shoreline at Chappaquoit Beach (Figure 5-34), the modeling predicts a return to background TSS concentrations within four hours following a disposal event. These estimates are based on relatively conservative model assumptions. Based on these results, it is not likely that increased turbidity following a disposal event will affect the nearshore areas in closest proximity to the candidate sites (Section 7.2).

The LTFATE model simulations indicated that there would be no significant transport of sediment outside either candidate site once it was deposited in stable mounds on the bottom, even under the most extreme conditions on record for the bay for the last 18 years (Hurricane Bob). Therefore, disposal activities in the vicinity of the candidate sites should not have any appreciable effect on the habitat quality and behavior/success of rare and endangered species utilizing the coastal areas in the vicinity of the candidate sites.

Motile species that use the open water areas of the Bay and possibly transit the candidate disposal sites include the following Federally threatened or endangered sea turtles: loggerhead, Kemp's ridley, green, and leatherback. Whales are much less likely to occur in Buzzards Bay. Additionally, the disposal sites do not provide the preferred feeding areas for these species. According to the NMFS, sea turtles are most likely to be found in New England waters during the summer months, when dredging and disposal activities will not occur. There is the possibility for only an occasional, rare occurrence of a sea turtle or marine mammal in Buzzards Bay during the times of year when disposal activities occur.

The SMMP (Section 11) includes the stipulation that a trained and certified marine mammal observer (MMO) may be required to be onboard the disposal vessel during transit to and from the site, depending on time of year, consultation with relevant Federal and state agencies, and other project-specific considerations. The responsibility of the MMO is to ensure avoidance of injury to any endangered/protected sea turtles or marine mammals that may be present at or near the BBDS at the time of disposal operations. If any sea turtles or marine mammals are sighted within one-quarter mile of the BBDS marker buoy, no release of dredged material will be allowed to occur until the animals have exited the site, or an alternative disposal location within the site is selected.

7.8 Wildlife

As described in Section 5.5, sea birds and waterfowl are the main wildlife utilizing the open waters of the Bay in the vicinity of the candidate disposal sites. Sightings of sea turtles, whales, porpoises, and dolphin are rare in the Bay. These animals are usually capable of avoiding disposal activities. Harbor seals prefer exposed rocky outcrops and islands and therefore would not inhabit the area within either candidate disposal site. Sea birds and waterfowl may seek prey fish and shellfish in the shallower areas near Gifford Ledge, just outside the eastern boundary of site 2. Within site 2, disposal activities in the basin west of Gifford Ledge are expected to temporarily increase turbidity and thereby reduce visibility for diving waterfowl around the Gifford Ledge. Use of this disposal site in winter, when many waterfowl species are most abundant in the Bay, may potentially effect the quality of their feeding grounds at Gifford Ledge, otherwise there are no differences between sites 1 and 2 in the potential effects of disposal activities on wildlife.

7.8.1 Avifauna

7.8.1.1 Shorebirds

Intertidal mud flats, salt marshes, and beaches are important shorebird feeding habitats. Since no tidal flats are located close to the candidate sites, impacts to shorebird habitats from suspended sediments or covering of feeding areas via siltation are expected to be negligible. No loss of shorebird breeding habitat (e.g., salt marsh, sand or cobble beach) will occur from dredged material release within either of the candidate disposal sites.

7.8.1.2 Seabirds

Depending on the species, seabirds such as gulls and terns forage in a variety of marine habitats, including open waters, along beaches, on tidal flats, in salt marshes, or within a combination of these habitats. Certain species are well-adapted to human activity and may forage in urban environments, but almost all nest in colonies on offshore islands, except the least tern (*Sterna antillarum*). The least tern often nests on barrier beaches attached to the mainland. However, since its breeding habitat lies far from the influence of the disposal site activity, no impact is expected. Temporary, localized impacts to open foraging areas above the disposal sites are expected, but would occur outside the time of year when least terns occur within Buzzards Bay.

Some species of pelagic seabirds (Order Procellariiformes) have been known to nest on smaller islands in the Elizabeth Island chain, but otherwise spend most of their life far offshore, and rarely enter the Bay (Peterson 2002). Since placement activities will not impact the island habitats of the bay, there will be no impact to pelagic seabirds inhabiting the region.

7.8.1.3 Waterfowl

Since the proposed candidate disposal sites lie within subtidal areas, marine-dwelling waterfowl that feed within intertidal zones or within protected bays, creeks and inlets will not be affected. Various species of waterfowl that frequent Buzzards Bay (e.g., loons, grebes, and ducks) reach their greatest concentrations in winter. Depending on their feeding guild, these waterfowl congregate in areas of abundant food supply proximal to submerged aquatic vegetation, shellfish beds, and areas where marine fish congregate, such as rocks, ledges and reefs. Sight-feeding piscivorous waterfowl such as loons, grebes, cormorants and mergansers are expected to follow feed-fish away from the areas of increased turbidity during dredged sediment release, since feeding success for these species is at least in part dependent upon unimpeded visibility. Because the increase in disposal-related turbidity is a short-term phenomenon, finfish and piscivorous waterfowl would be expected to return quickly to an effected area (Table 7-8). Therefore, the temporary impact to piscivorous waterfowl foraging habitat is expected to be negligible. However, diving waterfowl that feed primarily on benthic marine invertebrates and that are capable of reaching depths that exist within the disposal sites would lose foraging habitat for a longer duration.

7.8.1.4 Diving Waterfowl

The burial of the benthic marine invertebrate community will eliminate existing concentrations of marine molluscs that inhabit portions of the benthic environment within the footprints of the candidate disposal sites. This loss of potential feeding habitat for diving molluscivorous waterfowl will persist until areas effected by disposal are re-colonized by benthic organisms.

7.8.1.5 Principal Waterbird Colonies

No sites identified as principal waterbird colonies on the Massachusetts coast by Veit and Petersen (1993) are located within or proximal to the disposal sites. Therefore, dredged material disposal at either site will not have any negative impacts on the principal nesting waterbird or seabird colonies of Massachusetts.

7.8.2 Reptiles

Sea turtles, and the diamond-back terrapin, an estuarine species that reaches the northern limit of its range in Massachusetts, are not an integral part of the marine fauna of Buzzards Bay and are rarely seen in the bay. Any effect on the water column from sediment disposal will not extend to the open ocean where sea turtles live, nor to salt marshes where terrapins live. Therefore, disposal of dredged material at either of the candidate disposal sites will not have any negative impacts on marine reptiles.

Table 7-8. Diving waterfowl known or expected to winter in Buzzards Bay, their state status, diving depths, and marine food.

Species Name (Scientific Name)	MA Status (Veit and Petersen, 1993)	Diving Depth	Marine Foods (Terres, 1980)
Common Loon (*Gavia immer*)	Rare and local breeder. Common to very common migrant at the coast; uncommon inland; uncommon winter resident.	Up to 60.96 meters (200 feet).	Salt water fishes-rock cod, flounders, sea trout, herring etc. crayfishes, shrimps, crabs, amphipods, snails, leeches, grogs, salamanders, and aquatic insects.
Red-throated Loon (*Gavia stellata*)	Common to abundant migrant. Uncommon to rare winter resident; very rare in midsummer.	8.84 meters (29 feet) Has been caught in fishnets 21.34 meters (70 feet) below water.	Sculpins, capelin, codfishes, gunnel, sand lances, brook trout and sticklebacks; also shrimps, leeches, snails, aquatic insects, and aquatic plants.
Horned Grebe (*Podiceps auritus*)	Uncommon to very common migrant and winter resident. Abundance varies considerably from year to year.	1.5-7.6 meters (5-25 feet)	Small fish: carp, darters, anchovies, silversides, perch, gizzard shad, sculpins, sticklebacks, squawfishes: also crayfishes, amphipods, prawns, sand shrimps, opossum shrimp
Red-necked Grebe (*Podiceps grisegena*)	Erratic; occasionally very common to abundant migrant; uncommon winter resident in coastal waters. Rare to uncommon inland.		Sticklebacks, herring, pilchard, sculpins, top minnows, eels, Shrimps, mollusks, aquatic worms, and vegetable matter.
Gannet (Morus bassanus)	Abundant migrant and winter resident offshore.	15.24 meters (50 feet)	Mackerel, herring, pollack, garfish, haddock, whiting, and gurnard.
Great Cormorant (*Phalacrocorax carbo*)	Rare breeder. Common to very common migrant and winter resident. Occasional and increasing inland in small numbers.		Sculpins, haddock, cod, flounders, gurnards, herring; also crustaceans-spider crabs, shrimps.
Double-crested Cormorant (*Phalacrocorax auritus*)	Abundant breeder and migrant; rapidly increasing. Rare but increasingly regular in winter.	1.5-7.6 meters (5-25 feet)	Grunnel, sculpins, sand launces, capelin, herring, flounders, tomcod, eels, butterfish, blenny, Pollack, sea perch, wrasses, drum, sea catfish, gizzard shad, toadfish, skipjack, sticklebacks, crustaceans such as spider crabs, amphipods, shrimps, mollusks, and sea worms.
Common Merganser (*Mergus merganser*)	Rare breeder. Common to abundant migrant and winter resident.	Expert diver	minnows, killifishes and sticklebacks, eels, shrimps, and other small crustaceans, snails and other mollusks, leeches, worms, and the roots and stems of aquatic plants.
Red-breasted Merganser (*Mergus serrator*)	Rare breeder. Very abundant migrant and abundant winter resident on Cape Cod and the Islands; less numerous elsewhere along the coast and uncommon inland.		Minnows, sticklebacks, killifishes, carp, suckers, crayfishes and marine crustaceans.

Table 7-8. continued.

Species Name (Scientific Name)	MA Status (Veit and Petersen, 1993)	Diving Depth	Marine Foods (Terres, 1980)
Hooded Merganser (*Lophodytes cucullatus*)	Uncommon and local breeder; fairly common migrant, most numerous in the fall. Uncommon but regular in winter on Cape Cod and the Islands.	Expert diver/swimmer	Some fish, crustaceans, snails and other mollusks, and roots and seeds of aquatic plants and some grain.
Common Goldeneye (*Bucephala clangula*)	Very common to abundant migrant and winter resident on the coast; common migrant inland.	up to 6.1 meters (20ft) or more.	shrimp-like crustaceans, and seeds, tubers, and vegetative growth of pond weeds, wild celery and seeds of spatterdock, mud crabs, saltwater snails, mussels, hermit crabs, rock crabs, and others.
Barrow's Goldeneye (*Bucephala islandica*)	Uncommon winter resident on the coast and rare migrant inland.		crustaceans, and some plant food such as pondweeds; also small fishes; mollusks, blue mussels, periwinkles and other gastropods, sea urchins, starfishes, and marine worms.
Bufflehead Duck (*Bucephala albeola*)	Abundant migrant and winter resident on the coast; fairly common migrant inland.		shrimp-like amphipods, small fishes, seeds of pondweeds and naiads, and other water plants, bulrushes, etc.; shrimp and other small crustaceans and shellfishes, and snails.
Oldsquaw (*Clangula hyemalis*)	Abundant migrant and locally abundant winter resident; rare migrant inland.	Taken in fishing nets at depths of 54.9-70.0 meters (180-200feet)	Blue mussels and other bivalve and univalve mollusks; amphipods, shrimps, grounds eats roots, leaves, buds, and seeds of aquatic plants, and some fishes.
King Eider (*Somateria spectabilis*)	Uncommon to rare but regular winter resident on the coast.	Taken in fishing nets at depths of 45.7-54.9 meters (150 –180 feet)	Mollusks - mussels, periwinkles, moon shells, whelks, oyster drills, limpets, etc.; crustaceans such as king crabs, cancer crabs, hermit crabs, and amphipods, and among echinoderms, sand dollars, sea urchins, starfishes, brittle starts, sea cucumbers, etc.; also sea anemones, plant foods such as eelgrass, widgeon grasses, and algae.
Common Eider (*Somateria mollissima*)	Several recent breeding records in Buzzards Bay and Boston Harbor. Very abundant migrant and winter resident off Cape Cod and the islands; locally common to abundant elsewhere along the coast.	10.7-18.3 meters (35-60feet)	Mussels, clams, and other bivalves, whelks and other gastropods; also starfishes, sea urchins, and other echinoderms; crustaceans such as crabs and amphipods and some fishes, and marine worms, etc.

Table 7-8. continued.

Species Name (Scientific Name)	MA Status (Veit and Petersen, 1993)	Diving Depth	Marine Foods (Terres, 1980)
Greater Scaup (*Aythya marila*)	Common to abundant migrant and winter resident, greatly outnumbering Lesser Scaup throughout most of the state in all seasons.	6.1 meters (20feet)	small fishes, plant foods such as seeds of sedges, wild rice, water milfoil, and pondweeds, sea lettuce, eelgrass, wild celery, widgeon grass, mollusks such as oysters, clams, scallops, mussels, dog whelks, periwinkles, limpets, oyster drills, etc. Also crabs, barnacles and other crustaceans.
Lesser Scaup (*Aythya affinis*)	Fairly common to locally abundant migrant and winter resident.	Can feed at depths of 4.6-6.1 meters (15-20 feet), but typically dive 1.5-1.8 meters (5-6 feet).	Seeds of pondweeds, widgeon grass, wild rice, sedges, bulrushes; also snails and other mollusks, small shrimp-like crustaceans, and aquatic insects.
Black Scoter (*Melanitta nigra*)	Abundant migrant and uncommon to fairly common winter resident on the coast; uncommon migrant inland.	Typically 7.6 meters (25 feet) but can dive further	Mussels, clams, oysters, scallops, periwinkles, limpets, dog whelks, oyster drills, chitons, and others; such crustaceans as barnacles, shrimps, mud crabs, cancer crabs, hermit crabs, crayfishes, and others, also some fishes, eelgrass, muskgrass, and other algae, millet seeds, corn and other grains, aquatic insects, duckweed, pondweed, blue flags, water milfoil, bladderwort and other aquatics.
Surf Scoter (*Melanitta perspicillata*)	Common spring and abundant fall migrant and uncommon winter resident on the coast; rare migrant inland.	1.8 - 9.1 meters (6-30 feet)	Mussels, rock and razor clams, periwinkles, oysters, scallops, sand and mud crabs, hermit crabs, some fishes, sea urchins and sand dollars, marine worms and eelgrass, and widgeon grass, aquatic insects-larvae of caddis flies, damselflies, dragonflies, beetles, water boatmen, and others, muskgrass and other algae, seeds of sedges and bulrushes.
White-winged Scoter (*Melanitta fusca*)	Abundant migrant and winter resident on the coast; rare migrant inland.	7.3-12.2 meters (24-40 feet)	Mussels, oysters, scallops, hard and soft-shell clams, razor clams, *Macoma* shells, surf clams, cockleshells, dog whelks, moon shells, rock crabs, mud crabs, hermit and spider crabs, amphipods and barnacles, sand dollars, sea urchins, and starfishes, crayfishes, and small shrimp-like crustaceans, aquatic insects, some fishes-minnows sculpins, and gizzard shad, some plant foods-pondweeds, bur reeds, and other aquatics.

7.8.3 Marine Mammals

As discussed in Section 5.5.2, the marine mammals of the region, with the exception of the harbor seal, are rarely found in the vicinity of the candidate disposal sites and, therefore, they will not be negatively affected by disposal activities. Furthermore, the sheltered and undisturbed rocky ledges preferred by harbor seals will not be affected by disposal operations. In addition, seals are very mobile and easily able to avoid the limited area of the Bay affected by placement activity.

7.8.4 No-Action Alternative

If the no-action alternative is selected and neither of the two candidate sites is selected for future disposal activities, the wildlife resources of the area, including endangered species, will not be affected.

7.9 Wetlands and Submerged Aquatic Vegetation

As described in Section 5.5, there are no coastal wetlands or salt marshes within at least 2,000 meters of the candidate disposal sites in Buzzards Bay. Water depths at the candidate sites preclude any eelgrass growth, and the site nearest to the shoreline (candidate site 2) is located approximately 1,200 meters from the closest mapped eelgrass beds (Figure 5-34). Based on the STFATE model results presented in Section 7.3, suspended material entrained in the water column and transported shoreward after a disposal event will reach background concentrations before it has any impact on the submerged aquatic vegetation in the vicinity of the mapped eelgrass beds.

Additionally, based on the calculation provided in Section 7.3, the fine-grained sediment that remains suspended in the water column during disposal would, upon settlement, amount to an almost imperceptible accumulation on the sediment surface. This indicates that even if a portion of the turbidity plume passed over the eelgrass beds, the temporary increase in suspended sediment load would be comparable to normal fluctuations in TSS experienced regularly in the Bay and would thus constitute a negligible impact. In summary, there are no perceived differences between candidate sites 1 and 2 in terms of the potential impacts of disposal activities on wetlands and submerged aquatic vegetation.

7.9.1 No-Action Alternative

If the no-action alternative is selected, the wetland and submerged aquatic vegetation resources of the area would be expected to remain in their present state.

7.10 Impact to Commercial and Recreational Finfishing, Shellfishing and Lobstering Resources

7.10.1 Finfishing

The analysis of recreational and commercial harvesting activities presented in Section 6.1 indicated the potential for conflicts with finfishing in the vicinity of the candidate disposal sites. Some recreational fishing is conducted by boats in the area encompassed by the candidate disposal sites, but the preferred areas for recreational anglers are the waters around Cleveland

Ledge and north to the Cape Cod Canal. Some interference with recreational angling may occur in the vicinity of the designated disposal site in the fall. Of the angling activities described in Section 6.1, charter boats fishing for scup and tautog in September and October, smaller specialized charters utilizing the shoreline areas off West Falmouth and north to the Cape Cod Canal, and the more limited larger-scale charter (Head Boat) operations in the fall, could potentially overlap with the active disposal season at the designated site. Of these, the scup and tautog charters are most likely to be utilizing areas in the immediate vicinity of the candidate disposal sites.

Potential impacts to fishing vessels from disposal activities consist of the potential need to relocate and/or use other waters to avoid interference with barge activities. Given the relatively limited size of the disposal site, this will not constitute an appreciable impact for recreational and commercial anglers, particularly if sport species avoid disposal activities.

Potential conflicts with commercial harvesting activities in the bay consist primarily of fixed scup pots in the "5-acre area", located immediately west of candidate site 1, at the southwestern corner of CLDS (Figure 6-4). This potting activity will be most prevalent in the summer, but may overlap with disposal activities in the fall, prior to scup migration to deeper waters during the onset of winter. The other prominent commercial finfishing activities, including the striped bass fishery and the mosquito fleet, occur in the summer months when disposal activities have been suspended.

7.10.2 Shellfishing

As described in Section 5.2.8, areas within or in the vicinity of the candidate disposal sites may be utilized for recreational and commercial conch pots and scallop harvest. Harvesting of quahogs, soft shell clams, oysters, and blue mussels occurs shoreward of the candidate sites and would be unaffected by disposal activities.

Conch pot activity occurs in deeper water areas of the Bay and could include candidate disposal sites 1 and 2 (Figure 6-4). Because it is conducted from mid-April through mid-December, with peak activity from August to November, potting on the disposal sites will conflict with fall disposal activity. Disposal activities may interfere with pot setting over a relatively limited portion of the deeper-water Bay areas used for placing pots. Therefore, any loss of this area to potting activity represents a localized impact. It is a temporary loss of opportunity to those conch fishers who pot the area of the disposal sites.

A potential scallop set area was identified around Cleveland Ledge (Figure 6-5), north of the candidate disposal sites (Maguire 2002b). The muddy substrate in the basin areas of candidate sites 1 and 2 are less suitable scallop habitat, so alteration of the substrate at the disposal sites will not appreciably impact these scallop sets or harvests. Harvesting occurs throughout the winter months and could potentially be affected, if conditions in a particular year favor sandy areas within and around the candidate sites. Generally, the heavy usage of the area farther north, and the fact that disposal activities have been occurring in that northern region by the USACE (for disposal of Cape Cod Canal material), indicates that disposal activities in the designated site are unlikely to have an appreciable impact on the scallop sets or potential harvest.

7.10.3 Lobster Fishing

The lobster habitat within the candidate disposal sites is sub-optimal (refer to Section 5.2.7). Camisa and Wilbur (2002) found only two lobsters during trawl sampling within the candidate disposal sites. However, suitable lobster habitat and commercial lobstering exists in the vicinity of Cleveland Ledge and Gifford Ledge, (Figure 6-4). Recreational lobstering during the summer months will not be threatened by disposal events of the colder season. Commercial lobster fishers that traditionally pot the vicinity of Gifford Ledge in the fall would be impacted by disposal events at candidate site 2. These lobster fishers would need to move their gear outside the affected disposal area to avoid loss from disposal-related vessels. In doing so, they may be successful in catching lobsters displaced by dredged material disposal. The NAE has indicated that candidate site 2 would be less well-suited to the increased barge traffic accompanying its use for dredged material disposal, due to potential conflict with lobstering activities in the vicinity of Gifford Ledge (personal communication, F. Donovan, USACE-NAE, 2002). As a conservative recommendation, candidate site 1 would be preferred over candidate site 2 because it is located farther from lobster resource areas around Cleveland Ledge and Gifford Ledge.

7.10.4 No-Action Alternative

If the no-action alternative is selected, the area of the candidate disposal sites would continue to support the habitat attributes that currently attract the finfish species identified as important to commercial and recreational angling and their associated industry. However, failure to designate a regional open-water disposal site for Buzzards Bay limits berthing space of adequate draft for commercial and recreational fishers' boats.

7.11 Historic and Archaeological Resources

There is no knowledge of any historical shipwrecks in the vicinity of candidate sites 1 and 2, and side-scan sonar surveys of the sites have not provided evidence of any surface features that could be associated with a shipwreck. Historical disposal activities have deposited dredged material over a broad region of the substrate in the vicinity of sites 1 and 2, and natural sedimentation processes continue to deposit fine-grained material in the basin areas of both sites. Although this area of the bay was used historically for navigation, and there are potential hazards to navigation in the vicinity (Cleveland Ledge to the north and Gifford Ledge to the east), the sites are located in an area of the bay that is well-protected from the brunt of open-ocean conditions. The map of identified wrecks in the bay area (Figure 6-8) indicates that they are primarily located outside the bay and in the areas around the Elizabeth Islands, with the northern-most wreck located roughly in the center of the bay. Therefore, it is unlikely that shipwrecks would be identified in the vicinity of candidate site 1 and site 2. However, more detailed investigations, involving magnetometer and sub-bottom surveys, would be required to confirm this.

7.11.1 No-Action Alternative

If there is no action, candidate sites 1 and 2 will remain in their present condition, with no impacts to historical and archeological resources.

7.12 Navigation and Shipping

This section provides an evaluation of potential interference with existing navigation in the vicinity of the candidate sites, which includes commercial vessels transiting to and from the

Cape Cod Canal and both recreational and commercial boaters. It also provides an evaluation of the navigation and safety concerns associated with dredges and disposal scows navigating in and around the disposal site.

7.12.1 Interference with Navigation in the Vicinity of the Sites

Based on the projected volume of dredged material to be disposed at the site, and assuming material is transported for disposal scow having a capacity of 2,000 cy, there will be a maximum of approximately 53 disposal roundtrips to the site each year, or 106 trips if considered as both an approach and return transit. This constitutes roughly 1% of the total number of trips reported for the year 2000 for the Cape Cod Canal (8,829 trips for all types of vessels combined, Table 6-1 and Section 6.5). Disposal trips will only occur during a limited time of year to protect marine resources (e.g., November through March). For evaluation purposes, if the vessel traffic in Table 6-1 is assumed to occur uniformly throughout the year, the total number of all trips during a 5-month disposal season would be 3,678 trips, and 106 disposal barge trips represents approximately a 3% increase in vessel traffic in the vicinity.

Based on historical and on-going disposal activities in the area, and the relatively small number of vessel trips in relation to the total volume of vessel traffic in the region, the continued use of a disposal site in the vicinity of the approach channel to the Canal will minimally impact existing navigation and shipping in Buzzards Bay. A proposal to relocate the approach channel roughly 700 meters east of the current location will bring the channel closer to candidate sites 1 and 2. This channel relocation will allow adequate distance to prevent interference due to disposal activities. A tank vessel passage area through Buzzards Bay required by NOAA and recommended by DEP directs vessels to within just over two-tenths of a nautical mile of candidate disposal site 1 at the nearest point (see Section 6-5, Figure 6-9). Tank vessels will be advised of any dredged material disposal activities through the Notice to Mariners announced by the US Coast Guard. Disposal activities at candidate site 1 are not expected to interfere with tank vessel traffic within the restricted area. Impacts on recreational boat traffic in the BBDS area also will be negligible, because disposal activities will not occur during the summer months when recreational boating is most prevalent.

7.12.2 Navigation Considerations at the Candidate Disposal Sites

Candidate sites 1 and 2 offer different navigational access for disposal-related vessel traffic. Candidate site 1 is bordered by minimum water depths of approximately 11 meters, consisting of relatively flat, sandy areas to the west. The waterway south of site 1 consists of relatively, flat, deeper-water areas, with water depths generally consistent with the depth of the basin in site 1 (13 to 14 meters).

Roughly the southern third of candidate site 2, on the other hand, is located in immediate proximity to Gifford Ledge to the east, the historical disposal mound immediately west, and a natural, east-west trending ridge to the south. These shallow features occur directly along the boundaries of candidate site 2. The minimum depth of Gifford Ledge is approximately 3 meters, and the minimum depth of the historical disposal mound is approximately 8 meters. The shallow ridge to the south has a depth of 11 meters. The basin that lies between these features, with maximum depths exceeding 16 meters, provides the most suitable portion of candidate site 2 for disposal of dredged material. The substrate in the northern portion of site 2 is shallower and has coarser texture; it likely experiences more energetic wave and current conditions than the southern trough area.

Water depth and proximity to hazards to navigation must be considered for disposal activities, in conjunction with tide stage and weather conditions. Hopper dredges draw approximately 7.6 meters (25 feet), and disposal scows draw approximately 4.6 meters (15 feet). They also need room to maneuver during disposal activities. Therefore, it is unlikely the southern portion of candidate site 2 would be deemed to have safe access, given the proximity of the prominent, shallow features immediately bordering the site.

In contrast, access to site 1 from the north is wide open, from either the existing or relocated Cape Cod Canal approach channel and along the western side of CLDS, avoiding the BBDS, the historical disposal mound, and Gifford Ledge. Candidate site 1 affords unrestricted access (adequate water depths and lack of obstructions to navigation) from all other directions.

7.12.3 No-Action Alternative

If the BBDS, through state designation, is not utilized in the future for disposal, and cost-effective, open-water disposal options for projects generating suitable dredged material in the Buzzards Bay area are not allowed, then area maintenance and planned improvement dredging projects may not be undertaken. Historical rates of sediment accumulation will continue and navigation channels, anchorage areas, turning basins, marine terminals, marinas and boat ramps in the Cape Cod Canal and local municipal harbors will continue to become shallower because of siltation. Berthing and navigation will become increasingly difficult in the harbors, compromising regional economic development.

7.13 Land Use, Special Area Designations and Cape and Islands Sanctuary

There would be no direct negative impacts to land use in Falmouth and in the Special Area Designation, the Bourne Back River Estuary (Section 6.6.3), as a result of disposal activities at either of the candidate disposal sites. The Cape and Islands Ocean Sanctuary will receive only short-term impact from disposal events within the either site. According to 302 CMR 5.08(4.), any project authorized under M.G.L. c. 91, including channel and shore protection projects and navigation aids, shall be allowed, but only if it is not otherwise prohibited by 302 CMR 5.00, if it has received all required Federal and/or state approvals and if the approving agency also finds that the project is one of public necessity and convenience. The NAE has permitted disposal of suitable dredged material within the Cape and Islands Ocean Sanctuary as recently as 2002. Suitable dredged material permitted and disposed in accordance with the SMMP described in Section 11.0 is not considered a “physical structure” or waste. Short-term impacts from disposal events will be limited to the area of the disposal site and will not negatively impact the Cape and Islands Ocean Sanctuary.

Disposal activities will be limited to slightly increased vessel traffic, from barges and scow transiting to and from the site and from vessels involved in scientific monitoring activities at the site and nearby reference areas. The recreational activities of residents and visitors along the Falmouth and West Falmouth shorelines (Section 6.6.1) are unlikely to be noticeably compromised. There are no perceived differences between candidate sites 1 and 2 in terms of impacts on Falmouth land use. In particular, elevated TSS concentrations will return to background levels well before any disposal plumes reach the shoreline. Therefore, use of either of the candidate disposal sites will not have any negative impact on adjacent land conditions.

7.13.1 No-Action Alternative

If there is no action, land use and the special area designation will remain unaffected.

7.14 Air Quality and Noise

7.14.1 Air Quality

Air quality impacts from the disposal of dredged material at the candidate disposal sites in Buzzards Bay are expected to be minor and temporary. Impacts will result from the operation of tugboat engines and from the potential escape of odors from temporary storage of dredged material on barges (e.g., hydrogen sulfide).

Under the Enhanced Emissions and Safety Test (310 CMR 60.02), tug boats and dredge scows used in dredging are not required to undergo an emissions inspection because the boats are not defined as motor vehicles. Emissions from disposal activities are managed through the use of proper controls on diesel engines under the guidance of the Massachusetts Diesel Retrofit Program. All towing equipment is strongly encouraged to be equipped with proper air pollution control equipment and mufflers.

The Massachusetts Diesel Retrofit Program (MDRP) is the primary component of the DEP Mobile Source Emissions Control Program that responds to the need to control diesel emissions generated on-site by heavy-duty construction vehicles. The goal of the MDRP is to help reduce adverse health impacts related to emissions from diesel engines.

DEP believes that retrofitting heavy-duty construction equipment is a very cost effective and efficient way to significantly reduce emissions of fine particulates and toxics into the ambient air, to mitigate adverse localized impacts, and improve the air quality for construction workers, while not adversely affecting the construction phase of major construction and development projects. Oxidation catalysts and particulate filters are two of the control technologies that are being used in the MDRP. The oxidation catalysts retrofit consists of a replacement engine muffler: either an in-line engine muffler replacement system or an add-on control device. The equipment works by oxidizing particulates (PM), hydrocarbons (HC) and carbon monoxide (CO) to less harmful emissions such as H_2O and CO_2. The equipment is also anticipated to reduce toxics such as formaldehyde and benzene by as much as 70% (MADEP 2001).

DEP also recommends that project proponents require their contractors to use On-Road Low Sulfur Diesel (LSD) fuel in their Off-Road Construction equipment. LSD fuel has a sulfur content of approximately 500 ppm versus the lower grade Off-Road fuel with a sulfur content of 3,000 ppm (MADEP 2001). The use of LSD fuel, in conjunction with after-engine emission controls, can increase particulate matter (PM) removals by an additional 25% beyond that obtained solely with after-engine controls (MADEP 2001).

