Environmental Restoration of Dredged Hole #6

Barnegat Bay, New Jersey

Feasibility Report & Environmental Assessment

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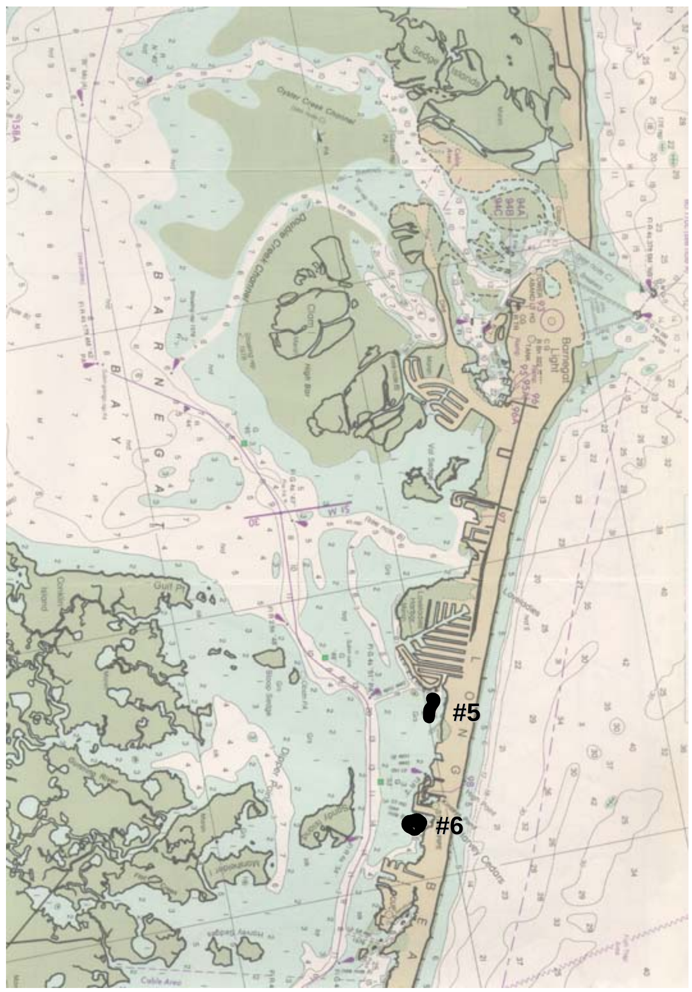

New Jersey Department
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FINAL REPORT

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List of Acronyms

CEDEP	Corps of Engineers Dredge Estimating Program
CERCLA	Comprehensive Environmental Response Compensation Liability Act
CFR	Code of Federal Regulations
DO	Dissolved Oxygen
EA	Environmental Assessment
EAR	Early Action Report
EFH	Essential Fish Habitat
HAPC	Habitat Area of Particular Concern
HSI	Habitat Suitability Index
HTRW	Hazardous Toxic or Radioactive Waste
IWR-Plan	Institute for Water Resources Plan
LBI	Long Beach Island
LERRD	Lands, Easements, Rights-of-Way, Relocations, Disposal Areas
NAVD	North Atlantic Vertical Datum
NJDEP	New Jersey Department of Environmental Protection
NJIWW	New Jersey Intracoastal Waterway
NJ SHPO	New Jersey State Historic Preservation Office
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWR	National Wildlife Refuge
ORP	Oxidation-Reduction Potential

PAR	Planning and Aid Report
PCA	Project Cooperation Agreement
PED	Preconstruction engineering and design
PMP	Project Management Plan
PSE&G	Public Service Electric & Gas
SAV	Submerged Aquatic Vegetation
TOC	Total Organic Carbon
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey

EXECUTIVE SUMMARY

As many as 38 depressions were created in New Jersey estuaries between Manasquan Inlet and Townsends Inlet when sand was mined for construction fill material (houses, highways and bridges) and to repair storm damaged beaches (Murawski 1969). Of these 38 depressions, 21 are located within the Barnegat Bay estuary, including 5 in Little Egg Harbor (U.S. Fish and Wildlife Service (USFWS) 1999). Studies by the New Jersey Department of Environmental Protection have indicated that poor water quality exists that has degraded aquatic habitat in the deeper portions of these dredged holes. The purpose of this project is to provide a pilot study to evaluate the feasibility of environmental restoration of aquatic habitat of two of the dredged holes (#5 and #6 per Murawski 1969).

Studies were conducted at the two dredged holes to investigate the feasibility for environmental restoration. Restoration would consist of partially filling them with sandy material to improve the overlying water quality and benthic habitat within the dredged holes. Field sampling of water, sediment, and aquatic organisms was conducted to evaluate water and sediment quality, benthic macroinvertebrate condition, and fish utilization. An analysis was performed to evaluate existing environmental conditions, to obtain baseline information as regards benthic and fish communities and for input into the analysis to predict increase in numbers of species, numbers of individuals for each species and quantities of total biomass following plan implementation.

This element of the study documented that benthic macroinvertebrate abundance, biomass, and diversity were poorest in the deepest bottom sediments while improved conditions were observed in the intermediate depths. Optimal benthic community conditions were observed in the shallow water regions. Water quality measurements in the spring and summer showed that bottom dissolved oxygen (DO) levels averaged about 4.0 mg/L in the deeper hole (dredged hole #6) and bottom DO averaged 5.0 mg/L in the shallower hole (dredged hole #5). Occasional measurements under 3.0 mg/L were observed. No salinity stratification was observed in either dredged hole.

Fish trawls and gill net sampling indicated that fish (primarily weakfish adults and juveniles) were using the habitat created by the dredged holes. Primary usage was at intermediate depths (12 to 20 feet below the water surface). The benthic data were used to estimate the increase in abundance, biomass, and diversity that may be expected if the dredged holes are filled to different depths. The data suggest that the greatest benthic community benefit would occur if the dredged holes were completely filled to levels occurring naturally in Barnegat Bay. However, because large numbers of juvenile weakfish and other species also use the dredged holes as refuge habitat, only partial filling of the dredged holes is recommended.

An incremental analysis was performed using IWR-PLAN to compare alternative plans for filling the dredged holes. Filling methodology consisted of hydraulic dredging and placement from existing nearby channels within Barnegat Bay. Placement methodology would allow for creation of relief within the dredged holes to enhance fish habitat. The comparison was to select the most cost-effective plan with respect to optimal benefit to habitat for both benthos and fish. The analysis concluded that filling dredged hole #6 to elevation –18 ft North American Vertical Datum (NAVD) with 125,000 cubic yards of sandy material from Double Creek Channel is the optimal plan. Sand would first be gently "rained" down to cover the existing fine-grained sediment with at least 3 feet of material, followed by pumping to specific locations within the holes to create mounds and the desired relief. Total first costs for the project are estimated to be about $2,048,460.

Table ES-1
Compliance of the Proposed Action at Dredged Hole #6 With Environmental Protection Statutes and Other Environmental Requirements

Federal Statutes	Level Of Compliance[1]
Anadromous Fish Conservation Act	Full
Clean Air Act	Full
Clean Water Act	Full
Coastal Barrier Resources Act	Full
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	N/A
Endangered Species Act	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act	Full
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act	Full
Marine Mammal Protection Act	Full
National Historic Preservation Act	Full
National Environmental Policy Act	Full
Resource Conservation and Recovery Act	N/A
Rivers and Harbors Act	Full
Watershed Protection and Flood Prevention Act	Full
Wild and Scenic Rivers Act	N/A
Executive Orders, Memoranda, Etc.	
Protection and Enhancement of Cultural Environment (E.O. 11593)	Full
Floodplain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full
Prime and Unique Farmlands (CEQ Memorandum, 11 Aug 80)	N/A
40 CFR 122.26 (B)(14), 19 Nov 1990	N/A
Environmental Justice (E.O. 12898)	Full

[1] Levels of Compliance
  a. Full Compliance: having met all requirements of the statute, E.O. or other environmental requirements for the current stage of planning.
  b. Not-Applicable: no requirements for the statute, E.O. or other environmental requirement for the current stage of planning.

1.0 INTRODUCTION

1.1 Purpose

As many as 38 depressions were created in New Jersey estuaries between Manasquan Inlet and Townsends Inlet when sand was mined for construction fill material (houses, highways and bridges) and to repair storm damaged beaches (Murawski 1969). Of these 38 depressions, 21 are located within the Barnegat Bay estuary, including 5 in Little Egg Harbor (U.S. Fish and Wildlife Service (USFWS) 1999). Studies by the New Jersey Department of Environmental Protection have indicated that poor water quality exists that has degraded aquatic habitat in the deeper portions of these dredged holes (Murawski 1969). The purpose of this project is to provide a pilot study to evaluate the feasibility of environmental restoration of aquatic habitat of two of the dredged holes (#5 and #6 per Murawski 1969).

The study evaluated existing environmental conditions at the dredged holes to establish baseline information with regard to benthic and fish communities, and predicted increases in numbers of species, numbers of individuals for each species and quantities of total biomass for each alternative plan considered. Plan formulation was based on benefits to environmental habitat, available source material, practical dredging methodology, and costs. Alternative plans consisted of collecting, transporting and placing sand material obtained from existing Federal and State channels into the two dredged holes to create suitable habitat for a productive aquatic community.

The study consists of identifying alternatives and evaluating costs, benefits and environmental impacts of the alternative plans. Topics included in this report are: 1) dredged hole design, 2) construction access, 3) environmental impacts, 4) plan formulation 5) cost estimates, and 6) cost effectiveness and incremental cost analysis. Beneficial use concepts will be incorporated into the plan. The alternatives included the No Action plan and a range of plans for placing varying quantities of material from several different sources into the two existing dredged holes.

1.2 Authorization

This report was developed as part of the Barnegat Bay Ecosystem Restoration Study. This study was the result of a resolution of the Committee on Transportation and Infrastructure of the United States House of Representatives, in Docket 2462 adopted on 15 September 1995. The committee requested the Corps of Engineers conduct a study of the Barnegat Bay estuary and surrounding areas for identifying and recommending improvements in the areas of ecosystem restoration and protection.

Implementation is proposed under authority contained within Section 1135 of the Water Resources Development Act of 1996, as amended. Section 1135 provides authority for the Corps of Engineers to investigate, study, modify, and construct projects for Environmental Restoration without specific Congressional Authorization. This usually involves restoration of degraded ecosystems through modification to Corps structures and operations of Corps structures or implementation of measures in affected areas. The restoration must also demonstrate that it is cost effective and contributes to an improved environment that is in the general public interest.

These projects are also limited to a Federal cost of $5 million per project. Use of a different implementation authority is proposed to minimize the time required to begin construction. By using Section 1135, specific Congressional approval contained in a bi-annual Water Resources Development Act is not required. Project implementation is also conditioned on non-Federal interests entering into cooperative agreement in accordance with the requirements of Section 1135. Non-Federal interests or sponsors provide 25% of the costs and provide any lands, easements, rights-of-way, relocations and disposal areas; and agree to operate and maintain.

1.3 General Description of Study Area

Dredged holes #5 and #6 are located in Barnegat Bay, Ocean County, New Jersey, in the southeastern part of the State. Figure 1-1 shows a vicinity map of the area. Figure 1-2 shows the location of the two dredged holes (#5 and #6) on a study area site map taken from National Oceanic and Atmospheric Administration (NOAA) chart 12324. Figure 1-3 shows a larger scale aerial photograph of the location of the two dredged holes. The dredged holes are located approximately 60 miles southeast of Philadelphia and 100 miles south of New York City. The closest major urban center is Atlantic City, located 41 miles to the south.

Barnegat Bay is formed by a barrier spit and a barrier island (Long Beach Island, which is south of Barnegat Inlet). Dredged holes #5 and #6 are located less than 100 feet west of Long Beach Island (LBI), near its northern end. Dredged hole #5 is located in the town of Loveladies, which is part of Long Beach Township, and is estimated to cover approximately 7 acres. Dredged hole #6 is located in the Borough of Harvey Cedars, approximately one mile south of dredged hole #5 and is estimated to cover 12 acres. Based on June 1999 survey soundings, the lowest points of elevation in dredged holes #5 and #6 are –19.1 ft NAVD and –37.9 ft. NAVD, respectively (Figures 1-4 and 1-5). Nominal maximum depths for dredged holes #5 and #6 are 18 ft. and 36 ft., respectively (measured downward from 0 ft. NAVD). It is believed that sand was dredged from these dredged holes in the 1960’s to replenish beaches on the Atlantic coast of LBI.

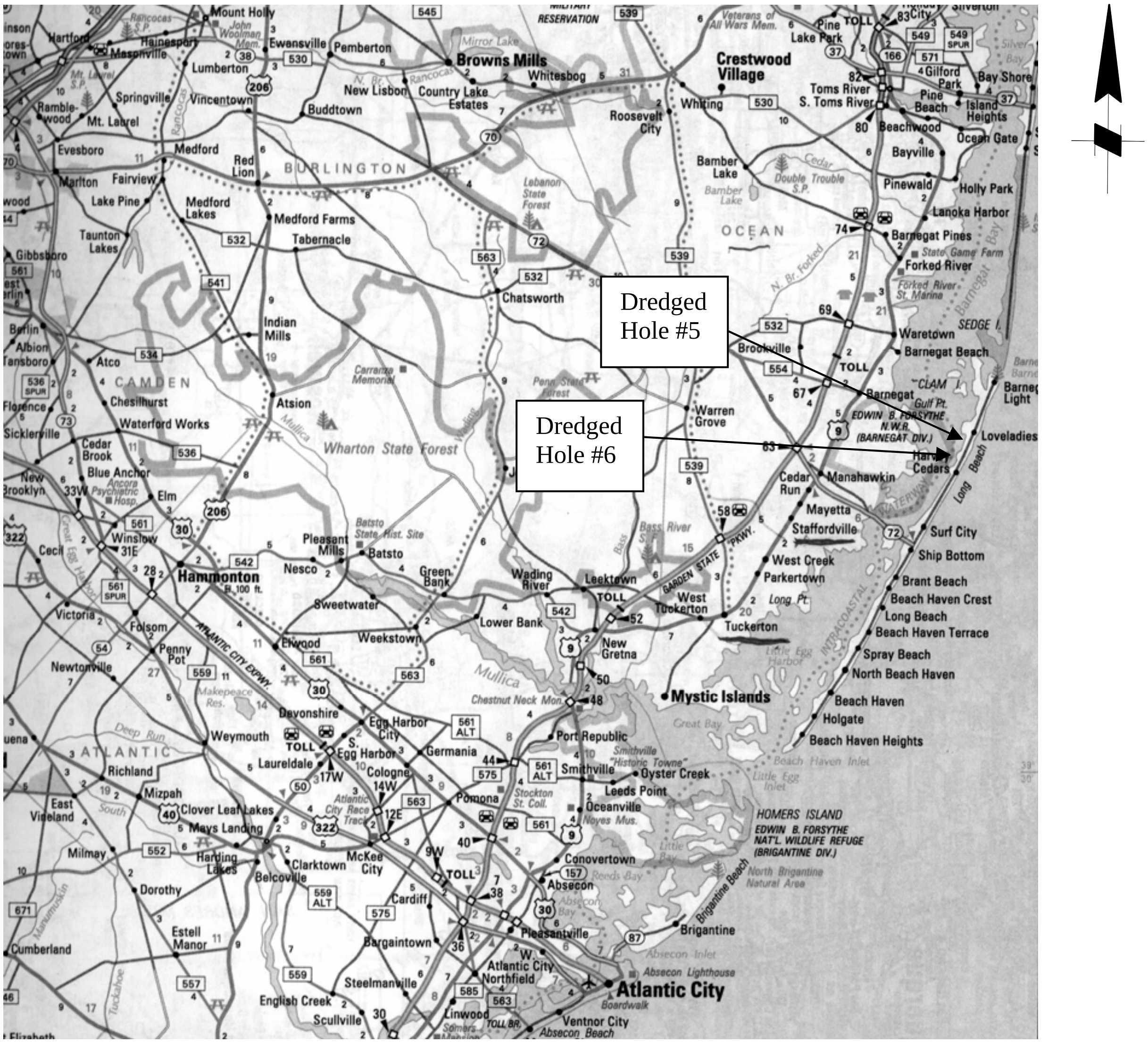


Figure 1-1. Vicinity Map

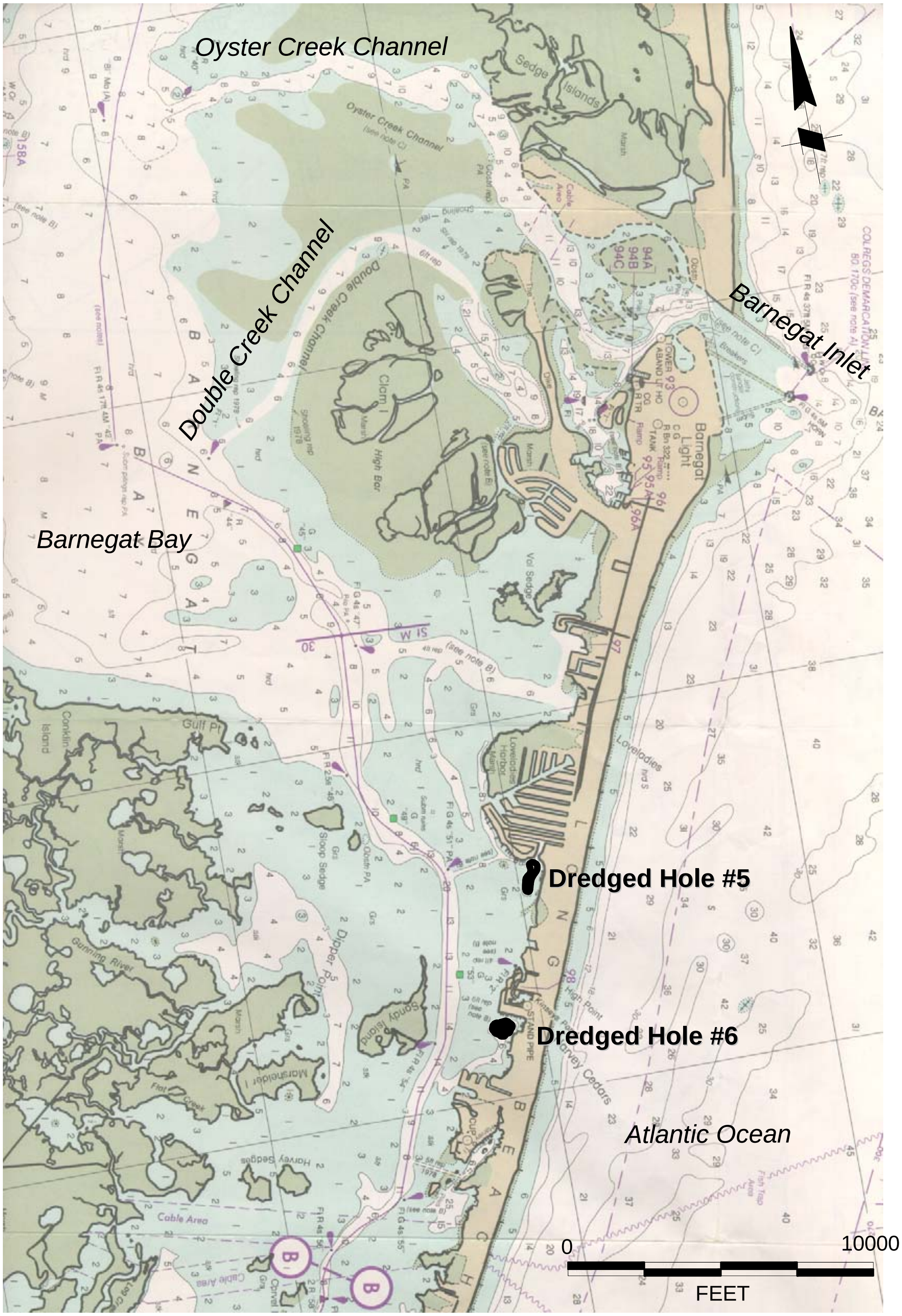


Figure 1-2 Site Map of Dredged Hole Locations.

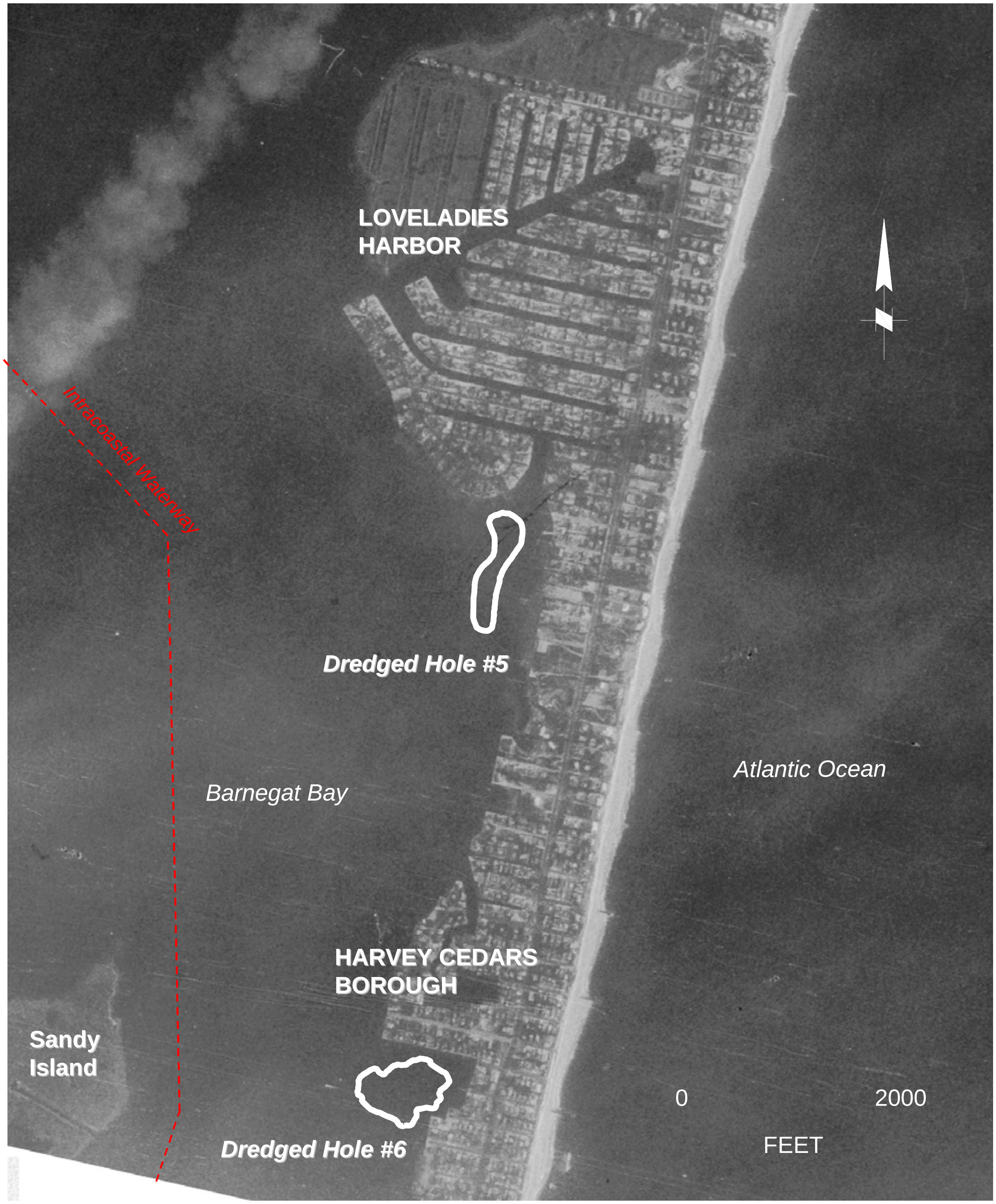


Figure 1-3 Aerial Photograph of Dredged Hole Locations.

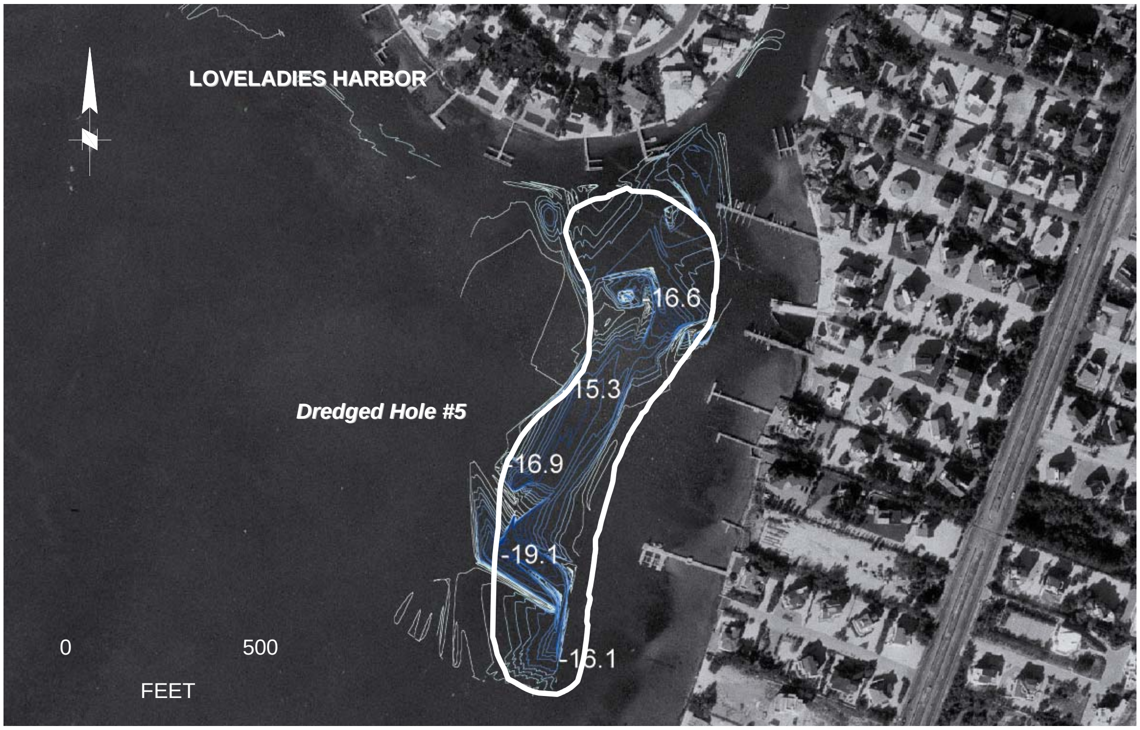


Figure 1-4 Site Map of Dredged Hole Location #5 (Source USACE – Phila. Dist).