Natural odors, occurring primarily as a result of the anaerobic decomposition of organic materials in the uncontaminated dredged sediments, pose slightly objectionable impacts in the vicinity of the disposal sites but will have negligible effects at the nearest shoreline areas roughly 1.5 kilometers to the east. Odors can be controlled, if necessary, by spreading lime over the sediment load, which neutralizes natural uncontaminated dredged material odors. Other factors that determine the degree of air quality and odor impacts include temperature (colder temperatures slow bacterial growth on dredge material and lessen odor impacts), wind direction, and proximity of residential areas.

7.14.2 Noise

Disposal activities at the candidate sites will result in temporary and localized minor noise impacts located relatively far offshore from the residential shoreline of Falmouth (minimum of 1.5 kilometers to nearest shore). Potential noise impacts are considered negligible because tug and barge traffic will represent only a relatively minor addition to existing marine traffic traversing the Bay to the Cape Cod Canal just northwest of the candidate disposal sites.

7.14.3 No-Action Alternative

If the aquatic disposal site is not designated for use in Buzzards Bay, there will be no additional temporary air quality, odor or noise impacts in the vicinity of the placement site.

7.15 Recreational Resources

The shoreline areas to the east of the candidate sites provide numerous recreational opportunities, with the areas closest to the sites consisting of sandy beaches and tidal flats for swimming, shellfishing, small boat access, bird watching, and related recreational activities. Disposal activities at the candidate sites will not directly impact these recreational resources, which are located a minimum of roughly 1.5 kilometers from the disposal sites. Additionally, recreational uses of the shoreline are heaviest in summer when dredging and disposal activities will not occur due to time-of-year restrictions to protect aquatic resources. There are no differences in effects to recreational resources between candidate site 1 and 2.

Impacts to off-season recreational boaters and recreational fishers are considered minimal during the disposal operations. Recreational boaters are more numerous during the warmer months in Buzzards Bay. Since disposal operations will occur during the off-peak recreational season in the colder months, only occasional recreational boaters navigating in the area of BBDS might be affected. These off-season recreational boaters will have ample opportunity to alter their courses and seek alternate routes to navigation channels.

7.15.1 No-Action Alternative

If an aquatic disposal site in Buzzards Bay is not designated, there will be no direct impacts to recreational resources in the Bay. However, over time, the lack of a cost-effective disposal alternative for suitable dredged material generated in the region will result in reduced numbers of moorings, slips at local marinas, and public boat ramp access points. Such reductions will have a significant negative impact on recreational boaters in the area.

7.16 Economic Environment

Disposal activities should have negligible impacts on land use and commercial enterprises along the shoreline, recreation, and existing commercial and recreational fishing activities. Designation of a disposal site should have positive impacts on the economic environment of the region. The economic impacts to the marine industry (both commercial and recreational) are anticipated to be significant due to the lower costs associated with dredging, greater ease of navigation, and potential increases in the number of available moorings and slips.

7.16.1 No-Action Alternative

Without a state-designated, open-water disposal site for suitable dredged material, area dredging projects will continue to experience difficulty finding cost-effective disposal alternatives. As indicated previously, dredging is essential to maintaining the harbor and waterway draft requirements of coastal ships, recreational boats, commercial fishing craft and military vessels. In the absence of a viable open-water disposal alternative, the dredging that is needed in many harbors and channels has been deferred indefinitely. Such postponements will have negative economic impacts upon a number of towns in the area. No action will compromise the ability of regional maritime industries to remain competitive, and it will limit the ability to implement the CCMP vision of maintaining and developing the Buzzards Bay area for benefit of local communities, the wider surrounding region, and the Commonwealth.

7.17 Environmental Justice

The candidate disposal sites are located in the Town of Falmouth, which has been determined not to be an environmental justice community. Therefore, an evaluation of environmental justice concerns from proposed disposal activities is not required. An improved coastal environment will generate more revenue and jobs for the community at large. Additionally, the Cape Cod Regional Policy Plan (RPP) supports maintenance and certain improvement dredging activities inclusive of the concept of open-water placement of suitable dredged material Cape Cod Commission 2002).

7.17.1 No-Action Alternative

If a disposal option for suitable dredged material is not identified, dredging projects essential to maintaining the fishing and maritime industries in Buzzards Bay will continue to be significantly delayed, with negative impacts to local and regional economies. No action would limit the ability to implement the RPP vision of maintaining and developing harbor areas as assets for local communities, as well as continue to compromise the ability of the fishing and maritime industries in the Buzzards Bay region to remain competitive.

8.0 SUMMARY EVALUATION OF CANDIDATE DISPOSAL SITE SUITABILITY

The physical, chemical, biological and human use characteristics of the candidate sites are described in Sections 4, 5 and 6. Impacts from proposed disposal activities are described in Section 7. The following is a summary of the suitability of candidate sites 1 and 2 with respect to the site evaluation factors presented in Section 3.6.11, based on the detailed information provided in the sections above. This section includes an overall summary recommendation of the preferred alternative site 1.

Section 8.1: Bathymetry, Site Capacity and Site Accessibility

Section 8.2: Sediment Grain and Chemistry

Section 8.3: Hydrodynamics and Sediment Resuspension Potential

Section 8.4: Water Column Chemistry

Section 8.5: Impacts on the Benthic Community

Section 8.6: Potential Impacts on Fishery Resources

Section 8.7: Potential Impacts on Commercial and Recreational Harvest of Finfish, Shellfish and Lobster

Section 8.8: Potential Impacts on Rare or Endangered Species

Section 8.9: Potential Impacts on Wildlife

Section 8.10: Potential Impacts on Wetlands or Submerged Aquatic Vegetation

Section 8.11: Potential Impacts on Historical and Archaeological Resources

Section 8.12: Potential Impacts on Navigation and Shipping

Section 8.13: Potential Impacts on Land Use and Special Area Designations

Section 8.14: Potential Impacts on Air Quality and Noise

Section 8.15: Potential Impacts on Recreational Resources

Section 8.16: Potential Impacts on the Economic Environment

Section 8.17: Potential Implications for Environmental Justice

Section 8.18: Summary Recommendation of Candidate Site 1 as the Preferred Alternative

8.1 Bathymetry, Site Capacity, and Site Accessibility

The goals for state site designation with respect to bathymetry consist of adequate access and capacity to accommodate projected volumes of dredged material over a 20-year planning horizon. Capacity estimates determined from projections of 20-year dredging volumes for the Buzzards Bay Region (Table 2-3) were applied to bathymetry of candidate sites 1 and 2. Table 4-1 shows the projected 20-year dredging volume filled uniformly at either of the candidate sites allows approximately 12.5 meters final water depth. This indicates that both candidate sites 1 and 2 provide more than enough capacity for the projected 20-year volume of material that may require open water disposal in the Buzzards Bay region. The capacity estimates assume a uniform filling of the sites, and therefore overestimate site capacity somewhat as the material would be deposited in mounds rather than layers of uniform thickness across the existing substrate at the sites. However, they provide an approximation of whether the sites are feasible and give an indication of whether one site has greater capacity than the other site. Using a conservative final water depth of 12 meters, candidate site 1 provides approximately twice the required capacity, and candidate site 2 provides 1.5 times the required capacity, indicating that candidate site 1 has somewhat greater capacity than candidate site 2.

Site accessibility is partly a function of bathymetry. While both sites are generally accessible from the surrounding areas, shallow features in close proximity to candidate site 2 make barge handling risky in approaching, maneuvering for the release, and leaving. Candidate site 1 has no navigational hazards as discussed in more detail in Section 8.12 on navigation below.

Disposal activities will modify the existing bathymetry only slightly with relative minor potential impacts of hydrodynamics on stability of the disposal mounds are discussed in Section 8.3 below.

8.2 Sediment Grain Size and Chemistry

Potential impacts on grain size and sediment chemistry are of concern with respect to the habitat characteristics of the seabed sites. The deeper-water areas of both candidate disposal sites consist of a predominance of fine-grained silt and clay, while shallower areas have a greater component of fine to medium sand. Historical records indicate that most of the dredged material disposed of in open waters in the Buzzards Bay region in the past has consisted of sandy material. In the more depositional areas of the historical disposal area, a veneer of finer grain material has covered coarser materials, particularly in the more northern reaches of candidate site 1. Finer grained sand and silt is expected to be the predominant disposal material to be deposited at the state designated site, however this expectation does not preclude the possibility of need for open water disposal of coarser grained materials at the site. The site SMMP (Section 11) of this DEIR identifies the importance to match disposal sediment to ambient seabed sediment.

The existing sediments of all grain sizes at sites 1 and 2 have non-detectable and/or negligible detected levels of contaminants. Slightly greater TOC and chemical concentrations associated with the finer grain sizes of both sites were not statistically significant. There is no evidence of increased contaminant concentrations related to historical disposal activities at each site.

This indicates that historical disposal of clean dredged material has not resulted in any evidence of degraded sediment quality. Since the alternative sites will be used for disposal of clean dredged material, there is no reason to suspect that sediment chemistry will be degraded by future disposal activities.

8.3 Hydrodynamics and Sediment Resuspension Potential

The preferred alternative site will consist of a depositional environment that will provide long-term stability of the substrate such that dredged material mounds will not experience appreciable erosion. Relatively weak tidal currents dominate hydrodynamic conditions in the vicinity of both candidate disposal sites, with predominant flood- and ebb-tidal current directions aligned along the northeast-southwest axis of the bay. The average tidal current velocity of 7.1 cm/s, and predominance of maximum current velocities less than 15 cm/s, are substantially less than tidal current strengths in the southern portion of the Bay (e.g., around the Elizabeth Islands) and in adjacent coastal waters. Analysis of wind conditions and fetch indicate that the average wind waves that would develop at the sites from the direction of greatest fetch should not impact the substrate in water depths greater than 11 meters (Section 4). Wind waves associated with very rare events would be quite infrequent. Since the water depth to seabed and sediment of the alternative sites will be similar to much of surrounding Buzzards Bay, sediment resuspension would not impact the bay ecology. Model runs using very rare wind conditions and greater bottom current velocity indicated that fine silt will be subject to limited resuspension, while coarser sediment fractions would experience negligible resuspension. Sediment resuspension modeling for the candidate sites indicated that under average hydrodynamic conditions (average wind wave conditions and tidal current velocity), no sediment resuspension would occur, even for fine silt.

Evidence to support these hydrodynamic estimates can be drawn from the existing grain size distribution on the substrate at each site. Candidate site 1 has fine-grained sediments in water depths of 12 meters and deeper, and a greater percentage of sand at shallower depths. Candidate site 2 has fine-grained sediments in water depths of 13 meters and deeper, suggesting that localized hydrodynamic effects are expected to exert a greater influence on the substrate at candidate site 2 than candidate site 1. This is due to the presence of more distinct topographic features at candidate site 2, including a deeper basin area and close proximity of two prominent, shallow features, Gifford Ledge to the east and the historical disposal mound to the west. Therefore, based on the available information, disposal mounds comprised of fine-grained material will remain stable with a final water depth of roughly 12 meters at site 1; fine-grained disposal mounds should remain stable with a final water depth of roughly 13 meters at site 2. This makes candidate site 1 preferred over candidate site 2 for assurance of maximum site capacity and maximum potential mound stability for all grain sizes.

Modeling estimates for a one-year disposal period for each site yielded minimum final water depths for a single disposal mound that were slightly shallower (10.7 meters at candidate site 1 and 11.6 meters at candidate site 2). Disposal management measures will maintain deeper depths at either site.

Coarser-grained disposal mounds are expected to be resistant to erosion at depths corresponding to the occurrence of sandier substrate at each site (12 meters and shallower at candidate site 1, 13 meters and shallower at candidate 2), or shallower. Supporting evidence includes the long-term stability of the historical disposal mound south of the historical BBDS and west of candidate site 2, with a mound apex at approximately 8 meters depth. Therefore, it is desirable to direct disposal of sandy material to shallower portions of either candidate disposal site, which have a comparable grain size distribution, and direct finer-grained sediments to the deeper water portions of either site, to minimize the potential for erosion by currents. Alternatively, disposal activities could be sequenced such that the final, surface layers of a particular mound consist of coarser material if warranted based on estimates of the final water depth over the mound. The reverse management practice of depositions for coarser-grained material to be covered with finer grained sediment in deeper more depositional areas will apply also.

In summary, overall site characteristics and hydrodynamics in the vicinity indicate that the basin areas of both sites are depositional environments that will contain dredged material composed of a range of grain sizes, predominantly finer grained. Surrounding shallower areas (including the occurrence of sand waves within the historical BBDS) indicate more energetic hydrodynamics at those depths that will winnow fine-grained material from disposal mounds. Small-scale winnowing of fines is a typical process on most open-water disposal mounds, leaving an armored surface of coarse sand, pebbles, or shell hash. It generally does not constitute an appreciable loss of material to the surrounding environment, as evidenced by the long-term stability of discrete disposal mounds at other New England disposal sites and the mound located south of the historical BBDS.

Disposal activities at either candidate site will be managed to maximize mound stability and minimize potential erosion. As a conservative recommendation, candidate site 1 appears to have a slightly greater depositional character, which sets it apart as the preferred alternative over candidate site 2.

8.4 Water Column Chemistry

Based on the results of modeling, increases in total suspended solids from disposal events will exceed pre-disposal background concentrations by very minor amounts, less than a total of 10 mg/L, within four hours of disposal. This is within the range of concentrations recorded for stations in Buzzards Bay (2.7 to 24.3 mg/L), and is well within the range of values that will be expected under a broad range of conditions in estuarine waters. According to the STFATE predictive modeling presented in Section 7.3.2, silt and clay particles originating from a typical disposal event at either candidate disposal site would reach background concentration for TSS within four hours of the release. The outside boundary of the horizontal extent of the suspended particles mentioned above extend approximately one-half mile from the landward boundary of disposal site 1 and nearly three-quarters of a mile landward of the boundary of disposal site 2. Even though the TSS at the fullest extent described above is equivalent to surrounding Bay water, disposal events at disposal site 1 will reach background much further from the shore at West Falmouth than similar disposal events at site 2. Results of LTFATE modeling discussed in section 7.3.3 show no sediment movement occurs inside the boundaries of either site under simulated storm waves and currents.

8.5 Impacts on the Benthic Community

Candidate sites 1 and 2 currently support comparable benthic communities, dominated by opportunistic species that will be expected to quickly recolonize the added clean dredged material resulting from disposal activities. Disposal of fine-grained material may result in an increased TOC concentration in the sediments at either site, which could provide an initial increase in opportunistic invertebrates that provide a food source for many aquatic species, such as bottom-feeding finfish. Disposal activities that result in coarsening of the substrate may cause a decrease in the overall percentage of Stage III organisms such as clams due to increased difficulty in burrowing in the coarser material, but the shift in abundance of these species would be localized and not be significant. Based on the determination to dispose of clean dredged material at the designated site, contaminant effects on the benthic community are not expected to occur.

Based on the similarity in the existing benthic community at both sites, there are no distinguishing factors that favor one candidate site over the other in terms of benthic community impacts. The bathymetry of site 2 influences the bottom sediment character somewhat. In site 2, some sandier soils exist due to shallower water in the more northern area and also in the eastern extent caused by slightly increased currents around ledges. Stage III benthic organisms that typically inhabit the unconsolidated soft mud over much of the deeper area of site 2 would have difficulty reestablishing in sandier substrate. Long-term impacts of disposal activities at either site are expected to be minimal.

8.6 Potential Impacts on Fishery Resources

8.6.1 Finfish

The trawl surveys conducted at the candidate disposal sites showed that they support essentially the same finfish populations. Despite the apparent lack of substantive differences in the finfish utilizing candidate sites 1 and 2, habitat features in proximity to candidate site 2 may be more valuable to finfish resources in the bay. Candidate site 2 is in closer proximity to two prominent features that likely provide feeding areas and refugia for finfish, including Gifford Ledge and the historical disposal mound. Therefore, in terms of finfish habitat, as a conservative recommendation, candidate site 1 is preferred over candidate site 2.

The candidate sites appear to provide suitable habitat for a variety of juvenile finfish. Because juveniles are less mobile than adults, they may not easily move to avoid barge activity and the short-term turbidity associated with disposal events. Therefore, should disposal event occur during the time of year when juvenile finfish biomass and abundance was highest, they will be susceptible to direct impact from disposal activity. However, direct impact to juvenile finfish during sediment disposal will be avoided via implementation of an open dredged window from November through March, the seasonal period when total juvenile finfish species richness, abundance and biomass is lowest. Therefore, direct adverse impact to the majority of the juvenile finfish population from disposal will be avoided. Structures like Gifford Ledge and the historical disposal mound generally attract many juvenile finfish species (e.g., black sea bass and tautog) for feeding, therefore a conservative recommendation in favor of further minimizing impacts to nursery habitat, favors selection of candidate site 1 over candidate site 2.

Potential impacts to sensitive stages of finfish (including eggs and larvae) and lobsters can be managed while still accommodating a reasonable dredged material disposal season. While it is impossible to avoid all potential spawning periods in the bay, limiting disposal activities to mid-fall through the onset of winter flounder spawning in mid-January or February protects most of the prevalent species in the northern bay (considering both deep-stratum and shallow-stratum species). While winter flounder were not represented as a particularly abundant species in terms of numbers or biomass in the site-specific trawl surveys (Section 5.2.2), they are an important commercial species and do occur throughout the bay (Section 5.2.1). Additionally, as they are a demersal species (with demersal eggs and larvae) they are one of the species that could be more susceptible to impacts from dredged material disposal. The recommended early spring dredged materials disposal prohibition (section 11.2) would be largely protective of winter flounder demersal eggs and larvae with consideration for lobster.

8.6.2 Shellfish

Shellfish harvesting activities in the vicinity of the candidate disposal sites include conch pot activity in deeper water areas of the bay and scallop harvest concentrated in deeper-water areas around Cleveland Ledge. Some interference with conch harvests, which occur through mid-December, may result from disposal activities. The fine-grained substrate in the basin areas of candidate sites 1 and 2 provides less suitable scallop habitat, so adding clean dredged material to similar substrate at the candidate sites from disposal activities will not constitute an appreciable long-term impact on the scallop fishery. Potential short-term impacts from disposal activities consist of the impacts from turbidity and settling of the finest grain material within and slightly beyond the disposal sites. Disposal activities have occurred in several areas around Cleveland Ledge historically and on an on-going basis. Additionally, water column impacts from disposal activities at the designated disposal site are estimated to be localized and of short duration. Therefore, while potential impacts to shellfish resources from disposal activities at each of the candidate sites is comparable, and secondary effects to nearby resource areas will be negligible, a conservative recommendation favors candidate site 1 over candidate site 2 to locate disposal activities further from possible scallop harvest areas.

8.6.3 Lobster

Based on site-specific information (Section 5.2.7), the lobster habitat within the candidate disposal sites is considered sub-optimal. However, the soft-bottom substrate at both sites likely provides burrowing sites for juveniles and is likely inhabited by adult lobsters as well. Burrows that could have been dug by juvenile lobster were observed in the soft-bottom portions of both candidate disposal sites (Maguire 2002d), and were comparable to those seen on dredged material disposal mounds at existing open water disposal sites in New England. Lobsters may be capable of avoiding the disturbance occurring in a disposal area, and are also capable of burrowing up through a dredged material deposit if buried. Some mortality of lobsters could occur from burial if individuals are unable to burrow up through the dredged material deposit. The overall habitat value to lobster at either site is not anticipated to change and lobsters are expected to recolonize either site following disposal activities.

8.7 Potential Impacts on Commercial and Recreational Harvest of Finfish, Shellfish and Lobster

8.7.1 Finfish

Mapped areas indicating commercial and recreational finfishing activities suggest that most recreational fishing efforts are concentrated further north of the candidate sites, between Cleveland Ledge and the Cape Cod Canal. Charter captains utilize the area encompassing CLDS and candidate sites 1 and 2 for scup and tautog, and some user conflicts may occur in the fall if the charter season overlaps with the start of the disposal season.

Commercial finfish harvesting activities may be affected by setting gear to avoid dredges and disposal barges operating at the designated site. Indirect impacts to finfish harvesting activities include potential impacts to resident finfish and habitat areas that may result from disposal activities. Overall, such impacts confined within the relatively small area of the disposal site in comparison to the extensive area of Buzzards Bay are minor and similar for both candidate sites. Conflicts with commercial scup potting activities would be most likely at candidate site 1, which abuts the "5 acre area" that is deemed valuable by commercial scup potters. This may pose limited site use conflicts in the early fall. Other commercial finfishing activities generally occur in the summer months when disposal activities would not be occurring. However, in an effort to avoid potentially valuable habitat areas associated with Gifford Ledge, selection of candidate site 1 over candidate site 2 would be favored.

8.7.2 Shellfish

Potential impacts to commercial shellfish harvests include possible conflicts with placement of conch pots, which would not be avoidable at either site and may be slightly more of an issue at candidate site 1, which is part of a broad, contiguous, deep-water area of the bay that may be suitable for this activity (Similarly, limited potential for conflicts with commercial scup pots exists at candidate site 1, Refer to Section 8.7.1). In contrast, avoidance of potential scallop sets will best be accomplished through designation of candidate site 1, which is located slightly further away from the northern limits of Cleveland Ledge where scallops sets are known to occur. In addition, candidate site 1 is further away from the nearshore shellfish resources and habitat such as quahog, soft-shelled clam, blue mussel, oyster, and eelgrass beds that provide attachment nurseries for juvenile shellfish.

There are potential conflicts with conch pot setting in the 5-acre area with disposal activities at candidate site 1. However, such conflicts are expected to be relatively minor given that the season will only overlap in the fall. Despite these conflicts, candidate site 1 is preferred over candidate site 2 overall, due not only to finfish concerns (Refer to Section 8.7.1 above) but also scallop sets to the north, and lobster habitat (refer to Section 8.6.3) within and proximal to candidate site 2.

8.7.3 Lobster

Gifford Ledge abutting candidate site 2 provides suitable lobster habitat and commercial harvesting is known to occur around the ledge in July (Figure 6.4). Commercial harvesting occurs throughout the winter and will overlap the typical disposal season. Potential impacts include conflicts with fixed gear, as well as potential impacts to habitat areas provided by the ledge from disposal activities in candidate site 2 (periodic, short-term increases in TSS). While impacts from increased turbidity were found via predictive modeling to be minor, a conservative recommendation favors use of candidate site 1 over candidate site 2, to afford added protection of lobster habitat areas at Gifford Ledge and avoid potential interference with commercial harvesting activities in the vicinity.

8.8 Potential Impacts on Rare or Endangered Species

Shoreline areas in West Falmouth that provide habitat for rare and endangered species (e.g., salt marsh systems, sandy dune and beach habitat) will not be affected by disposal activities at either candidate disposal site, based on the distance of the sites from shore.

The occurrence of motile species such as sea turtles is not very common in the Buzzards Bay, particularly during the typical disposal season (late fall and winter), and the candidate disposal sites do not provide preferred habitat or feeding areas for these species. The site management and monitoring plan includes the requirement for an observer to be on-board during disposal activities to help ensure these species are not affected by disposal activities. Therefore, based on the relatively low likelihood of occurrence in the vicinity of the disposal site, and the conservative management plan to monitor during disposal activities, adverse impacts to rare and endangered species are very unlikely.

8.9 Potential Impacts on Wildlife

Wildlife utilizing the open waters of the bay in the vicinity of the candidate disposal sites consists primarily of sea birds and waterfowl, which are attracted to the finfish and invertebrate biota resources inhabiting the shallow water column and submerged substrate within the project area. These resources may especially be concentrated around the structure provided by Gifford Ledge to the east of site 2. Disposal activities in the basin west of Gifford Ledge in candidate site 2 are expected to periodically increase turbidity during disposal events, potentially affecting finfish communities and visibility for diving waterfowl around the ledge within approximately 1000 meters of the disposal activities. This temporary interference could potentially encompass the main body of the ledge to the east. As a conservative recommendation, candidate site 1 is preferred over candidate site 2 to minimize potential impacts to wildlife that may exploit the biota inhabiting the vicinity of Gifford Ledge.

8.10 Potential Impacts on Wetlands or Submerged Aquatic Vegetation

Based on the distance between the nearest shoreline resource areas and the candidate disposal sites, no impacts on wetlands or submerged aquatic vegetation are expected. The primary concern with impacts to these resource areas would be increased turbidity associated with the dredged material settling through the water column at the disposal site. Candidate site 2 is located at least approximately 1,200 meters from the nearest mapped eelgrass bed, and candidate site 1 is located substantially farther away, approximately 2,800 meters. STFATE modeling results indicate that suspended material entrained in the water column during a disposal event would be at concentrations comparable to the normal range of values for the bay in the vicinity of the mapped eelgrass beds. Suspended sediment losses during disposal constitute a very small volume of material and would represent negligible accumulation if all the material settled in a relatively small area. Finally, disposal activities would most likely be occurring during fall and winter when the vegetation in these resource areas has become dormant for the year. Therefore, effects on these resource areas are not anticipated. As a conservative measure, candidate site 1 is located further from shoreline resource areas and the mapped eelgrass bed to the east, and would therefore be favored over candidate site 2.

8.11 Potential Impacts on Historical and Archaeological Resources

Shipwrecks constitute the primary historical and archaeological resource concern with use of the designated disposal site. Surveys conducted at the candidate disposal sites have not given any indication of the presence of shipwrecks. The sites are in a relatively protected portion of the bay with no known wreck sites in the vicinity. Portions of both candidate sites have already been impacted by disposal activities (northern portion of candidate site 1 and northern portion and deep-water basin area of candidate site 2). Continued use of the designated disposal site would continue covering any shipwrecks that may be present, essentially speeding up the burial process that would be occurring by natural sedimentation processes in these areas of the bay.

8.12 Potential Impacts on Navigation and Shipping

The volume of disposal activity related vessel traffic anticipated at the designated disposal site constitutes a very small increase in the substantial volume of commercial and recreational traffic in this portion of the bay. During 2002, the NAE utilized an area just north of the candidate disposal sites for disposal of Canal maintenance material without any evidence of conflicts with navigation. Additionally, site designation will resume activities that were occurring in this area in the past. Therefore, impacts of site designation on navigation and shipping in the bay are expected to be negligible for either candidate disposal site.

Candidate site 1 is located parallel with vessel traffic routes between the mouth of the bay and aligned between the Canal approach channel and the Woods Hole region. However, it will be possible for vessel traffic transiting the Bay in this area during disposal activities to pass to the east or west of candidate site 1 to avoid interference from the disposal scows. A federally designated tank vessel route recommended for vessels making through-passage in Buzzards Bay safely leaves candidate site one by at least 0.21 nm (Section 6.5). While candidate site 2 is located further east, out of alignment with these traffic corridors, there are overriding concerns with maneuvering within candidate site 2 that makes candidate site 1 the preferred site.

In terms of the safety and ease of navigation for dredge scows and tugs, or hopper dredges, within and around the candidate disposal sites, candidate site 1 is preferred over candidate site 2. Candidate site 1 has deeper water access from all sides compared to candidate site 2. Candidate site 1 has wider deep-water area available for maneuvering vessels during disposal. The boundaries of candidate site 2 abut two prominent, shallow features (Gifford Ledge, a rocky ledge located immediately to the east, and a historical disposal mound located immediately to the west). These features have water depths close to and/or shallower than the draft of a loaded scow or hopper dredge, and present obstacles to maneuvering that would decrease the safety and reliability of disposal operations at candidate site 2. Therefore, candidate site 1 is preferred over candidate site 2 for navigation and safety concerns.

8.13 Potential Impacts on Land Use and Special Area Designations

No impacts to land use in Falmouth are anticipated as a result of disposal activities at the proposed candidate disposal sites. Activities will be limited to vessel traffic to and from the sites and associated with environmental monitoring activities at the sites and nearby reference areas. Disposal activities will have negligible impacts beyond the boundaries of the disposal site. Therefore use of either of the candidate disposal sites will not have any impact on adjacent land conditions and/or land uses.

8.14 Potential Impacts on Air Quality and Noise

No impacts to air quality and noise are anticipated from use of either candidate disposal site. Vessel traffic represents a small increase in the existing patterns in the region and will not appreciably affect current air quality and noise levels.

8.15 Potential Impacts on Recreational Resources

The candidate disposal sites are located a considerable distance from shoreline areas to the east that are used for recreation. Additionally, disposal activities at the designated site would be occurring off-peak season, when recreational activities are more limited. Therefore, disposal activities should have no adverse impacts on recreational activities or uses of the waterway.

8.16 Potential Impacts on the Economic Environment

Disposal activities are expected to have negligible impacts on land use and commercial enterprises along the shoreline, recreation, and existing commercial and recreational fishing activities. Therefore, designation of a disposal site will have negligible negative impacts on the economic environment of the region.

As a conservative measure, avoidance of potential impacts to juvenile finfish and lobsters that may affect commercial and recreational harvest and associated economic concerns, are best be accomplished by avoiding impacts to the Gifford Ledge area that abuts candidate site 2. Therefore, a conservative recommendation favor candidate site 1 over candidate site 2 for economic reasons related to fisheries.

8.17 Potential Implications for Environmental Justice

The candidate disposal sites are located in the Town of Falmouth, which has been determined not to be an environmental justice community. Therefore, there are no concerns regarding environmental justice with use of either candidate disposal site.

8.18 Summary Recommendation of Candidate Site 1 as the Preferred Alternative

Based on the physical, chemical, biological, human use characteristics, impacts from proposed disposal activities data and information presented in Sections 4, 5, 6 and 7, both candidate sites provide suitable conditions for dredged material disposal. The following factors *favor* a conservative recommendation for designation of candidate site 1 as the preferred alternative over candidate site 2:

- Candidate site 1 has slightly greater disposal materials capacity than candidate site 2;
- Candidate site 1 has predominant occurrence of finer-grained sediment, indicating increased depositional character and substrate stability than candidate site 2;
- Candidate site 1 has no navigational hazards and plenty of maneuvering space for disposal barges compared to candidate site 2;
- Candidate site 1 provides less diverse habitat features for lobster, finfish and associated predators (e.g., waterfowl) than the Gifford Ledge area just east of candidate site 2;
- Candidate site 1 is located further from scallop harvest areas concentrated around Cleveland Ledge; and
- Candidate site 1 is located further west from shoreline resource areas, including a mapped eelgrass bed paralleling the shoreline to the east, intertidal beach/dune habitat areas, and inlets and salt marsh systems of West Falmouth.

9.0 MINIMIZATION AND MITIGATION OF IMPACTS

The MEPA Scope requires that the DEIR evaluate mitigation opportunities for identified impacts which cannot be avoided, identify the specific measures and strategies to be implemented and the parties responsible for funding and implementation. Resources subject to potential mitigation are characterized under the Wetlands Protection Regulations as Land Under the Ocean (LUO) and/or Land Containing Shellfish (310 CMR 10.25 and 10.34, respectively.