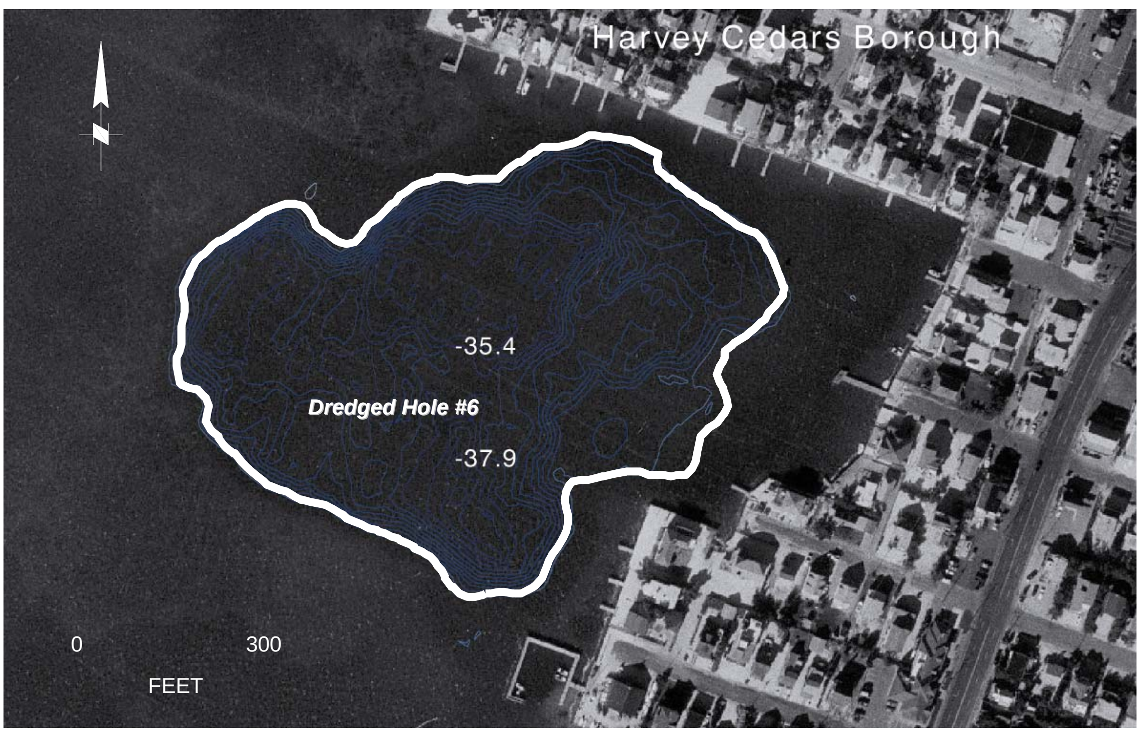


Figure 1-5 Site Map of Dredged Hole Location #5 (Source USACE – Phila. Dist).

2.0 PROJECT HISTORY

2.1 Prior Studies, Reports and Related Projects

The New Jersey Department of Environmental Protection (NJDEP) performed a study of 38 dredged holes located between Manasquan Inlet and Townsends Inlet (Murawski 1969). The NJDEP evaluated both water quality within the dredged holes and the benthic community in the sediment at the bottom of the dredged holes. The study found that 21 of the 38 dredged holes had low DO and high hydrogen sulfide concentrations, and 20 of 33 dredged holes did not have benthic invertebrates. In addition, the highest concentrations of organic matter, iron and manganese were found in stagnant dredged holes. The study did find that the dredged holes retained warmth in fall months, providing a localized concentration of fish at mid-depths. Subsequent to 1969, NJDEP resurveyed dredged holes #5 and #6 in January 1992 (Robert McDowell, NJDEP, Pers. Comm). Results indicated that current conditions have not changed substantially from the previous sampling event. NJDEP concluded that habitat conditions could be improved by filling the dredged holes with suitable material (i.e. sand).

USFWS prepared a Planning Aid Report (PAR) (USFWS 1999) for Barnegat Bay that addressed potential environmental impacts on benthos, fish and wildlife resources from proposed environmental restoration projects. The report stated that "…emphasis should be placed on selecting optimal depths of fill for existing dredged holes and making the best possible use of dredged hole location and conditions."

2.2 Limits of Scope

This document is to provide data related to the biological, environmental and structural benefits and impacts of environmental restoration of two dredged holes in Barnegat Bay, Ocean County, New Jersey. Dredged holes #5 and #6 (Murawski 1969) were selected by NJDEP who supports the project as a pilot study for restoring dredged holes within Barnegat Bay Estuary. All other biological or ecological problems within the surrounding areas are outside the scope of this report.

2.3 Related Institutional Programs

In 1995, the Barnegat Bay Estuary Program was accepted into the National Estuary Program for the development of a Comprehensive Conservation and Management Plan (New York – New Jersey Harbor Estuary Program, 1996). Under the authority of the U.S. House of Representatives, Docket 2462, adopted on 15 September 1995, the Barnegat Bay Ecosystem Restoration Study was initiated to identify possible improvements in the areas of ecosystem restoration and protection (USACE 1997).

2.4 Public Involvement and Coordination

Public involvement and coordination were initiated through the scoping process performed as part of the Environmental Assessment (EA) for the project (Appendix A). Responses to the scoping letter are summarized in Appendix B. Comments and information from the scoping process have been incorporated into this document. In addition, the USFWS prepared a PAR that provided information on ecological resources within the vicinity of the project. Conclusions and recommendations in the PAR have been incorporated into this document.

3.0 EXISTING CONDITIONS

This section describes existing environmental conditions at and surrounding dredged holes #5 and #6, as numbered in Murawski (1969). It provides baseline information for identification and evaluation of potential impacts that would result from implementation of the proposed habitat restoration in and potentially around the dredged holes.

3.1 Physical Setting

Dredged holes #5 and #6 are located in Barnegat Bay, Ocean County, New Jersey. The dredged holes are located approximately 60 miles southeast of Philadelphia and 100 miles south of New York City. The closest major urban center is Atlantic City, located 41 miles to the south.

Barnegat Bay is formed by a barrier spit called Island Beach, it extends from Metedeconk River/Mantoloking to Barnegat Inlet. Long Beach Island towards the south extends from Barnegat Inlet to Little Egg Inlet. Dredged holes #5 and #6 are located less than 100 feet behind the bay side of Long Beach Island, near its northern end. Dredged hole #5 is located in Loveladies, which is part of Long Beach Township, and is estimated to cover about 7 acres and have a maximum depth of about 18 feet. Dredged hole #6 is located in the Borough of Harvey Cedars, approximately one mile southwest of dredged hole #5. Dredged hole #6 is estimated to cover 12 acres and have a maximum depth of approximately 36 feet. It is believed that sand was mined for construction fill material (houses, highways and bridges) and to repair storm damaged beaches (Murawski 1969).

Double Creek Channel, a nearby navigation channel due for maintenance dredging, has been identified as a source area for sand fill material for the proposed restoration. Double Creek Channel is located approximately 3.75 miles northwest of dredged hole #5 and approximately 4.75 miles north-northwest of dredged hole #6.

3.1.1 Physiography and Topography

Barnegat Bay watershed topography varies from rolling to flat bottom. The Atlantic Coastal Plain rises from sea level along the coast to an altitude of 200 feet in the northwest corner of Ocean County.

The terrain in the vicinity of the dredged holes consists of both man-made and natural environments. The width of Long Beach Island varies, with typical widths of one-half mile or less. Man-made features (i.e., buildings) form the highest elevations on Long Beach Island while areas of the coastal dunes form the highest natural elevations. Natural elevations over most of Long Beach Island in the area of the proposed projects are generally less than 10 feet. The tidal marshes in the study area exist at approximately +0.5 feet NAVD and grasslands surrounding the marshes are at approximately +2.0 feet NAVD. Dunes along the shoreline in the project area range in elevation from about +4 feet NAVD to approximately +30 feet NAVD (CH2M Hill 1997).

3.1.2 Climate

The climate in Ocean County, New Jersey is continental in nature. Winter temperatures average 33° Fahrenheit (F) with an average minimum temperature in the county of 24°F. The average summer temperature is 72°F, with an average daily maximum temperature of 83°F. Precipitation in the county is well distributed throughout the year, with the "growing" season extending from April through September. Fifty-two percent of the average annual precipitation, or 24 inches, falls within the growing season (CH2M Hill 1997).

3.1.3 Infrastructure

3.1.3.1 Traffic and Transportation

There are several major land and water transportation routes near Barnegat Bay. In the project area, the Garden State Parkway and U.S. Route 9 parallel the coastline. Vehicle access to LBI, is via State Route 72/180, which crosses Manahawkin Bay from Beach Haven West to Ship Bottom approximately four miles south of the project area. Long Beach Boulevard runs the length of LBI and is the main north-south road.

Commercial and recreational boat traffic in Barnegat Bay was estimated to consist of 53,200 boats operated in the bay in 1988 (CH2M Hill 1997). The New Jersey Intracoastal Waterway passes through Barnegat Bay between the mainland and the barrier islands, approximately one-quarter to one-half mile west of the sites, and is used for recreational and commercial navigation purposes. Barnegat Inlet, located three miles to the northeast, is a primary passage between Barnegat Bay and the Atlantic Ocean. Double Creek Channel is the southern approach toBarnegat Inlet. Two other passages to the Atlantic Ocean from the bay, Point Pleasant Canal to the Manasquan River and Manasquan Inlet at the northern end and Little Egg Harbor Inlet at the southern end. Small navigation channels provide shallow draft (i.e., approximately five feet) access to numerous private docks and moorings located adjacent to dredged holes #5 and #6.

3.1.3.2 Utilities

Examination of the USGS topographic quadrangles and 1995 aerial photographs indicate that the areas of LBI surrounding holes #5 and #6 are largely residential and commercial (USGS 1972, 1999a, 1999b). These areas are likely served by both above and below ground electrical, water, sewer, and natural gas utilities.

Communication with the Superintendent of Public Works for the Borough of Harvey Cedars indicated that although there was an AT&T line further south in the bay near Ship Bottom, the Borough is not aware of any sewer, water, electric, gas, or telephone utilities in the bay near the project area (Vosseller, 1999, Pers. Comm.). The Long Beach Township Sewer and Water Department noted that there is a sewer line that runs from Ship Bottom to the mainland, but was unaware of any utilities in the vicinity of Loveladies (McDonald, 1999, Pers. Comm.).

3.2 Environmental Setting

3.2.1 Land Use

Man-made elements in the vicinity of the proposed projects include roads, houses, parking lots, marinas, and boat slips. Natural environments include low-lying, flat barrier beaches, dunes, tidal marshes, waterways, bays and lagoons.

3.2.2 Fisheries

The waters in the near vicinity of dredged holes #5 and #6 and Double Creek Channel also provide habitat for a large number of fish species, including Atlantic menhaden (*Brevoortia tyrannus*), American eel (*Anguilla rostrata*), bay anchovy (*Anchoa mitchilli*), Atlantic silverside (*Menidia menidia*), threespine stickleback (*Gasterosteus aculeatus*), northern pipefish (*Syngnahus fuscus*), and northern kingfish (*Menticirrhus saxatilis*). Anadromous fish likely to occur in the area include blueback herring (*Alosa aestivalis*) and alewife (*Alosa pesudoharengus*); American eel are catadromous. Important commercial and recreational fishery resources in the vicinity of the proposed projects include hard clams, blue crab (*Callinectes sapidus*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), bluefish (*Pomatomus saltatrix)*, Atlantic menhaden, striped bass (*Morone saxatilis*), and weakfish (*Cynoscion regalis).*

Site-specific data on fisheries resources at dredged holes #5 and #6 were recently described by Versar (1999). Fish surveys conducted with a 16-foot otter trawl demonstrated a similarity in species composition among dredged holes #5 and #6 and a reference site near ICW at about 39° 44’ N and 74° 09’ W. Bay anchovies and weakfish were common to all of the trawls as were blue crabs. Five different fish species were collected in the trawls. Total counts of bay anchovies were similar between dredged holes #5 and the reference site (22 and 26 individuals, respectively), but were somewhat less for dredged hole #6 (12 individuals). It should be noted that the Double Creek Channel is expected to possess similar fish (and benthic) communities as the reference site (located in the middle of the Bay). This channel is also expected to possess similar depth, tidal regime, flushing, and water quality characteristics as the reference site.

The presence of a large number of juvenile weakfish suggest that dredged holes #5 and #6 are used as a nursery habitat. The shallower hole, dredged hole #5 appeared to be a more important nursery habitat for juvenile weakfish than did dredged hole #6 and the reference site. In total, 161 weakfish were collected from dredged hole #5 at an average length around 100-mm, as compared to 14 at dredged hole #6 and 25 at the reference site. Size distributions of the juvenile weakfish were similar between dredged holes and generally ranged between 80 and 120-mm. Larger weakfish were collected by the trawls at the reference site (Versar 1999).

Fish surveys conducted by experimental gill nets revealed a different community structure reflecting nocturnal use of the sites by much larger fish. On the whole, species composition among the sampling sites was similar. A total of 10 species were collected in the gill nets. Total fish counts were greatest for the reference area at 44, followed by 29 at dredged hole #5 and 20 at dredged hole #6. Similar to the results of trawling, weakfish were the most common fish collected in the gill net among all sites. Counts among sites were similar with 13 weakfish taken from each dredged hole and 16 in the reference area. The size distributions of adult weakfish ranged from 260 to 520-mm (Versar 1999).

Spot were also frequently caught and were present at each of the gill net sampling sites. Sixteen were collected at the reference site, eight at dredged hole #5 and only three at dredged hole #6. Other species collected but at low frequencies included Atlantic croaker, northern sea robin, smooth dogfish, and bluefish. Blue crabs were collected in all of the nets and proved to be serious marauders of the gilled fish. Many fish were fragmented in the nets and several were partially consumed before the net was retrieved (Versar 1999).

Site-specific fisheries data most recently collected by Versar at dredged holes #5 and #6 during winter 2000 indicate that virtually no fish use these sites in the winter months; they should not be considered as over-wintering fisheries habitat (Versar 2000).

Versar also conducted a winter survey of dredged holes #5 and #6 during mid-February, 2000 (Versar 2000). To investigate the winter use of the holes by fish, trawling (16-foot otter trawl) and gill-netting was performed. A small-scale crab dredge was used to collect crabs from bottom sediments to evaluate the dredged holes as wintering habitat for blue crabs in the sediment. Water quality was also measured from the bottom to the surface at approximate 3-meter intervals. Analogous surveys were also conducted at reference locations representative of typical Barnegat Bay habitat in the vicinity of the holes.

The holes did not appear to harbor a significant winter fish population. The only species of fish collected from trawling were four-spined sticklebacks (Apeltes quadracus), naked goby (Gobiosoma bosc), and mummichog (Fundulus heteroclitus). All of the captured fish were small (less than 5-cm) and were probably living within the accumulation of sea grasses and algae that proliferates at the bottom of the holes. The results of trawling at the reference sites was mixed. Winter flounder and Atlantic silverside were collected at the northern reference location, while no fish were netted at the southern reference location.

Gill-netting within the holes also indicated an absence of a wintering fish population. No fish were collected from either dredged hole #5 or #6. Blueback herring was collected the northern reference location; its presence may represent early migration of this anadromous species into the bay for spawning rather than an overwintering population.

Dredged holes #5 and #6 did not appear to provide significant wintering habitat for blue crabs; no blue crabs were collected in either of the dredged holes. Blue crabs were collected, however, at both of the reference locations but with varying densities. Only 1 crab was collected at the northern reference location, while a total of 12 were collected from the southern one. A number of incidental species were collected from the holes during crab dredging including tautog (Tautoga onitis), green crab (Carcinus maenas), hard clam (Mercenaria mercenaria), tube worms, and grass shrimp.

Measures of water quality did not support the notion that the Barnegat Holes function as warm water refuges for wintering organisms. Temperatures measured near the bottom in all instances were lower than upper water column measures, and in two cases, less than 0ºC.

3.2.3 Benthos

Benthic organisms inhabiting the vicinity of dredged holes #5 and #6 and Double Creek Channel include a variety of polychaete worms, amphipods, isopods, bivalves, oligochaete worms and gastropods. Hydromedusae (*Rathkea octopunctata*), (*Sarsia* spp.), and (*Turritopsis nutricula*); and the mysid shrimp (*Neomysis americana*), and grass shrimp (*Palaemonetes* spp.) also occur in the vicinity. The study area also supports numerous species of shellfish, including hard clam (*Mercenaria mercenaria*), soft-shell clam (*Mya arenaria*), Atlantic razor clams (*Siliqua costata*), blue mussels (*Mytilus edulis*), Atlantic ribbed mussel (*Geukensia demissa*), bay scallop (*Argopecten irradians*), and blue crab (*Callinectes sapidus*).

3.2.3.1 Benthic Survey Results

The community composition of each dredged hole and surrounding shallow areas were similar to each other, between seasons, and at the various depths (Versar, 1999). In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, at both dredged holes, as well as at the different depths within the dredged holes. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Capitella capitata* and *Mediomastus ambiseta*). In addition, the majority of the epifaunal species collected from the area were amphipods.

Diversity (as measured by mean number of taxa) was the greatest in the shallow habitats of both areas. Mean number of taxa ranged from 29 to 33 at both shallow areas in both seasons. Diversity in the deepest areas of each dredged hole was extremely low in both seasons, and only ranged between a mean of 0.7 to 3.3. The intermediate depths also had depressed diversity with a mean range between 10 and 15.

Mean total abundance was greatest in the shallow areas near dredged hole #5, which also had the greatest number of amphipod crustaceans. Abundance at the shallow areas near dredged hole #6 was about 3 times less than at dredged hole #5. Mean abundance at the intermediate depths of dredged hole #5 in the summer was over 3 times higher than in the spring but was about the same and in both seasons for dredged hole #6. The numerical dominants in the summer at dredged hole #5 were the amphipods in the genus *Ampelisca* spp. Mean abundance was extremely depressed in the deepest areas of the dredged holes. Mean abundance at these depths ranged from $8/m^2$ to $15/m^2$. Recruitment in the spring was also extremely depressed and only ranged from 22 to $197/m^2$.

The number of large taxa collected in the samples was also examined, and for this summary, large taxa were defined as species with lengths greater than 2 cm. Sites containing many large individuals generally suggest the presence of a long-lived, established benthic community subjected to little stress. The shallow areas near both dredged holes contained numerous large taxa while the intermediate area contained some large taxa. No large taxa were collected from the deep areas of either dredged hole.

Total biomass in the shallow and intermediate areas of dredged hole #6 were dominated by the clam *Mercenaria mercenaria*. One clam, about 4 or 5 years old, was found at one sampling site each in both the shallow and intermediate areas. Because the sampling gear does not sample efficiently for these large clams and because their presence in the sample skew the biomass results, the weights of these two clams were dropped from further biomass summaries.

Mean total biomass in the deep areas was essentially zero. This was true in both seasons and at both dredged holes. As with abundance, mean total biomass were greatest in the shallow areas of both dredged holes, ranging between 2 and 5 g/m^2.

Mean amphipod abundance within each dredged hole was examined for two reasons. First, amphipods were the numerically dominant taxa within the area, and second, these organisms are important prey to the resident fish populations of the area. The shallow areas near dredged hole #5 supported the most amphipods. However, both intermediate depth areas supported larger populations of amphipods in the spring and summer than other taxonomic groups. Dredged hole #6 averaged higher numbers of amphipods than its nearby shallow area. Higher numbers of amphipods in dredged hole #6 may be a function of higher concentrations of dead submerged aquatic vegetation (SAV) (because the hole is deeper than dredged hole #5) which could be providing a food source for these organisms.

It should be noted that the Double Creek Channel is expected to possess similar benthic (and fish) communities as the reference site (located in the middle of the Bay). The Channel is also expected to possess similar depth, tidal regime, flushing, and water quality characteristics as the reference site.

3.2.4 Other Wildlife

A number of species of fish, waterfowl, and other wildlife use the open water and tidal marsh habitat in and around the project area for reproduction and feeding (CH2M Hill 1997). These habitats provide ample cover and food for all life stages of the many species of wildlife found throughout the Barnegat Bay area.

Wildlife utilizing the project area are dependent on a variety of habitats to provide necessary food, water, and cover. Owing to the heavily developed nature of Long Beach Island, however, most of the ecologically or economically important wildlife resources in the vicinity of the proposed projects are aquatic or semi-aquatic organisms. A recent environmental assessment by the USACE (1998) for a project in the vicinity of the proposed action compiled a list of the predominant wildlife species in Barnegat Bay and surrounding areas. The lists, shown in Annex A of the EA, include birds, mammals, amphibians, reptiles, and fish and other marine fauna.

Waterfowl, shorebirds, wading birds, and other aquatic birds use the marshes and open water in the general vicinity of dredged holes #5 and #6 and Double Creek Channel for feeding, cover, and breeding. The most predominant of these birds include mallard (*Anas platyrhynchos*), greater scaup (*Aythya marila*), canvasback (*A. valisineria*), sanderling (*Calidris alba*), semipalmated sandpiper (*C. pusilla*), pectoral sandpiper (*C. melanotos*), red knot (*C. canutus*), dunlin (*C. alpina*), eastern willet (*Catoptrophorus semipalmatus*), and ruddy turnstone (*Arenaria interpres*) (USFWS 1999). Predominant colonial nesting bird species known to occur in the general vicinity of the dredged holes (especially on Sandy Island, about 2,000 feet east of dredged hole #6) include great blue heron (*Ardea herodias*), snowy egret (*Egretta thula*), great egret (*Casmerodius albus*), glossy ibis (*Plegadis falcinellus*), greater black-backed gull (*Larus marinus*), herring gull (*L. argentatus*), and laughing gull (*L. atricilla*). These species utilize island resources (trees, shrubs, sandy substrate, etc.) for nesting, raising, and fledging of their young (USFWS 1999). Many of these species undoubtedly also use the vicinity of dredged holes #5 and #6 and Double Creek Channel for daily feeding activities.

3.2.5 Vegetation and Land Cover

In a recent environmental assessment for a project in the vicinity of the proposed action, the USACE (1998) identified plant species most likely to occur in this part of Barnegat Bay. These plants are listed in Appendix A. Other information on vegetation and land cover in the vicinity of the proposed projects was taken from the recent USFWS Service Planning Aid Report for the Barnegat Bay Watershed Feasibility Study (USFWS 1999, Appendix C).

Land cover on Long Beach Island in the vicinity of the proposed projects consists largely of man-made features such as houses, roads, parking lots, marinas, boat docks, and bulkheads. Natural vegetation in the vicinity of the proposed projects is composed of SAV beds and tidal salt marsh. No land cover is present in the immediate vicinities of dredged holes #5 and #6 and Double Creek Channel; they exist in open water.

From a review of recent aerial photographs (USGS 1999a, 1999b) and the topographic quadrangle that covers the area of the proposed projects (USGS 1972), Sandy Island, a large area of tidal marsh, exists about 2,000 feet to the west of dredged hole #6. Another large area of tidal marsh exists immediately north of the main channel to Loveladies. No other large areas of tidal marsh apparently exist in the immediate vicinity of dredged holes #5 or #6. Principal plants in the low estuarine marshes in the general vicinity of dredged holes #5 and #6 are dominated by salt water cordgrass (*Spartina alterniflora*); in the high marshes salt hay (*Spartina patens*) and marsh spike grass (*Distichlis spicata*) are predominant. Wetlands existing between the high marshes and uplands possess glassworts (*Salicornia* spp.), marsh elder (*Iva frutescens*), groundsel bush (*Baccharis halimifolia*), common reed (*Phragmites australis*), bayberry (*Myrica pensylvanica*), and poison ivy (*Toxicodendron radicans*) as the principal species.

SAV also occurs in beds in the general vicinity of the projects. According to USFWS, the most important species of SAV that occurs in the Barnegat Bay estuary is eelgrass (*Zostera marina*); other species of ecological importance include widgeon grass (*Ruppia maritima*), and macroscopic algae such as sea lettuce (*Uva lactuca*), spaghetti grass (*Codium fragile*), and *Gracilaria* sp., a red alga that grows unattached among eelgrass beds (USFWS 1999). These SAV beds provide an important direct food source in the food chain, and an indirect food source in the detrital chain. They provide substrate for epiphytes, cover, and protective habitat.

Additionally, some waterfowl are known to feed on these plants, and large numbers of fish use them for cover (USFWS 1999).

From Versar's recent SAV characterization for part of Barnegat Bay (Harriott and Burton 1996), SAV occurs in a broad band to the immediate west and north of dredged hole #5 (Figure 3-1). The SAV in this bed was characterized as sparse (10 percent to 40 percent cover). Another long, narrow SAV bed was mapped along the shoreline adjacent to dredged hole #5 and on either side of Double Creek Channel; this bed was characterized as very sparse (0 to 10 percent cover). The SAV characterization concluded that the principal SAV species in the vicinity of the projects was eelgrass; widgeon grass was also present in apparently much smaller quantities. No SAV was mapped adjacent to dredged hole #6. SAV mapping available from the Ocean County Planning Department also depicts eel grass in the vicinity of both dredged holes, however, the map scale is small and the data are not recent. Other mapping of SAV (from 1986) in Barnegat Bay indicated no eelgrass beds within the direct vicinities of dredged holes #5 and #6 (USFWS 1999, Appendix A).