Use of the disposal site will not cause permanent or significant adverse impacts to resources identified under 310 CMR 10.25 and 10.34. (See Section 7 for a full discussion of impacts.) The unavoidable impacts of disposal site use will be temporary, limited to burial of non-mobile organisms and a temporary, localized increase in turbidity. Because site designation and use does not constitute a permanent loss of wetland functions defined under the Wetlands Protection Regulations, mitigation is not proposed. Section 9 includes the following subsections.

Section 9.1: Land Under the Ocean

Section 9.2: Land Containing Shellfish

9.1 Land Under the Ocean

Land Under the Ocean – 310 CMR 10.25(6) states that activities like dredged material disposal shall be designed to minimize adverse effects on marine fisheries habitat caused by alterations in water circulation, destruction of aquatic vegetation, alteration in sediment grain size, changes in water quality, and the alteration of shallow submerged lands. As described in foregoing sections, the impacts of dredged material disposal will be avoided and minimized through site selection and, following designation, site management measures. Specifically:

> Water circulation – By selecting a site in a deeper area of Buzzards Bay, the impact of mounds of dredged material on the seafloor are minimized. The topographic relief of disposal mounds is relatively low: the placement of 147,000 cy of material from one project at the CCDS resulted in a disposal mound with a maximum elevation of 1.1 meter, which consolidated to a height of .8 meter over 16 months. (CR Environmental, 1997) Further, through site management, the placement of material will be managed to create smaller mounds over a greater area within the site. Although it is highly unlikely that material would accumulate to such a significant degree, the management plan establishes a maximum height from the bottom of 12 meters (40 feet) to preserve navigability at the site.
>
> Destruction of aquatic vegetation (eel grass and widgeon grass) – These resources are not present at the disposal site.
>
> Alteration in sediment grain size – While some heterogeneity of sediment grain size is expected in the material disposed of at the site, the primary type of material for which there is an identified need for an aquatic disposal option is clean, silty sediment, typically from inner harbor, low energy environments. This material is similar to the ambient sediments at the proposed disposal site, which are dominated by silt and clay (58% to

93%) with sand. The potential impact from the disposal of coarser material, including sands and gravels, is minimized by the state and federal policies that require applicants to evaluate beneficial uses for dredged material as an alternative to aquatic disposal. Because sands and gravels are most readily appropriate for beneficial use, these materials are not likely to be persistently disposed of at the site in significant quantities.

Changes in water quality - Modeling indicates that turbidity (as total suspended solids) will return within zero to three hours to within a range of normal variation for Buzzards Bay. Modeling for this project generally replicates the conclusions of modeling and field monitoring results for other disposal projects, finding that initial elevated levels of TSS return quickly (within hours) to background levels.

Alteration of shallow submerged lands with high densities of polychaetes, mollusks, or macrophytic algae – The boundaries of the disposal site has been located to minimize impacts to marine resources generally; these resources are not present in high densities at the disposal site.

9.2 Land Containing Shellfish

Land Containing Shellfish – 310 CMR 10.34(4) states that activities like dredged material disposal shall not adversely affect such land or marine fisheries by a change in productivity caused by alterations of water circulation, alterations in relief elevation, alteration in the distribution of sediment grain size, and changes in water quality. See the discussion of Land Under the Ocean, above, for a discussion of how these factors have been addressed, to be supplemented by 310 CMR 10.34(5), which states that "projects which temporarily have an impact on shellfish productivity but which do not permanently destroy the habitat may be permitted….if the area is returned to its former productivity within one year. Native populations of shellfish will be buried in the area of immediate disposal, but the new substrate will be suitable for and is expected to support recruitment of larval shellfish in the spawning season following disposal activity. Habitat supporting shellfish will therefore not be permanently destroyed.

10.0 COMPLIANCE WITH REGULATORY STANDARDS AND REQUIREMENTS FOR SITE USERS

10.1 Introduction

Disposal of dredged material within the baseline of the territorial sea is regulated at the local, state, and federal level. This section includes a description of the primary standards and regulations for aquatic disposal as they relate to use of the preferred alternative.

While the designation of the site itself does not require a permit, projects proposing to use the site will be required to receive permits under the following authorities:

- Wetlands Protect Act - Order of Conditions from Falmouth Conservation Commission
- Massachusetts Environmental Policy Act – Certificate from the Secretary of Environmental Affairs
- Clean Water Act Section 401 – Water Quality Certification from the Department of Conservation and Recreation
- MGL Chapter 91, the Public Waterfront Act – Waterways permit from DEP
- Coastal Zone Management Act – Federal consistency from Coastal Zone Management
- Rivers and Harbors Act – US Army Corps of Engineers
- Clean Water Act Section 404 – Corps with recommendations from National Marine Fisheries Agency and US Fisheries & Wildlife Service and formal concurrence from US Environmental Protection Agency

Although the Town of Falmouth has a Local Wetlands Bylaw, it is the position of the CZM that the local bylaw would not apply to the designation of the site as a dredge material disposal site and its use for such purposes. Such activities are essential government functions on Commonwealth property to which the local bylaw would not apply. However, CZM acknowledges that there would be extensive cooperation on wetlands issues with the Falmouth Conservation Commission through the application of the state Wetlands Protection Act to these activities. It also is suggested that the Town of Falmouth be represented on the Disposal Monitoring and Advisory Committee by its Conservation Commission (See 11.3.1).

This section includes a summary of site user compliance requirements to met regulatory standards.

Section 10.1: Introduction
Section 10.2: Wetlands Protection Act
Section 10.3: The Massachusetts Environmental Policy Act
Section 10.4: Water Quality Certificate
Section 10.5: Chapter 91
Section 10.6: Federal Consistency
Section 10.7: Clean Water Act Section 404(b)(1) Analysis
Section 10.8: Rivers and Harbors Act of 1899, Section 10

Section 10.9: The Endangered Species Act
Section 10.10: Magnuson-Stevens Fishery Conservation and Management Act

10.2 Wetlands Protection Act

The preferred alternative is an aquatic disposal site located in resource areas protected by the Massachusetts Wetlands Protection Act (WPA), specifically Land Under the Ocean (LUO). The WPA is administered on the local level by the Conservation Commission, which implements the Massachusetts Wetlands Regulations at 310 CMR 10.00. An NOI application to the Falmouth Conservation Commission will be required for disposal activities. An Order of Conditions (OOC) will need to be issued by the Conservation Commission to permit the disposal activity. Coordination and discussions with the Falmouth Conservation Commission and the MA DEP will be necessary to develop the preferred framework the WPA permitting process may take for the actual use of the site. There may be advantages to seeking the issuance of a blanket approval for the use of the designated site, which would consist of an OOC approving use of the designated site for a specific period of time subject to site management and monitoring requirements as outlined in the SMMP and reviewed by the Disposal and Monitoring Advisory Committee (DMAC). Refer to Section 11 for a discussion of the SMMP and the DMAC. The Falmouth Conservation Commission as a member of the DMAC would be provided with notification of individual disposal events.

LUO is defined as *"... land extending from the mean low water line seaward to the boundary of a municipality's jurisdiction and includes land under estuaries*," within the Wetlands Regulations at 310 CMR 10.25(2). Land under the ocean is likely to be significant to the protection of marine fisheries and, where there are shellfish, to protection of land containing shellfish (310 CMR 10.25).

Land containing shellfish, 310 CMR 10.34(3), is significant to the protection of marine fisheries as well as to the protection of the interest of land containing shellfish. The preferred alternative disposal site is not characterized as land containing shellfish.

Dredged material disposal projects proposing to use the preferred alternative disposal site are water-dependent projects as defined under the Waterways regulations of Chapter 91 (see below). As water-dependent projects, the standard under the regulations requires that disposal projects use the best available measures to minimize adverse effects on marine fisheries habitat caused by:

a. alterations in water circulation;
b. destruction of eelgrass *(Zostera marin*a) or widgeon grass *(Rupia maritin*a) beds;
c. alterations in the distribution of sediment grain size;
d. changes in water quality, including, but not limited to, other than natural fluctuations in the level of dissolved oxygen, temperature or turbidity, or the addition of pollutants; or
e. alterations of shallow submerged lands with high densities of polychaetes, mollusks or macrophytic algae.

Small scale, localized changes may occur in tidal current strength and direction based on the presence of disposal mounds. Based on the size of the typical mounds and their broad, relatively flat configuration within a depositional environment, such effects will be minimal and highly localized. The proposed disposal site is characterized by conditions similar to other depositional open water disposal sites (CCDS, MBDS); monitoring of these sites by the DCR and the USACE DAMOS program, respectively, have consistently observed that biological recolonization of the area of disposal begins almost immediately (within one to three months) (USACE NAE, 2001 and 2002; C.R. Environmental, 1997) and have not observed impacts in biological features elsewhere within the site (USACE NAE, 1990; Maguire 2001d, 2002d). The potential effect of mismanaged over-development of disposal mounds more common in the past will be minimized through the contemporary management plan (Section 11.0). The SMMP presented in Section 11.0 of this DEIR directs adjustments to the coordinates of disposal events within the disposal site, for each project, so that clean dredged material is distributed as evenly as practicable within the disposal site at low relief.

The water depth of the preferred alternative precludes the growth of sea grasses.

The potential impact to ambient biota from changes in sediment grain size will be minimized by limiting the number of projects that propose to use the site for the disposal of sandy material. However, while the majority of the projects identified as potential users of the disposal site are expected to generate clean, silt or silt/fine sand material, there may be instances where sandy material from private, municipal, or federal projects cannot be feasibly reused and where disposal at the site constitutes the least environmentally damaging practicable alternative. The DEP Water Quality Certificate (see below) requires that a hierarchical review of alternative uses and/or disposal alternatives be conducted to determine whether disposal at an open water site constitutes the least damaging practicable alternative. The USACE, with the participation of the federal agencies with jurisdiction over dredged material disposal, conducts a similar review under the CWA.

Given the persistent need for sand and coarse-grained material along the shoreline of Buzzards Bay, it is the policy of the Commonwealth to require that, to the maximum extent feasible, sand be used as a beneficial resource and not disposed of at open water sites. The Canal has in the past been the single largest contributor of sand and coarse-grained material to Buzzards Bay disposal sites. The Commonwealth is working with the USACE to develop a management plan for sand that is periodically dredged from the Canal; it is the Commonwealth's intent to use all sand removed from the Canal to nourish area beaches.

Impacts to ambient water quality as a result of other than natural fluctuations in the level of dissolved oxygen, temperature or turbidity, or the addition of pollutants are expected to be minimal, and within the range of normal conditions associated with the vicinity of the site. The preferred alternative site is being designated for clean material only. All material proposed for disposal at the preferred alternative site must undergo physical, chemical and, if warranted, biological testing to establish that dredged material disposed of at the site does not contain contaminants above background levels or have demonstrated no adverse impacts to marine species through biological testing. In addition, for materials subject to biological testing, the

EPA conducts a human health risk assessment before approving the USACE authorization to dispose of material at the site.

Based on the results of modeling, increases in total suspended solids from disposal events are expected to exceed pre-disposal background concentration by only minor amounts, less than a total of 10 mg/L, within four hours of disposal. Given the range of background concentrations recorded for specific stations in Buzzards Bay (2.7 to 24.3 mg/L), an increase on the order of 10 mg/L above background is expected to be within the range of normal ambient variations. The open water disposal of clean dredged material may result in localized decreases of dissolved oxygen. Evidence from previously monitored disposal activities has identified only short-term impacts to dissolved oxygen levels, with recovery occurring almost immediately (US Navy, 1979; NOAA; 1977; Normandeau, 2000). Marine organisms will be impacted locally and temporarily from elevated levels of total suspended solids and depressed levels of dissolved oxygen. These typical impacts are will be minimized through time of year restrictions proposed by regulators that prohibit disposal during sensitive life stages of fisheries resources.

The site does not contain high densities of macrophytic algae (sea weed). Dredged material disposal will impact polychaetes and mollusks present at the site. Generally, the limited area of the proposed preferred alternative site minimizes impacts to the seafloor of the bay. Specifically, impacts within the disposal site area are primarily limited to relatively small seafloor areas directly beneath the split-hulled scow at the predetermined release location in accordance with the management plan Section 11.0. Polychaetes have demonstrated almost immediate recolonization at other disposal sites (see above). Mollusks directly impacted by the main volume of the disposal event will be buried; shell stock within the area not affected by disposal will contribute spat to recolonize the affected area.

10.3 The Massachusetts Environmental Policy Act

MEPA applies to dredging projects that include dredging of 10,000 cy or more of material (310 CMR 11:03(3)(b)(30). MEPA requires that projects evaluate the environmental consequences of the proposed action and take all feasible measures to avoid, minimize, and mitigate damage to the environment. Projects that trigger the MEPA review threshold(s) are required to develop Environmental Impact Reports that provide an analysis of alternatives and additional detail regarding the resources and interests subject to potential impacts. MEPA review occurs before state and federal permitting agencies act, to ensure that the agencies know the environmental consequences of their actions prior to issuing permits or licenses.

This EIR has been developed in response to direction provided by MEPA under the Scope issued in 1995. A copy of the directive letter from the Secretary, which contains the MEPA Scope, is presented in the front matter of this document.

10.4 Water Quality Certificate

The Water Quality Certificate (WQC) is the primary state permit that controls the disposal of dredged material, and is required for all projects of greater than 100 cubic yards of material. Section 401 of the Clean Water Act authorizes individual states to certify that federally permitted discharges of dredged or fill material comply with state water quality standards. The state certification is known as a Section 401 water quality certification. DEP has developed Section

401 water quality regulations under 314 CMR 9.00 for discharges of dredged or fill material, dredging, and dredged material disposal in waters of the Commonwealth. The regulations prohibit discharges in the following cases:

a. if there is a practicable alternative that would have less adverse impact on the aquatic environment (314 CMR 9.06(1));
b. unless appropriate and practicable steps are taken to minimize potential adverse impacts to land under water (314 CMR 9.06(2));
c. if the discharge is located in Outstanding Resource Waters (314 CMR 9.06(3)); and
d. if the discharge would have substantial adverse impacts on the physical, chemical and biological integrity of surface waters of the Commonwealth (314 CMR 9.06(7)).

The regulations include more specific requirements for dredging and disposal of dredged material, including specifications for sampling and analysis of the material to be dredged, dredging performance standards, requirements for intermediate storage facilities and transportation of dredged material, and specifications for beach nourishment, and shoreline placement. Unconfined open water disposal activities are subject to the sediment and water quality sampling, tiered testing, and evaluation requirements of the USACE and EPA. The regulations state that the Commonwealth may include specific time-of-year restrictions on disposal activities in their certification.

Importantly, the regulations also include a hierarchical reuse assessment to determine if there are feasible alternatives to open water disposal. The evaluation must include a determination of whether reuse, recycling, or contaminant destruction and/or detoxification is feasible, in light of the volume of material to be dredged and the physical characteristics, presence of contaminants, relative public health and environmental impacts of management options, and relative costs of management options. Only where DEP determines that no practicable alternative to aquatic disposal will use of the disposal site be permitted.

To control impacts from disposal at the site, the WQC will impose a time of year restriction, based on recommendations from the division of Marine Fisheries, during which disposal will be prohibited. The WQC will incorporate recommendations from the NMFS regarding avoidance of marine mammals and turtles. In addition, the WQC will reference the site management and monitoring plan (see Section11.0 -Management and Monitoring Plan) regarding required project monitoring and reporting requirements.

10.5 Chapter 91

The Public Waterfront Act, MGL Chapter 91, and Waterways Regulations (310 CMR 9.00) are administered by MA DEP to regulate structures and discharges of fill material in tidelands of the Commonwealth, including disposal of unconsolidated material below the low water mark (310 CMR 9.05(c)(2)). Disposal of dredged material in open waters of the Commonwealth is considered a water-dependent activity (310 CMR 9.12(2)(a)). The Waterways Regulations require that projects serve a "proper public purpose which provides greater public benefit than detriment to the rights of the public" in tidelands. As a water-dependent use project, the use of the proposed preferred sites in Buzzards Bay are presumed to meet this standard.

As required under section 9.33, *Environmental Protection Standards*, use of the disposal site must comply with the applicable environmental regulatory programs of the Commonwealth, including: MEPA; the WPA; the Massachusetts Clean Waters Act (MGL c. 21, s. 26-53 and the regulations for WQCs, 314 CMR 9.00); Marine Fisheries Laws (MGL Chapter 130); and the Underwater Archaeological Resources Act (MGL c. 91 and c. 6, s. 179-180 and 310 CMR 22.00). Standards for dredged material disposal include an evaluation of whether the project serves a commercial navigation purpose of federal and state significance, and whether the disposal location has been located to avoid significant fisheries resources.

Operational procedures specified in the regulations to meet the requirements specified in section 9.40(4), *Operational Requirements for Dredged Material Disposal* and 9.40(5), *Supervision of Dredging and Disposal Activity* will be addressed in Section 11.0 of this DEIR which describes the management and monitoring measures to be implemented for the designated site.

10.6 Federal Consistency

Under the federal Coastal Zone Management Act, the state, through CZM, is required to certify that federal actions in the coastal zone are consistent with the state's enforceable coastal policies. The term federal action includes the issuance of a permit. Dredging and disposal projects are reviewed for consistency with the enforceable policies and management principles as those policies and principles are addressed through existing Massachusetts statutes and their implementing regulations. CZM policies address water quality, habitat, protected areas, coastal hazards, public access, energy, ocean resources, and growth management. CZM consistency is issued for each individual disposal project and includes a determination of consistency with the following policies, as applicable:

<u>Water Quality Policy #1</u> - Ensure that point-source discharges in or affecting the coastal zone are consistent with federally approved state effluent limitations and water quality standards.

<u>Habitat Policy #1</u> - Protect coastal resource areas including salt marshes, shellfish beds, dunes, beaches, barrier beaches, salt ponds, eelgrass beds, and fresh water wetlands for their important role as natural habitats.

<u>Habitat Policy #2</u> - Restore degraded or former wetland resources in coastal areas and ensure that activities in coastal areas do not further wetland degradation but instead take advantage of opportunities to engage in wetland restoration.

<u>Coastal Hazards Policy #1</u> - Preserve, protect, restore, and enhance the beneficial functions of storm damage prevention and flood control provided by natural coastal landforms, such as dunes, beaches, barrier beaches, coastal banks, land subject to coastal storm flowage, salt marshes, and land under the ocean.

<u>Coastal Hazards Policy #2</u> - Ensure construction in water bodies and contiguous land areas will minimize interference with water circulation and sediment transport. Approve permits for flood or erosion control projects only when it has been determined that there will be no significant adverse effects on the project site or adjacent or down-coast areas.

Public Access Policy #1 - Ensure that developments proposed near existing public recreation sites minimize their adverse effects.

Energy Policy #1 - For coastally dependent energy facilities, consider siting in alternative coastal locations. For non-coastally dependent energy facilities, consider siting in areas outside of the coastal zone. Weigh the environmental and safety impacts of locating proposed energy facilities at alternative sites.

Energy Management Principle #1 -Encourage energy conservation and the use of alternative sources such as solar and wind power in order to assist in meeting the energy needs of the Commonwealth.

10.7 Clean Water Act Section 404(b)(1) Analysis

The Code of Federal Regulations at 40 CFR 230 specifies guidelines for implementing the policies of Section 404(b)(1) of the federal CWA. The guidelines apply to discharges of dredged or fill materials into navigable waters; their purpose is to restore and maintain the chemical, physical, and biological integrity of waters of the United States. In Section 404 state waters, the CWA regulations governing the discharge of dredged or fill material are administered by the Corps and EPA, and consist of a public interest review and application of the 404(b)(1) guidelines, which include determinations that (a) only the LEDPA is permitted, (b) state water quality standards are not violated, (c) rare and endangered species and marine sanctuaries are not adversely impacted by the discharge, and (d) appropriate and practicable measures are included to ensure that the discharge has no more than minimal impacts on the aquatic environment.

The guidelines are divided into Subparts A through I. Subpart A is a general discussion of the guidelines. Compliance with more specific requirements is discussed below.

10.7.1 Subpart B - Compliance with the Guidelines

(a) The discharge shall not be permitted if there is a practicable alternative that would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

The Alternatives Analysis in Section 3.0 of this DEIR establishes that the preferred alternative, open water disposal, is the LEDPA considered.

(b) No discharge shall be permitted if it contributes to the violation of a state water quality standard, violates any applicable toxic effluent standard or prohibition under Section 307 of the Act, jeopardizes the continued existence of endangered or threatened species, or violates any requirement to protect any federally-designated marine sanctuary.

The proposed discharge shall not violate any of these requirements, as discussed in Section 7.0. There is no federal marine sanctuary near the disposal site.

(c) No discharge shall be permitted which will cause or contribute to significant degradation of the waters of the United States.

This discharge will not cause such degradation, as explained in discussions of the Subparts C through F.

(d) No discharge shall be permitted unless appropriate and practicable steps have been taken to minimize adverse impacts.

Steps that will be taken to minimize these impacts are listed in the discussion of Subpart H.

10.7.2 Subpart C - Potential Impacts on Physical/Chemical Characteristics of the Aquatic Ecosystem

The discharge will not have a significant impact on physical and chemical characteristics of the ecosystem, as discussed in Section 7.0. Within this section, impacts on sediments are discussed in 7.2; impacts on suspended particulates/turbidity and water column impacts and current patterns and water circulation are in 7.3. The discharge will have no impact on normal water fluctuations, because the proposed preferred disposal location is in an open area where it will not interfere with tidal circulation. Since the discharge will not affect circulation and is not near an area where fresh and salt water mix, it will therefore not affect salinity gradients.

10.7.3 Subpart D - Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

The disposal will have no impact on threatened and endangered species, as discussed in Section 7.7. There are no benthic endangered species in the area which could be covered or otherwise directly killed, and no habitat for these species occurs in the disposal site. The disposal will not permanently affect the aquatic food web including fish, crustaceans, mollusks, or other organisms. Any benthic organisms affected by disposal will be replaced by recolonizing organisms, and/or with aquatic larvae carried to the site by currents. Since the clean dredged material disposed of at the site will be clean in accordance with applicable regulations, toxins or heavy metals will not adversely affect the recolonizing organisms. Further discussion of impacts on aquatic organisms is contained in Section 7.4. Other wildlife such as mammals, birds, reptiles, and amphibians will not be adversely affected by the disposal. The subsurface open water disposal will not adversely affect their habitat, and any additional turbidity during disposal will be temporary. Wildlife impacts are further discussed in Section 7.8.

10.7.4 Subpart E - Potential Impacts on Special Aquatic Sites

Sanctuaries and refuges. The proposed disposal site will not adversely affect the resources of sanctuaries or refuges.

Wetlands. The disposal site is located in open water and will not adversely affect any wetlands as they are defined in these guidelines.

Mud flats. The proposed disposal site is subtidal and will not adversely affect any intertidal mud flats.

Vegetated shallows. Water depths at the proposed preferred site precludes potential habitat for sea grass.

10.7.5 Subpart F - Potential Effects on Human Use Characteristics

As an open water disposal site, the site will have no adverse effect on municipal and private water supplies. Impacts from use of the site to concentrations or important migration or spawning areas for species important in recreational or commercial fisheries will be minimized by time-of-year restrictions. Any impacts to the water column or substrate will be temporary and will have a minimal effect on fisheries. Fishery impacts are further discussed in Section 7.5. Water-related recreation activities will not be affected by disposal. Turbidity from disposal events, the most probable impact, will be temporary and limited in scope.

The disposal of clean dredged material at the proposed disposal sites will have no permanent aesthetic impacts because the subsurface disposal sites will not be visible. Temporary changes in appearance of the water will last no longer than the actual disposal operation. There are no parks, national and historical monuments, national seashores, research sites, and similar preserves which could be adversely affected by disposal at the proposed sites. The Cape and Islands Ocean Sanctuary, a state managed resource, in the area of the proposed preferred site, will not be adversely impacted by disposal events.

10.7.6 Subpart G - Evaluation and Testing

Any project that proposes to use the disposal site will be required to receive a WQC from DEP and a Suitability Determination from the USACE. Current guidelines for the review of dredged material for its chemical and physical suitability for unconfined open water disposal at Section 404 sites are addressed by the Inland Testing Manual, entitled “Evaluation of Dredged Material Proposed for Discharge in Waters of the US – Testing Manual” (USACE/EPA 1998). This guidance document includes tiered sediment testing protocols that are similar to the Section 103 requirements.

Review of existing information, sediment sampling plans, applications of the testing protocols, and determinations of suitability of material for open water disposal based on results of the testing protocols are coordinated with the federal agencies (NMFS and USFWS), the DEP for state water quality certification and CZM for coastal zone management consistency concurrence.

10.7.7 Subpart H - Actions to Minimize Adverse Effects

The following actions, among those listed in Subpart H of the guidelines, will be taken to minimize adverse effects from disposal.

Actions concerning the location of the discharge:

- Predetermined discharge locations to minimize smothering of organisms;
- Selecting a disposal site previously impacted by dredged material discharge;
- Selecting a disposal site where physical classification of substrate is similar to that being discharged (such as discharging sand on sand or mud on mud;

Actions concerning the material to be discharged:

- Disposal of dredged material in a manner that physiochemical conditions are maintained;
- Limiting the solid and liquid components of material to be discharged at a particular site.

Actions affecting the method of dispersion:

- Orienting a dredged or fill material mound to minimize undesirable obstruction to water current or water circulation pattern, and utilizing natural bottom contours to minimize the size of the mound for low relief;
- Selecting sites and/or managing discharges to restrict and minimize the release of suspended particles to give decreased turbidity levels and to maintain light penetration for organisms;
- Setting limitations on the amount of material to be discharged per unit of time or volume of receiving water

Actions affecting plant and animal populations

- Avoiding changes in water current or circulation patterns which would interfere with the movement of animals;
- Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species; and
- Timing discharge to avoid spawning or migration seasons and other biologically critical time periods.

10.8 Rivers and Harbors Act of 1899, Section 10

Section 10 of the Rivers and Harbors Act of 1899, authorizes the USACE to regulate structures or work within navigable waters of the United States. Under Section 10,

> "the decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use, on the public interest. Evaluation of the probable impact which the proposed activity may have on the public interest requires a careful weighing of all those factors which become relevant in each particular case. The benefits which reasonably may be expected to accrue from the proposal must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of this general balancing process." (33 CFR 320.4)

10.9 The Endangered Species Act

The Endangered Species Act of 1973 protects federally listed and proposed threatened and endangered species. Section 7 of the Act requires the consultation with USFWS and NMFS and an opinion statement from the respective agencies. Disposal site designation is being coordinated with NMFS and the USFWS to determine whether any endangered or threatened species under their jurisdiction may be adversely affected by use of the preferred alternative.

10.10 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) authorizes the NMFS to establish EFH areas. The general purpose of the act is to conserve productive fisheries that provide recreational and commercial benefits. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". All of Buzzards Bay is classified as EFH. Under section 305(b) of the Act, coordination between federal agencies is required for any work proposed within an EFH. The intent and procedures of the Act are very similar to the Endangered Species Act (ESA). CZM has been coordinating with NMFS and USFWS in accordance with Section 7 of the ESA as well as the MSFCMA. This DEIR contains a discussion of EFH in Buzzards Bay in Section 5.3 and potential impacts to the EFH are discussed in Section 7.5. A full EFH assessment developed for the pertinent quadrates of Buzzards Bay, see Appendix M.

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11.0 BBDS MANAGEMENT AND MONITORING PLAN

All open-water disposal sites used for placement of clean (i.e., suitable for open-water disposal) dredged material must be managed carefully to avoid or minimize adverse environmental effects. The BBDS SMMP is presented below as guidelines for users, managers, and regulatory agencies. Specific management and monitoring conditions will be developed on a project-by-project basis for the life of the designation.

11.1 Background

Periodic dredging activities are required to maintain safe and efficient use of the waterways, harbors, and marinas in the Buzzards Bay region.

For most of the twentieth century, dredged material from dredging projects in the Buzzards Bay region was placed within the CLDS. Since 1980, open-water disposal for private and municipal projects in the region were limited to a smaller, circular area within the CLDS called the BBDS. The NAE determines whether dredged material disposal at the BBDS is the LEDPA under the CWA regulations on a project-by-project basis. In the early 1990s, the State of Massachusetts determined that continued use of the BBDS should not be permitted until completion of an environmental analysis similar to that being undertaken at the time for the CCDS. This DEIR, directed by MEPA and Federal agencies, provides such an analysis of the existing BBDS and the surrounding area historically used for dredged material disposal.

The preferred alternative identified in this DEIR is site 1, a 1,600 square meters (m^2, roughly one square mile) seabed plot in approximately 14 meters (greater than 40 feet) of water, and centered at 70° 41' 48.1" W, 41 35' 5,15" N. Approximately one-third of site 1 is characterized as having coarser-grained sediments influenced by historical dredged material disposal activities. This section describes the SMMP that is proposed for use at the preferred alternative site 1 in Buzzards Bay. It incorporates elements of the state CCDS and the federally designated Rhode Island Regional Site “W” SMMPs.

11.2 SMMP Objectives

The objective of this SMMP is to perform two related functions: 1) ensure that all operational procedures and disposal activities are appropriately managed to avoid degradation of the existing marine environment or impacts to cultural resources; and 2) ensure a monitoring program and data synthesis protocol capable of determining negative impacts from dredged material disposal that may be harmful to human health and welfare and the marine environment and cultural resources. This SMMP provides operational short-term and long-term guidelines to minimize potential significant adverse impacts to the marine environment from placement of clean dredged material, to be used as the basis for project-specific permit conditions and long-term site management guidance.

The major elements of the management plan include the following:

1. Establish an Oversight Committee to review site use data and advise the Department of Conservation and Recreation on site use and management;
2. Develop project-specific site use requirements for incorporation as permit conditions;
3. Develop monitoring guidelines for continuing assessment of site conditions and site use impacts;
4. Designate the entire site boundary, but restrict disposal to sub-areas that can be expanded within the overall site in response to demonstrated future need;
5. Establish three initial sub-areas based on the general northwest/southeast orientation of generally diminishing grain size: one for placement of dredged material comprised mostly of medium sand, one for fine sand dredged material, and one for muddy dredged material (See Figure 11-1);
6. Prohibit site use between April 1 and October 31, based on the initial recommendation from the DMF (subject to modification per DMF); and
7. Formally reassess overall site capacity based on post-designation site use when 500,000 cubic yards of dredged material (25% of initial designation capacity) has been placed at the site.

11.3 Site Management Responsibilities and Authorities

The preferred alternative site will be managed by the state, through the DCR Division of Waterways. DCR may manage the site directly or formally coordinate management with the NAE DAMOS. Through DAMOS, the NAE undertakes systematic monitoring of Federal disposal sites from Maine to Connecticut. (For more information on the DAMOS program, go to http://nae.usace.army.mil/environm/damos/splash_page.htm).

11.3.1 Disposal and Monitoring Advisory Committee (DMAC)

The Disposal Monitoring and Advisory Committee (DMAC) is the proposed advisory group to represent municipal interests, environmental interests, and state and federal agencies to inform and guide DCR management (or DAMOS through DCR). Because the disposal site will be a regional resource, the intent of the DMAC is to provide the means for the several local and regional interests to participate in managing the site. The purpose of the DMAC is to evaluate site-use for conformance with the management plan and project-specific permit conditions, based on the review of site-use and monitoring data, and to recommend changes to site use and/or the management plan that may be appropriate in response to those data.

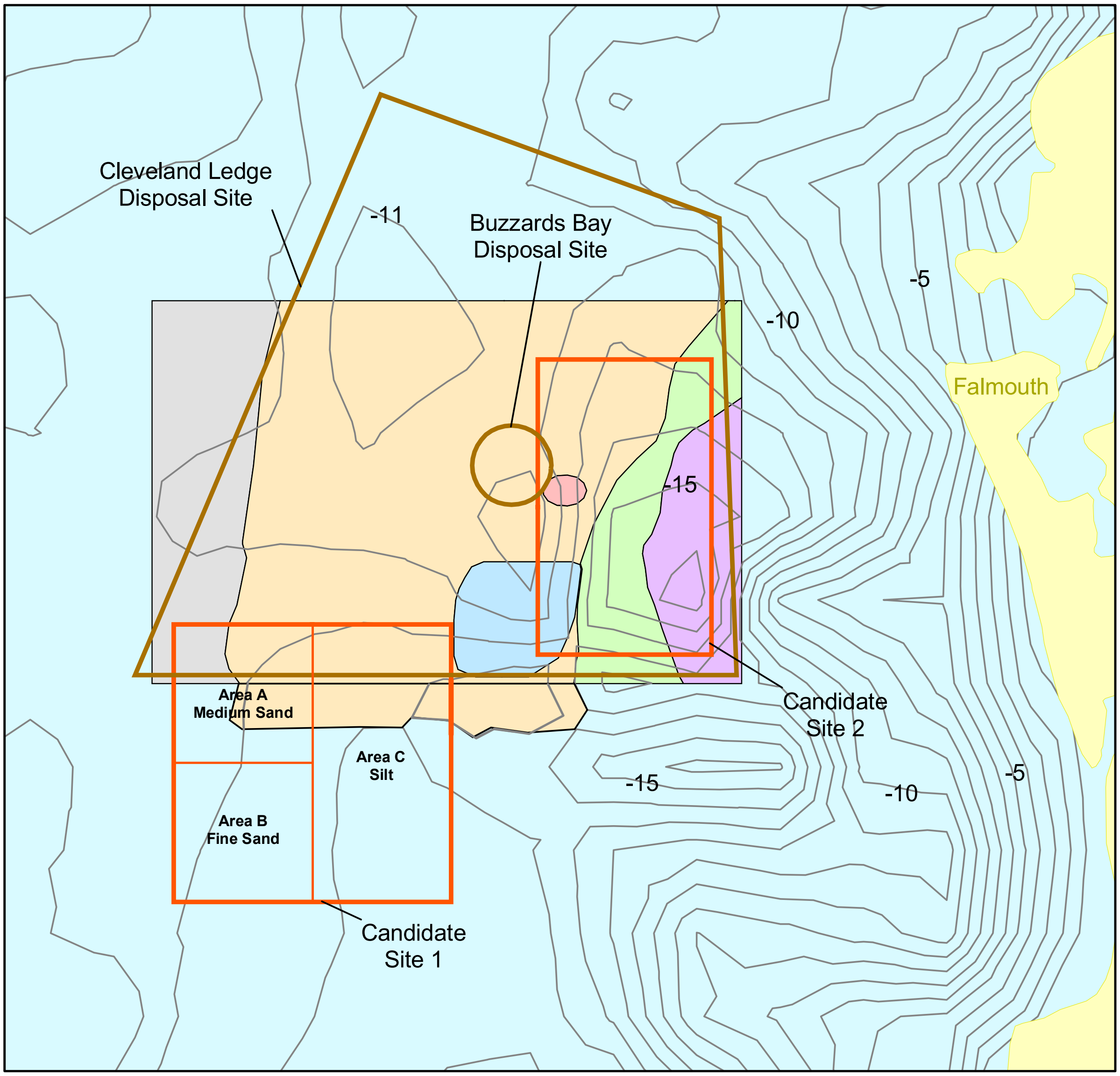

Figure 11-1
Candidate Site 1
Stages of Development
Bathymetry contours are in meters.

Recommended DMAC membership includes DCR (as chair), the Falmouth Conservation Commission, the Buzzards Bay Action Committee (BBAC), the Buzzards Bay Project, the Coalition for Buzzards Bay, the Department of Environmental Protection, Coastal Zone Management, the Division of Marine Fisheries, Massachusetts Board of Underwater Archaeological Resources, and the USACE, with participation by the USEPA, NMFS, and the USFWS at their discretion.

11.3.2 Enforcement and Monitoring

Aspects of the dredging process including dredging, transport, and disposal activities are required to comply with specific project–by-project permission. The enforcement of permit conditions authorizing use of the site on a project-specific basis is the responsibility of the Department of Environmental Protection (for the state permits, including the WQC and Chapter 91 permit), and the USACE (for the CWA section 404 and Rivers and Harbors Act section 10 permits), in conjunction with the DCR as site manager. Compliance with long-term site management requirements is the responsibility of DCR; it is the responsibility of the DMAC, working closely with DCR, to ensure that occurs. All projects that receive authorization to use the site are responsible for all aspects of their use of the site, as addressed in the respective permit conditions.

The DCR and/or the NAE will assume responsibility for site monitoring. Monitoring data may be collected by these agencies in a coordinated effort, or through the DAMOS program. Monitoring data collected by other agencies will be incorporated whenever appropriate to maximize the knowledge base of the site conditions. DCR has the responsibility to evaluate monitoring results and, in consultation with the DMAC, determine if any impacts associated with use of the site are acceptable. Such determinations will be made in consultation with other cooperating agencies and be founded on available monitoring data. The DCR is responsible for implementing modifications to the SMMP that may be recommended by the DMAC, including site use modifications or de-designation.

As in the past, disposal will continue to be practiced using a taut-wire buoy (Figure 11-2) or specified coordinates to ensure that disposal locations are known and that post-disposal monitoring is effective. On-board inspectors will be assigned and will be placed on disposal vessels, by the permittee, for all disposal activities at BBDS to ensure compliance with this policy. These inspectors will be trained and certified by the USACE specifically for the dredged material disposal program.

The ongoing work of the DMAC will address the specific elements of the management plan, as follows.

11.4 Site Management Approach

The two permits that will guide site use are the Federal Clean Water Act Section 404 permit and the state Water Quality Certificate. Conditions will be incorporated in project-specific permits to:

- Ensure compliance with permit conditions;
- Minimize sediment transport from the disposal site;
- Minimize disposal activity conflict with other users of the area;
- Avoidance of impacts to nearby significant cultural resources;
- Maximize disposal site capacity; and
- Observe and rectify conditions before unacceptable impact occurs.

SPECIFICATIONS

Buoy Dimensions	
Disc:	6' diameter, 3' height with conical bottom
Tower:	4 leg, 7' height
Battery Well:	2' diameter, 1' height
Cosntruction:	Steel
Buoyancy:	2,000 lbs.
Color:	Yellow epoxy paint
Radar Reflectors:	4 each mounted at right angles
Lantern:	ML-155 type case with yellow lens (USCG approved)
Lamp Flasher	
Change Type:	TF-3B/3C
Light Charactyer-istic:	3.6 sec. off, 0.4 sec. on
Power Source:	6.0 VDC Battery, air activated or 2 X 6.0 VDC dry cell
Chain:	3/4" heavy duty hot dip galvanized
Wire:	1/2", 6 X 19 torque balanced
Terminations:	3/4" HD thimbles cleansed with hydraulic crimped Nicopress sleeves
Mounting Hardware:	5/8" safety shackles locked with stainless steel cotter pins
Swivels:	1 Miller swivel 3 ton, 1 eye fisherman's type
Hang Weight:	500 lb. clump
Anchor:	1,800 lb. steel sphere

CONFIGURATION

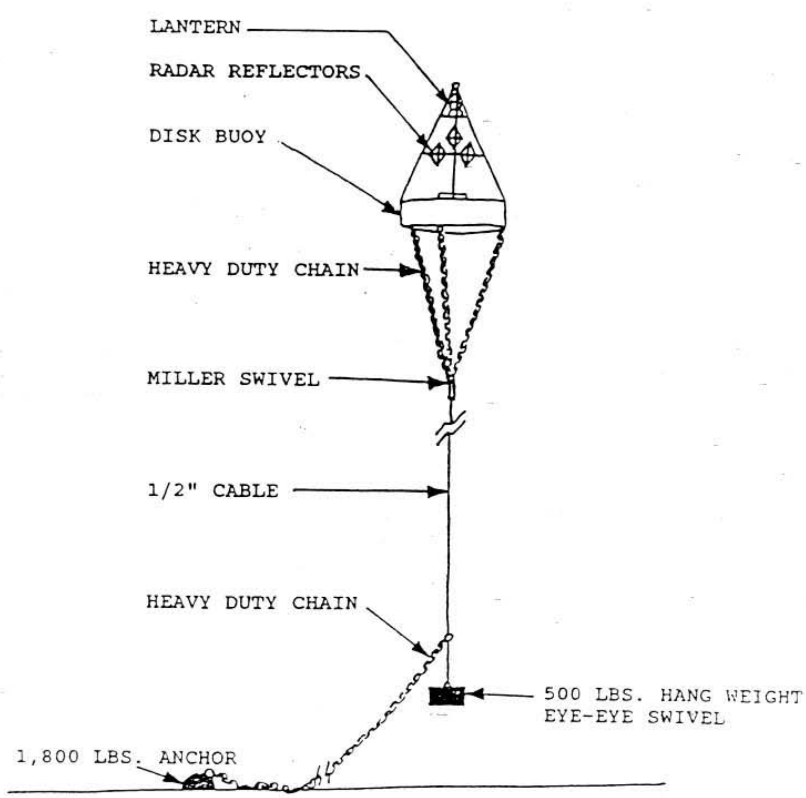

Figure 11-2. BBDS marker buoy specifications and configuration (from Massachusetts Department of Environmental Management 1993).

These site management goals will be accomplished through:

- Coordination among federal and state agencies;
- Material testing for disposal acceptability screening;
- General and specific permit conditions;
- Appropriate disposal technologies and methodologies;
- Inspection and enforcement procedures, periodic environmental monitoring at relevant reference areas for comparative evaluation; and
- Comprehensive information management and record keeping.

The BBDS management plan is designed to ensure: 1) that dredged material placed at the BBDS is clean and does not vary significantly from its original pre-dredging characterization, 2) that disposal operations are conditioned to minimize impacts to the marine environment, 3) that dredged material deposits remain in place within the site boundary, and 4) that post-disposal conditions at the site do not adversely effect the benthic ecosystem.

11.4.1 Other Management Considerations

In addition to the management practices outlined above, other management considerations may also be determined on a project-by-project basis through consultation with DMF in coordination with the NMFS and the USFWS, and other state and federal agencies. These may include the following:

- Use of marine mammal observers during disposal efforts;
- Establishment of time-of-year dredging seasons;
- Compliance with EFH recommendations; and
- Attention to ESA concerns.

11.5 Site Characterization

This section includes a general summary characterization of the preferred alternative BBDS site 1, identified through this DEIR MEPA process. The site location and the physical, chemical and biological features of the environment at the site are summarized in this section. Detailed site characterization information is provided in Sections 4, 5 and 6 of this DEIR.

11.5.1 Site Location

Site 1 is a 1,600 m^2 (roughly one square mile) seabed plot laid out in approximately 14 meters or slightly over 40 feet of water and centered at 70° 41' 48.1" W, 41 35' 5,15" N. This site overlaps the southern boundary of the traditional CLDS (see Figure 11-1). Essentially flat, this site slopes only slightly from 11 meters water depth in the northwest corner to 14 meters water depth in the southeast corner. The bottom sediment is primarily mud/sand. No navigational hazards exist with respect to preferred alternative site 1.

11.5.2 Reference Areas

The benthic community analysis that was conducted as part of the baseline characterization studies at Sites 1 and 2 included sampling at two nearby reference areas. Such sampling is commonly employed in environmental monitoring programs like DAMOS to characterize ambient or "reference" conditions in areas surrounding disposal sites and thus provide a comparative basis for assessing whether any impacts detected at the site can specifically be attributed to dredged material disposal. Reference site "REF-2" is located 3,200 meters to the west of the center of site 1 and "REF-NEW" is located 2,250 meters to the south of the center of site 1 (see Section 5.0). The precise location of these reference areas could shift depending upon the type of material placed at the disposal in any particular period, which would dictate whether siltier or sandier reference areas provide an optimal basis for comparison. Additional reference areas may also be selected in future monitoring efforts, including reference areas located closer to the disposal site.

11.5.3 Physical Characteristics

Bathymetry in the 1,600 meters by 1,600 meters (approximately one square mile) area constituting preferred alternative site 1 slopes gently downward from northwest to southeast, with depths of 11 meters (36 feet) in the northwest corner increasing to 14 meters (46 feet) in the southeast corner. Almost all of the area within site 1 has water depths of greater than 10 meters (33 feet), with the majority of the site having depths in the range of 13 to 14 meters (43 to 46 feet; Figure 4-1A and B; Maguire 2001a).

Previous studies of Buzzards Bay (Moore 1963; Howes and Goehringer 1996) have served to demonstrate that silts and muds tend to occur in the deeper basins and troughs, which represent lower-energy environments favoring entrapment and long-term accumulation of fine-grained sediments. The baseline characterization surveys conducted in support of this DEIR utilized a variety of seafloor sampling techniques (sediments grabs, SPI, side-scan sonar and video) that together serve to support the characterization of site 1 as a topographic depression favoring deposition and long-term accumulation of fine-grained (i.e., silt-clay or "muddy") sediments (Maguire 2001b; 2001c; 2002d).

11.5.3.1 Currents

Currents within Buzzards Bay are dominated by the semi-diurnal M_2 tides, with amplitudes of tidal currents decreasing from a maximum of 1 to 1.2 knots near the mouth to 0.2 to 0.3 knots at the head (Signell 1987). The field survey conducted at preferred alternative site 1 on November 11 and 12, 2003 found relatively weak tidal currents near the bottom, with a mean speed of 0.086 knots and a maximum speed of 0.131 knots during the measurement period. Bottom currents were generally aligned northeast/southwest, parallel to the axis of Buzzards Bay. Currents were relatively uniform throughout the water column at this location, and there was little spatial variation in currents within the area defined by preferred alternative site 1.

11.5.3.2 Waves

The eastern portion of Buzzards Bay is relatively well-protected from the effects of large, long-period, open-ocean waves (i.e., swells). As open ocean swells enter the mouth of Buzzards Bay from the southwesterly direction, they are refracted and slowed along the east and west shorelines as they progress towards the area of preferred alternative site 1. A preliminary hydrodynamic study conducted for this DEIR using available long-term datasets indicated a theoretical significant wave height at site 1 of 0.635 meters (2 feet) under average wind conditions and a height of 1.6 meters (5.25 feet), under high wind conditions. A follow-up, more-detailed hydrodynamic study estimated a maximum theoretical wave height of 12.8 feet at site 1 under the most extreme storm conditions likely to be experienced (i.e., comparable to Hurricane Bob in August 1991).

11.5.3.3 Erosion Potential

In the preliminary hydrodynamic analysis, a modeling simulation (Grant and Madsen 1979; Glen and Grant 1987) indicated that no sediment re-suspension would occur at site 1 under average wind, wave and tidal current conditions. Under relatively rare storm conditions characterized by extremely elevated winds, waves and currents, the model predicted that only the finest sediment fraction (i.e., fine silt) would be subject to limited re-suspension, while coarser sediment fractions would experience negligible re-suspension.

As a confirmatory follow-up to the preliminary analysis, a more-detailed hydrodynamic study was conducted to verify the results of the preliminary analysis using an independent, multiphase data collection, analysis and modeling approach. First, a field program was undertaken to characterize tidal currents near the bottom and throughout the water column at the candidate disposal sites. This was followed by an analysis of historical records to define a set of theoretical, but realistic, storm conditions at the sites. Finally, a computer simulation using the USACE's widely-accepted LTFATE model was conducted to evaluate the potential for erosion and off-site transport of dredged material deposited on the bottom within preferred alternative site 1. The LTFATE model simulations found that no sediment erosion or transport would occur over the long-term at site 1, even under the most extreme conditions (Hurricane Bob) on record for the Bay in the last 18 years (Maguire 2004b).

11.5.3.4 Sediment Quality

Results of grain size analyses (Maguire 2001b) were consistent with the historical surveys, indicating a predominance of silt and clay in surface sediments throughout the broad topographic depression in site 1 (58% to 93% silt and clay), with a component of fine sand and minor fraction of gravel (0% to 3.5%). Total TOC concentrations ranged from 0.5% (at the sandier Station B6) to 2.3%, which is typical for Buzzards Bay surface sediments removed from anthropogenic inputs of organic matter.

All metals analyzed were detected at low concentrations for all sampling stations at site 1. Despite evidence of historical dredged material disposal in the vicinity, sediment chemistry results indicated that site 1 has negligible levels of contaminants. Sediment chemistry at the site is comparable to ambient sediments and reflects the lack of direct anthropogenic inputs in the vicinity. Minor fluctuations in the low concentrations of some detected analytes reflect changes in grain size, with minor increased concentrations associated with finer grain sizes and increased TOC. Results indicate that past disposal activities in and around site 1 have not resulted in any significant elevations in chemical contaminant concentrations relative to ambient Buzzards Bay sediments.

11.5.3.5 Water Column Characteristics and Water Quality

Buzzards Bay is relatively shallow, so that tidal currents and wind waves are effective at producing a well-mixed water column and stratified conditions generally are not persistent. Camisa and Wilbur (2002) found no evidence of stratification within the water column above the preferred alternative site 1 during 20 sampling events conducted over a 13-consecutive month sampling period (March 2001 to March 2002). A vertically well-mixed water column also was observed at site 1 during the November 2000 baseline characterization survey effort. Stratified conditions may occur periodically in the central portions of Buzzards Bay, including in the vicinity of preferred alternative site 1, due to either excessive freshwater inflow associated with storms (i.e., salinity stratification) or thermal stratification during occasional periods of weak winds in the summer and early fall (Howes and Goehringer 1996). However, freshwater effects are much more pronounced in small harbors and embayments along the shoreline. Stratification events that may occur at site 1 would not be very pronounced and would generally be of short duration, given the propensity of the semi-diurnal tidal currents and wind waves to adequately mix the water column. Concentrations of chemical contaminants (metals, pesticides, PAHs and PCBs) in near-surface and near-bottom water samples collected at site 1 in November 2000 were consistently below EPA Water Quality Criteria.

11.5.4 Biological Characteristics

The results of a SPI survey (Section 5.1) showed only minor differences in benthic habitat characteristics between site 1 and two nearby reference areas, and the benthic communities in all three areas were found to be comparable. These communities were characterized by an abundance of several opportunistic, "Stage I" polychaete species (e.g., *Mediomastus ambiseta*, *Prionospio perkinsii, Caraziella hobsonae*) known to have high population turnover rates and therefore wide spatial and temporal variance. These species and several others were consistently among the numerical dominants of the infaunal communities within site 1 and the two reference areas.

Statistical analyses of various benthic community attributes (e.g., species richness, diversity, evenness) showed either no or only minor differences between preferred site 1 and the two nearby reference areas. The minor differences were attributed to normal variations in both sediment grain size and the distribution of benthic infauna. The benthic infaunal communities at preferred alternative site 1 and the reference areas were broadly comparable to those found in recent and historical studies in other areas of Buzzards Bay, in terms of being dominated by roughly the same group of relatively few taxa.

11.5.4.1 Commercial /Recreational Fish and Shellfish Resources

The marine fish and shellfish of Buzzards Bay are part of the faunal communities that comprise the Atlantic temperate biogeographical region. This region is characterized by moderate temperatures and longer summer warming, and therefore a wider annual temperature range than waters north of Cape Cod (the boreal region). Many northern species of fish reach the southern limit of their range at Cape Cod, while many southern species reach their northern range limit.

Many of the fish in Buzzards Bay are migratory, moving along the southeastern New England coast and into the Bay in spring and summer. Some species frequently continue the migration through the Cape Cod Canal into Cape Cod Bay (e.g., bluefish, striped bass). Some resident species also move throughout the Bay or disperse from it into adjacent coastal waters (e.g., winter flounder, tautog, skate). As a result, the nekton of Buzzards Bay is connected to a much larger population of fish and invertebrates affected by regional conditions of stress and opportunity. These populations are dynamic and will continue to change spatially and temporally in response to a variety of biotic and abiotic environmental factors.

Table 11-1 provides a summary of the occurrence of select species relative to the proposed alternative disposal sites. The presence and peak abundance of these species are discussed in great detail in earlier sections of this document and in the original report (Camissa and Wilbur 2002). Five of the select species were deemed to have major appearances at preferred alternative site (Table 11-1).

Table 11-1. Summary of select species relative to the proposed candidate disposal sites and proximal areas.

Species	Presence/ Peak Abundance	Appearence
Atlantic herring	Winter to early spring/ February to April	minor
Atlantic menhaden	Mid-September	minor
bay anchovy	Late June to early October/ mid-September	minor
black sea bass	Mid-May to mid-September/ mid-September	minor
bluefish	Late May to early October/ mid-September	minor
butterfish	Mid-May to mid-September/ mid-July	minor
cunner	Winter	minor
little skate	Early April to early June Mid-September to mid-December	major
long-finned squid	<id-May to mid-October/ July	major
striped searobin	Limited to low, absent in winter	minor
scup	Mid-May to mid-October/ early June	major
striped anchovy	Generally absent	minor
summer flounder	Mid-May to mid-July	major
tautog	Fall, winter, spring/ May-June	major
weakfish	July to mid-September/ early September	major
wndowpane	Little seasonal variation low yields	minor
winter flounder	Mid-march to Mid-April/ site 2	minor

The results of the 13-month otter trawl survey suggest that lobsters have very low abundance within preferred alternative site 1. The presence of shellfish within this site also was characterized via a comprehensive review of existing information and the various surveys conducted in support of this DEIR. Limited numbers of economically important gastropod and bivalve mollusks were collected in the grab sampling and trawl surveys at preferred alternative site 1 (see Section 5.0).

EFH is defined in the Magnuson-Stevens Act as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. Within the designated EFH grid for Buzzards Bay, EFH for specific life stages of 20 species is designated (Table 11-2). As part of this DEIR, an EFH Assessment was conducted and is included in Appendix F.

11.5.4.2Commercial/Recreational Fishing

While there is ample historical evidence of substantial finfish landings, the primary commercial fisheries in Buzzards Bay are now lobster and shellfish (Howes and Goehringer 1996). Commercial finfish trawling has been banned in the bay since the late 1800's (Howes and Goehringer 1996). However, this ban does not include commercial fish potting and angling. Deeper, muddy areas like most of the preferred site 1 are considered unproductive. The northern perimeter areas of the bay, west and east, are fished in summar with pots for cscup and black sea bass (Maguire 2002b). Angling for fluke and scup overlaps the potting areas and includes the grounds east of the navigational channel near the entrance to the Cape Cod Canal. Commercial finfish (e.g., sea bass, scup, conch, striped bass, fluke, tautog) are pursued between April and mid-November, with the highest abundance and harvesting activities during the warmer summer months.

Table 11-2. EFH-designated species and their life stages (denoted by "X") designated for the EFH grid [described in Table 5-12, includes finfish, invertebrates and shellfish].

Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua*)	X	X	X	X
Haddock *(Melanogrammus aeglefinus)*	X	X		
Red hake *(Urophycis chuss)*		X	X	X
Winter flounder *(Pseudopleuronectes americanus)*	X	X	X	X
Windowpane flounder *(Scophthalmus aquosus)*	X	X	X	X
American plaice *(Hippoglossoides platessoides)*			X	X
Atlantic sea herring *(Clupea harengus)*			X	X
Bluefish *(Pomatomus saltatrix)*			X	X
Long finned squid *(Loligo pealei)*	n/a	n/a	X	X
Atlantic butterfish *(Peprilus triacanthus)*	X	X	X	X
Atlantic mackerel *(Scomber scombrus)*	X	X	X	X
Summer flounder *(Paralichthys dentatus)*	X	X	X	X
Scup *(Stenotomus chrysops)*	X	X	X	X
Black sea bass *(Centropristus striata)*	n/a	X	X	X
Surf clam *(Spisula solidissima)*	n/a	n/a	X	X
King mackerel *(Scomberomorus cavalla)*	X	X	X	X
Spanish mackerel *(Scomberomorus maculatus)*	X	X	X	X
Cobia *(Rachycentron canadum)*	X	X	X	X
Sandbar shark *(Charcharinus plumbeus)*				X
Bluefin tuna *(Thunnus thynnus)*			X	

n/a = denotes that life stage is not applicable to that particular species

Commercial fishers seek areas with the most heterogeneous structure complexity inside Buzzards Bay. This practice usually translates to higher fish abundance for commercial potters, who largely pursue scup and black sea bass in the vicinity of the two candidate disposals sites evaluated in this DEIR (Maguire 2002b). As discussed above, the bottom at candidate site 2 was found to exhibit more habitat complexity due to its steeper slope, mosaic of sediment types, and proximity to structure (e.g., Gifford Ledge). Based on this habitat complexity, candidate site 2 was deemed of higher potential value as a productive fishing ground for commercial finfish potters compared to the preferred alternative site 1.

Based on interviews with commercial and recreational lobsterman, the shallower, structure-filled areas of the old CLDS are highly valued (Maguire 2002b). The deeper, muddy areas of this region appear to be less valuable as lobster habitat. Commercial conch potting is conducted within and proximal to preferred alternative site 1. The shallower waters around Cleveland Ledge support fluctuating stocks of bay scallops that are not found in the deeper muddy basin areas of preferred alternative site 1. Shoreline embayments, all located at considerable distances from site 1, are the most important quahog areas of Buzzards Bay.

Candidate sites 1 and 2 were both found to have value to recreational anglers who pursue various fish species with either their own craft or chartered vessels. Based on its greater habitat complexity, site 2 was deemed of higher potential value to recreational anglers than preferred alternative site 1.

11.5.4.3 Submerged Aquatic Vegetation

Water depths throughout preferred alternative site 1 are too deep to support eelgrass beds, and recent surveys do not give any indication that there are eelgrass beds associated with the shallow areas of Gifford Ledge (Howes and Goehringer 1996; Schwartz 2000).

11.5.4.4 Rare and Endangered Species

Within the Department of Fish and Wildlife Division of Fisheries and Wildlife Natural Heritage Program, personnel associated with the Endangered Species Review program failed to locate any records of any known rare plants, animals or exemplary natural communities within preferred alternative site 1 (DEP 2002). Likewise, no federally-listed or proposed threatened or endangered species under the jurisdiction of the USFWS are known to occur in the project area (USFWS 2002). The NMFS identified several federally-listed sea turtles that may be found in New England waters, including Buzzards Bay, during the summer months. However, it is considered highly unlikely that these turtles will be encountered in Buzzards Bay during the times of year when disposal activities are likely to be occurring (late fall through early spring).

11.6 Site Monitoring Program

Dredged material disposal activities will be monitored by the DCR and/or in a coordinated effort with the NAE DAMOS program. Effective environmental monitoring programs rely on available knowledge and understanding to develop approaches and clearly define objectives that focus on the primary issues of concern. Monitoring of disposal sites in New England over the past 25 years has followed the proven framework and innovative protocols developed by the DAMOS program (SAIC 1994; Fredette and French 2004). Elements of the site monitoring program described below incorporate a number of helpful aspects of the DAMOS framework.

The goal of the monitoring program for clean dredged material placed at BBDS is to provide, in a scientifically credible yet cost-efficient manner, information that will:

- Indicate whether disposal activities are occurring in compliance with permit and site restrictions;
- Support evaluation of the short-term and long-term fate of the dredged material based on MPRSA site impact evaluation criteria;
- Support assessment of potential significant adverse environmental impacts from dredged material disposal at the site.

To achieve this goal, data will be developed in two areas: 1) *compliance monitoring* of performance according to conditions in disposal permits and authorizations, and 2) *environmental monitoring* of the disposal site and nearby regions. The latter information will be evaluated together with historic and ongoing dredged material testing data and other accessible and relevant databases (e.g., Dredged Material Spatial Management and Resolution Tool [DMSMART]). These data will be provided to the USEPA, NAE, and the Commonwealth agencies, at least one month prior to each intermittent regional inter-agency dredging planning meeting these federal and state agencies regularly attend.

The evaluation of impacts from disposal at the site will be accomplished through a comparison of the conditions at the disposal mound(s) to both historical conditions (e.g., changes in historic mound height and/or footprint) and conditions at nearby reference stations that have not been influenced by any recent or historical disposal activities. Periodically, this information may be reviewed and discussed by the DMAC. The meeting participants will use this information and the monitoring data gathered in the previous year to assess the potential impact and plan additional monitoring surveys, as necessary. DCR and the USACE will coordinate to implement the appropriate action (e.g., field surveys, additional investigations, or management actions) within the tiered monitoring program and define appropriate actions to mitigate any unacceptable conditions.

This plan provides an overall framework for site monitoring activities and guides future sampling efforts. Specific details regarding such sampling efforts (e.g., sampling design, statistical comparisons) will be described in project-specific survey plans developed through the annual agency meeting. Similarly, the schedule for the monitoring surveys will be governed by the frequency/intensity of disposal at the site, results of previous monitoring surveys, and funding resources. The data gathered under this monitoring plan will be evaluated on an ongoing basis to determine whether modifications to the site usage or designation are warranted.

11.6.1.1General Management Conditions

Site capacity is established at 2 million cy, subject to reassessment based on the results of environmental monitoring, site use, and continued demonstration of need.

DCR will be required to develop and maintain a ten-year schedule of specific projects that propose to use the site. The purpose of this condition is not to create an exclusive list or prevent projects that do not provide notice from using the site, but to provide DCR and the advisory group with a reasonable estimate of future site need. This provides a basis for making sound site management decisions.

Disposal within the site will be initially restricted to sub-areas defined based on the principles of limiting geographic impact of site use, minimizing physical impact by placing material in an area of similar grain size, and minimizing the area of previously undisturbed bottom that will be effected. Management of these sub-areas will be refined over time in response to the volume of site use, demonstrated future need, and the results of environmental monitoring. Areas A, B and C are illustrated by Figure11-1 and further delineated in Table 11-3.

Overall site capacity will be formally reassessed once a total volume of 500,000 cy of dredged material (25% of the initial designation capacity of 2,000,000 cy) has been disposed. The effects of disposal on site capacity will be evaluated on a less formal basis through regular monitoring surveys conducted well before the 500,000 cy milestone is reached, but this condition formalizes the requirement to conduct a comparison of projected capacity and projected need.