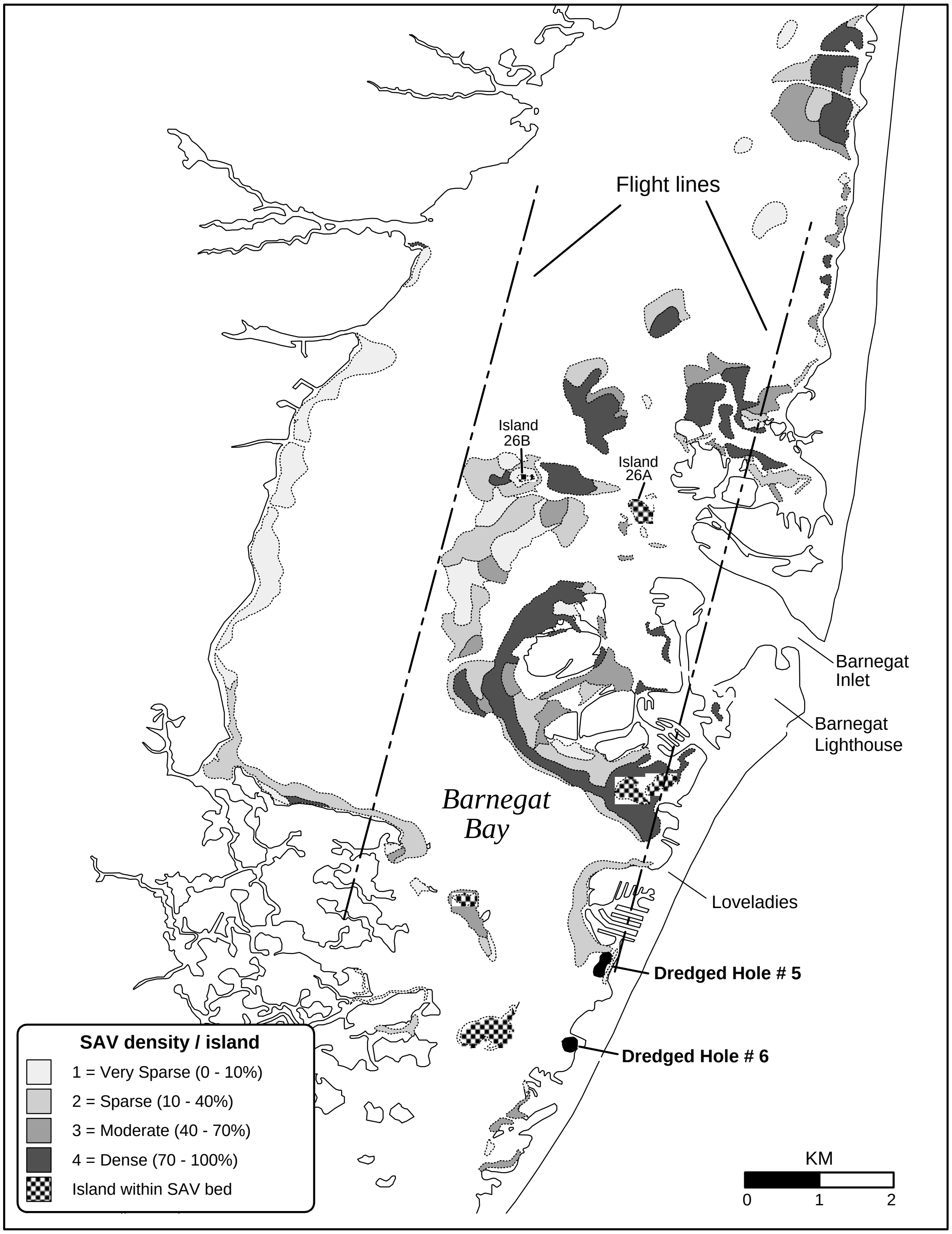


Figure 3-1

Submerged aquatic vegetation in Barnegat Bay based on mapping done by Harriott and Burton (1996), in relation to the potential dredged hole locations

3.2.6 Threatened and Endangered Species

The NJDEP Division of Fish, Game and Wildlife indicated in a recent letter that there are no known endangered or threatened species in the vicinities of dredged holes #5 and #6 that are likely to be affected by the proposed projects at dredged holes #5 and #6. They further indicated that "...the Endangered and Nongame Species Program, therefor [sic], has no information or concerns relevant to these proposed projects" (letter from C. David Jenkins, Jr./NJDEP to A. Morris Perot, Jr./Versar, dated 7 September 1999).

Further, other than an occasional transient bald eagle (*Haliaeetus leucocephalus*) or peregrine falcon (*Falco peregrinus*), no specific Federal-listed or State-listed species were cited by USFWS in their Planning Aid Report (USFWS 1999) as occurring in the vicinity of the projects, with the exception of sea turtles. These species include the threatened loggerhead (*Caretta caretta*), and the endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green (*Chelonia mydas*) sea turtles. All of these sea turtle species may travel or feed in the bay and Atlantic Ocean waters near the proposed projects. With regard to Double Creek Channel, it should also be noted that only sea turles would be species of concern. NMFS had no specific information or comments, however, regarding threatened or endangered species in the immediate vicinity of the proposed project (Anita Riportella, pers. comm., Dec. 6, 1999).

Publications by the NJDEP specify that the State of New Jersey has 331 State endangered plant species: 32 State threatened or endangered bird species; 10 State threatened or endangered reptile species; 7 threatened or endangered amphibian species; 8 threatened or endangered mammal species; 4 threatened or endangered invertebrate species; and 1 State threatened or endangered fish (USACE 1998). The New Jersey Natural Heritage Program (letter dated 17 November 1999, see Annex C of the EA) reported no records of rare plants, animals, or natural communities on the sites.

3.2.7 Wetlands

Tidal estuarine emergent wetlands are the prevalent wetland type within the general area of the proposed projects on Barnegat Bay, adjacent to Long Beach Island. Large areas of tidal emergent wetlands occur to the east and north of dredged holes #5 and #6, within the Barnegat Division of the Edwin B. Forsythe National Wildlife Refuge and other areas. Predominant vegetation in these tidal marshes include smooth cordgrass (*Spartina alterniflora*), salt hay (*Spartina patens*), glassworts (*Salicornia* spp.), sea lavender (*Limonium* spp.), and high tide bush (*Iva frutescens*).

From a review of recent aerial photographs (USGS 1999a, 1999b) and the topographic quadrangle that covers the area of the proposed projects (USGS 1972), no tidal marsh or other terrestrial wetlands occur in the immediate vicinity of dredged holes #5 or #6 or within Double Creek Channel. As previously discussed in Section 3.2.5, however, SAV occurs in a broad bed to the immediate east and north of dredged hole #5. This SAV bed was characterized as sparse (10 to 40 percent cover). Another long, narrow bed was mapped along the shoreline adjacent to dredged hole #5; this bed was characterized as very sparse (0 to 10 percent cover) (Harriott and Burton 1996). No SAV was mapped adjacent to dredged hole #6. The two principal SAV species in the vicinity of the projects are *Zostera marina* (eelgrass) and *Ruppia maritima* (widgeon grass). SAV communities provide food, spawning, nursery and refuge habitat for many estuarine species and contribute significantly to the production of organic material within the estuary.

3.2.8 Air Quality

There are several air monitoring stations in southeastern New Jersey. The Edwin B. Forsythe National Wildlife Refuge (NWR), which extends along the coast in Ocean County, monitors ambient ozone and sulfur dioxide concentrations. Carbon monoxide, total particulates, and lead are monitored at an Atlantic City, NJ station, while a station in Millville, NJ monitors nitrogen oxides (CH2M Hill 1997).

The U.S. Environmental Protection Agency (USEPA) has reported that ozone levels within Ocean County persistently exceed national air quality standards, causing the County to be classified as a non-attainment area for ozone. All other listed pollutants are in attainment status (CH2M Hill 1997; USEPA 1999a, 1999b, 1999c, 1999d, 1999e, 1999f).

3.2.9 Hazardous and Toxic Materials

A recent environmental assessment for USACE restoration activities at Sedge Island, located approximately three miles north of dredged hole #5 in Barnegat Inlet, found "no evidence indicating the presence of [HTRW] hazardous, toxic, or radioactive waste in or near the study area." Additional review of USEPA databases confirmed that no toxic releases, air releases, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites have been reported in either Harvey Cedars or Loveladies, New Jersey (USEPA 1999g, 1999h).

3.2.10 Water Resources

3.2.10.1 Surface Water

Surface water quality in the study area is generally good. Non-point source pollution from Long Beach Island carried by runoff into the bay is seen as a potential major contributor to declines in surface water quality (USACE 1998). Sources may include petroleum products, fertilizers, eroded soils from construction sites, solid waste discharge from boats, and animal wastes. Several public and private agencies conduct limited surface water monitoring programs in the Ocean County area, including local environmental organizations, the U.S. Geological Survey (USGS), NJDEP, and the Ocean County Health Department. Water quality problems in Barnegat Bay have been examined in "A Watershed Management Plan for Barnegat Bay" prepared by the NJDEP in June 1993. All Barnegat Bay surface waters have been assigned a Category One status, which designates them as having exceptional resource value. Geological deposits in Ocean County are low in calcium and magnesium, and high in sodium and potassium, making the surface waters generally soft. The USGS operates a water-stage recorder located at Little Egg Harbor, Beach Haven, New Jersey (USACE 1998). Other close and currently operating USGS gaging stations are located on the north branch of the Metedeconk River near Lakewood, New Jersey, and at Great Egg Harbor River at Folsom, New Jersey. The

Metedeconk River station is located about 9 miles northeast of dredged holes #5 and #6. The Great Egg Harbor River station (01411000) is located about 34 miles west of dredged holes #5 and #6.

Water quality in Barnegat Bay is periodically impacted by algal blooms, which increase turbidity and reduce visibility, smother submerged aquatic vegetation, and prevent shellfish from feeding. The bay has experienced three major algal blooms in the last five years, with the most recent in May and June 1999 (Florida 1999).

3.2.10.2 Water Quality in the Dredged Holes

Water quality was measured in 1-meter increments throughout the water column during the spring and summer sampling events (Versar, 1999). On 26 May 1999, DO levels in the deepest dredged hole (dredged hole #6) were generally high (e.g. over 7.0 mg/L) with the exception of the 10 meter measurement where DO was 5.7 mg/L. DO levels in the shallower hole (dredged hole #5) were generally higher (greater than 8.0 mg/L) and no decline in DO was noted in the lower portion of the water column. DO levels recorded at the reference site were slightly higher than those observed at the dredged holes. Measurements of salinity within each dredged hole did not indicate that the water column was stratified during the spring sampling. Extremely high winds that existed during the spring collection may have contributed to the variation in DO observed in the water column at all sites.

Summer measurements conducted on 3 August 1999 indicated lower dissolved oxygen concentrations than in spring, but no measurements below 5.0 mg/L were recorded. The lowest DO concentration observed in dredged hole #6 was 5.01 mg/L at 9 meters. Slightly better conditions existed in the bottom waters of dredged hole #5 during the summer survey as DO levels near the bottom were 6.48 mg/L which was close to 100% saturation. The reference site averaged about 7.0 mg/L in the summer tests. Measurements of salinity within each dredged hole indicated that the water column was not stratified during the summer sampling event.

Water quality was measured every hour for a four to six day period one meter from the bottom of each dredged hole using a data logging HydroLab DatasoneIII meter. The meter was moored in each dredged hole during the first week in August 1999; water quality in dredged hole #5 was monitored for 4 consecutive days while dredged hole #6 was monitored for six days. Measurements of DO in dredged hole #5 revealed that values never dipped below 2.0 mg/L (the level at which hypoxic conditions exist; Fig. 4-1). Over the four-day time series, DO averaged about 5.0 mg/L. Values near 3.0 mg/L were recorded late in the evening on August 4 and in the early morning of August 5, but, in general, DO remained above 5.0 mg/L over the monitoring period. Dissolved oxygen concentrations were generally lower in dredged hole #6 where DO averaged about 4.0 mg/L over the six-day time series. Although there were a number of times DO dropped below 3.0 mg/L, low DO conditions were not sustained and measurements below 2.0 mg/L were not recorded by the unit.

Hydrogen sulfide was analyzed in surface and bottom grab samples collected in the dredged holes during the spring and summer. Hydrogen sulfide was not detected in the spring and summer in dredged hole #5, or in the spring samples for dredged hole #6. However, hydrogen sulfide was detected in the summer sampling in both the surface (1.6 mg/L) and bottom (1.5 mg/L) samples for dredged hole #6. Reference area collections taken in shallow waters adjacent to each dredged hole resulted in no detection of hydrogen sulfide in spring. However, a concentration of 1.3 mg/L was detected in the summer reference sample.

These recent water quality results are not inconsistent with those from earlier sampling events conducted in 1969 and 1992 by NJDEP (1992; Murawski 1969), although the conclusions regarding implications for finfish populations at the sites were different.

3.2.10.3 Sediment Characteristics in the Dredged Holes

The sediment characteristics of both dredged holes were similar to each other and within each season during the spring and summer of 1999 (Versar, 1999). The deepest location within each dredged hole contained high amounts of silt-clay sediment and high total organic carbon (TOC) indicating excessive amounts of organic material. The intermediate depths contained fewer silt-clay particles and lower amounts of TOC. The shallow reference areas were sandy with low amounts of silt-clays and low TOC.

Sediment cores were collected from two dredged holes in Barnegat Bay to assess the geotechnical properties of the sediments within the holes. The study was part of an ecological restoration project that may include partially filling the holes with dredged material from nearby sources. Fifteen cores were collected among Hole Numbers 5 and 6. The sediments were tested for grain size, plasticity, cohesive properties, and other geotechnical parameters needed to predict what may happen to the existing material if it is filled with sediment from another area of Barnegat Bay. Sediments at the bottom of both holes consisted of three layers of material; a surficial mud layer averaging about 0.4 feet thick, followed by a silt layer averaging about 2± feet in thickness. These two layers were deposited on a base layer of sand.

The data were evaluated by geotechnical engineers to determine how much consolidation of the soft sediments will occur when new material is placed in the hole and how much displacement of the soft sediments can be expected. Based on the characteristics of the existing sediments it is possible that the relatively soft silt layer could be displaced into the water column. Also, if bottom placement is conducted with clamshell buckets slowly lowered through the water column localized pockets of silt and an uneven settlement of material will probably occur. Upward displacement could be avoided if the thickness of the fill layer can be evenly placed across the bottom during hydraulic placement.

Material from Double Creek Channel will be used to implement the selected plan. Sediment samples have been collected from the channel. Samples show that the sediment material for the whole channel is greater than 60 percent sand; material is greater than 70 percent sand in the anticipated borrow region of the channel. Samples show that areas of the channel are greater than 95 percent sand.

The material is satisfactory as regards constructability of the project. The high sand content would produce a suitable substrate for target species and allow for creation of mounds within the hole. As the material is less than 90 percent sand, samples collected from within the source area were analyzed for semivolatiles, pesticide/PCB, metals and total organic carbon. Reported sediment concentration data are non-detect for all semivolatiles, pesticides and PCBs. Reported sediment concentration data for metals are below criteria specified in Long *et al's* (1995) Effects Range Low (ERL) sediment guidance values. These values are the current New Jersey standards. Reported sediment concentration data for Total Organic Carbon (TOC) are less than 1.2 percent for all samples. Based on the results of the chemical analyses, the source material is considered clean and suitable for placement into the dredged hole.

3.2.11 Geology and Soil

3.2.11.1 Stratigraphy/Aquifers

Ocean County lies within the Atlantic Coastal Plain physiographic province and is underlain by unconsolidated sediments of the Mesozoic and Cenozoic Ages. The coastal plain sediments of Ocean County are primarily of marine and continental origin. The sediments are composed mainly of sands, silts and clays, and green sands or glauconite sands with interspersed gravel beds. Strata of iron-cemented sandstone are present locally. A thin veneer of sand, clay, and gravel deposits of more recent age overlie the older coastal plain sediments. This layer is less than one million years old (Quaternary Age) and was deposited by outwash or meltwater from the glacial ice that covered the land as far south as northern New Jersey (USACE 1998).

Aquifers that are different in aerial extent and thickness are formed from these highly permeable beds of coarse materials. Vertical flow of water is restricted by the slightly permeable beds of silt and clay.

3.2.11.2 Soils

The soils of Ocean County are varied, ranging from deep fertile soils to droughty infertile soils with little humus or organic material present. The Natural Resources Conservation Service (NRCS) recognizes 32 soil series, with 85 types or subtypes in Ocean County (USDA 1980).

According to the Ocean County Soil Survey (USDA 1980), the dominant soil associations for the project area includes the Downer-Evesboro and Sulfaquents-Sulfihemists associations. The Downer-Evesboro association consists of well-drained and excessively drained, loamy and sandy soils on uplands that are nearly level and gently sloping. The Sulfaquents-Sulfihemists association consists of poorly drained, mineral and organic soils on tidal flats and marshes that are nearly level. Based on the project location within the Atlantic Coastal Plain province, fine-to-medium sands from barrier formation processes or the underlying coastal plain are assumed to underlie the marsh deposits. Subsurface investigations performed in the area of the Barnegat Inlet South Jetty by USACE support this assumption. These subsurface investigations indicate that the area is underlain by fine-to-medium, dense-to-very dense sands with a layer of low-density silts 4 to 6 feet thick at depths from 20 to 24 feet below ground surface. (CH2M Hill 1997).

The substrate within dredged holes #5 and #6 was sampled as part of preliminary biological studies for the proposed action (Versar 1999). The sediment characteristics of both sites were similar to each other and within each season. The deepest location within each site contained high amounts of silt-clay particles and high TOC indicating large amounts of organic material. The intermediate depths contained fewer silt-clay particles and lower amounts of TOC. The shallow reference areas were sandy with low amounts of silt-clays and low TOC.

Composite samples from Double Creek Channel were collected by Earth engineering and Sciences in December 1999 (E2SI 1999). Analysis of these samples indicate that the eastern portion of the channel contains predominantly sandy silt materials while the western half consists of predominantly silty fine sand. The full geotechnical report is included in Appendix D of this report.

It should be noted that the majority of land cover on Long Beach Island in the vicinity of the proposed action consists of man-made features such as houses, roads, parking lots, bulkheads, marinas, etc. Most of the natural soils in the areas of these features were either covered up, mixed, or filled in preparation for construction of these developments. Few large areas of natural, undisturbed soils apparently exist on the land side of the proposed action. The soils at both dredged holes #5 and #6 are permanently submerged under the bay.

3.3 Recreational Facilities

Barnegat Bay and the project area offer a wide variety of hunting, fishing, boating, and outdoor recreation opportunities. Several large natural areas are located in the region, and are listed in Table 3-1. Six Flags Great Adventure Theme Park is also located in Jackson Township, Ocean County (CH2M Hill 1997).

Long Beach Island has long sandy beaches along the Atlantic coast and is a popular summer vacation area for sunbathers, swimmers, and boaters. Indicating the area's vacation potential, approximately 67 percent and 73 percent of the housing units reported in the 1990 Census for Harvey Cedars and Long Beach Township, respectively, are used for seasonal, recreational, or occasional use (U.S. Census Bureau (USCB) 1999a, 1999b). Specific recreational opportunities within the project area likely include boating, personal water craft use, fishing, crabbing, and other related activities. The Double Creek Channel serves as the southernmost approach for Barnegat Inlet, and as such provides an important travel route for recreational boaters. A large beach club, offering many recreation opportunities, is located near dredged hole #6.

Table 3-1
Wildlife areas and parks located in the vicinity of Dredged holes #5 and #6

Name	Direction	Approximate Distance
Edwin B. Forsythe NWR	West	1 mile
Barnegat Light State Park	Northeast	3 miles
Sedge Islands State Wildlife Management Area	North	4.5 miles
Manahawkin Hunting and Fishing Grounds	Southwest	4 miles
Island Beach State Park	Northeast	3 miles
Bass River State Forest	Southwest	6.5 miles
Brigantine NWR	Southwest	18 miles
Absecon State Wildlife Management Area	Southwest	20 miles
Port Republic Hunting and Fishing Grounds	Southwest	21 miles

3.4 Cultural Resources

The USACE has consulted with the New Jersey State Historic Preservation Office (NJSHPO) and other interested parties in order to assess the potential for historic properties in the project area as required under Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR Part 800. The following brief discussion on local history and historic properties in the project vicinity is taken directly from a report entitled "Phase I Submerged and Shoreline Cultural Resources Investigations and Hydrographic Survey, Long Beach Island, Ocean County, New Jersey" (Hunter Research, Inc. 1999). An evaluation of the potential for significant submerged cultural resources in the project area is based on site visit information, a review of previous dredging activity, information provided in the above referenced report, and other pertinent documentation.

Prehistoric Resources.

The prehistoric occupation of Barnegat Bay and the Atlantic coastal barrier island region has been categorized by archaeologists into three general periods of cultural development: Paleo-Indian (15,000 years before present (B.P.) - 8,500 B.P.), Archaic (8,500 B.P. - 5,000 B.P.), and Woodland (5,000 B.P. - 400 B.P.). The Paleo-Indian period is the time of the earliest human occupation of the region. Evidence of Paleo-Indian occupation in New Jersey is generally in the form of isolated fluted point sites. This is partly due to the low population density and nomadic lifestyle of the people from the period, as well as from the inundation of sites by sea level rise. Barnegat Bay was not an estuary system at the time of Paleo-Indian occupancy, but was the site of inland forest/riverine habitats. The present estuary system was established approximately 3,000 years ago.

Archaic period peoples responded to the changing environmental conditions of the post-Pleistocene by exploiting a greater variety of resources. Archaeological investigations have shown that Archaic period sites tend to be relatively small, suggesting short-term and intermittent occupations in areas adjacent to interior freshwater swamps and bay/basin locations. Coastal tidal salt marshes and estuarine environments remained food resource-rich habitats available for exploitation. The prehistoric period that is best represented is the Woodland period, which is characterized by the introduction of pottery, increasing cultural diversity, and the evolution of a sedentary lifestyle that increasingly relied on agriculture. Woodland period culture remained intact until European contact. Woodland period sites have been identified on both the coastal marshes and in the mid-drainage areas in the region. Archaeological sites from this period produce distinctive ceramic forms and small triangular projectile points indicative of bow-and-arrow technology.

Despite a Statewide survey of archaeological resources conducted in the early part of this century and more recent cultural resources investigations, no confirmed prehistoric sites have been identified within the tidal zones of the bay or ocean shorelines or on Long Beach Island itself.

Historic Resources.

Long Beach Island. Long Beach Island became a destination for summer visitors when stage service between Philadelphia and Tuckerton was established in 1815. In that same year, the island's first boarding house was opened on the southern end of the island by Joseph Horner. Guests were shuttled by sailboat from the Green Street wharf at Tuckerton to the island's bay side. The island's second hotel was a boarding house opened by Jacob Herring and it catered largely to sportsmen primarily from New York. In 1834, the United States Government constructed the first Barnegat Lighthouse, which helped spur the growth of a small community on the northern most tip of the island. During the mid-19th century, the landscape of Long Beach Island remained much as it had been since the construction of the first boarding houses. However, development of the island accelerated dramatically following the establishment of regular train service to Tuckerton in 1871.

Loveladies. The name Loveladies is derived from Lovelady Island, a bay islet named after its former owner, Thomas Lovelady. The name became applied to this section of Long Beach Island when a name was needed for U.S. Life Saving Station #114. Until the 1930's, when the Manahawkin and Long Beach Island Railroad stopped running on Long Beach Island, the area was also known as Club House, named after the James' Long Beach Island Club House. The railroad, for reasons of modesty, did not want to use the name "Lovelady's." Lovelady's did not come into general usage as an area name until after the demise of the railroad. The name was again changed, this time to Long Beach Park, following the decommissioning of the railroad station at the close of World War II. By mid-century only a few homes had been constructed in the area. Long Beach Park was most notable for the 30-acre Long Beach Island Center for the Arts and Sciences constructed in 1949. In 1952, the area was officially renamed Loveladies. Building on the tract did not truly begin until 1954 when the construction of the Garden State Parkway increased development pressures on Long Beach Island. Present-day Loveladies consists of the northernmost segment of Long Beach Township and extends from Barnegat Light at approximately Holly Drive south to 87th Street and the start of Harvey Cedars. The Loveladies Life Saving Station located on Long Beach Boulevard and Station Avenue has been recommended for listing in the State and National Registers of Historic Places.

Harvey Cedars. This town formed around the Harvey Cedars Life Saving Station and the Harvey Cedars Hotel. Although Harvey Cedars incorporated as its own borough in 1894, and attempts were made to attract development (for example, an impressive pavilion was constructed on the beach in 1898), the community remained sparsely built until the construction of the Garden State Parkway in 1954. Today, the borough of Harvey Cedars is located between Loveladies and North Beach, extending between 86th and Williams Streets.

Maritime History. Although Barnegat Bay was utilized by local fisherman and sportsmen throughout the 19th and 20th centuries, the majority of commercial shipping occurred in the shipping lanes running adjacent to the island's Atlantic Ocean shoreline. Over the centuries, numerous ships have been wrecked along New Jersey's 127-mile-long coastline and a great number occurred specifically off Long Beach Island. By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first Federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline, including the Barnegat Lighthouse and the Little Egg Harbor Light.

The first Federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives. Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, congress provided the first funds for a professional United States Life Saving Service and in 1886, the Federal government inaugurated the policy of manning all stations with paid crews. Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations.

Dredged holes #5 and #6 are located adjacent to the bay shorelines of Loveladies and Harvey Cedars, respectively. The holes were initially dredged in the 1960’s to provide sand for a major beach restoration project of the entire island following extensive damage caused by the March 1962 storm. These dredged holes also provided deeper water for vessels navigating to piers located along the bay shoreline.

Cultural Resources Potential

The remains of shipwrecks and other submerged cultural resources in Barnegat Bay may or may not be buried beneath sediment. Shipwreck material deposited in even the shallowest environment can settle rapidly into the bottom with its associated archaeological record intact. However, the potential for the presence of significant and intact cultural resources in the areas of dredged hole #6 and the Double Creek Channel borrow area, is considered extremely minimal. Any cultural resource, such as a sunken vessel or a small fishing boat, would have been considerably damaged or completely destroyed during previous dredging operations. The Double Creek channel borrow area has been previously dredged and is currently maintained by the State of New Jersey.

3.5 Socioeconomic Environment

3.5.1 Population

Ocean County is the second largest county in NJ and is one of four New Jersey counties that borders the Atlantic Ocean. The County has a land area of approximately 636 square miles, with 45 miles of oceanfront and more than 150 miles of bay shore and estuaries. For several decades, Ocean County has been the fastest growing county in the State. The U.S. Census reported a growth rate of 25.2 percent between 1980 and 1990, with a 1990 population of 433,203 (USACE 1998; CH2M Hill 1997). Census data from 1990 indicate that Ocean County's population is 95 percent Caucasian, 3.2 percent Hispanic, and 2.7 percent African-American (CH2M Hill 1997).

In 1990, Harvey Cedars Borough had a total population of 362. Loveladies is part of Long Beach Township, and the Township's 1990 population was 3,407. The 1990 Census data indicate that Harvey Cedars is nearly 100 percent Caucasian with one of these individuals also of Hispanic origin (USCB 1999a). The Census data also show that Long Beach Township's population is 99 percent Caucasian and 0.09 percent African-American; regardless of race, 1.2 percent of the population is also of Hispanic origin (USCB 1999b).

3.5.2 Schools

Both Harvey Cedars Borough and Loveladies utilize the Long Beach Island School District for Kindergarten through sixth grade. Long Beach Island School District operates two schools several miles south on the island, one in Surf City and the other in Ship Bottom (Times-Beacon Newspapers 1999a, 1999b).

Harvey Cedars, Loveladies, and Long Beach Island School District students in 7th through 12th grade are sent to the Southern Regional School District. The Southern Regional High School is located on the mainland in Manahawkin, New Jersey (Times-Beacon Newspapers 1999a, 1999b).

3.5.3 Regional Economic Development

Ocean County has a diverse economic base, with retail trade and service sectors employing the majority of the county's workforce. The largest employer group in the county is the healthcare industry; other large employers include eating and drinking establishments, food stores, and amusement and recreation services (CH2M Hill 1997). The 1995 unemployment rate for Ocean County was 6.6 percent. In 1989, the County's per capita income was $15,598, with 6 percent of the County's residents living below the poverty level (CH2M Hill 1997).

Harvey Cedars and Loveladies are largely seasonal communities that cater to summer tourists from elsewhere in the State and mid-Atlantic region. In 1989, the per capita income for Harvey Cedars was $21,482, with 5.5 percent living below the poverty level (USCB 1999c). The 1989 per capita income for Long Beach Township was $21,545, and 4.5 percent were living below the poverty level (USCB 1999d).