Table 11-3. Development of areas of the preferred candidate site 1.

	Area "A"	Area "B"	Area "C"
Location in BBDS	Northwest	Southwest	East
Area	0.25 square mile	0.25 square mile	0.5 square mile
Lat/Lon of center point (Northing; Easting)	266,575.33; 815,667.49	266,579.53; 814,869.96	267,377.06; 815,264.53
Predominant Sediment	Medium Sand	Fine Sand	Silt
Level of previous impact	Presence of Dredged Materials (rubble field)	Minor	Presence of Dredged Materials (rubble field in northern extent)

The disposal site will be closed from April through October to protect sensitive lobster and fish activity. The DMAC, using any additional data that may become available and/or based on the recommendations of the DMF, can revisit this time-of-year restriction in the future.

Because the characteristics of open-water disposal activities and their potential impacts are generally well-understood and consistent from project-by-project, the DEIR recommends that the DEP and the Falmouth Conservation Commission develop an approach to issuing OOC that protects the interests of the WPA and ensures consistency and predictability for project applicants. Such an approach could include, for example, a generic OOC, with provisions for unique circumstances that address the interests of the WPA as it relates to disposal activities. It could also incorporate recommendations from the Conservation Commission for inclusion in the state WQC.

11.6.2 Compliance Monitoring

Compliance monitoring consists of evaluating information and data to verify that disposal activities conform to the conditions in permits and authorizations. Such information and data will be gathered and evaluated separately from the environmental monitoring data.

Guidance on procedures and protocols for determining the suitability of dredged material for open-water disposal is provided in the Regional Implementation Manual (RIM), a document prepared jointly by Region 1 of the EPA and the NAE (EPA/USACE-NAE 2004). The RIM is derived from and consistent with the "national standards" that are documented in the Inland Testing Manual (ITM; EPA/USACE 1998). The RIM provides specific testing and evaluation methods for dredged material disposal projects within the New England area. Updates and/or revisions to this document will take precedence at the time of notification by the appropriate agencies.

11.6.2.1 Disposal Conditions, Locations, and Release Timing

The permit conditions listed below are representative of those typically imposed by the USACE under their 404/Section 10 permitting process. These conditions are subject to modifications as part of the review process for each individual dredging project. Alternative reporting procedures and requirements may be developed in the future by the DCR and or the NAE. If so, these will be distributed to the DMAC for review and comment.

The conditions specified by the NAE in a typical New England dredging permit are listed as follows:

1. At least ten working days prior to the project start date, the First Coast Guard District, Aids to Navigation Office (617- 223- 8356) shall be notified of the location and estimated duration of the dredging and disposal operations.
2. At least ten working days in advance of the project start date, the Coast Guard Marine Safety Office (617-223-3000) shall be notified of the location and estimated duration of the dredging and disposal operations.
3. An onboard inspector who has been trained by, and who holds a current certification from the NAE must witness every release of dredged material at the disposal site. The disposal inspector shall be contracted and compensated by the permittee. A list of currently certified disposal inspectors is available from the NAE Regulatory Division (978-318-8292). The inspector will insist that the permittee perform in accordance with all permit conditions and other special requirements as applicable.
4. To engage dredging project activities after a month or more of down-time, the permittee or the permittee's representative is required to notify the NAE Policy Analysis and Technical Support Branch (978-318-8292) at least ten working days prior to the date disposal activities are expected to resume. Required information to relay to the USACE in this notification include: permit number, permittee name, name and address of contractor, estimated dates dredging is expected to begin and end, name of the disposal inspector, name of the disposal site and estimated volume to be dredged. Disposal operations shall not resume until the permittee is in receipt of a letter of initiation or continuation authorized by the NAE Policy Analysis and Technical Support Branch. Disposal site coordinates to be used for the specific project and time period will be spelled out in the NAE letter. Disposal site coordinates for authorized resumed dredged material disposal may differ from those assigned to a project prior to the down-time or from any other project using the disposal site. Disposal may resume immediately on permittee receipt of the letter authorized by the NAE Policy and Technical Support Branch.
5. It is the permittee's responsibility to assure that a separate USACE disposal inspection report (scow log, see Figure 11-3) is fully completed by the inspector on each trip to the disposal site. In addition, permittees must assure that USACE disposal inspection reports must be received by the NAE at the following address within one week of the trip date indicated on the report: US Army Corps of Engineers, Regulatory Division, Policy Analysis and Technical Support Branch, 696 Virginia Road, Concord MA 01742-1751, telefax number 978-318-8303. When specific dredging seasons close for specific dredging projects, permittees must fill out a form supplied by the NAE following verification of disposal point coordinates.
6. Except when directed otherwise by the DCR Program Manager, all operations involving disposal of dredged material shall comply with the following:
   - The permittee shall release the dredged material at a specified buoy or set of coordinates within the disposal site (Figure 11-2).
   - Every disposal event must be located at the DCR marker buoy or at DCR specified coordinates. This disposal event protocol must be followed, with the only exceptions due to safety concerns stemming from weather conditions or sea state. When the dredged material disposal point is deviated due to unsafe maneuvering conditions resulting from weather conditions or the sea state, the scow must be moving only fast enough to maintain safe control and the release

must be within 150 feet of the marker buoy or specified coordinates. If worsened weather conditions and/or the sea state do not allow disposal within the confines of the exceptions described immediately above, disposal is prohibited. Scow operators and project managers need to pay special attention to weather conditions or sea state prior to departing for the disposal site.

- DCR and/or their designated representatives reserve all rights under the applicable law to free and unlimited access to and/or inspection of (through permit conditions):
    1. the dredging project site including the dredge plant, the towing vessel and scow at any time during the course of the project;
    2. any and all records, including logs, reports, memoranda, notes, etc., pertaining to a specific dredging project (federal, state or private);
    3. towing, survey monitoring, and navigation equipment.
- If dredged material regulated by a specific permit issued by the NAE in coordination with the DCR is released (due to an emergency situation to safeguard life or property at sea) in locations or in a manner not in accordance with the terms or conditions of the permit authorization, the master/operator of the towing vessel and or the USACE-certified Disposal Inspector shall immediately notify the NAE and/or the DCR, then follow-up with a full report within ten (10) working days. The report should contain factual statements detailing the events of the emergency and an explanation of the actions that were ultimately taken.
- DCR will maintain and make available to the DMAC, in annual report form, records associated with use of the site, including project-specific information (permits, scow logs, etc.).

11.6.2.2 Allowable Disposal Technologies and Methods

Dredging and dredged material disposal in Buzzards Bay have historically been accomplished using a bucket dredge to load split hull or pocket scows for transport to the disposal site. Typical capacity for these transport vessels ranges from 1,000 to 6,000 cy, and capacity limitations may be specified as a condition of project permits.

11.6.2.3 Modifications to Disposal Practices

Modifications to the disposal site use may be required. Potential disposal site use management measures may be recommended by the DMAC to avoid, minimize, or mitigate impacts, based on the results of site monitoring.

11.6.3 Environmental Monitoring

Periodic environmental monitoring of the BBDS is required to ensure that dredged material deposits are contained within the site boundary and remain stable on the seafloor over time. This environmental monitoring also is necessary to confirm that the deposited dredged material is not having any significant negative environmental impacts within and around the disposal site. In particular, regular environmental monitoring surveys are conducted to confirm that areas of the seafloor where dredged material has been placed are recolonized over time by communities of benthic organisms similar to those in surrounding areas. The environmental monitoring program for the disposal site is developed around four fundamental premises that establish the overall monitoring approach, from both a data acquisition perspective as well as in relation to the temporal and spatial scales of the measurement program:

1. Any available testing information from studies or projects previously authorized to use the site for dredged material disposal can provide key information about the expected quality of material that has been placed in the site;
2. Lack of benthic infaunal community recolonization on new dredged material disposal mounds is an early indicator pointing to potential significant adverse impact;
3. Certain aspects of the impact evaluation can be accomplished using available data from regional monitoring programs (e.g., fisheries impact),
4. Monitoring of certain conditions (e.g., long-term mound stability) at the site may be conducted on a less-frequent basis or only in response to major environmental disturbances such as the passage of major storms.

The first premise requires that historic and ongoing dredged material testing results be available. The second through fourth premises require various types and scales of monitoring to ensure dredged material disposal at the site is not resulting in unacceptable negative impacts to the marine environment. Given the four premises described above, the monitoring program is further structured with the following site management indicators of concern that reflect potential effects from disposal impacts:

Movement of Dredged Material. Movement of dredged material into sanctuaries, or onto beaches or shorelines. Movement of material towards productive fishery or shellfishery areas;
Absence of Pollutant-Sensitive Biota. Absence from the disposal site of pollutant-sensitive biota characteristic of the general area;
Changes in Water Quality. Progressive, non-seasonal changes in water quality or sediment composition at the disposal site, when these changes are attributable to dredged material placed at the site;
Changes in Composition and/or Numbers of Biota. Progressive, non-seasonal changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site, when these changes can be attributed to the effects of dredged material placed at the site.
Accumulation of Material Constituents in Biota. Accumulation of material constituents (including, without limitation, human pathogens) in marine biota at or near the site (i.e., bioaccumulation).

As described in the next section, a tiered approach is used to identify the concerns associated with open-water disposal at a given site, formulate monitoring objectives and hypotheses that specifically address these concerns, and tailor the monitoring activities to meet these objectives in a scientifically rigorous and cost-efficient manner.

11.6.3.1 Tiered Approach to Environmental Monitoring

In general, environmental monitoring of the disposal site will be conducted using a “tiered” approach, similar to that developed and used by the NAE DAMOS based on over 25 years of experience (SAIC 1994). The “first-tier” monitoring will be performed at regular intervals (i.e., once per year for the first two years of site usage and thereafter following the fifth year of site usage) to delineate the distribution of dredged material on the seafloor. This monitoring typically involves the use of bathymetric and side-scan sonar surveying techniques and is designed to address questions such as: 1) does the deposited material occur in a mound near the disposal buoy locations, as expected, and 2) does each disposal mound remain stable over time?

First-tier monitoring also is conducted to verify that each dredged material mound becomes recolonized by benthic organisms, in a manner consistent with expectations (as described in Section 5.1). Two survey techniques are used in New England and elsewhere to evaluate the benthic recolonization status of dredged material disposal mounds: 1) grab sampling to characterize both sediment characteristics (e.g., grain size and chemistry) and the composition of benthic communities, and 2) sediment-profile imaging (SPI). As previously indicated, SPI involves using a specialized underwater camera to obtain cross-section photographs of the surface sediments; subsequent analysis of the images provides information on physical and biological characteristics (including the recolonization status or "successional stage") and overall benthic habitat quality. Therefore, the first-tier monitoring at the BBDS would also involve a combination of grab sampling and SPI, both to delineate the distribution of dredged material on the seafloor and to evaluate sediment characteristics and benthic recolonization status.

The measurement program under Tier 1 focuses on both individual dredged material mounds and the overall site conditions. New mound construction will be evaluated within one to two years of completion, and the entire site will be evaluated as needed. Tiers 2 and 3 provide for progressively more detailed and focused studies to confirm or explain unexpected or potentially significant adverse conditions identified as a result of the Tier 1 monitoring. For example, if Tier 1 monitoring indicates an absence of pollutant-sensitive biota and/or an extremely slow or aberrant pattern of benthic recolonization, successive Tiers would enable examination of potential causes by incorporating additional investigation of sediment characteristics and quality. However, if the results of the Tier 1 monitoring activities conform to expectations and/or indicate a lack of significant negative impacts, additional and more expensive monitoring under Tier 2 would not be necessary.

This monitoring would entail sampling both the area(s) of dredged material placement activity within the BBDS boundary, as well as at several nearby reference areas. In general, reference areas or "control sites" are a critical element in most environmental monitoring programs because they provide a comparative basis for evaluating conditions at the "impact" site(s). Use of reference areas will help to determine the nature of any adverse conditions found within the BBDS (i.e., are such conditions due strictly to dredged material disposal, or are they also observed at the reference areas and therefore more likely due to a more widespread, regional phenomenon?).

The first-tier monitoring results will be used to test several predictions. First, the BBDS is being designated as a dredged material containment site, and it is therefore predicted that dredged material mounds formed within the BBDS will be stable over many years. Second, it is anticipated that benthic organisms will recolonize these dredged material mounds in a predictable sequence consisting of Stages I, II, and III, and this recolonization will occur over periods of months to years (see Section 5.1). If the first-tier monitoring results confirm these predications, than there is typically no need to initiate any more intensive, and costly, second- or third-tier monitoring.

If the first-tier monitoring results fail to verify the predictions, however, then it may be necessary to perform additional monitoring. For example, if it is found that benthic organisms are not recolonizing a particular dredged material disposal mound in the typical sequence, it may indicate that the disposed sediment is having an unanticipated toxicological effect. In this situation, additional sediment samples would be obtained for subsequent chemical and/or toxicological testing. If it were found that the sediment was exerting a toxicological effect, then the ensuing management action might involve covering the mound in question with additional dredged material, thereby capping and isolating the suspect sediment. Likewise, if the annual bathymetric and side-scan sonar surveying revealed that the dredged material was not remaining within the site boundary, it might require additional measurements of current patterns and/or a change in disposal practices.

In general, the second-tier monitoring at the BBDS may include one or more of the following elements:

1. additional collection and testing of sediments for chemical contaminants or toxicological effects,
2. collection and testing of benthic organisms to determine contaminant body-burdens,
3. additional bathymetric, side-scan sonar, or sub-bottom profiling surveys, and/or
4. deployment of current meters and wave gauges to evaluate sediment dispersal patterns

In general, Tiers 2 and 3 provide for progressively more detailed and focused studies to confirm or explain unexpected or potentially significant adverse conditions identified under Tier 1.

11.6.3.2 Baseline and First Year Monitoring

The DEIR recommends two initial monitoring efforts, followed by periodic monitoring as deemed appropriate or necessary by the DMAC, DCR, and/or NAE in response to site use and initial monitoring results. A first round of environmental monitoring will develop a pre-disposal baseline, and a second round will evaluate post-disposal site conditions after the first year of site usage.

A comprehensive pre-disposal monitoring cruise should be designed to develop a baseline characterization of the site. By developing a complete picture of bottom conditions, subsequent monitoring can be designed to provide a similarly comprehensive post-disposal characterization of site conditions, and allow for less intensive, focused monitoring efforts designed either to periodically take a "snapshot" of the site or to answer specific questions or address specific concerns. The following monitoring activities may be undertaken as part of the initial pre-disposal monitoring:

- Precision bathymetry on 25 meter line spacing – Bathymetry provides an accurate map of bottom topography and can assist in characterizing bottom types.
- Side-scan sonar – Side-can provides more detailed, three-dimensional representation of surficial features and is particularly helpful in assessing post-disposal conditions.
- Sub-botttom acoustic reflection profile – Sub-bottom acoustic data identifies sediment stratigraphy below the surface of the seafloor, and helps managers determine how much consolidation the disposal mound is experiencing.

- Sediment profile imaging (SPI) survey – SPI provides an image of the sediment surface (down to 20 cm) in cross-section. Parameters measured in SPI images are useful for characterizing both physical and biological seafloor conditions. SPI also is used extensively as part of post-disposal monitoring to verify that bottom conditions are recovering within an expected range.
- Sediment chemistry analysis – Sediment chemistry is determined through sampling and testing to establish the baseline sediment quality conditions at the disposal site and nearby reference areas. The results are used by the EPA and the NAE as part of the initial project review process that determines the suitability for open-water disposal of the sediment proposed to be dredged.

The post-disposal survey should replicate the sampling activities and data products of the pre-disposal survey. The need for any immediate, unscheduled, follow-up sampling activities will be determined through deliberations of the DMAC, upon review of the monitoring report(s).

11.6.3.3 Second Year Post-Disposal Monitoring

Following the second year that the BBDS is used for dredged material disposal, another round of monitoring surveys will be undertaken. These will repeat the surveys employed in the first year post-disposal monitoring, with sampling concentrated in the area(s) where dredged material has been deposited in the previous two years. The second year monitoring report will make comparisons to both the pre-disposal and first year monitoring results to evaluate the environmental effects of disposal in the intervening period. Report review, comment and approval procedures will be the same as those for the first year monitoring.

In compliance with MEPA regulations, an ENF will be prepared by DCR and submitted to the MEPA Unit before the end of the third year of site use for dredged material disposal. The ENF will make note of any adverse effects deriving from use of the BBDS and incorporate any DMAC recommendations regarding revisions to the SMMP. In accordance with existing regulations, an ENF will be filed every three years following the completion of the first three-year period.

11.6.4 Movement of Dredged Material

This indicator addresses two concerns relative to the disposal of dredged material at BBDS. The first is site management and compliance. The second is movement of the material after disposal. The questions that will be addressed include:

- Is the material deposited at the correct location?
- Are mounds constructed consistent with the site designation?
- Are mounds stable and dredged material retained within the disposal site?

The latter question directly addresses management concerns about material moving into sanctuaries, or onto beaches or shorelines and towards productive fishery or shellfishery areas. Because the site designation specifies that BBDS is a non-dispersive site (see Section 4.1), movement of dredged material out of the site is not expected. If the first-tier monitoring data indicate otherwise, disposal operations will be suspended until the cause(s) are ascertained and decisions made about appropriate second-tier monitoring activities and/or management options.

Disposal operations at the site will be directed by regulators to encourage the formation of discrete mounds of material on the bottom, and thus limit the area(s) of impact during any given disposal season. In the LTFATE modeling simulations, it was found that no significant sediment transport would occur at site 1, even at depths as shallow as 10 meters (33 feet). First-tier monitoring of mound formation at BBDS will consist of periodic precision bathymetric surveys, in part to determine when any given mound has reached its maximum desirable height. Mound growth will be controlled to ensure that a minimum water depth of 10 meters is maintained throughout the site. It is anticipated that the tops of most mounds created at the site will occur at depths greater than this 10 meters minimum depth goal, providing an additional measure of insurance against the likelihood of erosion and transport.

Tier 1: To monitor for loss of material, the data from the sequential one- and two-year post-disposal bathymetric surveys will be compared. Significant negative changes in the height of any mound, over and above those associated with normal mound consolidation, would indicate a possible erosive loss of material and would trigger more extensive Tier 2 monitoring.

Tier 2: This monitoring would be directed at determining whether there were any changes in sediment quality immediately outside the site that might be indicative of potential unacceptable off-site transport. The monitoring techniques to be employed may consist of some combination of additional precision bathymetric surveys, side-scan sonar surveys, and SPI technology to detect the presence of thin depositional layers of dredged material at the sediment surface outside the site and other potential changes in sediment characteristics.

Tier 3: If the Tier 2 monitoring confirms that significant off-site transport of dredged material has occurred, Tier 3 monitoring efforts would be directed at evaluating potential effects on sediment quality and benthic productivity in the affected area(s). Sediment chemistry, toxicity, and benthic community structure likely would be measured at representative locations (determined through interagency coordination) from any areas where the benthic community is suspected of being negatively effected (as a result of the Tier 2 SPI monitoring), as well as at the nearby BBDS reference areas.

Chemical and toxicity testing and analysis will be conducted using methods required by the RIM (EPA/USACE-NAE 2004) or subsequent approved documents. Benthic community sampling and analysis methods will be the same as those conducted during site designation studies. Statistical comparisons and numbers of samples will be determined during project-specific survey planning. Data from the area(s) of concern will be compared statistically to data collected concurrently from the nearby BBDS reference areas to determine if the quality of transported material is unacceptable, based on the results of all three indicators (i.e., sediment chemistry, benthic community analysis, and sediment toxicity).

11.6.5 Absence from the Disposal Site of Pollutant-Sensitive Biota Characteristic of the General Area

The premise underlying this indicator of concern is that the infaunal community on disposal mounds recovers rapidly after disposal activity ceases for the season. Therefore, the absence of recovery or slower-than-expected recovery of the benthic infaunal community indicates a potential biological impact at the mound and, by implication, the ability of the site to support higher trophic levels. The long history of disposal site monitoring in New England and other locations throughout the world has resulted in an excellent understanding of both the rates at which benthic infauna recover from the seafloor disturbance caused by dredged material disposal and the types of communities that are expected to recolonize the mounds. The results are documented in the large number of technical reports and scientific papers that have been produced steadily over the years by the DAMOS program (SAIC 2002a; Morris 1998; Charles and Tufts 1997; Wiley et al. 1996; Williams 1995; Wiley 1995; Wiley and Charles 1995; SAIC 1995: Wiley 1994; SAIC 1994; Germano et al. 1993; SAIC 1990a and b; SAIC 1988a and b; Morton et al. 1984: Scott et al. 1987; Morton and Paquett 1983; Morton et al. 1982; Morton and Stewart 1982: SAIC 1982; Morton 1980a and b; Valente and Fredette 2002; Valente et al. 2000; Fredette and French 2004; Bolam and Rees 2003).

The questions addressed with respect to this monitoring component target the expected rate of benthic recovery by a representative infaunal community consisting of both pollutant-tolerant and pollutant-sensitive taxa:

- After disposal activities cease for the dredging season, do the opportunistic species return to the mound within a growing season?
- Are the infaunal benthic assemblages comparable to those in nearby areas of the disposal site with similar habitat characteristics?
- Are the benthic communities and populations similar to those in the wider surrounding region (i.e., reference areas)?

If the answer to each of these questions is yes, the biological community on the mounds is recovering as expected, and significant adverse impact from the disposal operations is not demonstrated. If the answer to any of the questions is no, investigations into potential causes may be conducted under Tier 2.

Tier 1**:** This tier focuses on the biological recovery of the mound surface by determining the infaunal successional stage relative to nearby sediments. SPI will be used to survey both freshly deposited dredged material mounds created in a given dredging season as well as older mounds created during past seasons. The SPI evaluation will include characterization of sediment grain size and textural variability over both the disposal mounds and in nearby reference areas; this is a key variable affecting the types of organisms observed in the images. Initial SPI surveys would be conducted within 12 to 16 months after disposal activities have ended for the season. Evaluation of selected historic (inactive) mounds and imaging of the BBDS reference stations will be incorporated with each survey of newly created mounds. Sampling of historic mounds can be sequenced across years depending on budget availability and the results of previous surveys, to be reviewed and acted upon at the annual DMAC meetings.

SPI data collected from fresh and historic mounds will be compared to data from reference area stations to identify any significant adverse impacts. If this comparison shows the expected recolonization pattern, the biological community on the mound would be considered to be recovering as anticipated, with no significant adverse impact from the disposal operations. If there is a significant departure from the expected recolonization pattern that cannot be readily explained by grain size differences or region-wide factors effecting both the disposal site and reference areas, further investigation into the potential cause(s) of the difference(s) will conducted under Tier 2.

Tier 2: Tier 2 evaluations are conducted to determine if the inconsistencies in expected recolonization patterns are localized (mound specific) or regional, as well as to assess the potential effects of physical sediment properties (e.g., grain size) on the biological observations. Additional SPI sampling will be conducted under Tier 2 to evaluate seafloor conditions within the site and extending systematically to additional areas at least 1 kilometer (0.6 miles) beyond the site boundaries.

The SPI survey data will be used to compare among the areas sampled, including any differences in sediment grain size or other parameters (e.g., RPD depths, organic content, high sulfides or methane) known to influence the types of organisms observed in the images. If findings show that the limited recolonization does not occur over broad seafloor areas, suggesting a regional phenomenon unrelated to dredged material disposal, then additional Tier 3 studies may be warranted.

Tier 3: The evaluation proceeds to Tier 3 if the benthic recolonization data developed under Tier 2 indicates that the potential impacts are limited to one or more disposal mounds and therefore are clearly disposal-related. Tier 3 studies would only be conducted after a review and concurrence by the DCR and/or the NAE of the Tier 1 and 2 results.

Sediments will be sampled and analyzed to determine benthic infaunal community composition, as well as chemistry and toxicity, at selected locations among the dredged material mounds and nearby references areas. All sampling and testing will be conducted in accordance with the RIM (EPA/USACE 2004) or subsequent approved documents. Data from the area(s) of concern will be compared statistically to data collected concurrently from the BBDS reference areas to assess the degree of any disposal-related impacts. The benthic community data will be evaluated to assess the presence and relative abundance of pollutant-tolerant and pollutant-sensitive taxa at both disposal mound and reference area stations. If it is determined that there have been significant negative disposal-related impacts to benthic recolonization, one likely management action would be to cap the effected area(s) within the disposal site with dredged material from a different source. This would serve to bury and thereby isolate the in-place material that failed to support the expected benthic recolonization.

11.6.6 Changes in Water Quality

Two premises underlie this indicator of concern: water quality is influenced by numerous factors in Buzzards Bay, and clean dredged material placed at the site will only minimally impact dissolved oxygen concentrations through the water column. The modeling effort showed that the plumes of water with elevated TSS concentrations that are created during the release, convective descent and dynamic collapse phases of dredged material disposal will exist only for short periods of time (see Section 7.0). Turbidity levels in the water column above the site will return to ambient levels within minutes to hours. This finding, coupled with water quality testing conditions of the project permit, will assure that water quality criteria within the disposal site mixing zone will be met within an acceptable time period (i.e., within four hours within the site and always outside the site). This in turn will minimize the potential for any long-term, cumulative impacts to the water column at the site and surrounding areas of Buzzards Bay.

Significant short-term adverse effects are unlikely to result from the disposal operations.

Two questions related to potential water-quality impacts resulting from the disposal of clean (suitable) dredged material at the site are:

- How is water quality in BBDS different during disposal operations than in areas outside the site in the short-term?
- Will the disposal of clean dredged material have a substantive impact on water quality measures, particularly dissolved oxygen, over the long-term?

Most of the dredged material proposed for disposal at BBDS will be tested in accordance with the protocols specified in the RIM (EPA/USACE-NAE 2004) or subsequent approved manuals. As part of the determination of the suitability of the material for open-water disposal, potential water quality impacts are examined carefully by regulators in the permitting process. Based on this high level of scrutiny by qualified reviewers, short-term water quality impacts are not expected. Although not a concern for most projects, some may be required to demonstrate that Limiting Permissible Concentration (LPC) criteria will not be exceeded at the site boundary during disposal. Since placement of clean dredged material at BBDS is not considered threatening to water quality, a water-quality monitoring program aimed at documenting measurable short-term fluctuations is not proposed under Tier 1, but may be required as part of the disposal permit for individual projects.

11.6.6.1 Changes in Water Quality: Tier 1

Tier 1: As indicated, it is anticipated that water quality at the BBDS and the surrounding region will not degraded by the disposal of clean dredged material. Tier 2 monitoring may be triggered if sampling conducted for other purposes suggests that observed impacts (e.g., to benthic communities) may be related to poor water quality.

Tier 2: This monitoring is likely to consist of plume tracking and/or the collection and analysis of water samples at various times and locations in and around the site following disposal operations. It may also include special studies to evaluate sediment oxygen demand and determine any effects of the disposal site on spatial and temporal dissolved oxygen trends in the water column of Buzzards Bay. The specific comparative studies and/or evaluations to be undertaken cannot be defined beforehand but, when deemed necessary, they will be developed through interagency coordination.

Tier 3: As with Tier 2, no specific approaches are specified; these will be developed when necessary through interagency coordination.

11.6.7 Changes in Composition or Numbers of Pelagic, Demersal, or Benthic Biota at or near the Disposal Site

This indicator of concern addresses regional changes in species composition and abundance. Finfish and megainvertebrates like lobster will be considered for study. As presented in the DEIR (Section 7.0), significant short-term adverse effects to these aquatic communities are unlikely to result from the disposal operations. Long-term impacts to populations in Buzzards Bay are also unlikely. Populations of fish and shellfish are regularly monitored by NMFS and the Commonwealth through their fish trawl surveys, and indications of impacts from disposal of clean dredged material may show up through evaluation of the data sets. Relevant questions include:

- Are the compositions of pelagic and demersal fish communities unacceptably affected by disposal of clean dredged material at the site?
- Is the composition of the megainvertebrate community unacceptably affected by disposal of clean dredged material at the site?

Tier 1: It is assumed that dredged material disposal at BBDS will have no significant long-term impacts to fish and shellfish and no direct impacts on threatened or endangered species. Tier 1 studies will be initiated if information indicates that any impacts are suspected or actually occurring. The Tier 1 studies will utilize data developed under the DMF and the NMFS fish trawl surveys. These data are collected annually under a stratified random sampling design. Data proximal to the disposal site will be compared with data obtained from areas in Buzzards Bay having similar depths, sediment types, etc. but which otherwise have not been influenced by dredged material disposal.

Tier 2: Should data reviewed under Tier 1 imply dredged material disposal at BBDS is adversely effecting fish or shellfish populations, special studies to evaluate the population distribution of these species inside and proximal to the site will be planned. Planned studies will address the distribution and composition of fish and megainvertebrates inside and immediately outside and proximal to the site. Seafloor areas with similar habitat and depths to those found at BBDS would be identified and sampled as reference areas. Particular study questions and sampling design elements will be considered and approved by the DCR and/or NAE and cooperating agencies before any study is conducted.

If studies under Tier 2 show connectivity between reduced fish or shellfish abundance and dredged material disposal at BBDS, additional studies to determine cause will be conducted under Tier 3.

Tier 3: These studies may include evaluation of the availability of prey species in the site and surrounding areas and/or evaluation of chemical bioaccumulation in fish and megainvertebrates. Prey species studies may include evaluation of the successional stage, infaunal community analyses or bioaccumulation studies similar to those defined below. Particular study questions and sampling design will be developed and approved by the DCR and /or the NAE and other consulting agencies managing BBDS before any sampling is conducted.

11.6.8 Accumulation of Material Constituents in Marine Biota at or Near the Site

The intent of this indicator of concern is to determine if disposal of clean dredged material at BBDS results in any significant potential for bioaccumulation. It is assumed that the required testing of sediments proposed for open-water disposal eliminates material that categorically poses an unacceptable risk to the marine environment at BBDS. More importantly, because bioaccumulation of contaminants does not necessarily result in the death or significant impairment of organisms occupying lower-levels of the marine food chain, contaminants can become elevated in consumers at higher trophic levels, including humans. This process of biomagnification therefore may pose unacceptable risks to both marine animals and people.

Although it is considered a highly unlikely impact, monitoring for bioaccumulation represents a precautionary and prudent measure.

Bioaccumulation data can serve two purposes: 1) to determine if transfer of chemicals from sediments to organisms is leading to significant adverse biological responses (e.g., failure of a benthic infaunal community to thrive), and 2) to assess potential ecological and/or human health risks. The challenge in most monitoring programs is how to best gather the required information. Two questions are relevant:

- Are risks associated with disposal of clean dredged material at BBDS maintained at acceptably low levels?
- Does the bioaccumulation potential remain low following the deposition of dredged material (e.g., during and after mound consolidation)?

Answers to the first question can be derived using data from the pre-dredging testing of sediments (to be maintained in readily available database). The goal of this data analysis would be to confirm that only those sediments with background or negligible concentrations of chemical contaminants are determined to be suitable for disposal at the BBDS. An approach to the second question includes periodical evaluation of the bioaccumulation potential of sediments inside and proximal to the disposal site, using the same database. This can be accomplished in a variety of ways, including estimating bioaccumulation potential using widely-accepted models, measuring the actual levels of contaminants in organisms collected from the site, or conducting controlled laboratory bioaccumulation studies with test organisms. These approaches would be applied in a tiered manner to address bioaccumulation concerns at BBDS.

If the answer to either of the two questions above is no, significant negative impacts from the dredged material disposal operations may exist. The first question will be addressed through evaluation of the required testing data submitted as part of each project permit application. The answer to the second question may be approached through the tiered approach described below.

<u>Tier 1</u>: Under Tier 1 it is assumed that bioaccumulation potential at BBDS, and potential risk, will remain similar to baseline characteristics and not increase following the deposition of clean dredged material at the site. Bioaccumulation potential of sediment samples taken at the site would be evaluated relative to, and should not be significantly greater than, the range of bulk chemical concentrations found in the dredged material as part of the pre-dredging testing for each project. Periodic sampling and testing of sediments within the site and nearby reference areas for levels of contaminants may be performed in this Tier. Theoretical bioaccumulation calculations will be performed if statistically significant increases in sediment chemical concentrations above permitted dredged material limits are found. Collection of sediment samples from the disposal site and nearby reference areas is expected to occur shortly after the first, second and fifth years of disposal activities. If the predictive modeling points to a significant potential increase in risk at the site relative to the nearby reference areas, then more specific studies to measure actual bioaccumulation may be conducted under Tier 2.

<u>Tier 2</u>: A comparison of chemical contaminant concentrations in the tissue of organisms collected within the site and those from nearby reference areas would provide evidence of any unacceptable bioaccumulation from sediments placed at the disposal site. Alternatively, testing

of sediments would occur under controlled laboratory conditions using standard bioaccumulation tests and test organisms. Specific study questions and sampling designs would be developed and approved by the DCR and/or the NAE.

Tier 3: If significant increases in bioaccumulation are found to have resulted from the placement of clean dredged material at the site, comprehensive ecological and human health risk assessments may be undertaken to examine their significance. Additional, carefully-designed studies may be performed to evaluate the potential for transfer of bioaccumulated compounds to higher trophic levels. Such studies would be planned and authorized by the DCR and/or NAE prior to initiation.

11.6.9 Quality Assurance/Quality Control

A critical aspect of any site monitoring program is a quality assurance/quality control (QA/QC) system to assure that the monitoring data are reliable. QA/QC consists of two components:

1. Quality Control - activities undertaken to ensure that the data collected are of adequate quality given the study objectives and the specific hypothesis to be tested, and include standardized sample collection and processing protocols and technician training (National Research Council [NRC] 1990).
2. Quality Assurance - activities implemented to quantify the effectiveness of the quality control procedures, and include repetitive measurements, interchange of technicians and equipment, use of independent methods to verify findings, exchange of samples among laboratories and use of standard reference materials, among others (NRC 1990).

Each organization participating in the conduct of monitoring activities (including field work, laboratory analysis of samples, data management and reporting) will be required to have an internal QA/QC program. Laboratories responsible for sample analysis will be required to submit quality assurance documentation, such as datasheets, for review along with analytical results on a project-specific basis (see the RIM and ITM documents for further details).

11.6.10 Monitoring Technologies and Techniques

This section describes equipment and approaches typically used for environmental monitoring at dredged material disposal sites in the northeast United States, including the existing MDBS and CCDS in Massachusetts. Although the methods described below have historically been employed with demonstrated success, their continued use does not preclude the introduction of new technology and approaches, as necessary or appropriate.

11.6.10.1 Techniques to Monitor Mound Stability

Stability of dredged material mounds created at the site will be investigated primarily through the use of sequential precision bathymetric surveys (SAIC 1985). To date, this methodology has been applied to characterize seafloor topography within and in the immediately vicinity of candidate disposal sites 1 and 2 (see Section 3.8). Current bathymetric survey techniques can reliably detect changes in the elevation of dredged material disposal mounds on the order of 0.25 to 0.5 meters (0.8 to 1.6 feet) over areas of 50 by 50 meters. Positive or negative changes in the height of mounds above the seafloor can be detected by comparing the results of sequential bathymetric surveys conducted every few years. Significant reductions in mound height would signal that erosion is potentially occurring, and follow-up investigations would be conducted to determine the cause(s).

SPI typically is used in conjunction with precision bathymetry to detect the thinner layers of dredged material that occur on the outer margins or "apron" regions of dredged material mounds. Because such layers are too thin to be detected by bathymetry, use of SPI allows for identification and mapping of the entire "footprint" of the dredged material that has been deposited on the bottom (Rhoads and Germano 1982 and 1986; Rhoads 1994; Germano et al., 1989; Valente 2004). Side-scan sonar is another technique that has proven useful, alone or in combination with precision bathymetry and/or SPI, for detecting and mapping dredged material deposits on the seafloor. The appropriate combination of survey requirements and applications of these measurement tools will be identified for each tier and situation investigated.

11.6.10.2 Benthic Infaunal Monitoring Techniques

The recovery rate of benthic communities at disposal mounds will be measured primarily through the use of SPI (Germano and Rhoads 1982; 1994; Valente 2003). SPI sampling will be conducted at grids of stations located over both the disposal mound(s) and in nearby reference areas. Three replicate SPI images are typically obtained at each station; these replicates are spaced only a few meters apart as a result of the camera being repeatedly lowered and raised while the vessel holds station. Thus, they are useful for characterizing small-scale (i.e., within-station) spatial variability in sediment characteristics.

Computer-aided analysis of each SPI image is used to measure the following parameters:

- Sediment grain size;
- Prism penetration depth (indirect measure of sediment compactness)
- Vertical relief across the field of view (small-scale surface boundary roughness)
- Degree of sea floor disturbance
- Presence and thickness of surface depositional layers (e.g., dredged material)
- Apparent RPD
- Presence of high sediment oxygen demand (i.e., sulfidic sediments)
- Presence of sediment methane production
- Infaunal successional stage
- OSI – a metric indicating degree of disturbance.

As indicated previously, it may be necessary to follow-up the first-tier SPI sampling with second- and third-tier evaluations of benthic community structure. This would entail the collection of grab samples, followed by identification of the benthic organisms by qualified taxonomists in a laboratory setting. Standard methods will be followed for the collection, preservation, identification and enumeration of benthic macroinvertebrates. In addition, standard statistical techniques will be utilized to assess whether undesirable changes in the populations of particular species or in overall community structure have occurred as a result of dredged material disposal.

11.6.10.3 Water Quality Monitoring Techniques

In the unlikely event that sampling is required for water-quality monitoring, specific sampling and testing methodologies will be developed.

11.6.10.4 Sediment Quality Monitoring Techniques

Grab samples of surface sediments will be collected and may be analyzed for a number of sediment quality indicators, including grain size, total organic carbon, sediment toxicity and selected chemical constituents such as trace metals (e.g., mercury, lead, zinc, arsenic, iron, cadmium, copper), PCBs, PAHs, pesticides, and other contaminants of concerns as listed in the RIM (EPA/ USACE-NAE 2004). The number of stations and locations will be defined during survey planning and will be sufficient to enable characterization of within- and among-station variability. Sediment quality grab sampling was conducted as part of the baseline characterizations of candidate sites 1 and 2, and it has been employed as part of the routine monitoring at the existing CCDS and MBDS.

11.6.10.5 Living Resource Monitoring Techniques

Exhaustive fisheries surveys have been conducted as part of the evaluation of candidate sites 1 and 2 presented herein (Camisa and Wilber 2002; Maguire 2002a). Any new data from the continuing DMF and NMFS trawl surveys will be obtained and analyzed to determine whether the diversity and abundance of recreational and commercial fish in the vicinity of BBDS differs from other similar areas of Buzzards Bay.

11.6.10.6 Bioaccumulation Measurements

Should bioaccumulation testing be recognized as necessary, representative benthic infauna within the site and at reference areas will be collected and tested. Sufficient biomass of at least two types of organisms (filter feeders and sediment feeders) will be collected to enable quantifications of bioaccumulative compounds. Tissue samples will be prepared and analyzed using methods consistent with the RIM (EPA/USACE-NAE 2004). A specific number of sampling stations and locations will be identified during survey planning to characterize adequately both the area of concern and the degree of within- and among-station variability.

11.7 Disposal Site History

The preferred disposal site identified through this DEIR (site 1) is an approximately one-square mile area that has a history of deposition from regional dredging projects, due to its proximity to the former BBDS and the historic CLDS. NAE records indicate that the latter site has been used extensively for placement of material dredged from the Cape Cod Canal (USACE-NAE 1995). The substrate of the CLDS consists of variable topography and a somewhat chaotic mix of fine-grained and coarse-grained sediments, from silt to gravel, that reflects its historical use for disposal of dredged material (Moore 1963; Menzie et al. 1982; Germano et al. 1989; Maguire 1997a).

It is important to distinguish other historic BBDS locations from the preferred alternative site 1.

- BBDS – The Buzzards Bay Disposal Site is defined by a circle with a diameter of 500 yards that encompasses an area of 40 acres within the historic CLDS. It has been used for disposal since at least 1980. Although it has not been the subject of any previous, formal designation studies, the NAE considers it to be an acceptable site for consideration as a disposal alternative on a case-by-case basis with respect to Federal permits. Due to the lack of a comprehensive evaluation of environmental impacts, the Commonwealth has not permitted any disposal at the site since 1989.

- BBDS - East of Cleveland Ledge Light – This box-shaped polygon site located outside the historic CLDS was permitted for temporary use. A public notice from the USACE-NAE indicated the use of a disposal site located directly off the East Cleveland Ledge Light for the purposes of material dredged to maintain navigable depths within the Cape Cod Canal. This site was used in the past and as recently as 2002 for this purpose. For the most recent canal maintenance dredging project in the fall of 2002, approximately 228,000 cy of material was disposed (personal communication, T. Fredette, USACE-NAE, 2003). The 2002 project disposal scow logs revealed relatively shallow depths of 15 to 26 feet at a discrete disposal location within the site. The most current NOAA chart of Buzzards Bay (#13230) indicates depths between 26 and 33 feet for the same area within the site, based on surveys conducted as recently as 1994. The change in depth over time and the relatively shallow depths observed in 2002 indicate that this site may now have limited capacity to accept more dredged material in the future.

11.8 Site Closure

The BBDS will be closed when either the estimated capacity of 2 million cy has been reached or it is determined that continued use will result in unacceptable environmental impacts. The maximum capacity value is subject to adjustment based on actual site use and future monitoring results.

At the time of closure of the BBDS, a suite of monitoring surveys will be performed to document exisiting conditions. A report detailing these conditions will be prepared for submission to the DMAC and the Secretary of the EOEA, and it will become a part of the monitoring record for the site. Additional monitoring surveys may be performed at various intervals following closure to detect any changes in conditions over time. These results also will be compiled in a report to the Secretary of the EOEA that will become part of the monitoring record.

12.0 DRAFT SECTION 61 FINDINGS

This section of the DEIR presents the Proposed Section 61 Findings for BBDS designation, as required under the MEPA regulations at 301 CMR 11.12. Section 11.07 of the MEPA regulations requires that the proposed Section 61 Findings be included in the DEIR for a project. As a state agency, CZM is bound by the statutory requirement under MEPA to take all feasible measures to avoid or minimize damage to the environment. This section presents draft Section 61 Findings for designation of BBDS.

12.1 Potential Environmental Impacts from Designation of BBDS

Potential environmental impacts associated with designation of proposed alternative disposal site 1 and site 2 include those associated with sediments and water quality, benthos, finfish, wetlands, wildlife, endangered species, navigation and shipping, land use, air quality and noise, historic and archaeological resources and recreation areas.

12.1.1 Sediments

Disposal of clean dredged material at the designated site may cause changes in the physical properties of the substrate at the site, including changes in water depth, grain size, sediment texture, and organic content. Disposal of coarse-grained material in the deeper, fine-grained portions of each site will result in coarser-grained substrate. The existing substrates at both sites have relatively low organic content and there is the potential for disposal of dredged material to increase the organic content of the bottom sediments. Given the range of grain sizes currently present at each site, and the evaluation of potential impacts from changes in substrate characteristics on the benthic community (see Section 12.1.2 below), long-term impacts from altered sediment characteristics are likely to be negligible. The proposed alternative disposal sites include depositional basins, and the sites can be managed (i.e., management of the location and final water depths of disposal mounds) to minimize erosion of fine-grained material from the disposal mounds (see Section 11.0).

12.1.2 Water Quality

Short-term impacts on water quality during disposal operations will also minor, with short-term, localized increases in turbidity. Long-term water quality impacts from sediment resuspension from the disposal mounds will be neglibable. Because the site is to be used for disposal of clean material, water column increases in chemical contaminants are not expected to occur.

12.1.3 Benthos

The benthic community may be impacted through burial with dredged material, and by longer-term changes in habitat characteristics of the substrate. The existing community at each proposed alternative disposal site consists of opportunistic species typical for estuarine environments. Based on the character of the existing community, as well as long-term monitoring information from other open water disposal sites throughout New England, it is anticipated that disposal mounds would become recolonized with a comparable benthic community and long-term impacts from disposal should be negligible. Successional colonization of dredged material mounds is well documented and follows expected patterns that can be monitored to ensure long-term adverse impacts on the overall character of the benthic community are not occurring.

Changes in species composition may result from disposal of a wide range of grain sizes at the designated site, including the likelihood that coarse-grained material may be disposed of in areas of the designated site that currently have fine-grained sediments. Long-term effects on the benthic community are expected to be negligible. There may be some decrease in the relative abundance of deposit feeders with coarser-grained substrate, but existing differences between coarse- and fine-grained substrate throughout the proposed alternative sites are not statistically significant. Fine-grained dredged material disposed of at the site may provide an enriched source of organic material and result in an initial increase in abundance of opportunistic species that provide a food source for bottom feeders.

12.1.4 Finfish and Shellfish

Disposal activities at the designated site will have potential short-term impacts on finfish, particularly sensitive life stages such as eggs and larvae if their critical time-periods are not avoided. Time-of-year restrictions will ensure that disposal activities do not occur during the critical spawning periods for the most important species and/or times of year when spawning is at its peak or periods of relatively high juvenile fish abundance. Demersal feeders that do not avoid sinking dredged material will be buried by disposal activities, but most juvenile and adult finfish will avoid the descending dredged material and the temporary zone of increased turbidity in the near vicinity. Long-term changes in the character of the habitat for finfish are not anticipated because the benthic community, important in the local ecological food chain, will recolonize to ambient status.

12.1.5 Commercial and Recreational Fishing Site Use

Potential conflicts with commercial and recreational fishing activities have been evaluated and based on the relatively small size of the disposal site, limited time of year when disposal would be occurring (including lack of disposal activities during the warmest part of the year), and highly localized impacts during disposal activities, at worst, only minimal user conflicts are anticipated. Commercial charters, scup and conch pot setters, lobster harvesters, and scallop harvesters are the commercial interests most likely to be impacted by fall and winter disposal activities. Use of the designated site may necessitate avoidance of the disposal site buoy area at times during the disposal season. Use of the preferred alternative site 1 will allow lobster trap areas, and more valuable habitat for finfish, shellfish, lobsters, and other wildlife in the alternative site 2 vicinity of Gifford Ledge to remain unaffected.

12.1.6 Wetlands

No impacts are expected for coastal wetlands, salt marsh, or eelgrass beds from disposal activities at the preferred alternative site 1. Turbidity plumes from disposal events at preferred alternative site 1 will arrive at background concentration of TSS before reaching the nearest wetland resource areas. Short-term increases in turbidity during disposal will be relatively minor in magnitude, of short duration and limited in extent beyond disposal points at preferred alternative site 1.

12.1.7 Wildlife

Wildlife impacts assessed included those to avifauna, marine mammals, and marine reptiles. Disposal events of clean suitable dredged material at the preferred alternative disposal site 1, will not impact shoreline habitat areas for shorebirds and species associated with salt marsh systems and eelgrass beds. A variety of ducks and waterfowl may use the area in the vicinity of alternative site 2 near Gifford Ledge for feeding activities. The preferred alternative site 1 is the more conservative choice with least impact to wildlife.

12.1.8 Endangered Species

Whales, other marine mammals, and sea turtles are uncommon visitors to the bay. Although five whale and two sea turtle species listed by the USFWS occur in the ocean waters off Falmouth, there is only the slightest indication that these species occur at the preferred alternative site 1 or alternative site 2 of the BBDS during the time of year when disposal operations would occur. These species are expected to avoid disposal vessels transit and on-site maneuvering to dump dredged material at the preferred alternative site 1 under normal conditions. Potential impacts include only very rare collisions with disposal vessels and possible short-term stress imposed by the settling dredged material and short-term turbidity impacts.

12.1.9 Historic and Archaeological Resources

Adverse impacts to historical resources are not likely from continued disposal activities in this region of the bay. The primary historic and/or archaeological concern with disposal activities is the potential damage to any existing shipwreck. Vessels transited this region of the bay from earliest settlement times (including Native Americans and European settlers) to attain access to Cape Cod Bay (via existing streams prior to construction of the Cape Cod Canal). However, side-scan sonar surveys do not indicate any evidence of shipwrecks at either proposed alternative site. Disposal activities that have occurred within both proposed alternative sites 1 and 2, in the past (northern portion of preferred alternative site 1 and northern portion and trough area of alternative site 2) would have destroyed or buried any shipwrecks of importance. The Massachusetts Bureau of Underwater Archaeological Resources has identified a cultural resource near, but outside, the boundary of site 1. Special precautions will be taken to ensure no adverse impacts on this cultural resource.

12.1.10 Navigation and Shipping

Disposal activities at preferred alternative site 1 represent a very small increase to existing recreational and commercial traffic in the vicinity of the designated site. Disposal activities have occurred in this area of the bay for a number of years, including recent disposal activities north of the CLDS for Cape Cod Canal maintenance dredging. Past and future vessel traffic connected with disposal activities is not expected to interfere with existing marine traffic transiting the Cape Cod Canal into the Bay in this region. The proposed relocation of the approach segment of the Cleveland Channel will not alter this determination. There may be an occasional need for south-bound traffic transiting between the approach channel and Woods Hole to navigate east or west around preferred alternative site 1 to avoid barge traffic during disposal activities. The US Coast Guard requires and the DEP recommends a designated route for tank vessels making passage through Buzzards Bay. The designated passage comes closest, approximately a quarter mile, to the northwestern corner of preferred alternative site 1. Disposal activities at the alternative sites represent minor impacts and should not pose any obstructions or safety concerns.

Preferred alternative site 1 provides safer access and barge maneuvering space than alternative site 2, which is bordered on the east by the Gifford Ledge area, with a minimum water depth of 3 meters, and a historical disposal mound to the west with a minimum water depth of 8 meters.

Therefore, preferred alternative site 1 is the conservative choice for the disposal barges safety and ease of navigation.

12.1.11 Land Use

The preferred alternative site 1 will have negligible direct and indirect impacts on land use along the adjacent shoreline areas.

12.1.12 Air Quality and Noise

Air quality and noise impacts from disposal activities at the designated site that come from disposal event vessels will be minor and temporary. These slight impacts are common to commercial maritime traffic coursing Buzzards Bay.

12.1.13 Recreation Resources

The proposed alternative disposal sites are located a substantial distance from shoreline recreation resource areas, beaches and harbors. Additionally, disposal activities are not expected be permitted during the warmer months of Cape Cod recreational activities are at peak-season level. Therefore, minor impacts from dredge materials disposal at preferred alternative site 1 will be limited to off-season recreational resources.

12.2 Implementation of Mitigation Measures and Proposed Mitigation Implementation Schedule

Appropriate mitigation of potential impacts from disposal activities will be incorporated into the disposal SMMP (Section 11.0) included in the DEIR. The plan includes details of review/evaluation of the types of material to be disposed of at the designated site, consideration of disposal methods, and follow-up monitoring to ensure that short- and long-term impacts to the aquatic environment are negligible. These measures are based on a long history of disposal site use and monitoring at other open water disposal sites in New England. The knowledge and experience gained through use and monitoring of these sites, including the CCDS and MBDS, have resulted in a wealth of knowledge among federal and state regulators on the types of potential impacts from disposal activities, and appropriate measures to monitor for such impacts. In general, long-term impacts at other New England disposal sites have been negligible, particularly when considering disposal of clean suitable dredged material. The draft SMMP for the BBDS includes a conservative monitoring schedule, with comprehensive post-disposal monitoring requirements, to provide an early, post-disposal indication of whether adverse impacts are occurring.

12.3 Draft Section 61 Findings

The DEIR constitutes a comprehensive evaluation of the impacts of past disposal in the vicinity of BBDS and evaluation of the potential impacts at preferred alternative site 1 and alternative site 2. CZM finds that, with implementation of the mitigation measures included in the draft SMMP, all feasible means have been taken to avoid or minimize damage to the environment.

13.0 RESPONSE TO COMMENTS

This section of the DEIR provides individual responses to the public and agency comments received on the ENF for designation of the BBDS. Comments are presented in italicized text for ease in distinguishing between comments and responses. Some responses consist of a brief summary response with reference to the specific sections of the DEIR where the issue is addressed in greater detail. Copies of the original comment letters are included in Appendix A. It should be noted that considerable time has passed since the initial ENF was filed for the project, and considerable field investigations have been undertaken in an attempt to address the concerns raised in these comment letters. Presentation of the information in this DEIR will provide a useful opportunity for coordination and review of the information that has been collected so that any outstanding gaps in the understanding of the potential short- and long-term impacts from disposal at the designated site can be more fully considered.

13.1 Department of Environmental Protection, Southeast Regional Office (SERO) Division of Wetlands

MA DEP SERO provided the following comments by memo dated April 11, 1995.

Comment: *They indicated that an Order of Conditions under the Wetlands Protections Act (c. 131, s40) will be required for this project. The disposal of dredged material at the Buzzards Bay Disposal Site will result in the filling and alteration of an Area Subject to Protection under the Wetlands Protection Act Regulations at 310 CMR 10.25 as the disposal site fits the definition for Land Under the Ocean. Therefore, disposal activities at BBDS would require the filing of a Notice of Intent and the receipt of an Order of Conditions.*

MA DEP asks whether individual Notices of Intent and Orders of Conditions will be required for each dredge disposal project, or whether a single blanket Notice of Intent should be filed, and a single order of conditions issued for BBDS.

Response: Follow-up discussions with the MA DEP in the spring of 2005 clarified their comment to mean that an OOC is not required for the designation of a new Buzzards Bay Disposal Site, which by itself will have no impact on the wetland resources at the site. It was also made clear that the actual use of the disposal site will need to comply with the Wetland Protection Act and will require an OOC. Prior to use of the disposal site, CZM will initiate discussions with DEP and the Falmouth Conservation Commission to identify a suitable permitting framework under the Wetlands Protection Act. CZM believes there are advantages to seeking the issuance of a blanket approval for the use of the designated site, which would consist of an OOC approving use of the designated site for a specific period of time subject to site management and monitoring requirements as outlined in the SMMP and reviewed by the Disposal and Monitoring Advisory Committee (DMAC). Refer to Section 11 for a discussion of the SMMP and the DMAC. The Falmouth Conservation Commission as a member of the DMAC would be provided with notification of individual disposal events.

Comment: *MA DEP SERO stated that MA DEP prefers the use of clean dredge materials in beach nourishment projects whenever possible.*

Response: Designation of an open-water disposal site for clean dredged material for the Buzzards Bay region would not obviate the need for an alternatives analysis regarding disposal options for each individual dredging project. The alternatives analysis required by federal and state regulations generally would include an evaluation of the feasibility of upland disposal options and beneficial use, such as beach nourishment.

13.2 Department of Environmental Protection, Division of Waterways

DEP Division of Waterways provided the following comments in a message dated April 11, 1995.

Comment: *The memo states that concerns with impacts to finfish spawning would be primarily along the bottom [i.e., demersal, not pelagic eggs and larvae] since most of the material to be disposed of would be sandy and would settle quickly through the water column. Concerns with demersal eggs and/or larvae can reasonably be addressed through the use of time-of-year restrictions, including a prohibition on disposal activities during the February – May winter flounder spawning period.*

Response: Recognizing that the 1998 NOPC proposed that the site be used for all types of clean material, fine to coarse, the assessment of the impacts to all finfish, both demersal and neritic/pelagic is included in Section 7.5 of this DEIR. This section also includes an evaluation of the feasibility of using time-of-year restrictions to avoid sensitive stages during spawning periods, including the winter flounder spawning period.

Comment: *Potential conflicts with fixed lobster gear need be considered.*

Response: The available information on commercial lobster harvesting is summarized in Section 6.3, and potential conflicts are discussed in Section 7.5.

Comment: *DEP asked about the practicality of inspections for marine turtles during disposal activities.*

Response: The draft SMMP (Section 11) includes the requirement for a NMFS-certified Marine Mammal Observer to be on-board during disposal activities to help ensure no adverse impacts to these species occur. This is based on the existing monitoring plan for the CCBD Site.

Comment: *MA DEP suggests a major role for the Army Corps of Engineers (USACE NAE) in consultation with the Commonwealth. One concern with a state monitoring responsibility is the availability of funds to conduct the monitoring.*

Response: Once designated by the state, the site would become the responsibility of the Commonwealth under the Public Trust Doctrine. Site monitoring would be a requirement pursuant to the MEPA approval process and possibly under the WPA as well. DCR would be given responsibility for oversight of the monitoring program and they have the ability to coordinate monitoring efforts with the NAE if necessary or efficient to fulfill the overall objectives of the state monitoring requirements.

13.3 Commonwealth of Massachusetts, Division of Marine Fisheries

The DMF provided the following comments in a letter dated April 13, 1995.

Comment: *In response to the initial request for a waiver of the need to prepare an EIR, DMF stated that they were opposed to a waiver and that the formal designation of BBDS should require the preparation of an EIR. They stated concerns for lack of environmental assessment of historically used disposal sites in the Bay, as well as the possibility that the Bay may not be a suitable location for any disposal of dredged material.*

Response: The DEIR includes information to confirm that the long-term impacts of disposal activities in the vicinity of CLDS appear to be negligible in terms of sediment stability (Section 4.1), sediment chemistry (Section 4.2), benthic habitat and benthic community composition (Section 5.1), and utilization of the area by fishery resources (Section 5.2). Section 7 of the DEIR consists of a comprehensive evaluation of potential impacts at the two candidate disposal sites in the vicinity of CLDS. While overall, potential adverse impacts at both candidate sites appear to be minimal, Section 8 (Summary Evaluation of Site Suitability) includes a conservative recommendation for use of site 1, to minimize potential impacts to what likely constitutes more valuable resource areas in the vicinity of Gifford Ledge.

Comment: *Buzzards Bay has productive finfish and lobster habitat and spawning grounds. MA DMF stated that the potential effects of disposal activities on all life stages of finfish and invertebrates in the vicinity of the disposal site should be conducted, including the potential impacts of altering the substrate through disposal of coarse-grained material.*

Response: The aquatic resource characterizations summarized in Section 5 (5.1 benthos, and 5.2 finfish, shellfish, and lobster) were based on studies that were conducted to specifically characterize the resources in the vicinity of the candidate disposal sites and recreational and commercial harvesting activities. Section 7.5 (Disposal Site Impacts – Finfish and Shellfish) consists of an evaluation of potential impacts to the species likely to be present in the vicinity of the designated site, including sensitive life stages (eggs and larvae). Potential impacts on the substrate from disposal of coarse-grained material are addressed in Section 7.4 (Disposal Site Impacts – Benthic Communities).

Comment: *MA DMF states that disposal barge traffic is likely to cause conflicts with fixed fishing gear including lobster, fish and conch pots in the area. MA DMF stated that pots may be set in Buzzards Bay from late March though early December, and existing gear placement in the vicinity of the disposal site has not been documented.*

Response: The Competing Site Use report that forms the basis for the summaries of commercial and recreational harvest in Section 6 of the DEIR provided information on the areas most likely to be used for harvesting activities in the Bay. Harvesting activities that occur through December would pose potential conflicts with late-fall disposal activities (likely to be initiated sometime in the September to October time period). This information has been included in the assessment of potential impacts in Section 7, and in the conservative recommendation favoring use of site 1 to avoid potential conflicts with fixed lobster gear around Gifford Ledge.

Comment: *MA DMF expressed concern with erosion of fine-grained material from the previously-used disposal site and suggested a suggested modeling the fate of two different disposal events consisting of various quantities of material and percentages of fines.*

Response: Information on substrate characteristics and grain size obtained in the surveys of CLDS, BBDS, and the two candidate disposal sites have provided more detailed information on hydrodynamic conditions in the area. While there is evidence of hydrodynamic influence on sediment transport and winnowing of fines in shallow areas in this area of the Bay, the candidate disposal sites have fine-grained substrates in deeper water areas, including water depths greater than 12 meters at site 1, and water depths greater than 13 meters at site 2 (Section 4.2, Sediment Grain Size and Chemistry). This indicates that both sites provide depositional areas that would be suitable for containment of fine-grained material.

MDFATE modeling was conducted using the projected volume of material that could possibly be disposed of at the site in an entire, single disposal season, assuming normal dredge scows conducting multiple releases at the site. Details of the modeling effort are provided in Section 7.1 (Disposal Site Impacts – Bathymetry), and the resulting information on mound formation was used to assess long-term sediment stability and possible management strategies to minimize potential for erosion in Sections 7.1 and 7.2 (Disposal Site Impacts – Bathymetry, Sediment Quality).

Comment: *MA DMF stated concerns with lack of information on potential impacts to fisheries resources outside the disposal site from off-site transport of dredged material.*

Response: The potential for transport of material outside the disposal site during disposal operations was evaluated using the model STFATE. Results are discussed in detail in Section 7.3 (Disposal Site Impacts – Water Quality) and suggest that increases in turbidity beyond the site boundary should be relatively minor and of short duration. Estimates of the volume of material potentially lost during disposal operations consist of very small quantities of material that would form a very thin deposit if the material settled over a relatively limited area of the Bay (Section 7.1). Therefore, the potential impacts to adjacent substrate from the material settling are essentially negligible.

13.4 Cape Cod Commission

The Cape Cod Commission (CCC) provided comments in a letter dated April 10, 1995. The Commission stated support for designation of a regional disposal area for dredged material.

Comment: *The CCC stated that clean, medium to coarse-grained material [the initial ENF was limited to disposal of this type of material] would be suitable for beach nourishment, and disposal at an open-water site would not be consistent with the CCC Regional Policy Plan, MA CZM policy, the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP) and the state's Chapter 91 regulations. They recommend that the costs and benefits of beach nourishment be evaluated through the site designation process, and compared to the costs and benefits of open water disposal, so that potential barriers to beach nourishment disposal options can be investigated.*

Response: Designation of an open-water disposal site for clean dredged material for the Buzzards Bay region would not obviate the need for an alternatives analysis regarding disposal options for each individual dredging project. Designation of an open-water site is being undertaken to ensure that dredging proponents have an open-water disposal option available for consideration if other disposal alternatives are not feasible. The alternatives analysis required by federal and state regulations includes an evaluation of the feasibility of upland disposal options and beneficial use, such as beach nourishment. The burden of implementation of the alternatives analysis lies with the various regulatory agencies on a case-by-case basis for individual dredging project review.