3.6 Aesthetic and Visual Resources

The areas within which both dredged hole #5 and #6 exist are highly visible to the Long Beach Island public. Many citizens of Harvey Cedars can readily see the open water area of dredged hole #6 from their residences and properties, although the site is only visible as open water on the bay. The same is true with dredged hole #5; many of the citizens of Loveladies can see the open water site to the south and east. Owing to the fact that both Harvey Cedars and Loveladies are largely developed with man-made features, open water over the dredged holes and in the Bay is a major aesthetic resource. Scattered landscaped trees, taller residences, and other buildings occasionally block views of the water, however, views of the water are generally open. Public beach is present on the Atlantic Ocean side of Long Beach Island, providing both aesthetic and recreational opportunities. Many residents in both Harvey Cedars and Loveladies possess docks and boats, and use these amenities for aesthetic and recreational opportunities.

Double Creek Channel is located approximately one-mile southwest of Barnegat Inlet and Long Beach Island. Although the channel is located relatively far from populated areas to the south, the open water area is visible from Sedge Islands Wildlife Management Area and to the many people who pass through the channel. As with the areas surrounding the two dredged holes, the open water portions of the Bay are a major aesthetic resource.

4. PROBLEM IDENTIFICATION

4.1 Methodology of Problem Identification

Dredged holes #5 and #6 are relatively deep (-18 ft NAVD and –36 ft NAVD, respectively) compared to typical natural water depths (-6 ft NAVD) of Barnegat Bay. Data were collected from the dredged holes and from reference sites that included water quality parameters, benthic macroinvertebrate conditions and fish utilization. Benthic sampling was performed at a range of depths from the deepest portion of each dredged hole to adjacent shallow water reference sites. It was found that benthic macroinvertebrate abundance, biomass and diversity were poorest within sediments found in the deepest locations, whereas optimal benthic conditions were located at shallow reference sites. Spring and summer water measurements indicated that DO levels in deeper areas were not hypoxic with levels generally above 5.0 mg/l. Continuous DO measurements at the deepest portions of dredged holes #5 and #6 for a one-week period showed only occasional values below 3.0 mg/l. Average DO levels were approximately 4.0 and 5.0 mg/l in dredged holes #6 and #5, respectively, where corresponding measurement depths were roughly 35 and 18 feet. Fish trawls and gill net sets found primarily weakfish adults and juveniles with much greater abundance in dredged hole #5. This finding suggests that intermediate depths (defined relative to dredged hole #5 depth of 18 feet) are more attractive to fish. Trawls at shallow water reference sites for similar periods produced similar fish species, but notably lesser abundance than dredged hole #5. On the other hand, fish abundance was somewhat greater than produced from fish trawls in deeper waters (dredged hole #6).

In summary, findings suggest that the greatest benthic community benefit would occur if the dredged holes were completely filled to levels occurring naturally in Barnegat Bay. However, because large numbers of juvenile weakfish and other species also use the dredge holes as refuge habitat, only partial filling of the holes is recommended. The problem is to determine the optimum level to fill the holes to provide the greatest benefit to fish and their benthic food source.

4.2 Problems, Needs, and Opportunities

4.2.1 Habitat Preferences

4.2.1.1 Benthos Habitat Preferences

The shallow areas near the two dredged holes are highly productive areas with high diversity, abundance, and biomass of benthic organisms. On the other hand, the benthic communities within each dredged hole, in both the intermediate and deep areas, are clearly depressed compared to the surrounding shallow areas. Though the intermediate areas support a benthic community, and in some cases support high numbers of amphipods, all measures of benthic community health (including diversity, abundance, and biomass) were less than those found at nearby areas with “natural” depths. The deepest areas of each dredged hole were essentially azoic in the summer and recruitment was extremely depressed in the spring.

Based on the limited water quality data collected for this study, the quality of the water near the bottom of both dredged holes does not appear to explain the depressed benthic populations of the dredged holes. The differences in sediment types between the shallow and deep areas also do not appear to explain the population differences. The deepest areas within the dredged holes appear to be a sink for both silts and clays and for large amounts of decaying plant material. The sediment samples collected from these areas contained large amounts of decaying sea grasses and smelled of hydrogen sulfide. In addition, TOC in these areas was extremely high. Circulation within the dredged holes is driven by wind and at the depths occurring within them, circulation may be limited. Scott and Kelley (1999) suggested that this decaying material, along with the possible limited circulation, may be causing a thin layer of hypoxia or anoxia at the sediment-water interface, which in turn is causing lethal conditions for the benthic community. This suggestion is further supported by other studies, which show that benthic populations reflect long-term conditions at the site and are particularly influenced by poor DO conditions that may have previously occurred there. (Ranasinghe et al. 1998)

Regression analysis indicated a relatively strong relationship between benthic community condition and depth (Fig. 4-10 in Scott and Kelley, 1999). Samples collected from the deepest habitat of dredged hole #5 and #6 resulted in essentially no organisms, while the intermediate and shallower depths showed relatively higher values in all three benthic measures. The regression for total abundance had an r^2 of 0.34, while the regressions for biomass and number of species resulted in an r^2 of 0.44 and 0.75, respectively.

4.2.1.2 Fish Habitat Preferences

Weakfish was the most abundant species taken in fish sampling for this project (Scott and Kelley 1999); it can be considered representative of a number of other estuarine fish species. Thus, habitat evaluation focused on this species. The weakfish captured by trawl in dredged holes #5 and #6 as well as at the reference site were primarily juveniles, less than one year of age (i.e., age 0+), based on their length distribution (Scott and Kelley 1999). Most fish taken were between 90 mm and 120 mm; mean length at age one is generally reported to be on the order of 200 mm (Mercer 1989). The smaller number of weakfish taken in gill nets ranged up to three years in age, based on size. The use of estuarine waters as nursery habitat by juvenile weakfish and as general foraging habitat by adults is well established in the literature (Mercer 1983; Mercer 1989). However, their use of specific habitats within estuaries is not precisely described. Both juvenile and adult weakfish move out of estuaries into coastal waters in the fall and over winter in deeper marine waters. Thus, the dredged holes addressed in this assessment are of primary value to this species during the summer and fall. Weakfish have been found to avoid low DO conditions, i.e., when levels drop to a range of 1.0 to 2.3 ppm (Thomas 1971). Since the lowest DO measured in the dredged holes was about 3 ppm (Scott and Kelley 1999) and the average was about 4 ppm in dredged hole #6 at 1 meter above the bottom, it would not appear that low DO was a constraint on their use of the dredged holes, at least during the times when sampling was conducted.

Weakfish are pelagic rather than benthic feeders and are important top predators in ecosystems, such as Barnegat Bay, that support substantial submerged aquatic vegetation, particularly eel grass (Mercer 1983). Weakfish feed primarily on mobile, pelagic or semi-pelagic prey;

examples include mysid shrimp and anchovies for juveniles and clupeid fish such as menhaden for adults (Mercer 1983). They forage in appropriate shallow water habitats during times of feeding, particularly early morning and early evening, but occupy channels and deeper water locations as refuges when not feeding, generally during daylight hours (Mercer 1983). In extensive studies in North Carolina estuaries, juvenile weakfish were not captured frequently during summer and fall in shoal waters of low salinities and mud and/or mud-grass bottoms, but occurred most commonly in secondary nursery areas, usually shallow bays or navigation channels, moderate depths, slightly higher salinities, and sand or sand-grass bottoms (Spitsbergen and Wolff 1974). The bottom substrate of dredged hole #6 had high levels of organic material (Scott and Kelley 1999) and could fall in the mud-grass habitat category. Studies of the vertical distribution of age 0+ weakfish conducted in Delaware Bay in 1980 demonstrated that these fish were bottom oriented; the highest catches were taken in tows made near the bottom (Public Service Electric & Gas (PSE&G) 1984). Lowest densities tended to occur at bottom depths less than 3 meters and there was a tendency for higher densities to occur at bottom depths between 6 and 9 meters. However, the catches were highly variable, and no quantitative relationship between density and bottom depth was evident from the data presented. Also, the data were collected in waters with widely varying depths ranging as deep as 24 meters. Because the environment sampled was very dissimilar from the relatively homogeneous and shallow Barnegat Bay, the data may not be representative of habitat utilization by this life stage of this species in Barnegat Bay. PSE&G (1984) reported that adult weakfish were taken throughout the water column and showed no depth preference.

Data taken in field surveys for this project showed the highest densities of juvenile weakfish in dredged hole #5, which has a bottom depth of about 18 feet (about 6 m). Densities in dredged hole #6, with a bottom depth of 36 feet (about 11 m), were low and similar to densities at the shallow (about 2 m) reference site (Scott and Kelley 1999). These data suggest a mid-depth preference by juvenile weakfish, not inconsistent with the vertical distribution information in the literature discussed above, particularly observations of low densities at depths of less than 3 m. As was also noted above, the high amounts of organic material along the bottom of dredged hole #6 may create an undesirable substrate type that might be avoided by weakfish. One habitat attribute that cannot be quantified but may play a role in the use of these dredged holes by weakfish and other species is heterogeneity. In a homogenous, shallow estuary such as Barnegat Bay, any bottom depression is likely to represent an attractive habitat feature because of its impact on water currents and movement of forage.

Literature review and consideration of the fish survey data indicate that dredged holes #5 and #6 do provide significant beneficial habitat to weakfish and other estuarine fish species, but that the deeper habitat in dredged hole #6 offers less fisheries habitat value than the shallower dredged hole #5.

4.2.2 Habitat Unit Calculations

Habitat Suitability Index (HSI) curves were developed separately for benthos and fish based on the distribution of biomass observed in summer 1999 sampling. Benthic sampling results for dredged holes #5 and #6 and for a reference area were combined and a regression analysis was used to relate benthic biomass to water depth between 6 and 16 feet (these data are shown in

Figure 4-10 Scott and Kelley, 1999). Suitability was set to zero at depths below the water surface of 16 feet and greater, where little or no benthos were observed. Depths shallower than 6 feet were not included, since no alternatives are being considered that would fill the dredged holes beyond that point as this would impact navigation in the area. Suitability ranged from zero at 16 feet to one at 6 feet, where the greatest benthic biomass occurred, based on the regression analysis.

The HSI for fish was determined using the number of juvenile weakfish caught in trawls in dredged hole #6 (14 fish) at depths of 25-30 feet below the water surface, in dredged hole #5 (161 fish) at depths of 13-20 feet and in a reference area (25 fish) at depths of 0-6 feet. Since the sizes of fish were similar for all trawls, fish numbers were assumed to represent relative biomass of fish that preferred the respective depth ranges. The HSI curve was developed by setting the depth range with the greatest number of fish to one (i.e., at 13-20 feet, based on dredged hole #5 numbers), and setting the other sampled depth ranges to proportionate values (0.16 for 0-6 feet and 0.1 for 25-30 feet below the water surface). Since no data were available for other depth ranges, the HSI value was linearly interpolated between these known values. HSI curves for benthos and fish are shown in Figure 4-1.

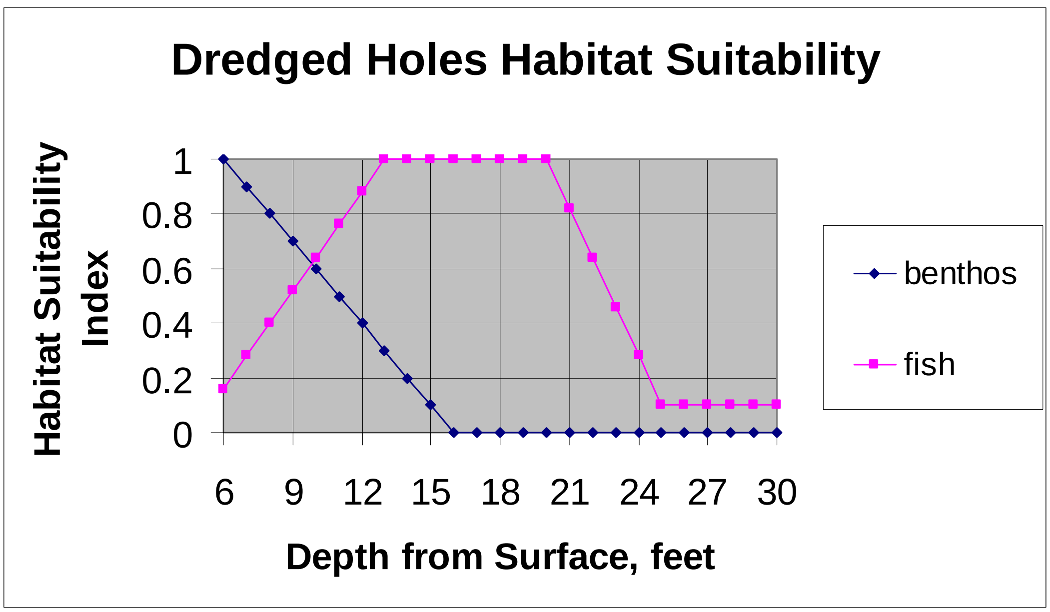


Figure 4-1. Dredged Holes Habitat Suitability

Development of Habitat Values Based on Unit Areas

Areas within each of the dredged holes were available for 3 depths (6, 12, and 18 feet below the surface). These data were used to calculate habitat units that would be available for benthos and fish for 5 proposed filling alternatives in each dredged hole below water surface (6, 9, 12, 15, and 18 feet below water surface). Areas that would be available at 1-foot increments in each dredged hole were estimated from the information available at the 3 depths. These areas were then multiplied by the HSI values shown in Figure 4-1 to obtain benthic or fish habitat units for the total area within each dredged hole, for each of 5 filling alternatives (filling to 18, 15, 12, 9, and 6 feet below the water surface); these results are shown in Figures 4-2 and 4-3 and Table 4-1. Combined habitat units are illustrated in Figure 4-4.

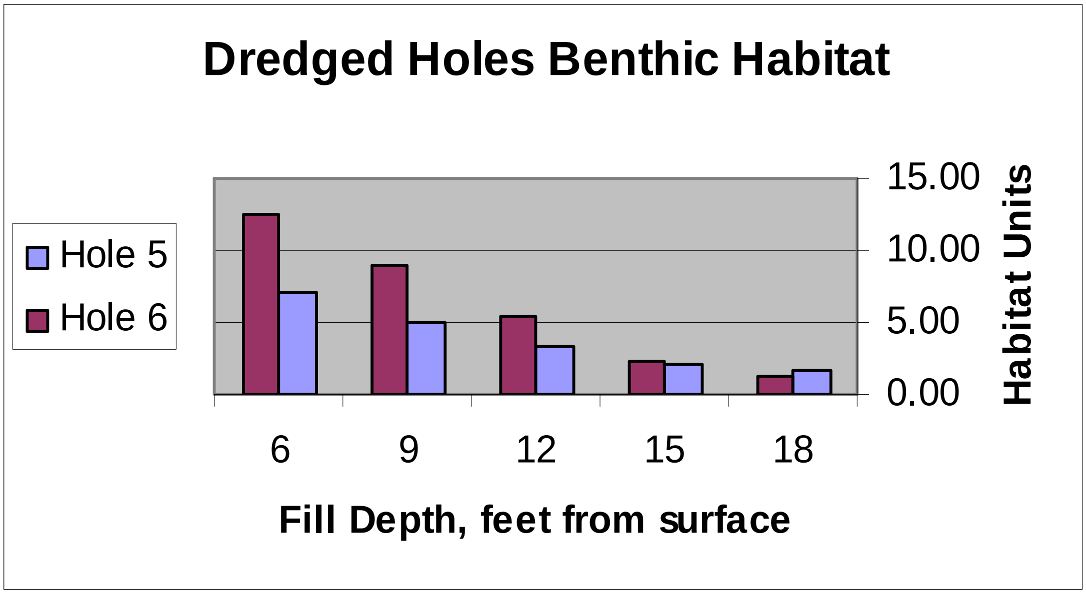


Figure 4-2 Dredged Holes Benthic Habitat

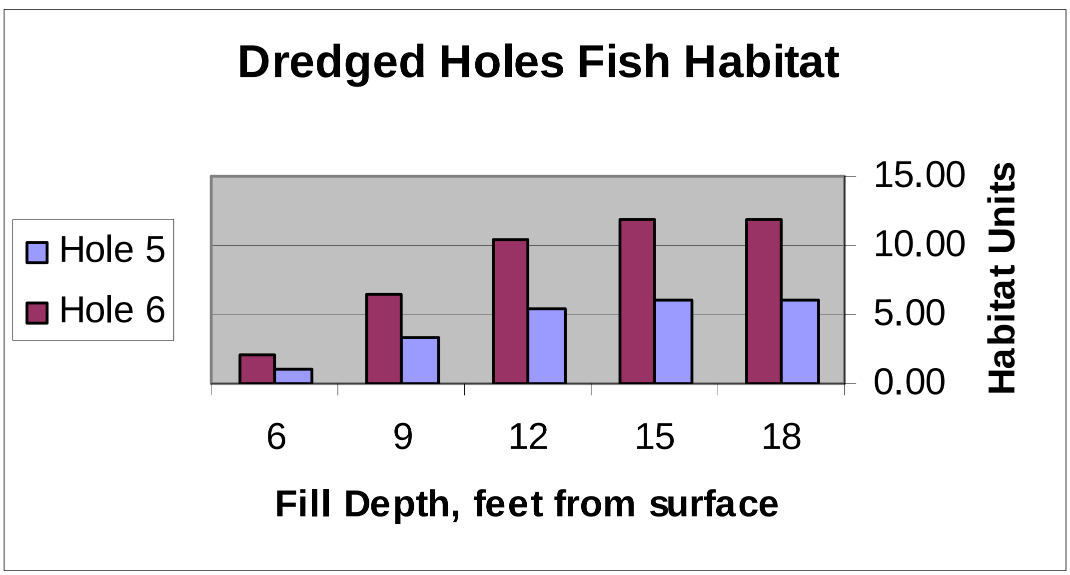


Figure 4-3 Dredged Holes Fish Habitat

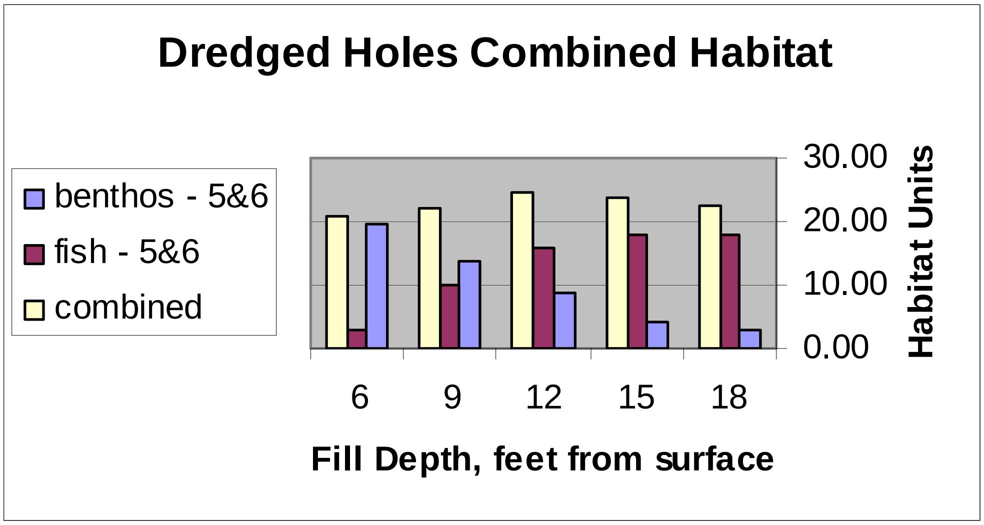


Figure 4-4 Habitat Results for Incremental Analysis

Results in terms of benthic habitat units show that the amount of habitat is greatest for benthos if the dredged holes are filled to 6 feet below the water surface. Habitat is greatest for fish if the dredged holes are filled to only 15-18 feet, although there is only a slight decrease between 12 and 15 feet. There is a large decrease in habitat for fish if the dredged holes are filled to 6 feet. These results show the greatest habitat for both groups if the dredged holes are filled to 12 feet. These results will be used in the incremental analysis along with the costs of filling the dredged holes to various depths to select the best alternative. Alternatives to be evaluated include: (1) no action at either dredged hole; (2) fill dredged hole #5 to 18, 15,12, 9, or 6 feet below the water surface; (3) fill dredged hole #6 to 18, 15, 12, 9, or 6 feet below the water surface; and (4) any combination of filling both dredged holes to 18, 15, 12, 9, or 6 feet below the water surface. Section 5.4.3 presents the incremental analysis used to evaluate these alternatives in all the possible combinations, along with the dredging cost to supply the material to fill the dredged holes.

Table 4-1
Benthic and Fish Habitat Units in Barnegat Bay Dredged Holes Project

Depth (feet) from Water Surface to Fill Surface	Dredged Hole #5 Benthos	Dredged Hole #6 Benthos	Dredged Hole #5 Fish	Dredged Hole #6 Fish	Combined Habitat Units
6	7.0	12.5	1.1	2.0	22.6
9	5.1	8.9	3.4	6.4	23.7
12	3.4	5.4	5.5	10.5	24.8
15	2.0	2.3	6.1	11.8	22.1
18	1.6	1.3	6.1	11.8	20.8

4.3 Recommendations for Habitat Restoration

Although the benthic data suggests that filling the dredged holes up to average depths naturally occurring in Barnegat Bay would have the most benefit to the ecosystem, the fish data collected with otter trawls and gill nets suggest otherwise. Relatively large numbers of juvenile weakfish and other important resident fish species were found in the deep habitat of dredged hole #5 at depths of about 13 to 20 feet. This clearly indicated that fish are using the shallower dredged hole as refuge and feeding habitat (significantly fewer fish were caught in the 25 to 33 feet deep trawls in dredged hole #6). While the benthic data for dredged hole #5 indicated that the deepest portion was essentially azoic, the intermediate depths had large numbers of benthic macroinvertebrates, particularly amphipods. Inspection of the stomach contents of several juvenile weakfish retained from the trawl samples revealed that they were feeding on amphipods. It is therefore likely that weakfish juveniles were moving into the intermediate depths to feed and using the bottom strata for refuge from predators. Fewer fish may be using the deep habitat of dredged hole #6 since the distance to the food source in the intermediate depths is farther.

The regression data was inspected to determine at what depth we could expect a dramatic improvement in benthic macroinvertebrate condition over the azoic conditions observed in the deepest portion of the dredged holes. The optimal depth would retain refuge habitat for weakfish and other resident species while also providing a measurable improvement in benthic condition. Based on the regression data, optimal habitat would be obtained by filling both dredged holes to a depth of 12 feet. At 12 feet, dramatic improvements in number of species, biomass, and total abundance were observed.

It should be noted that while filling the dredged holes up to the 12-foot depth contour could potentially improve the benthic community conditions, the possibility exists that no net gain in benthic productivity could occur. The current study has demonstrated that essentially no secondary productivity occurs within the deepest areas of the dredged holes, despite the fact that dissolved oxygen levels one-meter from the bottom were well above hypoxic levels. The poor benthic production within each dredged hole is probably caused by an overabundance of organic material that tends to accumulate in the bottom of the dredged holes. The organic material is primarily dead SAV carried by currents and wind from live beds located in shallower waters. The build up of decaying organic material is exacerbated by the poor circulation within dredged holes #5 and #6 (both dredged holes are surrounded by 1 to 2 foot shoals with only one primary channel in and out of the area). Organic materials that enter these sub-aqueous pits therefore tend to be trapped. High concentrations of decaying SAV could be producing a tremendous biological oxygen demand at the sediment–water interface lowering dissolved oxygen concentrations to levels lethal to benthic organisms. Evidence of this was noted during the summer sampling when sediments taken from the deep habitats reeked of hydrogen sulfide (produced by anaerobic bacteria).

Decreasing the depths of the dredged holes will improve the benthic community conditions, provided the build up of organic material does not reach excessive levels. Shallower water depths should improve water column mixing by wind events. One solution to the problem of dead SAV accumulation would be to place dredged material in mounds on the bottom. By mounding the material, dead SAV would tend to accumulate in the valleys. We would expect that poor benthic conditions would still exist in the trough areas, but better conditions (i.e., live bottom) would likely exist on and near the tops of the mounds. Based on the analysis of the number of habitat units that may be created, the tops of the mounds should be placed at depths between 12 and 15 feet below the water surface. Creating mounds within the dredged holes will have the added potential benefit of creating more habitat heterogeneity and may increase the amount of refuge area for juvenile weakfish, soft crabs, and other species that inhabit the dredged holes. As this is a pilot study, monitoring will be conducted as described in Section 5.4.2 to determine changes that occur in water quality, benthic invertebrate condition and fish use.

5.0 PLAN FORMULATION

5.1 Plan Formulation Methodology

The alternative plans were formulated based on benefits to environmental habitat, available source material (type, location and quantity), practical dredging methodology, and costs. Input from the USACE and NJDEP was used to evaluate source material and benefits to the environment. Input from commercial dredging contractors were used to evaluate dredging equipment and develop dredging methods. The Corps of Engineers Dredge Estimating Program (CEDEP) was used to develop costs for dredging and placement of material into the dredged holes.

5.2 Planning Objectives

The planning objectives involved assessing problems and opportunities expected at the dredged holes and evaluating potential solutions for environmental restoration. The evaluation of the alternatives includes several filling scenarios and concepts. These scenarios primarily consist of filling to varying depths. However, within a given “depth to fill” scenario, the material would be placed in such a manner to provide bathymetric relief within the dredged holes. This placement methodology would consist of holding the end of the discharge pipeline stationary at a location within the dredged hole to create a mound of sand at the bottom, then moving the pipeline end to another location within the dredged hole to create another mound of sand. This operation would continue until all the material would be placed and the desired relief would be created. By mounding the material, dead SAV would tend to accumulate in the valleys, creating better conditions (i.e., live bottom) on and near the tops of the mounds. Creating mounds within the dredged holes will have the added potential benefit of creating more habitat heterogeneity and increasing the amount of refuge area for juvenile weakfish, soft crabs, and other species that inhabit the dredged holes.

5.3 Formulation and Evaluation Criteria

5.3.1 General Criteria

The goal of the project is the environmental restoration of two dredged holes as regards the benthic and fish communities. Through the implementation of the project, long-term environmental benefits in the benthic and fish communities at the dredged holes will be realized. The work and results of the project should be compatible with other ongoing efforts by Federal, State and Local agencies and non-profit organizations without compromising public health, safety, and well being. The benefits provided by and costs associated with the project will be analyzed in accordance with Corps of Engineer’s regulations and must ensure that any plan is complete, efficient, safe, and economically feasible.

5.3.2 Economic Criteria

Economic analysis of project costs versus environmental benefits will be based upon incremental costs for production of benthos and fish habitat units. Due to the environmental focus of this project, other economic criteria are secondary. However, it is assumed that the proposed restoration project will improve localized habitat and potentially provide enhanced recreational opportunities.