Potential costs of beach nourishment have not been investigated in the DEIR and would depend on project-specific factors such as proximity of the dredging site to the proposed beach disposal site. While a state-wide assessment of potential beach nourishment sites and estimates of associated costs would be useful, it is beyond the scope of the site designation EIR process. Additionally, specific details of beach nourishment benefits and costs would be particular to each individual dredging and disposal project, which limits the usefulness of a state-wide or region-wide assessment in the consideration of project costs.

Comment: *CCC recommends a regional needs assessment be conducted to determine the volume and type of material that could be generated and a cost conscious approach to disposal.*

Response: Section 2.3 (Dredging Needs By Town), Section 2.4 (Dredging Needs By Region), and Section 2.5 (Estimated 20-Year Dredging Need For The Buzzards Bay Region) provide an estimate of the volume and type of material that may be dredged in the region for the next 20 years. Consideration of disposal costs is included in Section 3.0 (Alternatives Analysis).

Comment: *CCC states that the EIR should evaluate the role regulatory agencies may have in resolving disagreements that could occur between disposal site management and the advisory committee that has been established to assist the management agency.*

Response: The SMMP (Section 11 of the DEIR) indicates that DEM, now DCR, would manage the operation of the site based on the approved plan and subject to recommendations of a technical advisory committee, the DMAC. This is comparable to the management structure for the CCDS. Recommendations for revisions to the plan would be made through the EOEA, which would therefore assume responsibility for coordination of disagreements between the DMAC and the DCR. Additionally, federal agencies would be represented on the DMAC, and would have some role in dictating revisions to the plan as it would be utilized in the federal permitting process as well as the state regulatory process.

13.5 The Coalition for Buzzards Bay

The Coalition for Buzzards Bay provided the following comments by letter dated April 7, 1995.

Comment: *The Coalition for Buzzards Bay (CBB) recommended an EIR for the formal designation of the BBDS for disposal of clean dredged materials.*

Response: This represents concurrence with the CBB comment.

Comment: *CBB expects an alternatives screening study or a regional/statewide needs projection for BBDS.*

Response: Alternative disposal methods are discussed in detail throughout Section 3 of this DEIR. A regional needs assessment and projections for the use of the BBDS are covered in Section 2 of this DEIR.

Comment: *CBB stated the need for a clear presentation of the proposed BBDS dredged materials management plan, including the monitoring schedule, and specifications for monitoring sediment chemistry, bathymetry and benthic recolonization.*

Response: Section 11 of the DEIR consists of a draft Site Management and Monitoring Plan that includes the stated elements.

Comment: *CBB stated concern that Category II and III dredged materials may pass bioassay and/or bioaccumulation test but their cumulative impacts may actually need monitoring.*

Response: The suggestion that the site may need monitoring for cumulative impacts, including impacts on sediment chemistry, is noted. The draft SMMP includes provisions for monitoring sediment chemistry and ecosystem effects from disposal activities.

The Coalition for Buzzards Bay provided additional comments following the April 23, 2005 Notice of Project Change in a letter dated May 11, 2005.

Comment: *The CBB is concerned that the reopening of a dredge material disposal site will lead to harmful impacts on Buzzards Bay.*

Response: Sections 4, 5, and 6 of this DEIR discuss in detail the existing conditions of the candidate disposal sites, which to a significant degree have been subject to historic dredge material disposal activities. Section 7 of the DEIR discusses the expected impacts of dredge material disposal at the candidate sites.

Comment: *The CBB stated that greater effort should be expended to identify beneficial upland reuse of dredge material.*

Response: Section 3.5 of this DEIR discusses the universe of potential upland/reuse alternatives for the 20 year estimated dredge volume. Also, as mentioned in an earlier response to a Cape Cod Commission comment, designation of an open water disposal site for clean dredge material for the Buzzards Bay Region would not obviate the need for an alternatives analysis regarding disposal options for each individual dredging project as required by federal and state regulations.

13.6 Sierra Club, Cape Cod Group

The Cape Cod Group of the Sierra Club provided the following comments by letter dated April 8, 1995.

Comment: *The Sierra Club stated that cumulative impacts of disposal at BBDS must be evaluated, given the potential for toxic pollutants and elevated nutrients in material removed from dredging areas. Coarse-grained materials may exhibit greater bioavailability of contaminants to the marine environment than fine-grained materials.*

Response: The tiered testing protocol is described in detail in Section 7 2 (Regulatory Evaluation of Sediment Chemistry) of the DEIR provide information on the evaluation of sediments that is applied to determine the suitability of material for open-water disposal. The Site Management and Monitoring Plan (Section 11 of the DEIR) includes details of the monitoring to be conducted to ensure that adverse effects on sediment chemistry and the ecosystem in the vicinity of the disposal site are negligible.

13.7 Massachusetts Board of Underwater Archaeological Resources and the Massachusetts Historic Commission

The Massachusetts Board of Underwater Archaeological Resources (MBUAR) and the Massachusetts Historic Commission (MHC) provided similar comments to the April 23, 2005 Notice of Project Change in letters dated May 10, 2005 and May 24, 2005 respectively.

Comment: *Both the MBUAR and the MHC identified the presence of a potentially significant archaeological/cultural resource within or near one of the two potential disposal sites, and suggested collaborative efforts to ensure its protection from dredge material disposal activities.*

Response: Section 6.4 of the DEIR discusses historical and archaeological resources and their relevance to the proposed dredge material disposal sites. Note that while the site of the cultural resource is near the preferred disposal site, Site 1, the cultural resource site is in fact outside of the proposed disposal area. Furthermore, the DEIR in Section 11.3.1 proposes that the MBUAR be invited to participate on the Disposal and Monitoring Advisory Committee to ensure that dredge disposal activities at the proposed site will not adversely impact the cultural resource.

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14.0 REFERENCES

References for this DEIR were compiled from existing print literature, the world-wide web and from studies conducted intentionally to meet the MEPA requirements of this EIR. Studies conducted intentionally for this DEIR document were in many cases performed by members of the Maguire team and consequently produced by Maguire for CZM. These references cite Maguire as the primary source of information for the convenience of readers. For information regarding Maguire references, readers are encouraged to contact hmerrill@maguiregroup.com. CZM published a number of DMMP technical reports on their web site at http://www.mass.gov/czm/publications.htm.

Able, K. W., M.P. Fahay, K. L. Heck, Jr., C. T. Roman, M. A. Lazzari, and S. C. Kaiser.
2002 Seasonal Distribution and Abundance of Fishes and Decapod Crustaceans in a Cape Cod Estuary.Northeastern Naturalist 9(3): 285-302.

Able, K.W. and M.P. Fahay.
1998 The first year in the life of estuarine fishes in the Middle Atlantic Bight. Rutgers University Press. New Brunswick, NJ. 342 p.

Able, K.W., R.E. Matheson, W.W. Morse, M.P. Fahay, and G. Shepherd.
1990 Patterns of summer flounder Paralichthys dentatus early life history in the Mid-Atlantic Bight and New Jersey estuaries. Fish. Bull. (U.S.) 88: 1-12.

American Oceans.
2001 Essential Fish Habitat Brochure. http://www.americanoceans.org/fish/efhbroch1.htm

Anderson, T.H. and G.T. Taylor.
2001 Nutrient pulses, plankton blooms and hypoxia in western Long Island Sound. Estuaries, 24(2): 228-243.
Atlantic States Marine Fisheries Council
www.asmfc.org/Programs/Fish%2Mgnt/Am.%20Eel.html

Ayvazian, S. G., L.A. Deegan, and J.T. Finn.
1992 Comparison of habitat use by estuarine fish assemblages in the Acadian and Virginian zoogeographic provinces. Estuaries 15(3) 368-383.

Battelle Memorial Institute, Duxbury Operations Center.
1990 Final Environmental Impact Report for the Identification of Dredged-Material Disposal Sites) in Cape Cod Bay, Massachusetts, Duxbury, MA.

Beach, Douglas W., National Marine Fisheries Service.
1991 Marine Mammal Observer Requirements and Training, Gloucester, MA, correspondence with U.S. Army Corps of Engineers, Waltham, MA.

Berrill, M. and R. Stewart.
1973 Tunnel-digging in mud by newly-settled American lobsters, Homarus americanus. J. Fish. Res. Board Canada. 30:285-287.

Berrill, M.
1974 The burrowing behavior of newly-settled lobsters, Homarus vulgaris (Crustacea-Decapoda). J. Mar. Biol. Assoc. UK. 54:797-801.

Bigelow, H.B., and W.C. Schroeder.
1953 Fishes of the Gulf of Maine. Fishery Bulletin 74, Fishery Bulletin of the Fish and Wildlife Service, v. 53.

Black, D.E., D.K. Phelps, and R. L. Lapan.
1988 The Effect of Inherited Contamination on Egg and Larval Winter Flounder, Psuedopleuronectes americanus. Mar. Env. Res. 25:45-62.

Blaxter, J.H.S.
1969 Development: Eggs and Larvae. In: W.S. Hoar and D.J. Randall (eds.) Fish Physiology. Academic Press. New York, NY.

Blaxter, J.H.S.
1974 The Early Life History of Fish: the Proceedings of an International Symposium Held at the Dunstaffnage Marine Research Lab of Scottish Marine Biological Association at Oban, Scotland, 17-23 May, 1973. Springer-Verlag, New York. 765 pp.

Blaxter, J.H.S.
1985 The herring: a successful species. Canadian Journal of Fisheries and Aquatic Sciences. 42(supplement 1) 21-30.

Botero, L. And J. Atema.
1982 Behavior and substrate selection during larval settling in the lobster Homarus americanus. J. Crust. Biol. 2:59-69.

Boyar, H. C.
1968 In: Long Island Sound Dredged Material Disposal EIS. Essential Fish Habitat for Important LIS Species. USACE. November 2001. p. 3-7.

Bowman, Ray E. Charles E. Stillwell, William L. Michaels, and Marvin D. Grosslein.
2000 Food of Northwest Atlantic Fishes and Two Common Species of Squid. NOAA Technical Memorandum NMFS-NE-155.

Brower, James E., von Ende, Carl N., Zar, Jerrold H.
1990 Field and Laboratory Methods for General Ecology. Wm. C. Brown Publishers. 1990. 237pp.

Brown, Captain Steven.
2004 Federal Pilot for Buzzards Bay. personal communication

Bourne Shore and Harbor Committee.
1995 Dredging needs review. Bourne Shore and Harbor Committee, Bourne, MA.

Brandes, Horst, Armand Silva, and Thomas Fredette.
1991. Settlement of Offshore Mounds of Capped Dredged Materials. Maritimes pp. 12-14.

Buchman, M. F.
1999 NOAA Screening Quick Reference Tables. NOAA HAZMAT Report 99-1, Seattle, WA, Coastal Protection and Restoration Division, National Oceanic and Atmospheric Administration, 12 pages.

Butman, Bradford, and Michael Bothner.
1998 US Geological Survey, Predicting the Long-Term Fate of Sediments and Contaminants in Massachusetts Bay, USGS Fact Sheet FS 172-97, Woods Hole, MA.

Buzzards Bay Project (BBP).
1991 Buzzards Bay Comprehensive Conservation and Management Plan (CCMP). Buzzards Bay Project, Marion, MA, 215 pp.

Cacchione, D.A., W.D. Grant, D.E. Drake, and S.M. Glenn.
1987 Storm dominated bottom boundary layer dynamics on the Northern California continental Shelf: Measurements and predictions. J. Geophys. Res., 92, 1817-1827.

Camisa, Matthew.
2003 Personal Communication

Camisa, Matthew., and Anthony Wilbur.
2002 Buzzards Bay Disposal Site Fisheries Trawl Survey Report. March 2001 – March 2002. Commonwealth of Massachusetts, Department of Fisheries and Wildlife and Environmental Law Enforcement, Division of Marine Fisheries – Southeast Marine Fisheries Station . Pocasset, MA. July 2002.

Cape Cod Commission.
2002 Regional Policy Plan. Barnstable, MA.

Cape Cod Commission.
2001 Annual Progress Report Comprehensive Economic Development Strategy (CEDS) for Barnstable County (Cape Cod), Massachusetts 2001. Submitted to U.S. Department of Commerce Economic Development Administration.

Carey, D. A. , N. Haley, and E. Cook.
2001 Analysis of Connecticut Department of Environmental Protection Trawl Data for Long Island Sound. Long Island Sound Dredged Material Disposal EIS. USEPA and USACE, Concord, MA.

Cargnelli, Luca M., Sara J. Griesbach, Cathy McBride, Christine A. Zetlin, and Wallace W. Morse.
1999 Longfin Inshore Squid, (Loligo pealeii) Life History and Habitat Characteristics NOAA Technical Memorandum NMFS-NE-NMFS-NE 146. 29pp.

Chambers, R.C., W.C. Leggett, and J.A. Brown.
1988 Variation in and Among Early Life History Traits of Laboratory-reared Winter Founder, Pseudopleuronectes americanus. Mar. Ecol. Prog. Ser. 47: 1-15.

Chang, Sukwoo, Peter L. Berrien, Donna L. Johnson, and Wallace W. Morse.
1999. Windowpane, (Scophthalmus apuosus) Life History and Habitat Characteristics. NOAA Tech. Memo. NMFS-NE-137. 32 pp.

Charles, J. and G.J.Tufts.
1997 Monitoring Cruise at the Western Long Island Sound Disposal Site, August 1993. DAMOS Contribution No. 114. U.S. Army Corps of Engineers, New England District, Concord, MA.

Chittenden, M.E.
1972 Salinity tolerance of young blueback herring, Alosa aestivalis. Transactions of the American Fisheries Society 101:123-125.

Clarke, K.R.
1993 Non-parametric multivariate analyses of changes in community structure. Aust. J. Ecol. 18, 117-43.

Clarke, K. R.
1999 Nonmetric multivariate analysis in community-level ecotoxicology. Environ. Toxicol. and Chem. 18(2):118-127.

Clarke KR, Green, R.H.
1988 Mar Biol 92, 557-562 [176].

Clarke, K. R. and R. M. Warwick.
1994 Change in Marine Communities: An Approach to Statistical Analysis and Interpretation. Plymouth Marine Laboratory, UK, 144 pp.

Clayton, G., C. Cole, S. Murawski, and J. Parrish.
1978 Common marine fishes of coastal Massachusetts. Institute for Man and Environmental Publication R-76-16. University of Massachusetts, Amherst. 231 pp.

Coalition for Buzzards Bay
2004 Personal communication, February.

Coler & Colantonio, Inc.
1995 Cape Cod Disposal Site, Biological Assessment, Endangered Species, Draft Report to US Army Corps of Engineers, Norwell, MA.

Collings, W.S., C.C. Sheenan et al.
1981 The effects of power generation of some living resources of the Cape Cod Canal and approaches. Massachusetts Dept. of Fisheries, Wildlife and Recreational Vehicles, Div. Mar. Fisheries, xii + 212 pp. + Appen. A-K

Cooper, R.A.
1961 Early life history and spawning migration of the alewife, Alosa aestivalis. M.S. thesis, University of Rhode Island, Kingston. 58 pp.

Costa, J.E.
1988. Eelgrass in Buzzards Bay: Distribution, production and historical changes in abundance. Rep. U.S. Environ. Prot. Agency, 190 pp.

Costello, C.
1997 Personal Communication. Mass. Dept. Environmental Protection

Costello, D.P. and C. Henley.
1971 Methods for obtaining and handling marine eggs and embryos. Marine Biological Laboratory, Woods Hole, MA (Second Edition).

CR Environmental, Inc.
1997 Final report, Cape Cod Disposal Site First Year Monitoring, East Falmouth, MA.

Cross, Jeffrey N., Christine A. Zetlin, Peter L. Berrien, Donna Johnson, and Cathy McBride.
1999 Essential Fish Habitat Source Document: Butterfish, Peprilus triacanthus, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-145. U.S. Department of Commerce 42 pp.

Day, John W. Jr., Hall, Charles A. S., Kemp, Michael W., Yáñez-Arancibia, Alejandro.
1989 Estuarine Ecology. John Wiley & Sons, Inc. 1989. 542pp.

Department of Environmental Management (DEM).
1995 Past, present, and future of dredging in the Commonwealth of Massachusetts. Department of Environmental Management, Division of Waterways, Executive Office of Environmental Affairs, Boston, MA.

Design Engineer, Waterways Office of Division of Conservation and Recreation.
2004 Personal Communication

Diaz, R.J. and R. Rosenberg.
1995 Marine benthic hypoxia: A review of its ecological effects and the behavioral responses of benthic macrofauna. Oceanography and Marine Biology Annual Review 33:245-303

Donovan, F.
2002 Personal communication with the Chief Engineer of the Cape Cod Canal, USACE, New England District, 07/03/02 and 11/25/02.

Drake, D.E. and D.A. Cacchione.
1989 Estimates of the suspended sediment reference concentration (Ca) and the resuspension coefficient (g°) from near-bottom observations on the California shelf. Cont. Shelf Research, v.9, 54-61.
ENSR.
2002 Boston Harbor Navigation Improvement Project Phase 2 Summary Report

Environment Canada
1996 *SEDTEC- A Directory of Contaminated Sediment Removal and Treatment Technologies*, Computer Database

Estrella, B.T. and R.P. Glenn.
2000 Massachusetts Coastal Commercial Lobster Trap Sampling Program. May-November, 1999. Commonwealth of Massachusetts Department of Fisheries, Wildlife and Environmental law Enforcement, Executive Office of Environmental Affairs. August 28, 2000.

Estrella, Bruce.
2003 Aquatic Biologist III, MADMF Coastal Lobster Program. Personal Communication

Fahay, Michael P., Peter L. Berrien, Donna L. Johnson, and Wallace W. Morse.
1999 Essential Fish Habitat Source Document: Bluefish, Pomatomus saltatrix, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-144. U.S. Department of Commerce 68.

Farson, R.H.
1993 Cape Cod Canal. Second Edition. Cape Cod Historical Publications, Yarmouthport, MA, 177p.

US Department of the Interior.
2000 Endangered and Threatened Species; Final Endangered Status for a Distinct Population Segment of Anadromous Atlantic Salmon (Salmo salar) in the Gulf of Maine.Federal Register Vol. 65, No 223/Friday, November 17, 2000/Rules & Regulations. 69459

Fiedland, Kevin.
2001 Status of Fisheries Resources of Northeastern United States. Atlantic and Shortnose Sturgeons. www.nefsc.noaa.gov/sos/spsyn/af/sturgeon/sturg.pdf

Forster, Richard A.
1994 Bar Graph Species Accounts. In: A Birders Guide to Eastern Massachusetts. Bird Observer. 1994. American Birding Association, Inc.

Fredette, T. J.
2004. Personal conversation with US Army Corps of Engineers New England Division.

Fredette, T. J. and G. T. French
2004. Understanding the physical and environmental consequences of dredged material disposal: history in New England and current perspectives. Marine Pollution Bulletin 49:93-102.

Fredette, T. J., Germano, J. D., Kullberg, P. G., Carey, D. A., and Murray, P.
1992 Chemical stability of capped dredged material disposal mounds in Long Island Sound, USA. Chemistry and Ecology 7:173-194.

Fredette, T. J., P. G. Kullberg, D. A. Carey, R. W. Morton, and J. D. Germano.
1993 Twenty-five years of dredged material disposal site monitoring in Long Island Sound: a long-term perspective. Proceedings of the Long Island Sound Research Conference, New Haven, Connecticut, pp. 153-161.

Gailani, J., Davis, J., and Pollock, C.
1999 MODEL: Sediment grain size depth of residence, DOER Technical Notes Collection (TN DOER-N4), USACE Research and Development Center, Vicksburg, MS

Gallagher, Eugene D. and Kenneth E. Keay.
1998 Organism-sediment-contaminant interactions in Boston Harbor. pp. 89-132 In: K.D. Stolzenbach and E.E. Adams, eds. Contaminated sediments in Boston Harbor. MIT Sea Grant Press. 170 pp.

Germano, J.D. and D.C. Rhoads.
1984 REMOTS® Sediment Profiling at the Field Verification Program (FVP) Disposal Site, in R.L. Montgomery and J.W. Leach, eds., Dredging and Dredged Materials Disposal, Vol. 1, ASCE, NY.

Germano, J.D., D.C. Rhoads, L.F. Boyer, C.A. Menzie and J.A. Ryther, Jr.
1989 REMOTS® imaging and side-scan sonar: efficient tools for mapping seafloor topography, sediment type, bedforms, and benthic biology. Pp, 39-44 In: D.W. Hood, A. Schoener, and P.K. Park [Eds.], Oceanic Processes in Marine Pollution, Vol. 4: Scientific Monitoring Strategies for Oceanic Waste Disposal. Robert E. Krieger Publishing Co., Malabar, FL.

Germano, J.D.,J. Parker and R.W. Williams.
1993 Monitoring Cruise at the Westrren Long Island Sound Disposal Site, July 1990. DAMOS Contribution No. 85. U.S. Army Corps of Enginers, New England District, Waltham MA 67 pp.

Germano, J.D., D.C. Rhoads, and J.D.Luntz.
1994 An Integrated, Tiered Approach to Monitoring and Management of Dredged Material Disposal Sites in the New England Region. DAMOS Contribution No. 87. U.S. Army Corps of Enginers, New England District, Waltham MA 81pp.

Glenn, S.M., and W.D. Grant.
1987 A suspended sediment stratification correction for combined wave and current flows. J. Geophys. Res., 92, 8244-8264.

Gosner, K. L.
1978 A Field Guide to the Atlantic Seashore. Invertebrates and Seaweeds of the Atlantic Coast Form The Bay of Fundy to Cape Hatteras. 1978. Houghton Mifflin Company, Boston. 329pp.

Grant, W.D., and O.S. Madsen.
1979 Combined wave and current interaction with a rough bottom. J. Geophys. Res., 84, 1797-1808.

Grant, W.D., A.J. Williams, and S.M. Glenn.
1984 Bottom stress estimates and their prediction on Northern California continental shelf during CODE-1: The importance of wave-current interaction. J Phys. Oceanogr., 14, 506-527.

Grimes, B.H., M.T. Huish, J.H. Kerby, and D. Moran.
1989 Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Mid-Atlantic): summer and winter flounder. U.S. Fish Wildl. Serv. Biol. Rep. 82 (11.112). 18 p.

Hampson, G. R.
1988 Ground Truth Verification of a REMOTS® Survey of Buzzards Bay. Final Draft Report prepared for Region 1 of the U.S. Environmental Protection Agency, Water Management Division, 18 pp.

Harbormaster (Falmouth).
2004 Personal. comm., May

Harbormaster (Mattapoisett).
2003 Personal comm., 2003

Harbormaster and Town Planner (Wareham).
2003 Personal Communication

Horikawa, K.
1978 Coastal Engineering, Halsted Press, New York, 402 pp.

Hough, J. L.
1940 Sediments of Buzzards Bay, Massachusetts. Journal of Sedimentary Petrology, Vol. 10, No 1, pp. 19-32.

Howes, B.L. and D.D. Goehringer.
1996 Ecology of Buzzards Bay: An estuarine profile. US Department of the Interior, National Biological Service Biological Report 31, 141 p.

Howes, B. L., Williams T. and Rasmussen M.
1999 Baywatchers II. Nutrient related water quality of Buzzards Bay embayments: a synthesis of Baywatchers monitoring 1992-1998. Produced by The Coalition for Buzzards Bay. 150pp.
Hudon, C.
1987 Ecology and growth of post-larval and juvenile lobster, Homarus americanus, off Isle de la Madeleine (Quebec). Can. J. Fish. Aquat. Sci. 44:1855-1869.

Johnson, L.L., E. Casillas, T.K. Collier, J.E. Stein and U. Varanasi.
1992 Contaminant Effects on Reproductive Success in Selected Benthic Fish Species. Marine Environmental Research. 35:165-170.

Kaplan, E.H., J.R. Welker, M.G. Kraus and S. McCourt.
1975 Some Factors Affecting the Colonization of a Dredged Channel. Mar. Biol. 32: 193-204.

Karr, James R.
1991 Biological integrity: A long-neglected aspect of water resource management. Ecological Applications, 1(1):66-84.

Kelly, K.H. and J.R. Moring.
1986 Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic) – Atlantic herring. U.S. Fish Wild. Serv. Biol. Rep. 82 (11.38). 22 p.

King, M.
1995 Fisheries Biology, Assessment and Management. Fishing News Books, London.

Klein-MacPhee, Grace.
2002a Sea Basses. Family Serranidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klein-MacPhee, Grace.
2002b Croakers, Drums, and Weakfishes. Family Sciaenidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klein-MacPhee, Grace.
2002c Cods. Family Gadidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klein-MacPhee, Grace.
2002d Righteye Flounders. Family Pleuronectidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klein-MacPhee, Grace.
2002e Butterfishes. Family Stromateidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klein-MacPhee, Grace and Richard S. McBride.
2002 Searobins. Family Triglidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Klemens, Michael W.
1993 Amphibians and Reptiles of Connecticut and Adjacent Regions. State Geological and Natural History Survey of Connecticut. Bulletin No. 112. Connecticut Department of Environmental Protection. 318 pp.

Knebel, H.J., R.R. Rendigs, J.H. List, and R.P. Signell.
1996 US Geological Survey Seafloor Environments in Cape Cod Bay, a Large Coastal Embayment, Marine Geology, 133: 11-33.

Kocik, John.
2000 Status of Fisheries Resources of Northeastern United States. American Shad. www.nefsc.noaa.gov/sos/spsyn/af/shad/amshad.pdf

Kocik, John and Russell Brown.
2001. Status of Fisheries Resources of Northeastern United States. Atlantic salmon. www.nefsc.noaa.gov/sos/spsyn/af/salmon/atlsalm01.pdf

Landahl, J.T., B.B. McCain, M.S. Myers, L.D. Rhodes and D.W. Brown.
1990 Consistent associations between hepatic lesions (including neoplasms) in English Sole (Paraphrys vetulus) and polycyclic aromatic hydrocarbons in bottom sediment. Environ. Health Perspect. 89:195-203.

Leahy, Christopher W.
1994. Cape Ann In: A Birder's Guide to Eastern Massachusetts. Bird Observer. 1994. American Birding Association, Inc.

Lee, G.F., Et Al.
1977 Aquatic Disposal Field Investigations, Galveston, Texas, Offshore Disposal Sites: Appendix B: Investigation of Water Quality Parameters and Physicochemical Parameters. Center for Environmental Studies, Richardson, Texas. Technical Report D-77-20, p. 435.

Leenknecht, D. A., A. Szuwalski, and A. R. Sherlock
1992. Automated Coastal Engineering System, Technical Reference version 1.07, Coastal Engineering Research Center, Department of the Army, Waterways Experiment Station, Vicksburg, MS.

Levinton, Jeffrey S.
1982 Marine Ecology. Prentice Hall, Inc. Englewood Cliffs, New Jersey. 526 pp.

Long, E.R., D.D. McDonald, S.L. Smith, and F.D. Calder.
1995 Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments, Environmental Management, Vol. 19 (1).

Maguire Group Inc.
1997a Buzzards Bay Disposal Site investigation. Dredged Material Management Plan Phase I, Task M Submitted to Maguire by Aubrey Consulting (Boston, MA) for MA CZM

Maguire Group Inc.
1997b Dredging inventory report. Dredged Material Management Plan Phase I, Task B. Submitted by Maguire (Foxborough, MA) to MA CZM

Maguire Group Inc.
1998a Possible Shipwreck and Aboriginal Sites on Submerged Land. Submitted to Maguire. by Warren. C. Reis, Ph. D. (Walpole, ME) for MA CZM.

Maguire Group Inc.
1998b Dredged Material Management Plan Phase 2. Physical Characterization of the Proposed Buzzards Bay Disposal Site. Submitted to Maguire by SAIC (Newport, RI) for MA CZM.

Maguire Group Inc.
1998c MEPA Scope I: Needs Analysis. Submitted to Maguire by SAIC (Newport RI) for MA CZM

Maguire Group Inc.
1998d MEPA Scope II: Alternatives Analysis. Submitted to Maguire by SAIC (Newport, RI) for MA CZM.

Maguire Group Inc.
1999a Early Benthic Phase Lobster Survey for Gloucester Harbor. Submitted to Maguire Group Inc. by Normandeau Associates Inc. (NAI) (Bedford, NH) for MA CZM

Maguire Group Inc.
1999b Habitat Characterization of the DMMP Candidate Aquatic Disposal Sites. Submitted to Maguire by SAIC (Newport, RI) for MA CZM.

Maguire Group Inc.
2000a Draft Environmental Impact Report for Gloucester, Massachusetts Prepared by: Maguire (Foxborough, MA) for .MA CZM

Maguire Group Inc.
2000b New Bedford Aquatic Disposal Site Screening: Characterization of the New Zone of Siting Feasibility and West Island Ledge Sites. Submitted to Maguire by SAIC (Newport, RI) for MA CZM

Maguire Group Inc.
2001a Results of the October 2000 Bathymetric Survey at Candidate Disposal site 1 in Buzzards Bay. Submitted to Maguire by SAIC (Newport, RI) for MA CZM

Maguire Group Inc.
2001b November 2000 Baseline Characterization of Sediment Chemistry at Two Candidate Dredged Material Disposal Sites in Buzzards Bay. Submitted to Maguire by SAIC (Newport, RI) for MA CZM

Maguire Group Inc.
2001c November 2000 REMOTS Survey at Two Candidate Dredged Material Disposal Sites in Buzzards Bay. Submitted to Maguire by SAIC (Newport, RI) for MA CZM

Maguire Group Inc.
2001d November 2000 Baseline Characterization of Benthic Macroinvertebrate Communities At The Two Candidate Dredged Material Disposal Sites In Buzzards Bay. Submitted to Maguire by SAIC (Newport, RI) for MA CZM

Maguire Group Inc.
2001e November 2001 Evaluation of Baseline Water Column Chemistry and Sediment Resuspension Potential at Two Candidate Dredged Material Disposal Sites in Buzzards Bay

Maguire Group Inc.
2002a Buzzards Bay Disposal Site Report: Massachusetts Division of Marine Fisheries Trawl Data Analysis. Submitted to Maguire by Coastal Vision (Carey and Haley.Newport, RI) for MA CZM

Maguire Group Inc.
2002b Competing Site Use Assessment. Submited to Maguire by Coastal Vision (Colburn, Carey and Haley. Newport, RI) for MA CZM

Maguire Group Inc.
2002c DMMP Draft Environmental Impact Report for New Bedford/Fairhaven Harbor Prepared by Maguire (Foxborough, MA) for MA CZM

Maguire Group Inc.
2002d Bottom Classification Survey Buzzards bay Disposal Site Survey Report. Submitted to Maguire by C.R.Environmental, Inc.(Falmouth, MA) for MA CZM

Maguire Group Inc.
2003 DMMP Final Environmental Impact Report for New Bedford/Fairhaven Harbor. Prepared by Maguire for MA CZM

Maguire Group Inc.
2004a Results from MDFATE and STFATE Simulations at Two Proposed Buzzards Bay Disposal Sites. Submitted to Maguire by Applied Science Associates. (Narragansett, RI) for MA CZM

Maguire Group Inc.
2004b Buzzards Bay Disposal Site Analysis "Detailed Hydrodynamic Analysis". Submitted to Maguire by Applied Science Associates. (Narragansett, RI) for MA CZM

Manahan, S. E.
2000 "Environmental Chemistry,". 7th ed., Lewis Publishers, Boca Raton,.