5.3.3 Environmental Criteria

Technical criteria were selected to optimize environmental benefits with consideration for economic feasibility. All alternatives will improve aquatic habitat. The material will be obtained from nearby existing Federal and State channels. The source material will be sandy material and will meet all New Jersey standards. The material is satisfactory as regards constructability of the project. The high sand content would produce a suitable substrate for target species and allow for creation of mounds within the hole. As the material is less than 90 percent sand, samples collected from within the source area were analyzed for semivolatiles, pesticide/PCB, metals and total organic carbon. Reported sediment concentration data are non-detect for all semivolatiles, pesticides and PCBs. Reported sediment concentration data for metals are below criteria specified in Long *et al's* (1995) Effects Range Low (ERL) sediment guidance values. These values are the current New Jersey standards. Reported sediment concentration data for Total Organic Carbon (TOC) are less than 1.2 percent for all samples.

Based on the results of the chemical analyses, the source material is considered clean and suitable for placement into the dredged hole. Dredging of the material may be conducted using either hydraulic or mechanical methods; however, hydraulic dredging is typically more efficient. The quantity of material to be dredged is determined based upon the incremental analysis conducted. No work will be conducted during critical periods for important environmental resources such as SAV, endangered species, and essential fish habitat. Finally, best management practices will be used during construction, to avoid and/or minimize impacts.

5.4 Description and Discussion of Alternatives Considered

5.4.1 Identification of Alternatives

5.4.1.1 Cycle 1 - Initial Screening of Solutions

An initial screening of solutions was performed that consisted of making preliminary cost estimates for alternative plans to collect, transport and place material from potential sources into the two dredged holes. The alternatives included the No Action alternative, and primarily consisted of placing varying quantities of material from several different sources into the two dredged holes. Assumptions inherent in these preliminary cost estimates were:

- Source would be sandy material
- Source material may be obtained from Barnegat Inlet, Oyster Creek Channel and the New Jersey Intracoastal Waterway (NJIWW)
- Actual source material data not available at the time of this initial screening
- Source material may be dredged using either hydraulic or mechanical methods
- CEDEP was used to develop dredging costs

Five alternatives were evaluated with respect to costs; four of the alternatives had three sub-alternatives. The following were the initial alternatives.

- Alternative No. 1: No Action
- Alternative No. 2: Barnegat Inlet/Oyster Creek Channel Source Area – Hydraulic Dredging Method
    - A. Fill Dredged Hole #6 to –18 ft MLLW (100,000 CY volume)
    - B. Fill Dredged Holes #5 and #6 to –10 ft MLLW (200,000 CY volume)
    - C. Fill Dredged Holes #5 and #6 to –6 ft MLLW (250,000 CY volume)
- Alternative No. 3: Barnegat Inlet/Oyster Creek Channel Source Area – Mechanical Dredging Method
    - A. Fill Dredged Hole #6 to –18 ft MLLW (100,000 CY volume)
    - B. Fill Dredged Holes #5 and #6 to –10 ft MLLW (200,000 CY volume)
    - C. Fill Dredged Holes #5 and #6 to –6 ft MLLW (250,000 CY volume)
- Alternative No. 4: NJIWW Source Area, maximum distance to dredged holes 2000 ft – Hydraulic Dredging Method
    - A. Fill Dredged Hole #6 to –18 ft MLLW (100,000 CY volume)
    - B. Fill Dredged Holes #5 and #6 to –10 ft MLLW (200,000 CY volume)
    - C. Fill Dredged Holes #5 and #6 to –6 ft MLLW (250,000 CY volume)
- Alternative No. 5: NJIWW Source Area, maximum distance to dredged holes 6000 ft – Hydraulic Dredging Method
    - A. Fill Dredged Hole #6 to –18 ft MLLW (100,000 CY volume)
    - B. Fill Dredged Holes #5 and #6 to –10 ft MLLW (200,000 CY volume)
    - C. Fill Dredged Holes #5 and #6 to –6 ft MLLW (250,000 CY volume)

Alternative No. 1 was No Action, which is the basis by which the other alternatives were evaluated. This alternative has no costs. Alternative No. 2 consisted of hydraulically dredging material from either the Barnegat Inlet or Oyster Creek Channel and pumping it to the dredged holes. It was assumed that a 24-inch pipeline dredge would be used to perform the work. Estimated costs for implementing this alternative ranged from $2.01 million to $3.50 million. Alternative No. 3 consisted of mechanically dredging material from either the Barnegat Inlet or Oyster Creek Channel and barging it to the dredged holes. It was assumed that a 21-CY clamshell dredge would be used to perform the work. Tugs would convey the loaded barges to the dredged holes for filling. Fill method would be either pumpout or mechanical unloading. Estimated costs for implementing this alternative ranged from $2.99 million to $5.72 million. Alternative No. 4 consisted of hydraulically dredging material from the NJIWW relatively nearby to the dredged holes and pumping it to the dredged holes. The maximum distance from the dredged holes was assumed to be 2000 ft. It was assumed that a 12-inch pipeline dredge would be used to perform the work. Estimated costs for implementing this alternative ranged from $1.23 million to $2.57 million. Alternative No. 5 was similar to No 4 in that it consisted of hydraulically dredging material from the NJIWW and pumping it to the dredged holes. The maximum distance from the dredged holes, however, was assumed to be 6000 ft. It was also assumed that a 12-inch pipeline dredge would be used to perform the work. Estimated costs for implementing this alternative ranged from $2.22 million to $4.92 million.

Through the cycle one analysis the short distance alternative was eliminated due to insufficient material. Additionally, mechanical dredging was eliminated.

5.4.1.2 Cycle 2 – In-depth Evaluation and Screening of Solutions Considered

Further evaluation and screening of solutions was performed for Cycle 2. This cycle consisted of evaluating the alternative plans presented in Cycle 1 with increased focus on performance of the alternative for environmental restoration. Potential sources were expanded to include Double Creek Channel in addition to the previous channels. Topics included in this cycle included: 1) dredged hole design; 2) construction access; 3) environmental impacts; 4) cost estimates; and 5) cost effectiveness and incremental cost analysis. The alternatives evaluated included the No Action alternative, and still primarily consisted of placing varying quantities of material from several different sources into the two dredged holes. Quantities of material estimated to be placed in the dredged holes were as follows:

1) Dredged Hole No. 5 – The area of the dredged hole (about 7 acres) was estimated based on information presented in Figure 1-3, obtained from the USACE. Electronic survey data for this dredged hole was not available. The area of the bottom of the dredged hole was estimated to be about half of the top, about 3.5 acres. Vertical depth within the dredged hole is measured from –6 ft NAVD to –18 ft NAVD. Volume was thus computed to be approximately 100,000 cubic yards (CY). The area of the dredged hole at a depth of –12 ft NAVD was assumed to be midway between the top and bottom, about 5.3 acres. Volume within the dredged hole from –18 ft NAVD to –12 ft NAVD was computed to be approximately 40,000 CY.

2) Dredged Hole No. 6 – Quantity calculations for this dredged hole were based on electronic survey data provided by the USACE. The data were input into the SURFER® program; output from this program was subsequently used to compute areas and volumes. The area of the dredged hole at the top was computed to be about 12 acres. Volume of the dredged hole between elevation –6 ft NAVD and the bottom surface was computed to be approximately 330,000 CY. Volume of the dredged hole between elevation –12 ft NAVD and the bottom surface was computed to be approximately 220,000 CY. Volume of the dredged hole between elevation –18 ft NAVD and the bottom surface was approximately 125,000 CY.

For purposes of the evaluation of alternatives in this report, the above quantities were assumed to be fill quantities for the environmental restoration project. Similar to Cycle 1, three alternative fill volumes for each method of dredging and placement were evaluated, with the quantities as follows: 1) 125,000 CY, 2) 260,000 CY, and 3) 430,000 CY. Costs to perform the work were based on these quantities.

Alternative No. 1 was No Action and, as before, had no costs and is the basis by which the other alternatives are evaluated. Alternative No. 2 estimated costs ranged from $1.87 million to $3.77 million. Alternative No. 3 estimated costs ranged from $3.52 million to $8.42 million. Alternative No. 4 estimated costs ranged from $1.19 million to $2.62 million. Alternative No. 5 estimated costs ranged from $1.43 million to $3.39 million. Table 5-1 summarizes costs for the alternatives.

Table 5-1 Cycle 2 Costs	
Alternative Number	Cost (millions)
1	$0
2A	$1.87
2B	$2.87
2C	$3.77
3A	$3.52
3B	$5.69
3C	$8.42
4A	$1.19
4B	$1.86
4C	$2.62
5A	$1.43
5B	$2.33
5C	$3.39

This cycle included performing a preliminary incremental cost analysis using costs in Table 5-1 and the habitat unit calculations presented in Section 4.2.2. The analysis consisted of comparing the plans and identifying which one provided the optimal combination of financial investment and environmental enhancement. Environmental factors that were considered in the analysis included benthic biomass, benthic number of species, benthic abundance, fish abundance, fish number of species, water depth, water quality and sediment quality. Alternatives that were considered include "No Action", intermediate filling of the dredged holes (to elevation –18 ft NAVD and –12 ft NAVD), and completely filling of the dredged holes (to elevation –6 ft NAVD). Initial assessment of the analysis indicated that the most beneficial environment for both the benthos and the fish would be to fill both dredged holes to –12 ft NAVD.

Through Cycle 2 analysis the New Jersey Intercoastal Waterway was eliminated as a source and the list of sources was expanded to include Double Creek Channel. Additionally, the –10 ft depth was changed to –12 ft.

5.4.1.3 Cycle 3

5.4.1.3.1 Plan Formulation, Refinement of Alternatives

The alternatives were further refined in Cycle 3 to: 1) include additional fill elevations for both dredged holes; 2) eliminate potential sources as data became available to indicate these sources did not contain sufficient material (or no material); 3) more accurately predict the potential quantity of material available from the remaining sources; and 4) estimate the costs associated with dredging, transporting and placing material into the dredged holes for the alternatives.

Existing information from the USACE and NJDEP indicate there are two sources containing sand material that could be placed into the dredged holes. The two sources are Double Creek

Channel and Barnegat Inlet. Geotechnical investigations conducted in Double Creek Channel indicated that the material is between 60% and 70% sand. Chemical analysis conducted on sediments from Double Creek Channel indicated that sediment in the Channel meets chemical requirements as specified by NJDEP. Reports from the geotechnical and analytical testing are included in Appendix D. Alternatives that were evaluated include:

1. No Action (A0 & B0)
2. Fill Dredged Hole #5 to -15 ft NAVD (A4)
3. Fill Dredged Hole #5 to -12 ft NAVD (A3)
4. Fill Dredged Hole #5 to -9 ft NAVD (A2)
5. Fill Dredged Hole #5 to -6 ft NAVD (A1)
6. Fill Dredged Hole #6 to -18 ft NAVD (B5)
7. Fill Dredged Hole #6 to -15 ft NAVD (B4)
8. Fill Dredged Hole #6 to -12 ft NAVD (B3)
9. Fill Dredged Hole #6 to -9 ft NAVD (B2)
10. Fill Dredged Hole #6 to -6 ft NAVD (B1)

Note that the code in parentheses following each alternative is the system used in the incremental analysis IWR Plan software (see table 5.2, Section 5.4.3).

<u>No Action (Alternative 1)</u>

This alternative is the basis by which the other alternatives are evaluated.

<u>Dredged Hole #5 (Alternatives 2 through 5)</u>

The area of the dredged hole (about 7 acres) was estimated based on information presented in Figure 1-3, obtained from the USACE in a PDF file (Adobe PostScript format). Electronic survey data for this dredged hole is not available at this time. The area of the bottom of the dredged hole is estimated to be about 3.5 acres. The side slopes within the dredged hole are assumed to be constant from top to bottom. Vertical depth within the dredged hole was measured to be from –6 ft NAVD to –18 ft NAVD. Figures 5-1 through 5-4 show plans for alternatives 2 through 5. Figures 5-5 through 5-8 show schematic cross-sections of the filling plan to each of the four alternatives. Volumes for fill material were computed using average end area with the following areas:

- 4.4 acres (20,000 CY) at –15 ft NAVD
- 5.3 acres (40,000 CY) at –12 ft NAVD
- 6.2 acres (70,000 CY) at –9 ft NAVD
- 7.0 acres (100,000 CY) at –6 ft NAVD

<u>Dredged Hole #6 (Alternatives 6 through 10)</u>

Quantity calculations for this dredged hole are based on electronic survey data provided by the USACE. The data were used to compute areas and volumes. The area of the dredged hole at the top is about 12 acres. Figure 5-9 shows the plan for Alternative 6, and Figures 5-10 show the plan and pipeline arrangement for Alternatives 7 through 10. Figures 5-11 through 5-15 show schematic cross-sections for the filling plans. Volumes of fill material estimated necessary to fill dredged hole #6 to each of the depths are as follows:

- 125,000 CY for –18 ft NAVD
- 170,000 CY for –15 ft NAVD
- 220,000 CY for –12 ft NAVD
- 280,000 CY for –9 ft NAVD
- 330,000 CY for –6 ft NAVD

5.4.1.3.2 Alternatives Costs

No Action Alternative

This alternative has no costs and, as stated above, is the basis by which the other alternatives are evaluated.

Filling Alternatives

As stated in Section 5.4.1.3, based on findings and comments for the draft reports of the *Alternatives Plans Costs Estimates* and *Evaluation of Alternative Plans*, it was determined that filling of the dredged holes would be performed using hydraulic dredging methods due to the shallow water depths and relatively large distance from the source sites to the dredged holes. The source for material would be Double Creek Channel, Barnegat Inlet, or a combination of the two in Barnegat Bay. Filling alternatives will be coordinated with the NJDEP, Bureau of Coastal Engineering, and the U.S. Army Corps of Engineers Operations Division.

Cost estimates were made using CEDEP and consisted of using a 20-inch cutterhead suction dredge. Tables 5-2 through 5-5 summarize costs for the four filling volumes of dredged hole #5 (Alternatives 2 through 5). Tables 5-6 through 5-10 summarize costs for the five filling volumes of dredged hole #6 (Alternatives 6 through 10). These costs were used in the incremental analysis IWR-PLAN described in the following section. First costs ranged from about $1,107,000 to $1,813,000 for the various filling options for dredged hole #5, and from $2,062,000 to $4,470,000 for the various filling options for dredged hole #6.

Table 5-2 – Total First Cost
Alternative 2: A4 - Fill Dredged Hole No. 5 to -15 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And preparatory work	1	Job	LS	$455,092	$54,611	$509,703
	Pipeline Dredging						
	Excavation and Placement	20,000	CY	$6.66	$133,200	$19,980	$153,180
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$619,392	$80,811	$700,203
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$66,275	$8,647	$74,922
	Total Project First Cost				$973,667	$132,658	$1,106,325
	(Rounded)				$974,000	$133,000	$1,107,000

Table 5-3 – Total First Cost
Alternative 3: A3 - Fill Dredged Hole No. 5 to –12 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And preparatory Work	1	Job	LS	$455,092	$54,611	$509,703
	Pipeline Dredging						
	Excavation and Placement	40,000	CY	$6.15	$246,000	$36,900	$282,900
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$732,192	$97,731	$829,923
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$78,345	$10,457	$88,802
	Total Project First Cost				$1,098,537	$151,388	$1,249,925
	(Rounded)				$1,099,000	$151,000	$1,250,000

Table 5-4 - Total First Cost Alternative 4: A2 - Fill Dredged Hole No. 5 to -9 Ft. NAVD							
							Price Level: Oct 99
Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And Preparatory Work	1	Job	LS	$455,092	$54,611	$509,703
	Pipeline Dredging						
	Excavation and Placement	70,000	CY	$6.40	$448,000	$67,200	$515,200
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$934,192	$128,031	$1,062,223
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$90,617	$12,419	$103,036
	Total Project First Cost				$1,312,809	$183,650	$1,496,459
	(Rounded)				$1,313,000	$184,000	$1,497,000

Table 5-5 - Total First Cost Alternative 5: A1 - Fill Dredged Hole No.5 to -6 Ft. NAVD							
							Price Level: Oct 99
Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And Preparatory Work	1	Job	LS	$455,092	$54,611	$509,703
	Pipeline Dredging						
	Excavation and Placement	100,000	CY	$6.99	$699,000	$104,850	$803,850
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$1,185,192	$165,681	$1,350,873
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$114,964	$16,071	$131,035
	Total Project First Cost				$1,588,156	$224,952	$1,813,108
	(Rounded)				$1,588,000	$225,000	$1,813,000

Table 5-6 - Total First Cost
Alternative 6: B5 - Fill Dredged Hole No. 6 to -18 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$470,930	$56,512	$527,442
	Pipeline Dredging						
	Excavation and Placement	125,000	CY	$6.95	$868,750	$130,313	$999,063
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$1,370,780	$193,044	$1,563,824
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$146,673	$20,656	$167,329
	Total Project First Cost				$1,805,453	$256,900	$2,062,353
	(Rounded)				$1,805,000	$257,000	$2,062,000

Table 5-7 - Total First Cost
Alternative 7: B4 - Fill Dredged Hole No.6 to -15 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$481,241	$57,749	$538,990
	Remobilization	1	Job	LS	$525,736	$63,088	$588,854
	Pipeline Dredging						
	Excavation and Placement	125,000	CY	$6.95	$686,750	$130,313	$999,063
	Excavation and Placement	45,000	CY	$6.93	$311,850	$46,778	$358,628
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$2,218,677	$304,147	$2,522,824
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$215,212	$29,502	$244,714
	Total Project First Cost				$2,721,889	$376,850	$3,098,738
	(Rounded)				$2,722,000	$377,000	$3,099,000

Table 5-8 - Total First Cost
Alternative 8: B3 - Fill Dredged Hole No. 6 to -12 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$481,241	$57,749	$538,990
	Remobilization	1	Job	LS	$525,736	$63,088	$588,824
	Pipeline Dredging						
	Excavation and Placement	125,000	CY	$6.95	$868,750	$130,313	$999,063
	Excavation and Placement	95,000	CY	$6.83	$648,850	$97,328	$746,178
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$2,555,677	$354,697	$2,910,374
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$247,901	$34,406	$282,306
	Total Project First Cost				$3,091,578	$432,303	$3,523,881
	(Rounded)				$3,092,000	$432,000	$3,524,000

Table 5-9 - Total First Cost
Alternative 9: B2 - Fill Dredged Hole No.6 to -9 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$481,241	$57,749	$538,990
	Remobilization	1	Job	LS	$120,310	$14,437	$134,747
	Pipeline Dredging						
	Excavation and Placement	125,000	CY	$6.95	$868,750	$130,313	$999,063
	Excavation and Placement	155,000	CY	$6.84	$1,060,200	$159,030	$1,219,230
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$2,967,027	$416,400	$3,383,427
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$287,802	$40,391	$328,192
	Total Project First Cost				$3,542,829	$499,991	$4,042,819
	(Rounded)				$3,543,000	$500,000	$4,043,000

Table 5-10 - Total First Cost
Alternative 10: B1 - Fill Dredged Hole No.6 to -6 Ft. NAVD

Price Level: Oct 99

Account Number	Description of Item	QTY	UOM	Unit Price	Estimated Amount	Contingency	Total Cost
01.	Lands and Damages	1	Job	LS	$0	$0	$0
09.	Channels and Canals						
	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$481,241	$57,749	$538,990
	Remobilization	1	Job	LS	$525,736	$63,088	$588,824
	Pipeline Dredging						
	Excavation and Placement	125,000	CY	$6.95	$868,750	$130,313	$999,063
	Excavation and Placement	205,000	CY	$6.82	$1,398,100	$209,715	$1,607,815
	Associated General Items						
	Turbidity Control Curtains	2,500	LF	$12.44	$31,100	$6,220	$37,320
	Total Channels and Canals				$3,088,125	$448,079	$3,536,204
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$288,000	$43,200	$331,200
31.	Construction Management						
	(S & A)	1	Job	LS	$320,578	$45,307	$365,885
	Total Project First Cost				$3,912,305	$555,592	$4,469,097
	(Rounded)				$3,914,000	$556,000	$4,470,000

5.4.2 Environmental Monitoring and Costs

Ecological conditions within the dredged holes and in nearby reference areas should be evaluated for three years following restoration of one or both dredged holes by conducting field investigations of water quality, benthic invertebrate condition, and fish use. This information will be used to evaluate the success of the restoration effort and to refine the restoration procedure for possible expansion to additional sites.

To evaluate the benthic invertebrate conditions within the dredged holes, spring and summer surveys should be conducted. The spring survey will determine seasonal recruitment of benthic invertebrates within the dredged holes and reference areas, and recovery of dredge material-covered areas in the restored sites; the summer survey will evaluate benthic community conditions during a period when dissolved oxygen stress is most likely, thus indicating the increase in habitat value of the restored sites relative to the reference areas. Sampling of two depth strata within the dredged holes and nearby shallow water reference sites will determine any depth related changes in benthic community composition.

Macroinvertebrates should be sorted from sample residue, identified to species, where possible, enumerated, and weighed. Length of all specimens relative to 2 cm (i.e. < or > 2 cm) should be recorded. Since benthic macroinvertebrate community composition is strongly correlated with the nature of substrate conditions, the substrate particle size and organic content should be determined for each sampling site. Ash-free dry weight for each individual taxon should also be determined. Species of recreational, commercial, or ecological value such as live Spisula (surf clams), Mercenaria (hard clams), Ensis (razor clams), Tagelus (Stout tagelus clams), and

Limulus (horseshoe crabs) should be recorded. Length and sex of all specimens relative to 2 cm (i.e. < or > 2 cm) should be recorded by species.

Data analysis should include but not be limited to habitat and biological parameters. Habitat parameters to be analyzed include percent silt-clay and percent total organic carbon. Three (3) measures of biological condition including measures of diversity, abundance, and biomass should be analyzed. Measures of diversity should include number of taxa (i.e., taxa richness), Shannon-Wiener Diversity Index, and Simpson's Dominance Index. Abundance and biomass measures should be presented in terms of numbers or grams per square meter.

The physical and chemical conditions within the dredged holes and reference areas should be tested to determine water quality conditions following restoration. During each benthic survey, temperature, dissolved oxygen, salinity, turbidity, pH, and Oxidation-Reduction Potential (ORP) should be measured throughout the water column at each dredged hole and a reference site. Surface and bottom water samples should also be collected and tested for hydrogen sulfide concentrations during a late summer survey, a data logging water quality meter should be deployed one (1)-meter from the bottom within each dredged hole and set to continuously monitor the physical and chemical conditions for a one-week period of maximum water temperatures near the bottom of the dredged holes.

To evaluate the fish habitat in the restored areas in comparison with reference areas, otter trawling and gill netting should be conducted during the summer (e.g. July and August) and late fall (e.g., November) seasons. Duplicate (2) fish trawls using a 10-meter otter trawl should be conducted within the deepest portion of each dredged hole and at a nearby reference area. Trawls should be conducted for 5 minutes into the current at 2 to 3 knots using a cod end liner with quarter inch mesh. Experimental gill nets equipped with mesh sizes from 2 inches to 9 inches should be deployed for eight hours in each dredged hole and at a nearby reference site. All fish collected by each gear should be identified to species and counted.

During the monitoring work, biological communities [SAV, colonial nesting birds or others] that occur adjacent to the dredged holes should be recorded and described as to their species density and quality. In addition, the magnitude and direction of currents, and salinity should be recorded.

Costs for ecological monitoring of both dredged holes and reference areas will be a total of approximately $52,000 per year, including benthic, fish and water quality sampling as described above and preparation of a report describing monitoring results. The ecological monitoring report should compare the restored sites to reference areas, the latter including nearby dredged holes at which no restoration has occurred, as well as in shallow areas where no dredging has occurred. The report should also include a comparison with data collected in previous studies in the vicinity of the dredged holes.

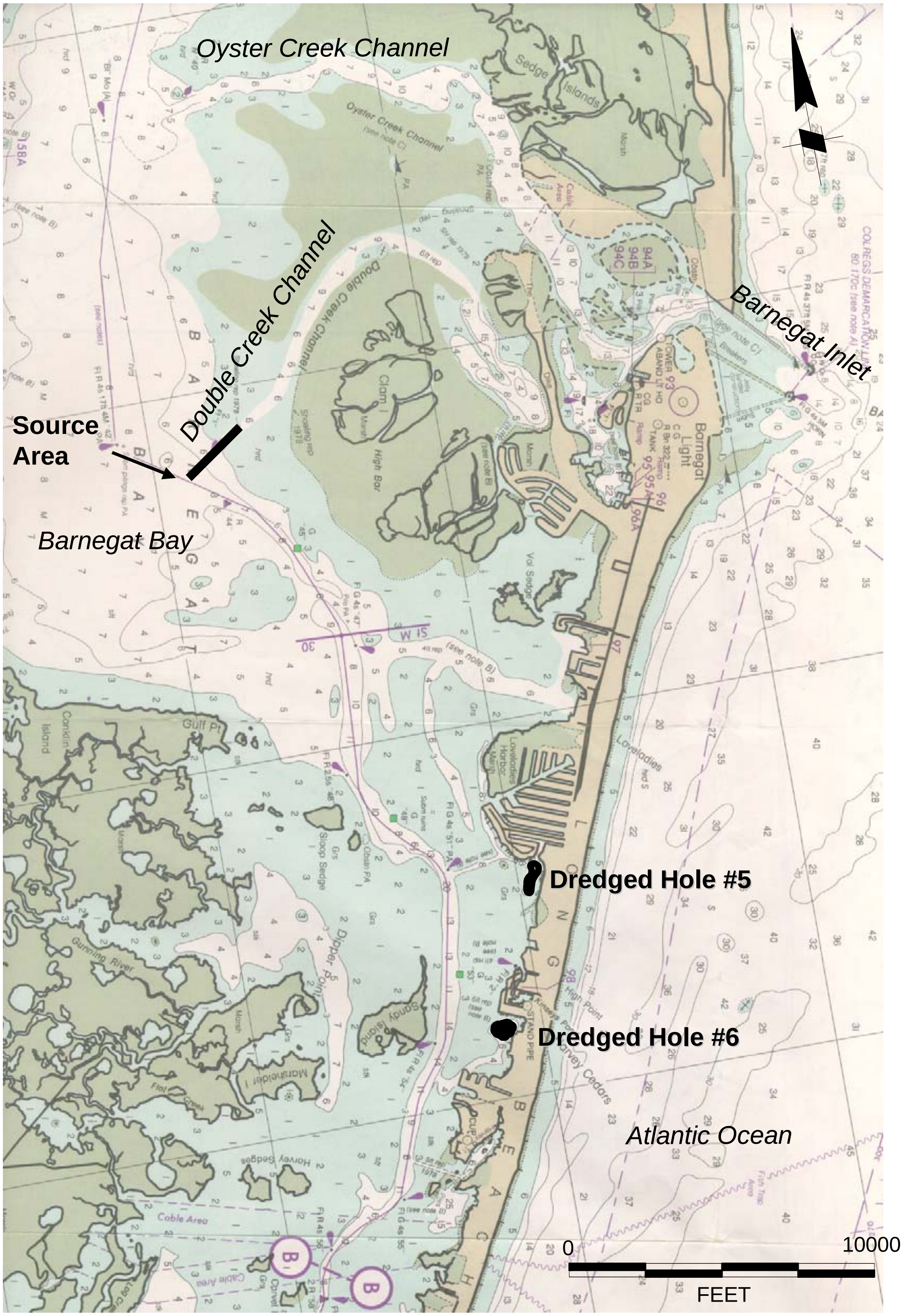


Figure 5-1 Plan for Alternative No. 2.