Massachusetts Department of Environmental Management
1993 Section 61 Finding - Designation of the Cape Cod Disposal Site, Management and Monitoring Plan, EOEA # 3692, FGEIR Office of Waterways, Boston, MA

Massachusetts Department of Fish and Wildlife, Natural Heritage and Endangered Species Program (DFW).
1991 www.state.ma.us/dfwele/dfw/nhesp/nhespnhfacts/Acibre.pdf
www.state.ma.us/dfwele/dfw/nhesp/nhespnhfacts/Acioxy.pdf

Massachusetts Division of Marine Fisheries (DMF).
1999 Massachusetts Designated Shellfish Growing Areas. Produced February 10, 1999.

Massachusetts Office of Travel and Tourism (MOTT).
2002 Labor Force Estimates, WebSARAS, www.detma.org/MassStats/WebSARAS, July 10, 2002.

Massachusetts Office of Travel and Tourism (MOTT).
2000 The Economic Impact of Travel on Massachusetts Counties 2000. Research Department of the Travel Industry Association of American, Washington, D.C.

MassGIS.
2003 www.state.ma.us/mgis/acec.htm

Massachusetts Department of Environmental Protection (DEP).
2001 Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program Correspondence for Buzzards Bay Disposal Site- Dredged Material Management Plan. August 23, 2000.

Massachusetts Department of Environmental Protection (DEP).
2002 Division of Municipal Services/Diesel Retrofit Program. Guidance for the Massachusetts Dredged Material Management Plan. July, 01, 2002.

Massachusetts Department of Environmental Protection (DEP).
2002 Draft WQC regulations. November, 2002.

Massachusetts Department of Environmental Protection (DEP). Southern Regional Office.
2004 Personal communication, February 25, 2004.

Massachusetts Division of Employment and Training.
2002 Mass Stats Falmouth Population Data 2000. July 10, 2002. http://massstats.detma.org/websaras/index.asp

Massachusetts Division of Employment and Training.
2002a MassStats Falmouth Labor Data 2001. July 10, 2002. http://massstats.detma.org/websaras/index.asp

Massachusetts Department of Public Works
1990 Final Environmental Impact Report, Supplement: Central Artery/Tunnel Project, PartII: Project Changes and Refinements Since 1985 FEIS/R

Matthews, William J.
1998. Patterns in Freshwater Fish Ecology. Chapman & Hall. 1998. 616pp.

Maughan, J. T. and C. A. Oviatt.
1993 Sediment and benthic response to wastewater solids in a marine mesocosm. Water Environ. Res. 65:879-889.

Maurer, D., R.T. Keck, J.C. Tinsman, and W.A. Leathem.
1982a Vertical Migration and Mortality of Benthos in Dredged Material: Part III - Polychaeta. Marine Environ. Res. 0141-1136/82/0006-0049. Applied Science Publishers Ltd., England 1982.

Maurer, D., R.T. Keck, J.C. Tinsman, and W.A. Leathem.
1982b Vertical Migration and Mortality of Benthos in Dredged Material: Part II - Crustacea. Marine Environ. Res. 0141-1136/81/0005-0301. Applied Science Publishers Ltd., England 1982

McBride, Holly M. and Thomas B. Hoopes.
2000 1999 Massachusetts Lobster Fishery Statistics. MA Division of Marine Fisheries, Technical Report TR-2.

McCall, P.L.
1977 Community Patterns and Adaptive Strategies of the Infaunal Benthos of Long Island Sound. J. Mar. Res. 35: 221-266.

McHugh, J.L.
1993 The Magnuson Act and the Middle Atlantic Fisheries. Underwater Naturalist. 22 (1): 3-11.

McGurk, M.D.
1986 Natural Mortality of Marine Pelagic Fish Eggs and Larvae: Role of Spatial Patchiness. Mar. Ecol. Prog. Ser. 34: 227-242.

Menzie, C.A., J. Ryther, Jr., L.F. Boyer, J.D. Germano, & D.C. Rhoads.
1982 Remote methods of mapping of seafloor topography, sediment type, bedforms, and benthic biology. Oceans 82 Conference Record, NOAA-OMPA, Washington, D. C., September 2022, l982, pp. l046-l05l.

Mercer, L.P.
1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (mid-Atlantic)—weakfish. U.S. Fish and Wildlife Service Biological Report. 82(11.109). U.S. Army Corps of Engineers, TR EL-82-4. 17 pp.

Messieh, S.N.
1988 Spawning of the Atlantic herring in the Gulf of St. Lawrence. Am. Fish. Soc. Symp. 5: 31-48.

Metro West Dive Club.
2000. Buzzards Bay Vineyard Sound Shipwreck Map at http://www.kersur.net/~mwdc/zoomin.html, last updated 07/28/01.

Munroe, Thomas A.
2002 Herrings. Family Clupeidae. In: Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Edition. B.B. Collette and G. Klein-MacPhee (eds.). Smithsonian Institution Press, Washington and London. 748 p.

Montague, Paul.
2003 Personal Communication with Town of Falmouth Shellfish Warden.

Moore, J.R. III.
1963 Bottom studies, Buzzards Bay, Massachusetts. J. Sed. Pet. 33(3): 511-558.

Morris, J. T; Tufts, G. J.
1997 Monitoring cruise at the Central Long Island Sound Disposal Site, July 1994. DAMOS Contribution No. 117 (SAIC Report No. 327). U.S. Army Corps of Engineers, New England District, Waltham, MA.

Morris, J.T.
1998 Monitoring Cruise at the Western long Island Dispodsal Site, July 1996. DAMOS Contribution 119. U.S. Army Corps of Engineers, New England District, Concord MA.

Morton, R.W.
1980a Capping Procedures as an Alternative Terchnique to Isolate Contaminated Dredge Material in the Marine Environment DAMOS Contribution No. 11. U.S.Army Corps of Engineers, New England District, Waltham MA, 26 pp.

Morton, R.W.
1980b Management and Monitoring of Dredge Spoil Disposal and Capping Procedures in Central Long Island Sound. DAMOS Contribution No. 8. U.S.Army Corps of Engineers, New England District, Waltham MA, 56 pp.

Morton, R.W. and L.L. Stewart and G. D> Paquette.
1982a Baseline Survey of Proposed WLIS III Dredged Material Disposal Site, January 1982. DAMOS Contribution No. 19. U.S.Army Corps of Engineers, New England District, Waltham MA,

Morton, R.W. and L.L. Stewart.
1982b Interim Survey of Western Long Island Sound III Disposal Site DAMOS Contribution No. 18. U.S.Army Corps of Engineers, New England District, Waltham MA, 21 pp.

Morton,R.W. and G.D.Paquette.
1983 Summary of Measurements made at the WLIS III Disposal Site. DAMOS Contribution No. 27. U.S. Army Corps of Engineers, New England District, Waltham, MA. 60 pp.

Morton, R.W., J. H. Parker, and W. H. Richmond (Eds.).
1984 Disposal Area Monitoring System (DAMOS) Annual Report, Summary of Program Results, 1981-1984 DAMOS Contribution No. 46. U.S. Army Corps of Engineers, New England District, Waltham, MA.

Murray, P.M. and G.D. Paquette.
1983 Summary of Measurements made at the WLIS III Disposal Site, September 1997 and March 1998. Contribution No. 125 (SAIC Report No. 44`). Disposal Area Monitoring System (DAMOS) Report. U.S. Army Corps of Engineers, New England District, Concord MA.

National Research Council (NRC).
1990 Managing Troubled Waters. Washington, D.C. National Academy Press. 125 p.

National Marine Fisheries Service - Northeast Regional Office (NMFS/NERO).
2001 Essential Fish Habitat. Source Documents: Long-finned squid (Loligo pealeii) www.nero.nmfs.gov/ro/doc/list.htm

NOAA.
1975 Environmental Survey of the Effects of Dredging and Spoil Disposal, New London, CT. Various Quarterly Reports

NOAA.
1977 Environmental Survey of the Effects of Dredging and Spoil Disposal, New London, CT. Various Quarterly Reports

Newcombe, C. P. and J. O. T. Jensen.
1996 Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management. Vol. 16, No. 4 pp 693-727.

New England Fisheries Management Council (NEFMC)
1998 Essential Fish Habitat Source Documents http://www.nefsc.gov/nefsc/habitat/efh/ Atlantic Sea Herring (*Clupea harengus*)

Nichols, J.A., G.T. Rowe, C.H. Clifford and R.A. Young.
1978 In Situ Experiments on the Burial of Marine Invertebrate. Journal of Sedimentary Petrology, Vol. 48, No. 2, pp. 419-425.

Nimeskern, Philip.
2002 Personal communication with Marine Analysis Unit of USACE New England District, 11/26/02.

Normandeau Associates Inc. (NAI).
2000 Dissolved Oxygen Near the Bottom in Disposal Cells M4, M5, and M12 and Adjcaent Sites in the Mystic River, Boston Harbor. Prepared for: Great Lakes Dredge and Dock Company, February 2000.

O'Brien, L., J. Burnett and R.K. Mayo.
1993 Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. NOAA Tech. Rep. NMFS 113. 66 p.

Packer, David B., Sara J. Griesbach, Peter L. Berrien, Christine A. Zetlin, Donna L. Johnson, and Wallace W. Morse
1999 Summer Flounder, (Paralichthys dentatus) Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-151 87 pp. September 1999.

Palma, A.T., R.A. Wahle, and R.S. Steneck.
1998 Different early post-settlement strategies between American lobsters Homarus americanus and the rock crab Cancer irroratus in the Gulf of Maine. Marine Ecology Progress Series 162:215-225.

Payne, P.M.
1991 A Distributional Assessment of Endangered and Threatened Marine Mammals and Turtles in the Massachusetts Bay-Cape Cod Areas with Special Emphasis on the Massachusetts Bay Disposal Site. Mass. Dept. Public Works, Central Artery (I-93)/Tunnel (I-90) Project, Technical Appendix 3 for Biological Assessment. 57 pp.

Pearson, T.H., and R. Rosenberg.
1978 Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology Annual Review 16:229-331.

Pereira, Jose J., Ronald Goldberg, John Ziskowski, Peter L. Berrien, Wallace W. Morse, Donna L. Johnson.
1999 Essential Fish Habitat Source Document: Winter Flounder, Pseudopleuronectes americanus, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-138.

Peterson, R.T.
2002 A Field Guide to Birds of Eastern and Central North America. Houghton Mifflin. New York

Pilson, M.E.Q. and C.D. Hunt.
1989 Water quality survey of Narragansett Bay, a summary of results from SINBADD 1985-1986. Report #NBP-89-22. Rhode Island Department of Environmental Management, Providence, RI.

Reid, Robert N., Luca M. Cargnelli, Sara j. Griesbach, David B. Packer, Donna L. Johnson, Christine A. Zetlin, Wallace W. Morse, and Peter L. Berrien.
1999 Atlantic Herring, (Clupea harengus) Life History and Habitat Characteristics. September 1999. V+ 54 p.

Revelas, E. C., Germano, J. D., and Rhoads, D. C.
1987 REMOTS® Reconnaissance of benthic environments. Coastal Zone '87: Proceedings of the Conference, WW Div/ASCE/May 26-29, Seattle, WA, pp. 2069-2083.

Rhoads, D. C. and D. K. Young.
1970 The influence of deposit-feeding organisms on sediment stability and community trophic structure. J. Mar. Res. 28:150-178.

Rhoads, D.C., P.L. McCall, and J.Y. Yingst.
1978 Disturbance and production on the estuarine seafloor. American Scientist, 66:577-586.

Rhoads, D.C., and J.D. Germano.
1982 Characterization of benthic processes using sediment profile imaging: an efficient method of remote ecological monitoring of the seafloor (REMOTS System). Marine Ecology Progress Series 8:115-128.

Rhoads, D.C. and J.D. Germano.
1986 Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiologia 142: 291-308.

Rhoads, D. C.
1994 Analysis of the Contribution of Dredged Material to Sediment and Contaminant Fluxes in Long Island Sound. DAMOS Contribution No. 88. U.S. Army Corps of ERNgineers, New England District, Waltham, MA 32pp.

Ritter, C. and P. A. Montagna.
1999 Seasonal hypoxia and models of benthic response in a Texas Bay. Estuaries 22:7-20

Robins, C. Richard and G. Carleton Ray.
1986 A Field Guide to Atlantic Coast Fishes North America. Houghton Mifflin Company. Boston, MA. 354 pp.

SAIC.
1982 Disposal Area Monitoring System Annual Report 1980 , Volume I:Physical Measurements, Volume II: Biological Observations, Volume III: Visual Observations. DAMOS Contribution No. 17. US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1985a Stamford New Haven Disposal Operation Monitoring Survey Report. DAMOS Contribution No. 7. US Army Corps of Engineers, New England District, Waltham, MA.41pp.

SAIC.
1985b Standard Operating Procedure Manual for DAMOS Monitoring Activities, Volume I and Volume II. DAMOS Contribution No. 48. US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1985c. Rhode Island and southeastern Massachusetts dredging needs survey: 1985 - 1995. DAMOS Contribution No. 485 (SAIC Report No. SAIC-84/7520&C45). Prepared for the US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1988a Seasonal Monitoring Cruise at the Western Long Island Sound Disposal Site, August 1986, 1985. DAMOS Contribution No. 61 (SAIC Report No. SAIC-87/7510&C55). US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1988b Monitoring surveys at the Western Long Island Sound Disposal Site, August and October, 1985. DAMOS Contribution No. 55 US Army Corps of Engineers, New England District, Waltham, MA.20 pp.

SAIC.
1989a 1985 monitoring surveys at Central Long Island Sound Disposal Site: an assessment of impacts from disposal and Hurricane Gloria. DAMOS Contribution No. 57 (SAIC Report

No. SAIC-87/7516&C57). US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1989b Monitoring cruise at the New London Disposal Site, August 1985-July 1986. DAMOS Contribution No. 60 (SAIC Report No. SAIC-86/7540&C60). US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1989c Buzzards Bay Disposal Site Literature Review. DAMOS Contribution No. 58 (SAIC Report No. SAIC-86/7519&C58 April 1989). US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1990a Monitoring Cruise at the Western Long Island Sound Disposal Site, July 1988. DAMOS Contribution No. 76. U.S.Army Corps of Engineers, New England District, Waltham, MA 20 pp.

SAIC.
1990b Monitoring Cruise at the Western Long Island Sound Disposal Site, November 1987. DAMOS Contribution No. 74. U.S.Army Corps of Engineers, New England District, Waltham, MA 90 pp.

SAIC.
1991 Buzzards Bay Disposal Site baseline study, March 1990. DAMOS Contribution No. 80 (SAIC Report No. SAIC-90/7582&C86). Prepared for the US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1994 An Integrated, Tiered Approach to Monitoring and Management of Dredged Material Disposal Sites in the New England Region. DAMOS Contribution No. 87 (SAIC Report No. SAIC-90/7575&234). Prepared for the US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
1995 Sediment Capping of Subaqueous Dredged Material Disposal Mounds: An Overview of the New England Experience 1979-1993. DAMOS Contribution N0. 95. U.S. Army Corps of Engineers, New England District, Waltham, MA 101pp.

SAIC.
1996 DAMOS Summary Report 1985-1990. DAMOS Contribution No. 109 (SAIC Report No. SAIC-91/7610&C97). Prepared for the US Army Corps of Engineers, New England District, Waltham, MA.

SAIC.
2001a Observations of Physical Oceanographic Conditions at the New London Disposal site 1997–1998. DAMOS Contribution Report No. 130 (SAIC Report No. SAIC-453 October 2001) Prepared for: New England District U.S. Army Corps of Engineers – New England District. Concord, MA 01742-2751

SAIC.
2001b Monitoring Cruise at the New London Disposal Site August 2000. DAMOS Contribution Report No. 133 (SAIC Report No. SAIC-512 December 2001) Prepared for: New England District U.S. Army Corps of Engineers – New England District. Concord, MA 01742-2751

SAIC.
2002a Monitoring Survey at the Massachusetts Bay Disposal Site, Fall 2000. DAMOS Contribution Report No. 134 (SAIC Report No. SAIC-545). Prepared for the US Army Corps of Engineers-New England District. Concord, MA 01742-2751

SAIC.
2002b Central Long Island Sound Disposal Site Synthesis, 1999-2000. DAMOS Contribution 139. U.S. Army Corps of Engineers, New England District, Concord, MA.

Saila, S.B.
1961 The contribution of estuaries to offshore winter flounder fishery in Rhode Island. Proceedings of the Gulf and Caribbean Fisheries Institute 14:95-109.

Sanders, H. L.
1958 Benthic studies in Buzzards Bay. I. Animal-sediment relationships. Limnol. Oceanogr. 3:245-258.

Sanders, H. L.
1960 Benthic studies in Buzzards Bay. II. The structure of the softbottom community. Limnol. Oceanogr. 5:138-153.

Santos, S.L. and J.L. Simon.
1980a Marine Soft-Bottom Community Establishment Following Annual Defaunation: Larval or Adult Recruitment Mar. Ecol. Prog. Ser., Vol. 2: 235-241, 1980.

Santos, S. L., and Simon, J. L.
1980b Response of soft-bottom benthos to annual catastrophic disturbance in a south Florida estuary. Mar. Ecol. Prog. Ser. 3:347-355.

Schwartz, J.
2000 The Historical Effects and Future Implications of Nitrogen Inputs on the Eelgrass Communities of West Falmouth Harbor, MA.

Scott, K.J., D.C. Rhoads, S. Pratt, J. Rosen, and J.H. Gentile. 1987. Impact of Open-water Disposal of Black Rock Harbor Dredged Material on Benthic Recolonization at the FVP

Site. Technical Report D-87-4, prepared by the US Environmental Protection Agency, Narragansett, RI, for the US Army Engineer Waterways Experiment Station, Vicksburg, MS

Selectman and Town Administrator (Dartmouth).
2003 Personal Communication

Signell, R. P.
1987. Tide- and Wind-Forced currents in Buzzards Bay, Massachusetts, *WHOI Tech. Rpt.*, *WH-87-15*, Woods Hole Oceanographic Institution, Woods Hole, MA.

Sokal, R. R. and F. J. Rohlf.
1981 Biometry: The Principles and Practice of Statistics in Biological Research (second edition). W.H. Freeman and Company, San Francisco.

Sosebee, Katherine A.
2000 Status of Fisheries Resources of Northeastern United States. Little Skate. www.nefsc.noaa.gov/sos/spsyn/op/skate/skates00.pdf

Spaulding, M., D. Mendelsohn and J.C. Swanson.
1999. WQMAP: An integrated three-dimensional hydrodynamic and water quality model system for estuarine and coastal applications, *Mar. Tech. Soc. J.*, *33* (3), 38-54.

Steimle, Frank W., Christine A Zetlin, Peter L. Berrien, and Sukwoo Chang.
1999a Essential Fish Habitat Source Document: Black Sea Bass, Centropristis striata, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-143

Steimle, Frank W., Christine A Zetlin, Peter L. Berrien, Donna L. Johnson, and Sukwoo Chang.
1999b Essential Fish Habitat Source Document: Scup, Stenotomus chrysops, Life History and Habitat Characteristics. NOAA Technical Memorandum NMFS-NE-149

Steimle, Frank W. and Patricia Shaheen.
1999c Tautog (Tautoga onitis) Life History and Habitat Requirements. NOAA Technical Memorandum NMFS-NE-118. 23pp.

Studholme, Anne L., David B. Packer, PeterL. Berrien, Donna L. Jackson, Christine A Zetlin, and Wallace W. Morse
1999 Atlantic Mackerel, (Scomber scombrus) Life History and Habitat Characteristics September 1999 V+ 35p.

Superintendent of Cape Cod County Dredge Program.
2004 Personal Comunication

Swanson, J. C., 1986. A three dimensional numerical model system of coastal circulation and water quality. Ph. D. Thesis, Dept. of Ocean Engineering, University of Rhode Island, Kingston, RI.

Terres, John K.
1980 The Audubon Encyclopedia of North American Birds, Alfred A. Knopf, NY.

Town Administrator (Marion).
2003 Personal Communication

Town Dredging Committee Member (Westport).
2003 Personal Communication

Travel Industry Association of America.
2002 The Economic Impact of Travel on Massachusetts Counties 2000. Prepared for the Massachusetts Office of Travel and Tourism.

Turek, James.
2002 Personal Communication with NOAA National Marine Fisheries Habitat Restoration Unit.

U. S. Army Corps of Engineers (USACE).
2001 Implementation of Dredging Risk Assessment Modeling Applications for Evaluation of the No-Action Scenario and Dredging Impacts. Dredging Operations and Environmental Research Program. ERDC TN-DOER-R2. December 2001.

USACE New England Division (USACE-NAE).
2001d Providence River and Harbor Maintenance Dredging Project, Final Environmental Impact Statement, August 2001.

USACE–NAE.
1989 Guidance for performing tests on dredged material to be disposed of in open waters. Draft guidance document in cooperation's with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. May 1989. 32 pp.

USACE-NAE.
1995 Massachusetts navigation and dredging management study, Section 22 - Planning Assistance to States Program, January 1995. US Army Corps of Engineers, New England District (NAE), Waltham, MA.

USACE-NAE.
1996a Inventory of dredging needs in the designated port areas of Massachusetts: 1996-2016. Prepared by the US Army Corps of Engineers, New England District (NAE) for the Coastal Zone Management Agency, Massachusetts Executive Office of Environmental Affairs, Boston, MA.

USACE-NAE.
1996b An Investigation of the Dispersion of Sediments Resuspended by Dredging Operations in New Haven Harbor. DAMOS Contribution 112. November 1996. USACE New England District, Concord MA.

USACE-NAE.
1998 Providence River and Harbor Maintenance Dredging Project, Draft Environmental Impact Statement.

USACE-NAE.
2001a Monitoring at the New London Disposal Site, 1992-1998, Volume I. DAMOS Contribution No. 128 (SAIC Report No. 515), US Army Corps of Engineers, New England District, Concord, MA.

USACE–SAIC.
2001b Monitoring Cruise at the New London Disposal site 1992-1998 Volume II SEAWOLF Mound, DAMOS Contribution Report No. 132.

USACE–SAIC.
2001c Monitoring Cruise at the New London Disposal Site, DAMOS Contribution Report No. 133.

US Census Bureau, Census 2000.
2000 Summary File 1, Population, Housing Units, Area and Density:. http://factfinder.census.gov.

US Environmental Protection Agency (USEPA).
1989 Evaluation of the continued use of the Massachusetts Bay Dredged Material Disposal Site. Draft Environmental Impact Statement, September 1989. U.S. Environmental Protection Agency Region I, John F. Kennedy Building, Boston, MA. 230 pp. + references and appendices.

USEPA.
1992 Final Environmental Impact Statement: Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay, Boston, MA.

USEPA.
1996 *Vendor Information System for Innovative Treatment Technologies, Version 5*, Computer Database, Office of Solid Waste and Emergency Response

USEPA-USACE.
1989 Guidance for Performing Tests on Dredged Material to be Disposed of in Open Waters, Waltham, MA.

USEPA-USACE.
1991 Evaluation of Dredged Material Proposed for Ocean Disposal. Testing Manual. EPA Office of Marine and Estuarine Protection, Washington D.C. and Department of the Army, U.S. Army Corp Of Engineers, Washington, D.C., 186 pp. February 1991.

USEPA-USACE NAE
2003 Draft Environmntal Impact Statement for the Designation of Dredged Material Disposal Sites in Central and Western Long Island Sound, Connecticut and New York

USEPA-USACE NAE
2004 Regional implementation manual for the Evaluation Of Dredged Material Proposed For Disposal in New England Waters

USEPA-USACE NAE
2004 Draft Environmental Impact Statement for Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project

USFWS.
1983 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico). Coastal Ecology Group Waterways Experiment Station. FWS/OBS-82/11.14 Technical Report TR EL-82-4. October 1983.

US Fish and Wildlife Service.
1983 Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Gulf of Mexico). Coastal Ecology Group Waterways Experimewnt Statipn. FWS/ODS-8211/14 Technicla Report TR EL-82-4. October 1983.

US Department of the Interior USFWS.
2002 Letter Response to Consultation dated July 29, 2002

US Navy.
1979 Draft Environmental Impact Statement, Trident Dredging, Thames River Channel, Groton and New London, CT.

Valente, R. M., D. C. Rhoads, J. D. Germano and V. J. Cabelli.
1992 Mapping of benthic enrichment patterns in Narragansett Bay, RI. Estuaries 15:1-17.

Valente, R. M.
The role of seafloor characterization and benthic habitat mapping in dredged material management: a review. Journal of Marine Environmental Engineering 7(3):185-215.

Valente, R.M. and T. Fredette.
2002. Benthic recolonization of a capped dredged material mound at an open water disposal site in Long Island Sound. Proceedings of Dredging ’02: Third Specialty Conference on Dredging and Dredged Material Disposal, May 5-8, Orlando, Florida. American Society of Civil Engineers, Reston, VA.

Valente, R. M., S. M. McChesney and G. Hodgson.
2000. Benthic recolonization following cessation of dredged material disposal in Mirs Bay, Hong Kong. Journal of Marine Environmental Engineering 5: 257-288.

Van Dolah, R. F., Calder, D. R., Knott, D. M.
1984. Effects of dredging and open-water disposal on benthic macroinvertebrates in a South Carolina estuary. Estuaries 7: 28-37.

Veit, Richard R. and Wayne R. Petersen.
1993 Birds of Massachusetts. Natural History of New England Series. Massachusetts Audubon Society 514 pp.

Wahle, R.A. and R.S. Steneck.
1991 Recruitment habitats and nursery grounds of American lobster (Homarus americanus Milne Edwards): a demographic bottleneck? Mar. Ecol. Prog. Ser. 69:231-243.

Walsh, H.J., D.S. Peters, and D.P. Cyrus.
1999 Habitat utilization by small flatfishes into a North Carolina estuary. Estuaries 22: 803-813.

Waterways Committee (Mashpee).
2004 Personal Communication

Webb, D. G.
1993 Effect of surface deposit-feeder (Macoma balthica L.) density on sedimentary chlorophyll a concentrations. J. Exp. Mar. Biol. 174:83-96.

Weiss Howard M.
1995 Marine Animals of Southern New England and New York. Identification Keys to Common Nearshore and Shallow Water Macrofauna. State Geological and Natural History Survey of Connecticut Department of Environmental Protection. Bulletin 115.

Whitlach, R. B., Boyer, L. F., Sanders, H. L., and Hampson, G. R.
1980 Station "R" revisited: Long-term persistence of a subtidal benthic community. Draft manuscript.

Whitworth, Walter R.
1996 Freshwater Fishes of Connecticut. State Geological and Natural History Survey of Connecticut. 1996. 243pp.

Wiberg, P.L. and J.D. Smith.
1983 A comparison of field data and theoretical models for wave-current interactions to the bed on the continental shelf. Cont. Shelf Res., 2, 147-162.

Wilbur, A.R.
2000 Fish habitat characterization assessment: Approach to integrate seafloor features and juvenile organism data. The OCEANS 2000 MTS/IEEE Conference. Providence, RI. 11-14 September 2000.

Wiley, M.B.
1994 DAMOS Capping Model Verification. , 1985-1990. DAMOS Contribution No. 89. U.S. Army Corps of Engineers, New England District, Waltham, MA, 35 pp.
Wiley, M.B.
1995 Deep Water Capping DAMOS Contribution No. 98. U.S. Army Corps of Engineers, New England District, Waltham, MA, 23 pp.

Wiley, M.B. and J.B. Charles.
1995 DAMOS Monitoring Cruise at the Massachusetts Bay Disposal Site March 31-April 4, 1992. DAMOS Contribution No. 100. U.S. Army Corps of Engineers, New England District, Waltham, MA, 23 pp.

Wiley, M.B., J. Charles, C. Eller, and R. Williams.
1996 DAMOS Summary Report, 1985-1990. DAMOS Contribution No. 109. U.S. Army Corps of Engineers, New England District, Waltham, MA, 117 pp.

Wilk, Stuart J., R.A. Pikanowski, A.L. Pacheco, D.G. McMillan, and L.L. Stehlik.
1995 Response of Fish and Megainvertebrates of the New York Bight Apex to the Abatement of Sewage Sludge Dumping - An Overview. In: Effects of the Cessation of Sewage Sludge Dumping at the 12-mile Site. NOAA Technical Report NMFS 124. U.S. Department of Commerce Seattle, Washington. Wolfe, S., 2000. ENSR. Personal communication.

Wilk, Stuart J., R.A. Pikanowski, A.J. Pacheco, D.G. McMillan, B.A. Phelan and L.L. Stehlik.
1995 Response to Fish and Megainvertebrates Collected in the Hew York Bight Apex to the Abatement of Sewage Sludge Dumping - An Overview. In: Effects of the Cessation of Sewage Dumping at the 12-Mile Site. 12-Mile Dumpsite Symposium Long Branch, New Jersey, June 1991. NOAA Technical Report NMFS-124 United States Department of Commerce National Oceanic and Atmospheric Administration National Marine Fisheries Service Northeast Region Northeast Fisheries Science Center Woods Hole, MA. 78 pp.

Williams, R. W.
1995 Monitoring Cruise at the Western Long Island Sound Disposal Site, July 1991. DAMOS Contribution No. 99. U.S. Army Corps of Engineers, New England District, Waltham, MA, 45 pp.

Woods Hole Oceanographic Institute (WHOI).
2002 Pilot Census of Marine Life in the Gulf of Maine. www.whoi.edu/marinecensus/doc/Reference/fishes_c01_6.htm.

Zajac, R.N. and R.B. Whitlatch.
1982 Responses of Estuarine Infauna to Disturbance. I. Spatial and Temporal Variation of Succession. Mar. Ecol. Prog. Ser. 14, 15-2XX

Additional Web Pages:
www.state.ma.us/dfwele/dfw/nhesp/nhfacts/Acibre.pdf
www.state.ma.us/dfwele/dfw/nhesp/nhfacts/Acioxy.pdf

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