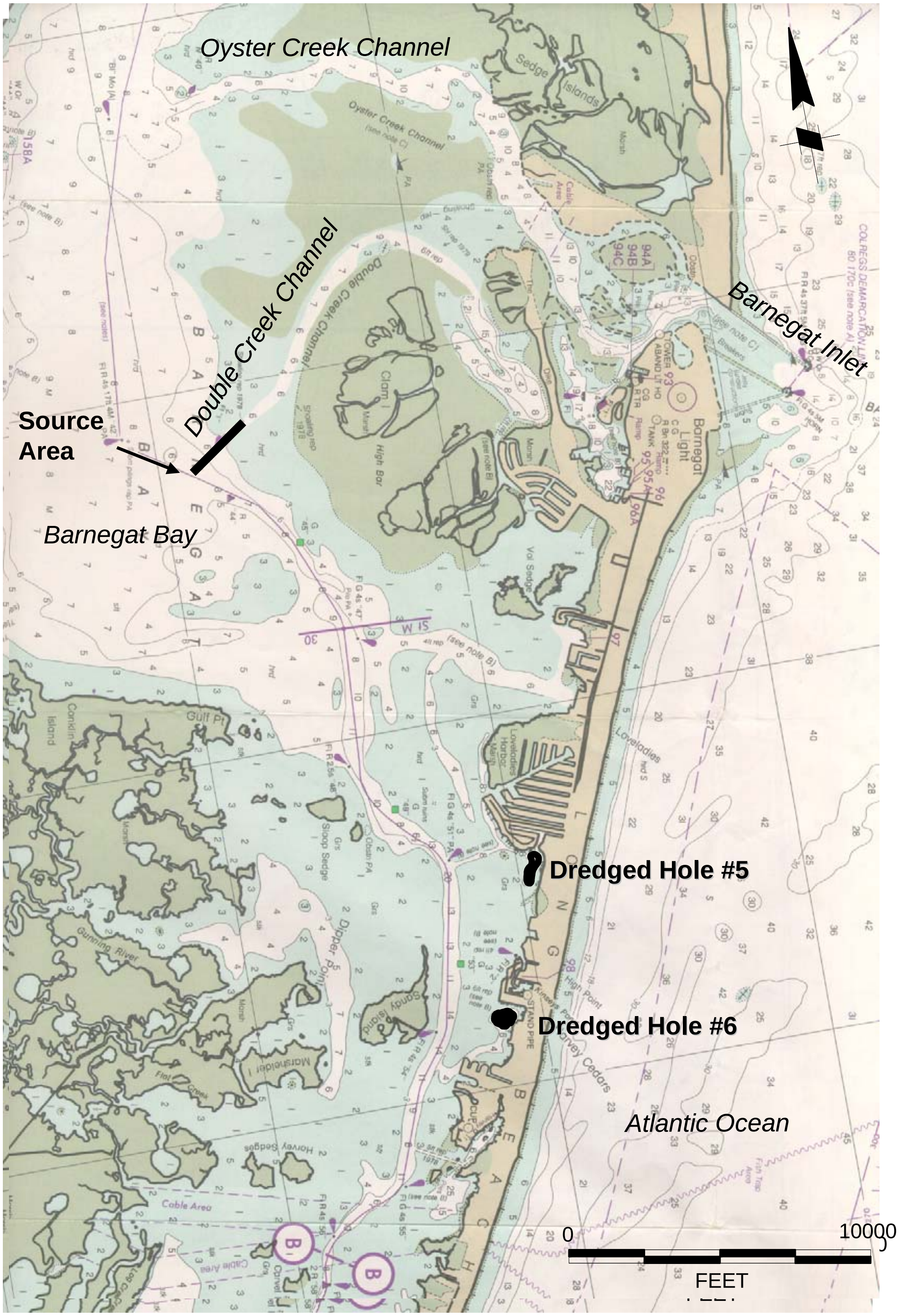


Figure 5-2 Plan for Alternative No. 3.

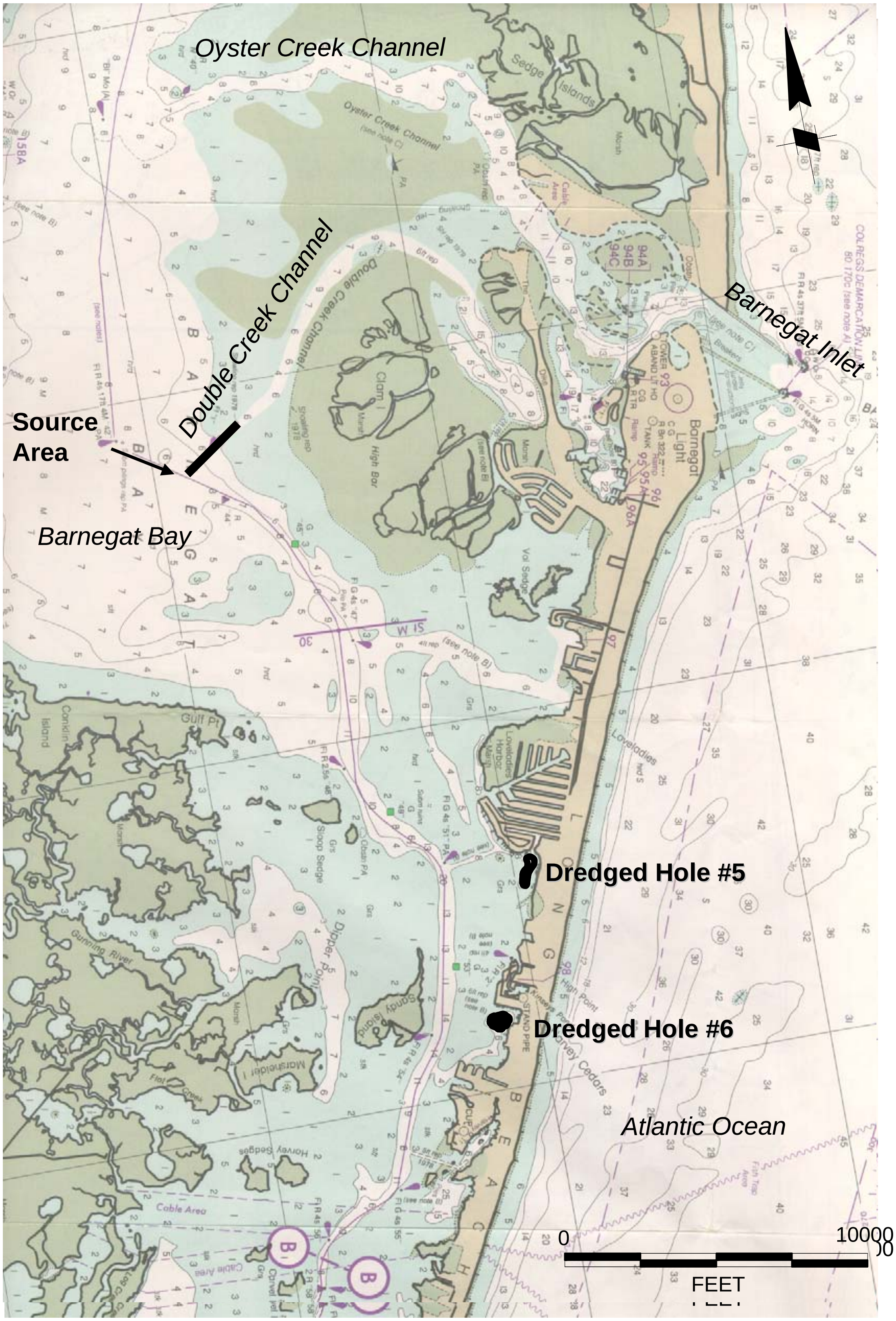


Figure 5-3 Plan for Alternative No. 4.

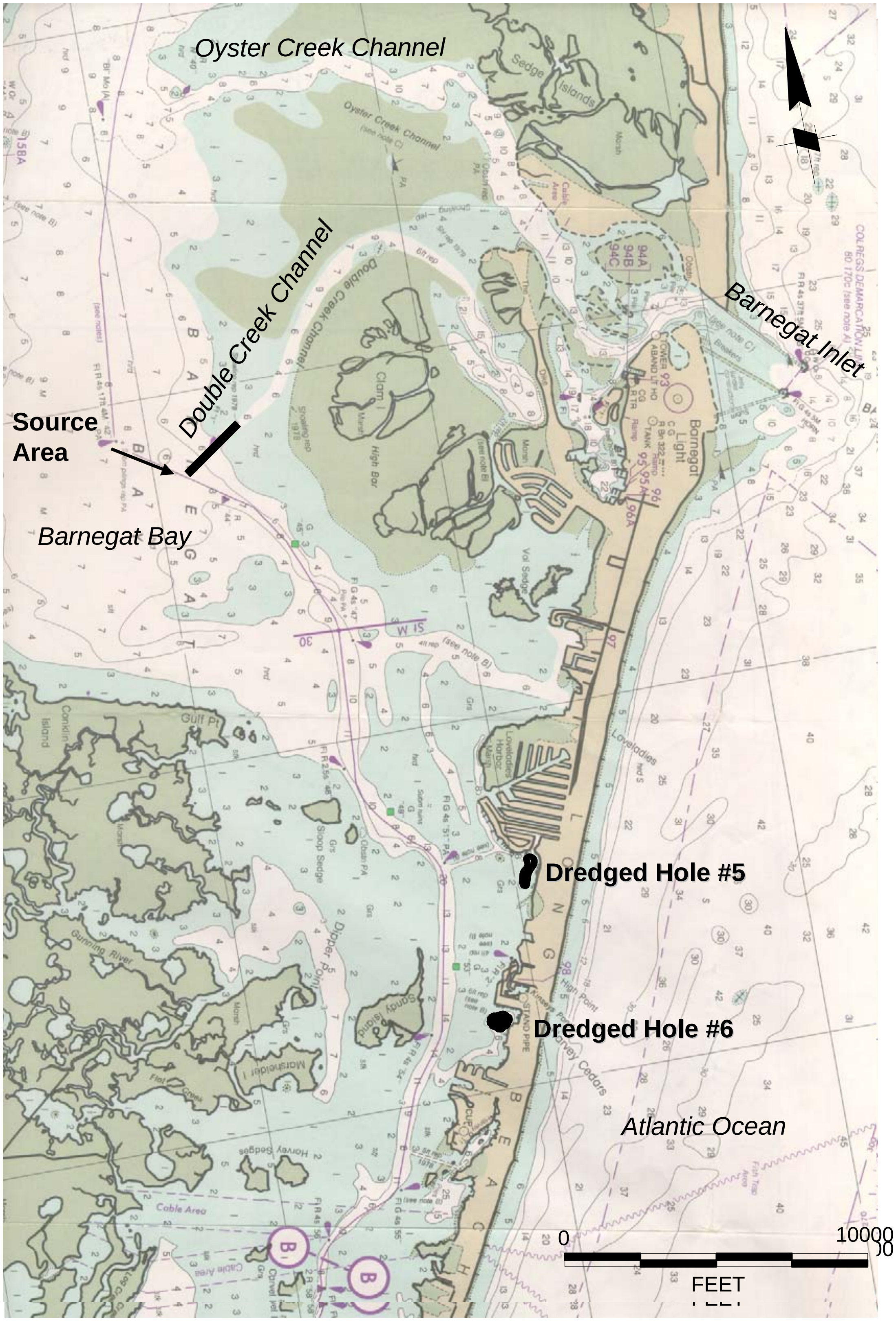
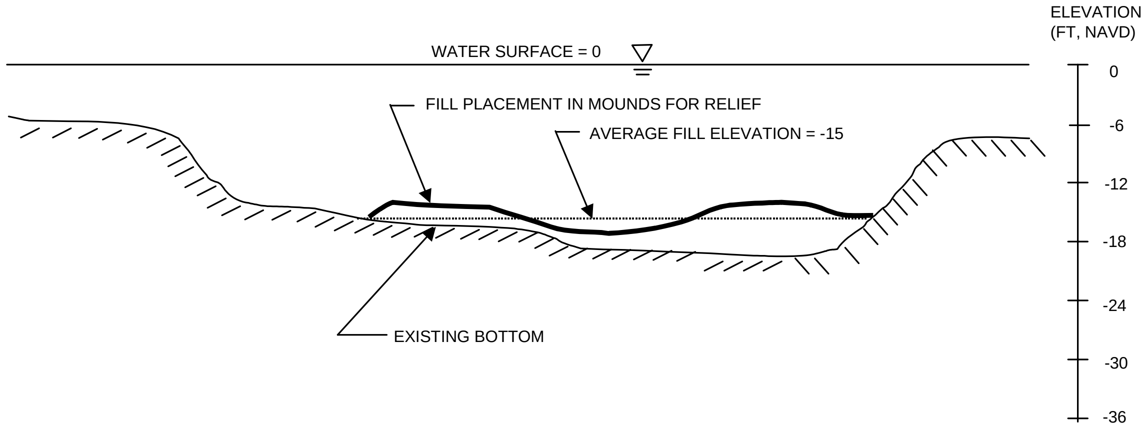
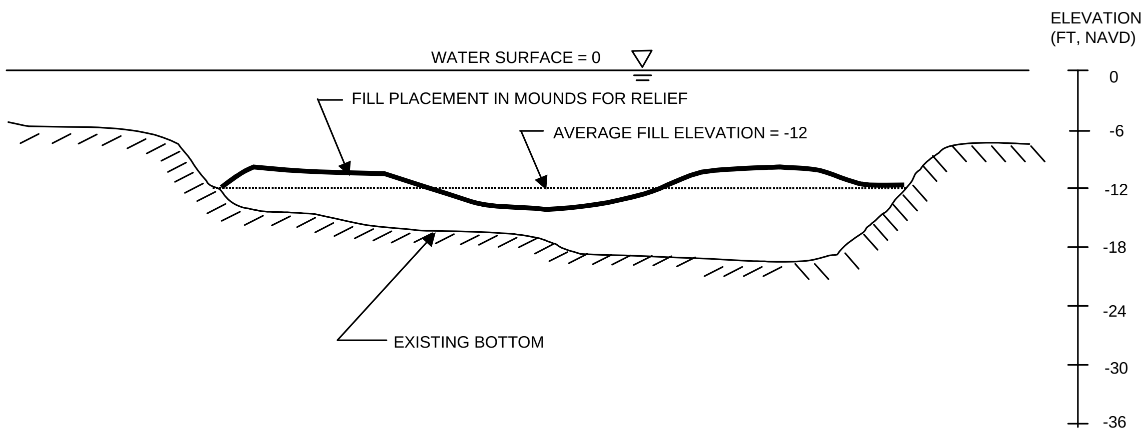


Figure 5-4 Plan for Alternative No. 5.



NOTE: NOT TO SCALE

Figure 5-5. Schematic Cross-Section for Filling of Dredged Hole #5 to –15 ft.



NOTE: NOT TO SCALE

Figure 5-6. Schematic Cross-Section for Filling of Dredged Hole #5 to –12 ft.

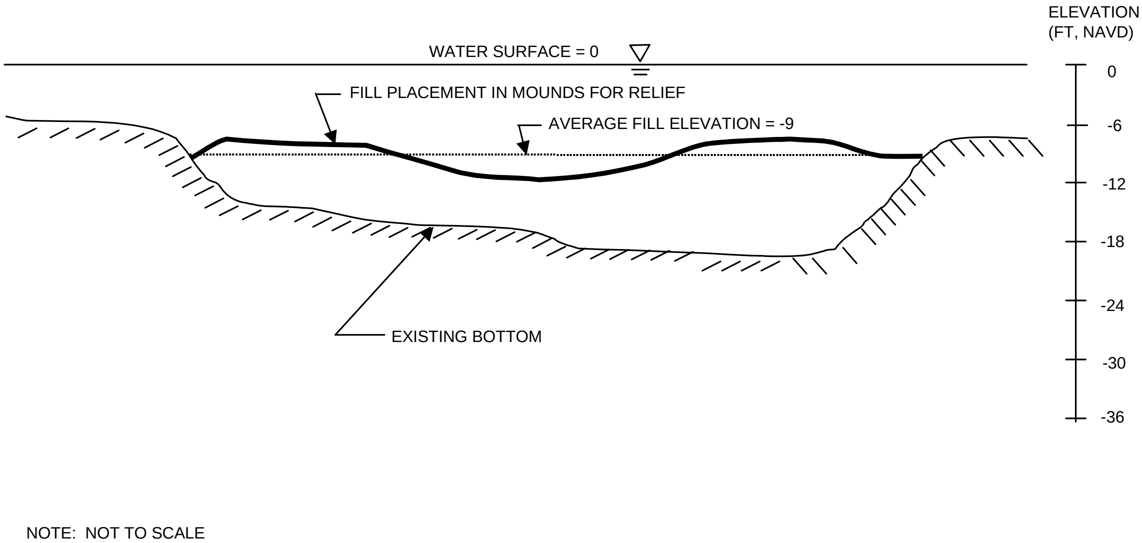


Figure 5-7. Schematic Cross-Section for Filling of Dredged Hole #5 to –9 ft.

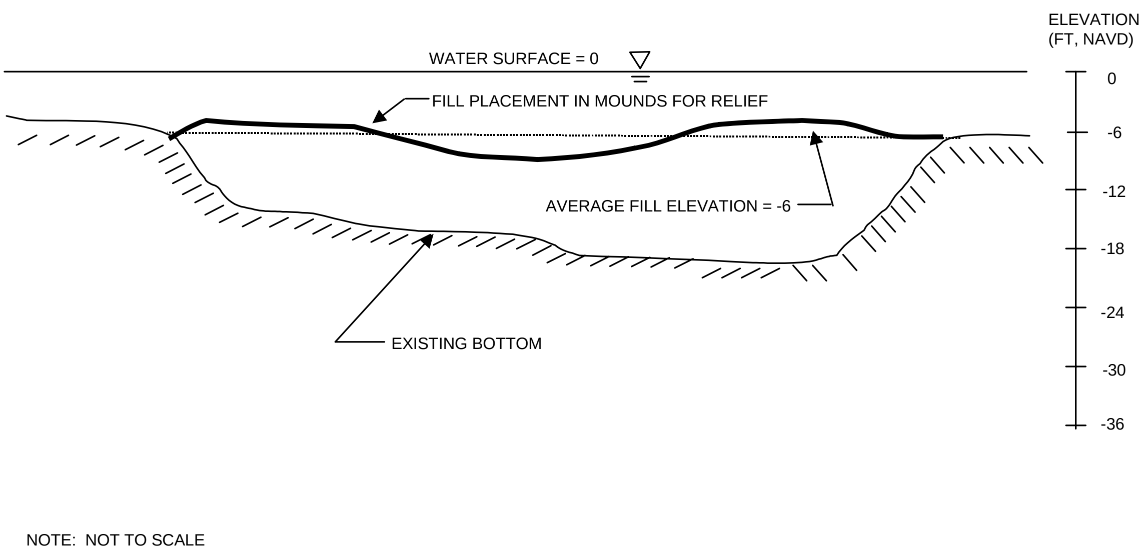


Figure 5-8. Schematic Cross-Section for Filling of Dredged Hole #5 to –6 ft.

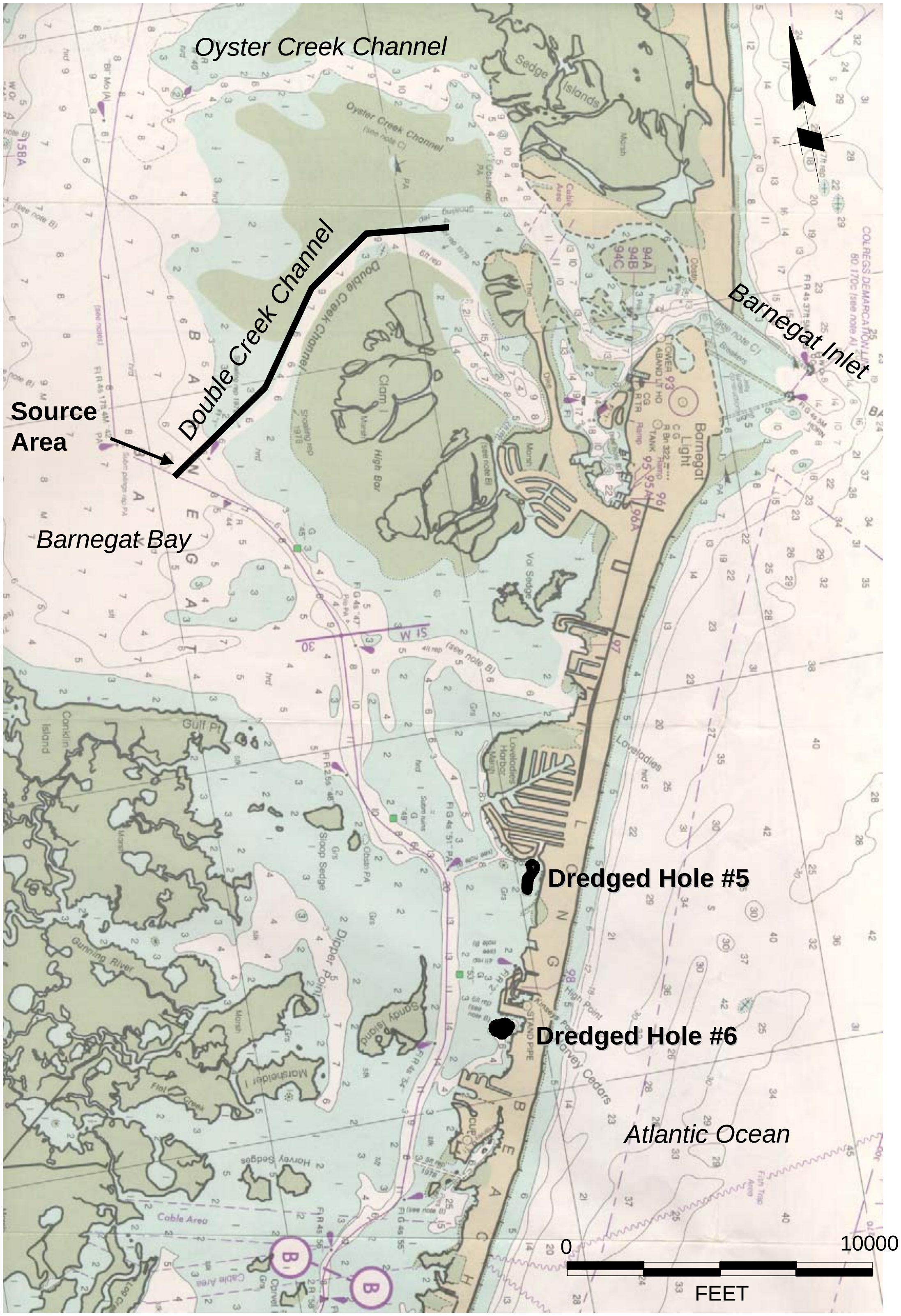


Figure 5-9. Plan for Alternative No. 6.

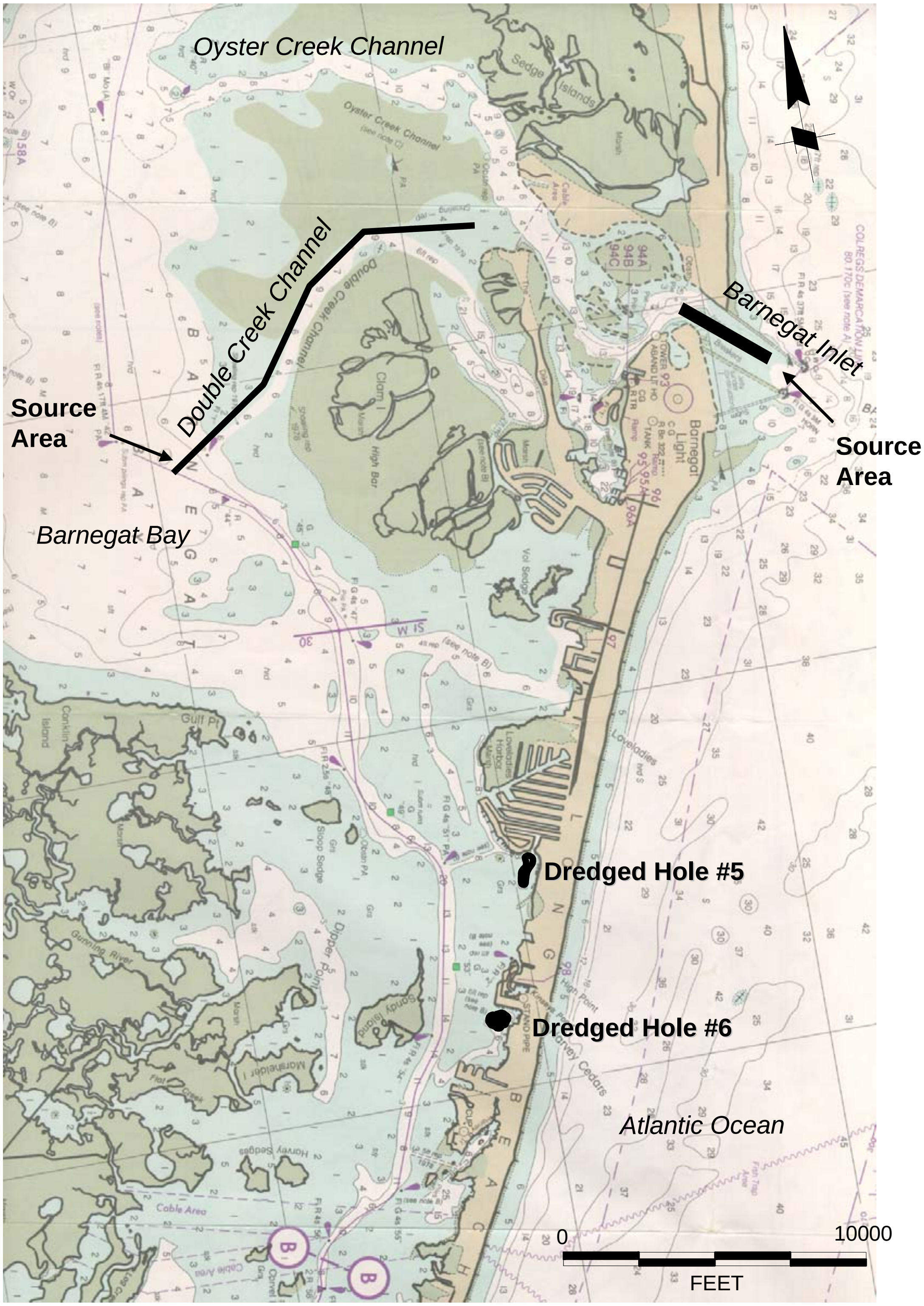


Figure 5-10. Plan for Alternative Nos. 7-10.

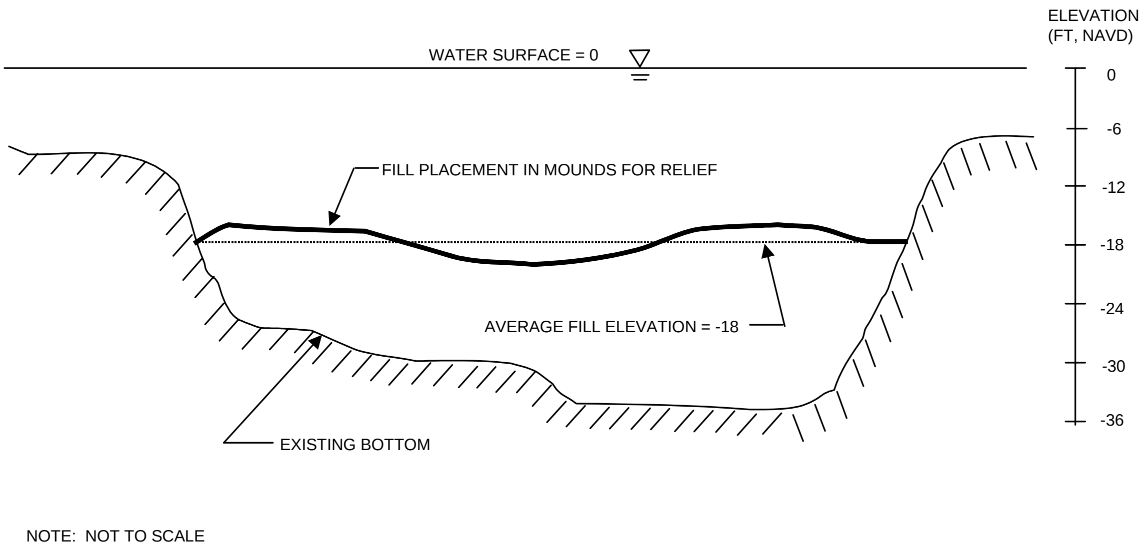


Figure 5-11. Schematic Cross-Section for Filling of Dredged Hole #6 to –18 ft.

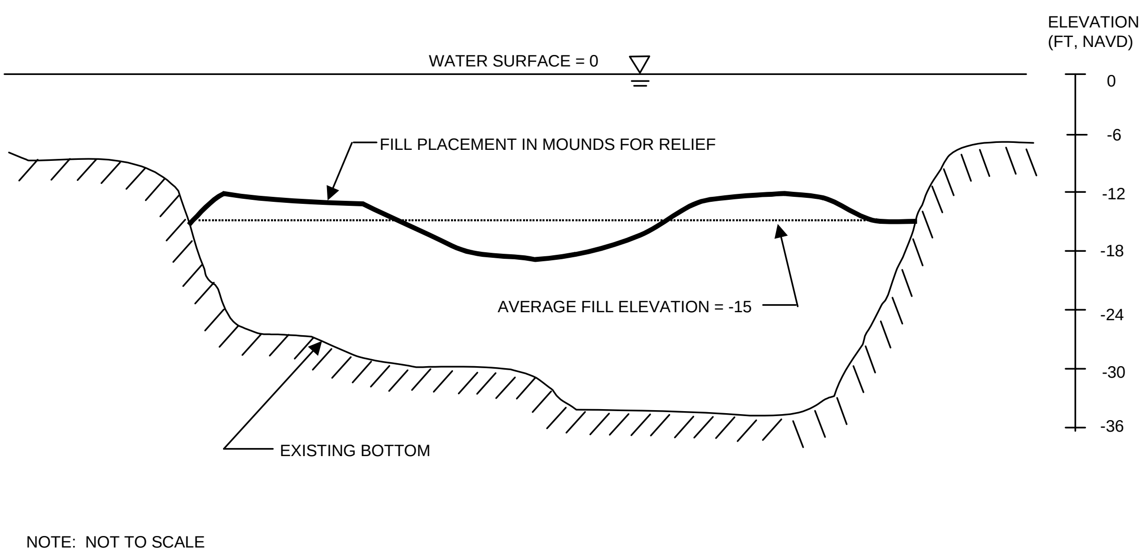


Figure 5-12. Schematic Cross-Section for Filling of Dredged Hole #6 to –15 ft.

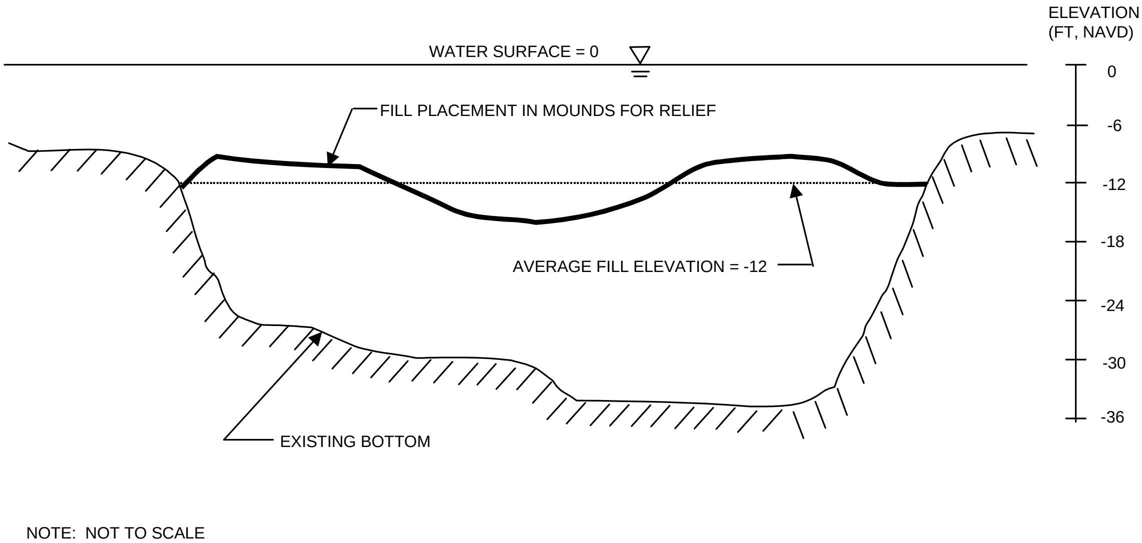


Figure 5-13. Schematic Cross-Section for Filling of Dredged Hole #6 to –12 ft.

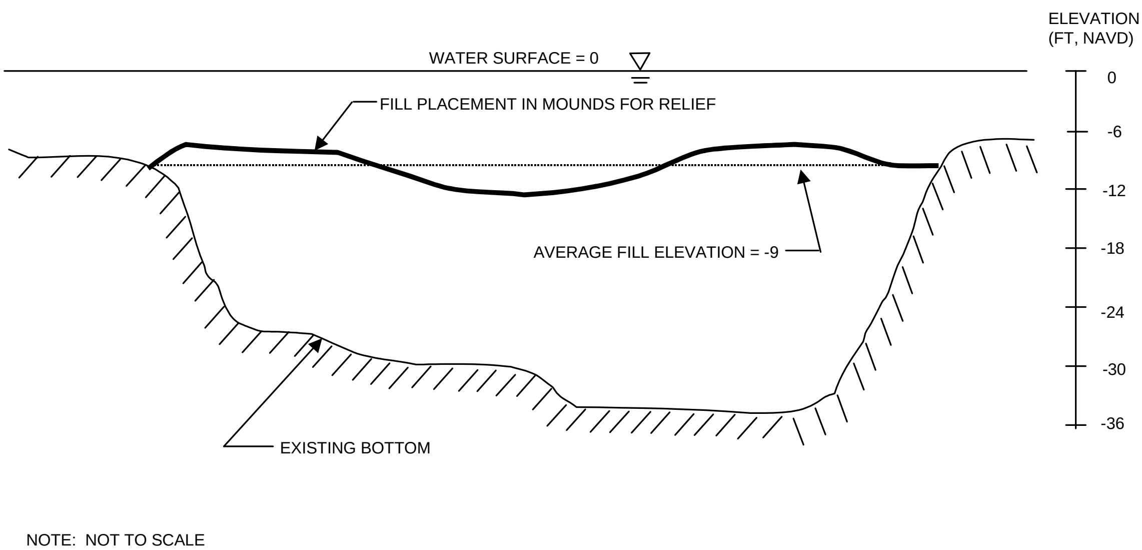


Figure 5-14. Schematic Cross-Section for Filling of Dredged Hole #6 to –9 ft.

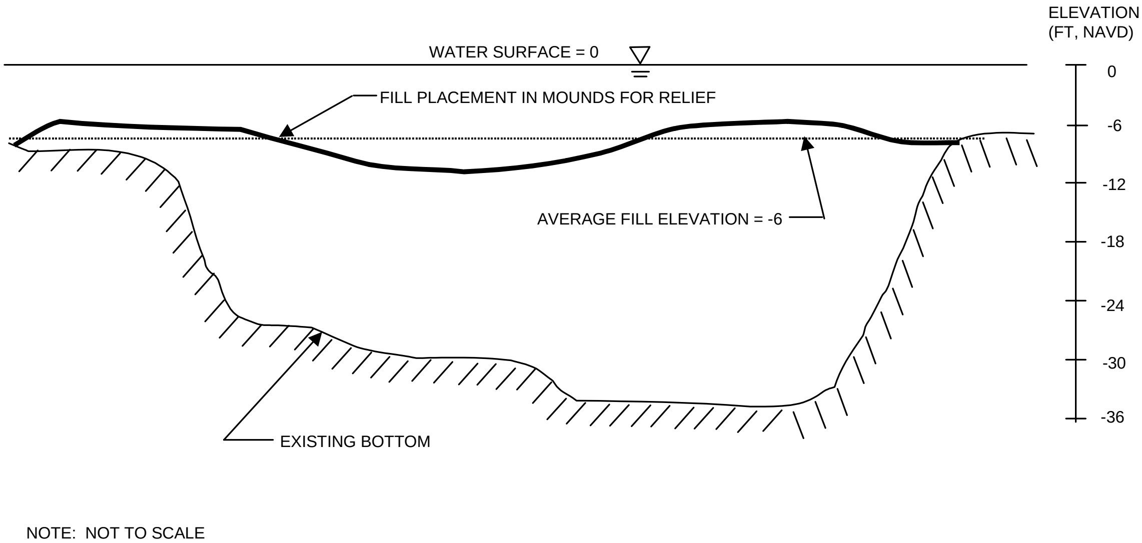


Figure 5-15. Schematic Cross-Section for Filling of Dredged Hole #6 to –6 ft

5.4.3 Alternative Plans Cost Estimates

Cost estimates were prepared for each of the preceding alternatives described in Section 5.4.1.3. Assumptions inherent in the cost estimates include:

- Source material is sandy material
- Source material would be obtained from Double Creek Channel, Barnegat Inlet, or a combination of the two
- Source material is dredged from the source and placed in the dredged holes using hydraulic dredging methods
- CEDEP was used to develop dredging costs
- Costs to place the material are independent of the final fill topography, i.e., there is no difference in costs for placing the material flat or with relief (mounds)

As indicated in section 5.4.1.3, the four alternative fill volumes for dredged hole #5 are: 1) 20,000 CY, 2) 40,000 CY, 3) 70,000 CY and 4) 100,000 CY. The five alternative fill volumes for dredged hole #6 are: 1) 125,000 CY, 2) 170,000 CY, 3) 220,000 CY, 4) 280,000 and 5) 330,000. Costs to perform the work are based on these quantities.

5.4.4 Incremental Cost Analysis

Cost effectiveness and incremental cost analysis were conducted to screen out restoration plans that were not cost effective and to identify changes in costs as levels of environmental output increase (Robinson, et al. 1995). For purposes of this project, the incremental cost analysis was completed using the USACE's publication "Evaluation of Environmental Investments Procedures Manual: Interim – Cost Effectiveness and Incremental Cost Analysis" and the IWR-

PLAN version 2.1 software. The results from the Incremental Cost Analysis are included Appendix E.

The "Nine EASY-Steps" process outlined in Robinson, et al. (1995) was followed during this analysis. The first three steps of the analysis review plan formulation, in particular the generation of all possible alternative plans from the management measures under consideration. In steps four and five, cost effectiveness was analyzed by identifying and eliminating inefficient solutions. Steps six through nine involve the development of the incremental cost analysis which computes changes in costs for increasing levels of environmental outputs which will be measured in habitat units. The analysis undertaken at this point has evaluated two basic restoration plans. The first plan involves filling Dredged Hole #5, for which four fill levels were considered in addition to the No Action alternative (Table 5-11). The second plan involves filling Dredged Hole #6, for which five fill levels were considered in addition to the No Action alternative (Table 5-11). Implementing both plans could also be selected by this analysis.

The first phase of this analysis was the calculation of the average annual cost (annualized over a 50 year project life at a 6 7/8 percent discount) per output for the alternative plans (Table 5-11).

Table 5-11
Restoration plans and scales considered at the Dredged Holes projects in Barnegat Bay

Code	Description	Total First Cost (in $1000s)	Annualized Cost ($)	Benthos HU	Fish HU	Combined HU
A1	Fill Dredged Hole #5 to -6 feet NAVD	1,813	134,200	7.0	1.1	8.1
A2	Fill Dredged Hole #5 to -9 feet NAVD	1,497	111,700	5.1	3.4	8.5
A3	Fill Dredged Hole #5 to -12 feet NAVD	1,250	94,000	3.4	5.5	8.9
A4	Fill Dredged Hole #5 to -15 feet NAVD	1,107	83,800	2.0	6.1	8.1
A0	No Action	0	0	1.6	6.1	7.7
B1	Fill Dredged Hole #6 to -6 feet NAVD	4,470	324,000	12.5	2.0	14.5
B2	Fill Dredged Hole #6 to -9 feet NAVD	4,043	293,600	8.9	6.4	15.3
B3	Fill Dredged Hole #6 to -12 feet NAVD	3,524	256,400	5.4	10.5	15.9
B4	Fill Dredged Hole #6 to -15 feet NAVD	3,099	226,100	2.3	11.8	14.1
B5	Fill Dredged Hole #6 to -18 feet NAVD	2,062	152,000	1.3	11.8	13.1
B0	No Action	0	0	1.3	6.1	7.4

The environmental output for this portion of the analysis was derived according to the methods outlined in Section 4.2.2 and represents Benthic Habitat Units, Fish Habitat Units, and Combined

Habitat Units, respectively. Several fill levels, or scales, for each alternative were identified and are listed in Table 5-11.

For the purposes of this study, filling dredged hole #5 was considered to be independent of filling dredged hole #6, and within each dredged hole, scales were considered to be mutually exclusive. For example, activities at dredged hole #5 would not influence the activities at dredged hole #6, however, dredged hole #5 can only be filled to one of the four identified levels. Scales between dredged holes were considered combinable (e.g., fill dredged hole #5 to -9 feet NAVD and fill dredged hole #6 to -18 feet NAVD).

Three incremental analysis scenarios were performed for this project. The first looked only at restoring habitat for benthic organisms, while the second scenario examined fish habitat. The third scenario looked at a combination of the two habitats. A total of 49 combinations were considered in the incremental analysis. The average cost per habitat unit for each alternative is shown in the "Average Cost" table in Appendix E. It is anticipated that a reduction in the cost would be realized in alternatives with action at both holes due to decreased mobilization/demobilization costs. However, these reductions were not considered at part of the incremental analysis. Figure 5-16 shows a "Best-Buy" graph of cost-effective plans for all three scenarios. This figure indicates that both the fish habitat and benthos habitat scenarios are less efficient (i.e., have a higher cost for fewer habitat units) than the combined habitat, therefore, further analysis and discussions will be limited to the combined habitat scenario.

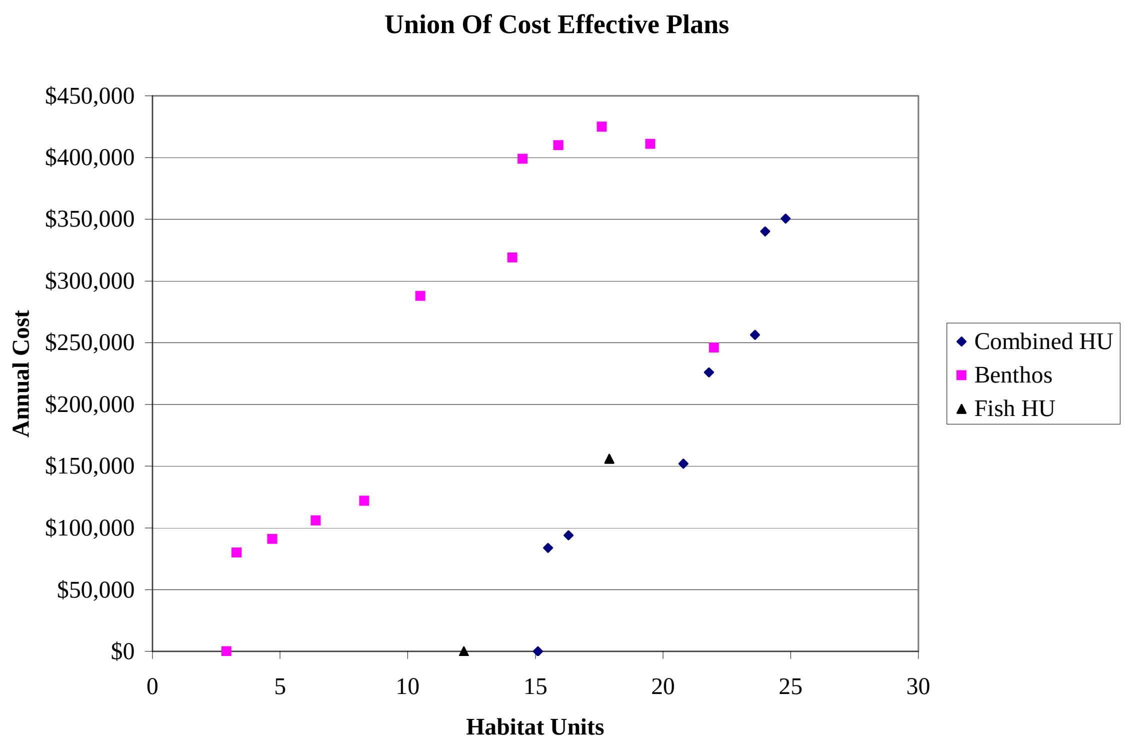


Figure 5-16
Best Buy graph showing the relationship between the Total Cost of habitat restoration versus the gain in habitat units

A summary of the incremental cost analysis for the combined habitat units plan is presented below in Table 5-12. Inefficient plans were eliminated using the IWR-PLAN software and only data for the four Best Buy plans have been presented. The incremental cost per output for each alternative is based on the difference between that alternative and the cost of the plan providing the next smallest level of output. The no-action plan is associated with a $0 cost level and the existing 15.1 units of combined habitat units (i.e., output). Figure 5-17 shows the incremental cost per combined habitat unit. For example, this graph shows that while 15 habitat units will exist under the No Action plan, implementation of plan A0 B5 (Alternative 6) will cost $26,700 per habitat unit, and will provide an additional 5.7 units of combined benthic and fish habitat. The graph also shows that the highest level of habitat output (i.e., A3 B3) is more costly to restore because each of the 1.2 habitat units will cost $78,900.

While the cost effectiveness and incremental cost analysis have identified plan A0 B5 (Alternative 6; filling dredged hole 6 to –18 feet NAVD), as the selected plan, it should be noted that plan A0 B3 (Alternative 8; filling dredged hole 6 to –12 feet NAVD) is the next best plan. This next best plan provides an additional 2.8 units of habitat at only a slightly higher cost than the selected plan, namely $37,200 per habitat unit. Therefore, it may be desirable to consider whether the additional habitat units associated with Alternative 8 are worth their slightly higher unit cost.

Table 5-12
Annualized Incremental Cost of the Best Buy Combined Habitat Units Plans.

Plan Code	Description	Combined HU	Annual Cost ($1000)	Average Cost $1,000/HU	Incremental Cost ($1,000)	Incremental Output (HU)	Incremental Cost per HU ($1,000)
A0 B0	No Action at either Dredged Hole	15.1	$0	$0	$0	0	$0
A0 B5	Fill Dredged Hole #6 to -18’ only	20.80	$152	$7.31	$152	5.7	$26.7
A0 B3	Fill Dredged Hole #6 to -12’ only	23.6	$256	$10.9	$104	2.8	$37.3
A0 B3	Fill both holes to -12’	24.8	$351	$14.1	$94.0	1.2	$78.4

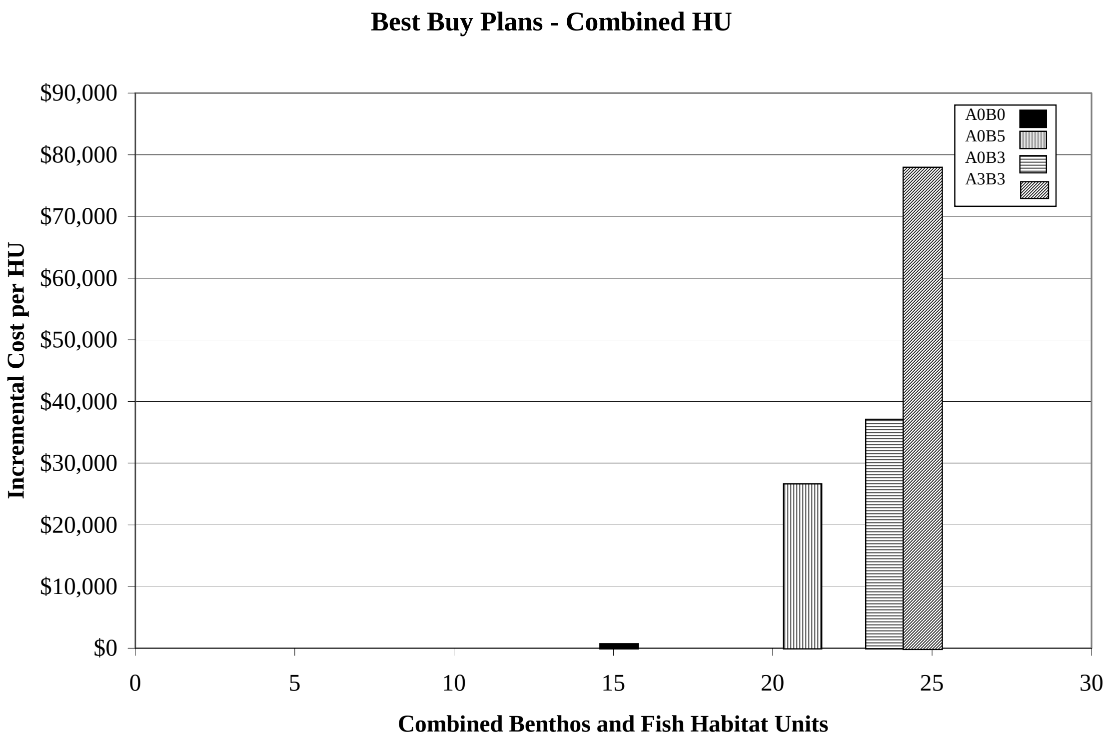


Figure 5-17
Incremental Cost Graph for Combined Benthos and Fish Habitat Units

The incremental cost analysis question for each best buy option – "is it worth it ?" is presented below in Table 5-13.

Table 5-13
Best Buy – Is it worth it?

Best Buy Alternative	Incremental $ / Unit	"Is it worth it?"	Remarks
No Action	$0	No	Provides no environmental restoration.
Fill Hole #6 to –18' No Action at Hole #5	$26,700	Yes	Provides additional habitat units at the least cost per unit $7,310.
Fill Hole #6 to –12' No Action at Hole #5	$37,300	No	The production of 5.7 additional habitat units for an average cost of $10,900 is not a good investment when compared to $7,310 for filling to –18'.
Fill Hole #6 to –12' Fill Hole #5 to –12'	$78,370	No	The production of 1.2 additional habitat units for an average cost of $78,400 is not a good investment when compared to $7,310 filling hole #6 to -18'.

6.0 DESCRIPTION AND EVALUATION OF SELECTED PLAN

6.1 Identification of the Selected Plan

Although the benthic data suggest that filling the dredged holes up to average depths naturally occurring in Barnegat Bay would have the most benefit to the ecosystem, the fish data collected with otter trawls and gill nets suggest otherwise. Relatively large numbers of juvenile weakfish and other important resident fish species were found in the deep habitat of dredged hole #5 at depths of about 13 to 20 feet. This clearly indicated that fish are using the shallower dredged hole as refuge and feeding habitat. Fewer fish were caught in the 25 to 33 feet deep trawls in dredged hole #6.

The regression data were inspected to determine at what depth one could expect a dramatic improvement in benthic macroinvertebrate condition over the azoic conditions observed in the deepest portion of the dredged holes. These data were incorporated into the incremental analysis to select a depth that would retain refuge habitat for weakfish and other resident species, provide a measurable improvement in benthic condition, and be cost effective. An incremental cost analysis (Section 5.4.3) revealed the most economical plan (the selected plan) based on the habitat gained and the cost to fill each dredged hole to a range of depths from 6 to 18 feet below the water surface. The selected plan based on this analysis is to fill dredged hole #6 to 18 feet below the water surface and to leave dredged hole #5 at its existing depth of 18 feet below the water surface.

Material would be placed in dredged hole #6 to create variable relief, with final bathymetry ranging from about -15 to -21 ft NAVD (some peaks may occur at –12 ft NAVD). Average final elevation of the placed sand would be about –18 ft NAVD. Figures 6-1 and 6-2 show conceptual plans for the mounding. Note that this conceptual plan envisions about five large mounds created from pumping sand into dredged hole #6, actual mound design may be different.

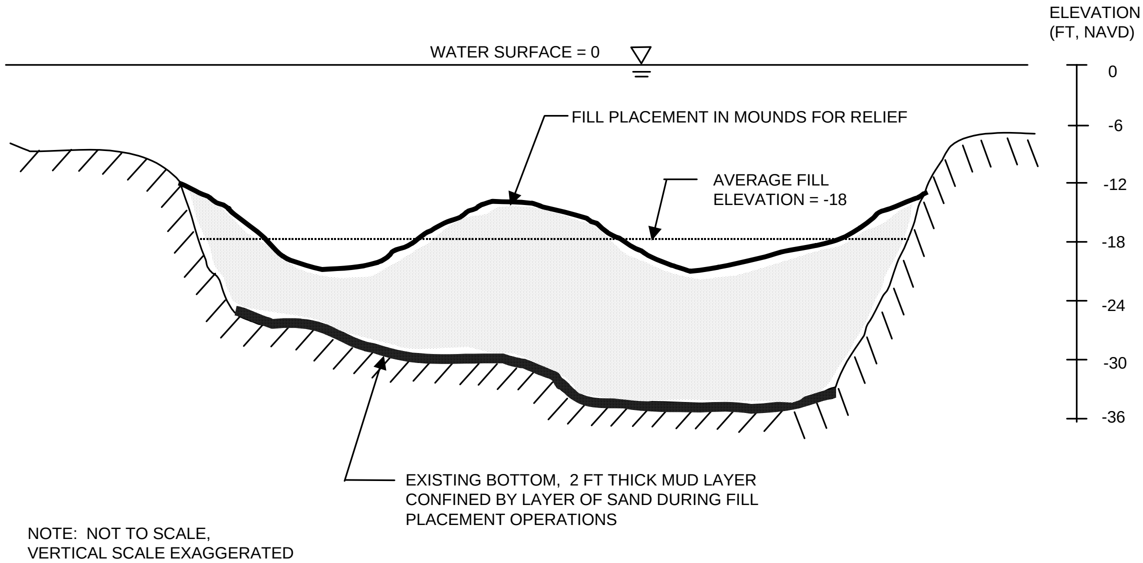


Figure 6-1. Schematic Cross-Section for Selected Plan: Filling of Dredged Hole #6 to –18ft.

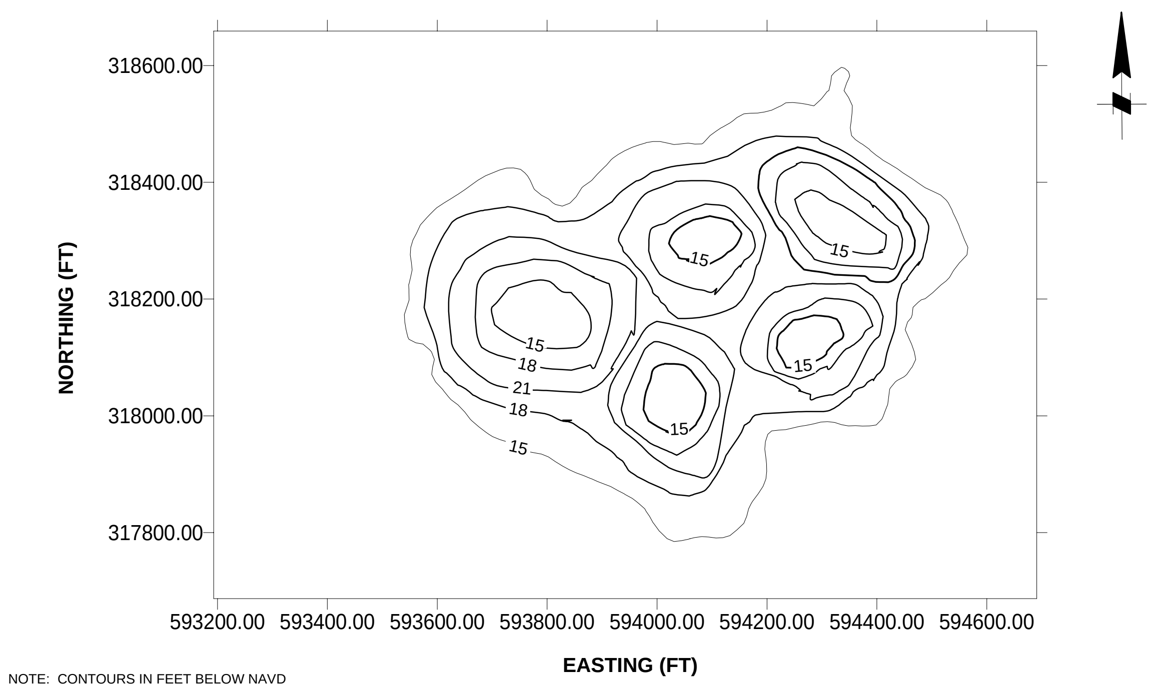


Figure 6-2. Schematic Cross-Section for Selected Plan Showing Mound Creation and Average Filling of Dredged Hole #6 to –18 ft.

6.1.1 Mounding Dredged Material in Dredged Holes

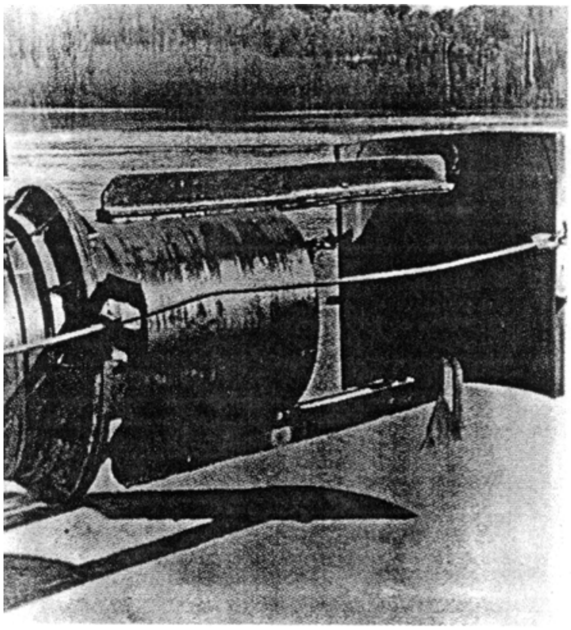
The thin layer of decaying SAV observed in the deepest portion of the dredged holes is the most probable reason little or no benthic macroinvertebrates inhabit the bottom sediments. During the benthic collections the sediment samples smelled of hydrogen sulfide; the grab also retrieved large amounts of partially decayed SAV. Azoic conditions were not consistent with the results of week long monitoring of DO concentrations one-meter off the bottom where DO was rarely below 4 mg/l. However, it is likely that DO right at the sediment/water interface was anoxic given the high biological oxygen demand that must occur during the decay of the plant material. Although the regression analysis of benthic community composition and depth suggests that improvements will occur if the dredged holes are partially filled, dead SAV could still build up in a shallower dredged hole. This will be particularly true if wind-driven currents are not strong enough to keep the material from settling.

The recommended solution to this potential problem would be to place dredged material in mounds on the bottom. By mounding the material, dead SAV would tend to accumulate in the valleys. It is possible that poor benthic conditions would still exist in the trough areas, but better conditions (i.e., live bottom) would likely exist on and near the tops of the mounds. Based on the analysis of the number of habitat units that may be created, the tops of the mounds should be placed at depths between 12 and 15 feet below the water surface. Creating mounds within the dredged holes will have the added potential benefit of creating more habitat heterogeneity and may increase the amount of refuge area for juvenile weakfish, soft crabs, and other species that inhabit the dredged holes.

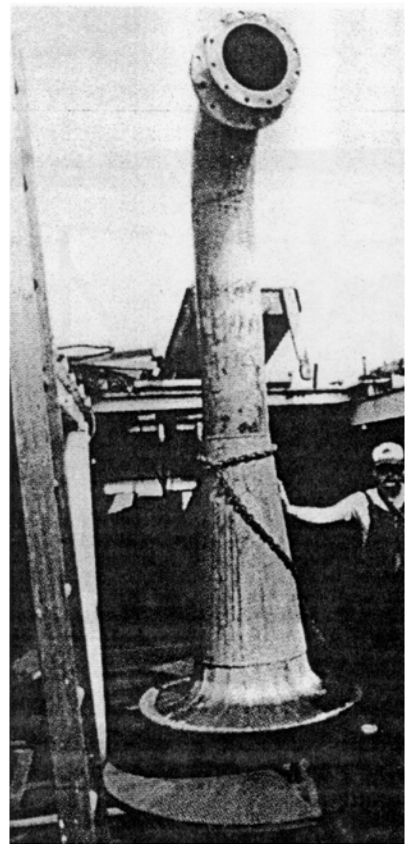
6.2 Detailed Description of Selected Plan

The selected plan will consist of dredging material from Double Creek Channel within Barnegat Bay using cutterhead suction dredges. Material will be obtained from areas where soil type is sandy, and whenever possible, where there is an existing need to dredge. Dredging of channels will only be to meet authorized dimensions; no new work is to be performed for this plan. Dredging depth will be to –8 ft NAVD and a bottom channel width of 100 ft. Based on the geotechnical investigation, the majority of material will be obtained from the northern portion of the channel, where greater than 70% is sand. Material will be pumped to the dredged hole. Placement of the outlet pipe will be such to minimize environmental concerns, e.g. the pipe outlet will be located below the water surface and down into the dredged hole (if a submerged diffuser is used) to prevent sediment from migrating from the area.

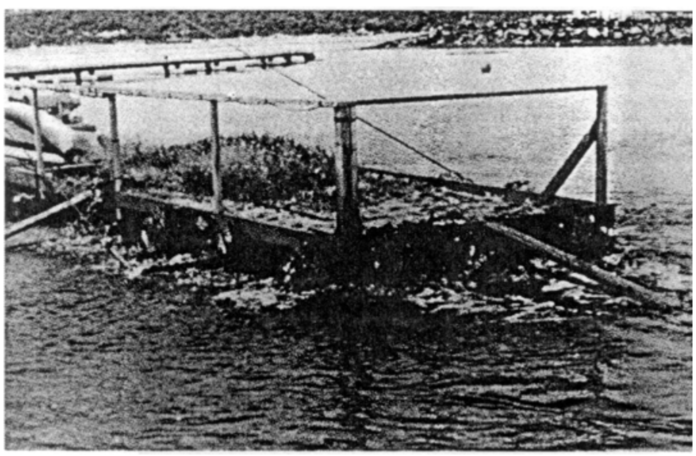
Various methods for material placement with hydraulic dredging are available that can provide reduced disturbance of existing bottom material (including relatively soft, fine-grained silt and mud) and decreased suspended sediments in the upper water column (USACE 1998). These methods include use of a baffle plate, sand box , or a pipeline with submerged diffuser (Figure 6-3). A baffle plate serves two functions. First, when the material strikes the plate the discharge velocity is reduced, thus reducing erosion of existing material. Second, the plate can be angled to allow the momentum of the discharge to swing the pipeline in an arc. A sand box is a diffuser plate with baffles and side boards, constructed so that sediment is released downward through the entire box. The box is mounted on a spud barge and can be swung around the barge using



BAFFLE PLATE



DIFFUSER



SAND BOX

Figure 6-3. Methods to Reduce Discharge Velocity from Dredge pipeline (USACE 1998).

anchor lines. Material falling from the sand box gently "rains" down onto the bottom, causing little if any disturbance. A submerged diffuser consists of conical and radial sections and allows the dredged material to be dispersed radially, parallel to the water surface. The cone-shaped diffuser serves to increase the flow area of the discharge from the pipe, causing a reduction in velocity of the discharge. The diffuser may be oriented horizontally or upward to further reduce downward velocities to primarily gravity-induced velocities.

For placement using baffle plates, sand boxes or diffusers an arc placement pattern ensures even spreading. To achieve arc placement, the discharge end of the submerged pipeline is a floating length with ball joints. The action of baffle plate or the cables for a sand box would pivot the pipeline at a ball joint, and the material would be deposited in a semi-circular arc pattern (USACE 1998). During placement operations, it will be desirable to place the material in such a manner as to provide relief on the bottom, as this would be advantageous to both fish and the benthic community. This relief may be accomplished by allowing the discharge from the pipe to create mounds within the dredged holes, and moving the end of the pipe periodically to create additional mounds. Material would be placed beginning in the shallow water along the perimeter of the dredged hole, working toward the deeper water in the center to minimize effects from mud waves and turbidity. A minimum of three feet of sand would be placed over the underlying fine-grained sediment before placing sand in mounds.

Surveys would be conducted along with the filling operations to ensure that the desired relief is being obtained. Turbidity controls such as turbidity curtains would be used to minimize migration of material away from the project site, however, due to the relatively slow currents, lack of significant wave energy and "trapping" capacity of the dredged hole, it is anticipated that no significant quantity of material would leave the project site.

Material from Double Creek Channel will be used to implement the selected plan; the quantity is estimated to be about 125,000 CY. The most recent dredging event of this channel occurred in the early 1980's, between 1982 and 1984 (data are presented in Appendix D). Material dredged from this channel was reported to be 100 percent sand (NJDEP 1999). Recent bathymetric survey data are not available, however, recent observations indicate that the channel has shoaled to approximately the early 1980 conditions. Sediment samples have been collected from the channel. Samples show that the sediment material for the whole channel is greater than 60 percent sand; material is greater than 70 percent sand in the anticipated borrow region of the channel. Samples show that areas of the channel are greater than 95 percent sand.

The material is satisfactory as regards constructability of the project. The high sand content would produce a suitable substrate for target species and allow for creation of mounds within the hole. As the material is less than 90 percent sand, samples collected from within the source area were analyzed for semivolatiles, pesticide/PCB, metals and total organic carbon. Reported sediment concentration data are non-detect for all semivolatiles, pesticides and PCBs. Reported sediment concentration data for metals are below criteria specified in Long *et al's* (1995) Effects Range Low (ERL) sediment guidance values. These values are the current New Jersey standards. Reported sediment concentration data for Total Organic Carbon (TOC) are less than 1.2 percent for all samples. Based on the results of the chemical analyses, the source material is considered clean and suitable for placement into the dredged hole.

Refer to Appendix D for additional engineering information regarding the selected plan

6.3 Comparison of With & Without Project Conditions

6.3.1 Without Project Conditions

Without project conditions at the dredged holes would continue as currently exists, i.e. the dredged holes would have the following characteristics.

Benthic macroinvertebrate abundance, biomass, and diversity would continue to be poor in the deepest bottom sediments while improved conditions would exist in the intermediate depths. Optimal benthic community conditions would continue to be in the shallow water regions of the dredged holes. Dissolved oxygen levels would remain at an average of about 5.0 mg/L in dredged hole #5 and 4.0 mg/L in dredged hole #6, with occasional occurrences under 3.0 mg/L. No salinity stratification would occur.

Fish (primarily weakfish adults and juveniles) would continue to use the habitat created by the dredged holes. The majority of fish would be located at intermediate depths of about 12 to 20 feet below the water surface.

6.3.2 With Project Conditions

With project conditions would be improved with respect to the benthic community, fish usage and water quality (i.e., improved substrates, dissolved oxygen conditions, light levels, increased temperature and greater water circulation) at dredged hole #6. Filling dredged hole #6 to -18 ft NAVD would provide significant improvements in the number of species, biomass, and total abundance for the benthic community. Fish would continue to have a relatively deep water refuge in dredged hole #5 and gain an additional, improved deep water refuge in dredged hole #6. Water quality would be improved due to increased mixing resultant from shallower water. Bottom substrate would be improved from anoxic mud to clean sand. Though dead organic matter may continue to accumulate, the creation of mounds should help localize accumulation to the troughs.

6.4 Environmental Effects

This section identifies and evaluates the expected environmental and socioeconomic consequences of implementing the proposed projects. No potential environmental impacts are associated with dredged hole #5 as the no action plan has been selected. The consequences of implementing the proposed project at dredged hole #6 and Double Creek Channel are described.

6.4.1 Physical Setting

6.4.1.1 Physiography and Topography

The proposed projects would not alter the surrounding terrestrial topography.

The existing underwater topography of dredged hole #6 would be raised toward the water surface as a result of the proposed projects. This, however, is expected to result in several beneficial effects, such as increased dissolved oxygen content of the surrounding waters, increased benthic invertebrate production, improved fish habitat, and overall improvement of habitat for aquatic wildlife. A segment of Double Creek Channel would be deepened to authorized depth.

6.4.1.2 Climate

The proposed project would not alter the local or regional climate.

6.4.1.3 Infrastructure

Traffic and Transportation

During restoration activities, water and land transportation routes in the project area are likely to be temporarily affected by short-term increases in boat and vehicular traffic caused by construction activities. The New Jersey Intracoastal waterway and the smaller navigation channels leading to the dredged holes are expected to be primary routes of access to the project site.

The depths of the surrounding navigation channels are between four and eight feet deep and these currently limit the access of deep-draft watercraft to the area. Restoration of dredged hole #6 would not completely fill the dredged hole, therefore, the surrounding depths will still limit access to the project areas causing navigation conditions to remain relatively unchanged. Dredging Double Creek Channel to authorized depth would improve small boat traffic in this channel.

SAV is not expected to become a navigation hazard because it typically fails to establish in water depths greater than six feet. Although the desired increase in fish and benthic invertebrate production in the project areas may draw additional recreational anglers to these areas, any increased traffic is expected to be minor.

Utilities

No impact to utilities is expected from the proposed project as no known utilities were identified in the project area and restoration activities will involve filling previously dredged portions of the bay. Because above and below ground utilities may be located near dredged hole #6 and Double Creek Channel, utility locator services will be contacted prior to any construction activities to avoid potential injuries to construction workers and damages to utilities.

6.4.2 Land Use

The project would not occur on land so no changes in land use would occur and there would be no impact to land use.

6.4.3 Fish and Wildlife

6.4.3.1 General

The proposed action is expected to have only minor and temporary impacts on aquatic biota in the vicinities of dredged hole #5, dredged hole #6, and Double Creek Channel, resulting from potential turbidity during filling and dredging operations. No long-term negative impacts are anticipated as a result of implementing the proposed action. On the contrary, restoring habitat closer to the original historic conditions would be likely to increase populations of fish and benthos in the immediate vicinity of both sites. Greater numbers of fish and benthos in these areas would also provide additional foraging opportunities for piscivorous birds, fish, and other wildlife.

In the short-term, removal of material from Double Creek Channel and deposition of material in the dredged hole will cause a temporary increase in turbidity and suspended materials. This conclusion is fully supported by the recent results of fish, benthos, and water quality surveys in summer (Versar 2999) and winter (Versar 2000). These materials may decrease visibility, impacting the ability of some fish to visually acquire prey or avoid threats, but are unlikely to cause physical impacts since fish are highly mobile and will avoid such disturbances by temporarily relocating to an undisturbed location. Given the poor water quality conditions found at the bottom of the dredged hole, it is unlikely that fish eggs and larvae would utilize this bottom habitat. Any short-term impacts are expected to be relatively minor given the low utilization of habitat within the deep portion of the dredged hole. Any short-term impacts to fish populations are expected to be rapidly offset as fish move into the newly restored habitat. Since better quality habitat will be available after the placement of fill material, the restored habitat is expected to support a greater diversity and density of fish species. The proposed action could improve habitat for other important commercial and recreational fishery resources such as blue crabs, hard clams, summer flounder, winter flounder, bluefish, Atlantic menhaden, and striped bass. Other fish that could potentially benefit include Atlantic silverside, blueback herring, and alewife. No adverse impacts to wildlife are expected to result as a consequence of the proposed action.

Dredging of sediments from Double Creek channel could have immediate localized effects on the benthic macroinvertebrate community through; removal of the existing natural communities, generation of suspended sediments, alteration of the sediment substrate, alteration of the hydrodynamics of the area. Besides the physically disruptive effects of dredging, a long-term environmental concern is the recolonization and resettling of the dredged area. The benthic community is initially decimated but resettling and recolonization can be fairly rapid, typically taking from three months to a few years for complete recovery (Saloman et al. 1982, Van Dolah et al. 1984, and Hirsch et al. 1978). Initial recolonization is dominated by opportunistic taxa, whose reproductive capacity is large, and flexible environmental requirements allow them to occupy disturbed areas (Boesch and Rosenberg 1981, McCall 1977). With time and favorable environmental conditions, the initial surface-dwelling opportunistic species will be replaced by benthic species that represent a more mature community (Bonsdorff 1983). Many benthic organisms are relatively sessile and it is expected that these organisms would experience significant impacts. However, the diversity and abundance of benthic organisms was extremely depressed in the deeper portion of the dredged hole (Versar 1999) and the impacts are expected to be minimal.

While the open water habitat surrounding dredged hole #6 and Double Creek Channel is likely to be used by a variety of waterfowl, shorebirds, and other aquatic birds, the project sites are small in relation to the amount of similar habitat available nearby. Therefore, no adverse impacts to wildlife are expected to result as a consequence of the proposed action.

6.4.3.2 Essential Fish Habitat

Dredged hole #5, dredged hole #6, and Double Creek Channel are within a large geographic area of Barnegat Bay mapped as Essential Fish Habitat (EFH). In its guide to EFH designations in the northeastern United States (National Marine Fisheries Service (NMFS) 1999), NMFS provides a comprehensive summary of EFH designations completed by the New England Fishery Management Council, the Mid-Atlantic Fishery Management Council, the South Atlantic Fishery Management Council, and the NMFS, pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (Act). The 1996 amendments to the Act strengthened the ability of NMFS to protect and conserve the habitat of marine, estuarine, and anadramous finfish, mollusks, and crustaceans. This habitat is broadly defined to include “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity “ (NMFS 1999). Under the Act, the NMFS must coordinate with other Federal agencies to conserve and enhance EFH, and Federal agencies must consult with NMFS on all activities, or proposed activities that could adversely affect EFH. In turn, NMFS must provide recommendations to Federal and State agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH (NMFS 1999).

The NMFS has identified EFH within 10’ X 10’ square coordinates. Dredged hole #5, dredged hole #6, and Double Creek Channel contain EFH for various life stages of 20 species of managed fish and shellfish. Tables 6-1 and 6-2 present the managed species and their life stage for which that EFH has been identified within two 10’ x 10’ squares (#26, and #33) that cover the proposed project area. The habitat requirements for identified EFH species and their representative life stages are provided in Table 6-3.

Initial communications between NMFS and USACE have indicated that all of the appropriate managed species lists are applicable, with summer flounder (*Paralicthys dentatus*) and winter flounder (*Pseudopleuronectes americanus*) being especially important species, considering the nature of the projects (telephone conversation between Mr. John Brady/USACE and Ms. Anita Riportella/NMFS). NMFS indicated that the winter flounder’s eggs and larvae can be imbibed by dredging equipment. To avoid this occurrence to many similar species, NMFS has imposed general restrictions on all bay-area dredging projects from 1 January to 31 May. According to NMFS, summer flounder populations are less critically affected, as juveniles and adults are more likely to escape from dredging operations. Additionally, to protect from the effects of dredging on eelgrass, there is a restriction on dredging from 15 April until 15 October. The total restriction is from 1 January until 15 October. It must be noted that the proposed project involves only deposition of existing clean sandy dredged materials resulting from other projects.

It is not likely, therefore, that winter flounder eggs would be entrained at the dredged holes as a result of any of the alternatives.

Further, it must be noted that only one individual flounder was caught during Versar's biological sampling at dredged holes #5 and #6 in 1999 (Versar 1999); from these site-specific results, it appears that neither summer or winter flounder exist in any numbers at the site. It is not known at this time whether this is because of the lack of appropriate habitat for flounder or other reasons. Conversely, juvenile weakfish (a species that is not included within the New Jersey/Delaware EFH managed species lists) were numerous at dredged hole #6.

Table 6-1
Summary Of Species With EFH Designation In The 10' x 10' Square
(#26 At 39 50.0'n 74 00.0' w; 39 40.0' N 74 10.0') (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua*)				3
Red hake (*Urophycis chuss*)	3	3	3	
Windowpane flounder (*Scopthalmus aquosus*)	3	3	3	3
Atlantic sea herring (*Clupea harengus*)			3	3
Monkfish (*Lophius americanus*)	3	3		
Bluefish (*Pomatomus saltatrix*)			3	3
Witch Flounder (*Glyptocephalus cynoglossus*)	3			
Winter Flounder (*Pseudopleuronectes americanus*)	3	3	3	3
Yellowtail Flounder (*Pleuronectes ferruginea*)	3	3		
Atlantic butterfish (*Peprilus tricanthus*)			3	
Summer flounder (*Paralicthys dentatus*)		3	3	3
Scup (*Stenotomus chrysops*)	n/a	n/a	3	3
Black sea bass (*Centropristus striata*)	n/a		3	3
Surfclam (*Spisula solidissima*)	n/a	n/a	3	
King mackerel (*Scomberomorus cavalla*)	3	3	3	3
Spanish mackerel (*Scomberomorus maculatus*)	3	3	3	3
Cobia (*Rachycentron canadum*)	3	3	3	3
Tiger shark (*Galeocerdo cuvieri*)		3		
Dusky shark (*Charcharinus obscurus*)		3		
Sandbar shark (*Charcharinus plumbeus*)		3	3	3

Table 6-2
Summary Of Species With EFH Designation In The 10' x 10' Square
(#33 At 39 40.0'n 74 10.0'w; 39 30.0' N 74 20.0'w) (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua*)				3
Red hake (*Urophycis chuss*)	3	3	3	
Winter flounder *(Pseudopleuronectes americanus*)	3	3	3	3
Windowpane flounder (*Scopthalmus aquosus*)	3	3	3	3

Table 6-2
Summary Of Species With EFH Designation In The 10' x 10' Square
(#33 At 39 40.0'n 74 10.0'w; 39 30.0' N 74 20.0'w) (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic sea herring (*Clupea harengus*)			3	3
Bluefish (*Pomatomus saltatrix*)			3	3
Atlantic butterfish (*Peprilus triacanthus*)			3	
Summer flounder (*Paralicthys dentatus*)		3	3	3
Scup (*Stenotomus chrysops*)	n/a	n/a	3	3
Black sea bass (*Centropristus striata*)	n/a		3	3
King mackerel (*Scomberomorus cavalla*)	3	3	3	3
Spanish mackerel (*Scomberomorus maculatus*)	3	3	3	3
Cobia (*Rachycentron canadum*)	3	3	3	3
Tiger shark (*Galeocerdo cuvieri*)		3		
Dusky shark (*Charcharinus obscurus*)		3		
Sandbar shark (*Charcharinus plumbeus*)		3	3	3
Sandbar shark (*Charcharinus plumbeus*)		HAPC[1]	HAPC	HAPC

[1]Habitat Area of Particular Concern

Table 6-3
Habitat Utilization Of Identified EFH Species And Summary Of EFH Designation In The 10' x 10' Squares #26 And #33 (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Atlantic cod (*Gadus morhua*)				Bottom (rocks, pebbles, or gravel) winter for Mid-Atlantic
Red hake (*Urophycis chuss*)	Surface waters, May – Nov.	Surface waters, May –Dec.	Bottom (shell fragments)	
Witch flounder (*Glyptocephalus cynoglassus*)	Surface waters <13 C temp deep water high salinity	Surface waters <13 C temp deep water high salinity Mar-Nov Peaks May-Jul	Bottom habitats Fine grained Temp < 13 C 50-450 m depth salinity 34-36%	Bottom habitats Fine-grained Temp < 13C 25-300 m depth salinity 32-36%
Winter flounder (*Pleuronectes americanus*)	Bottom habitats Temps <10C 10-30% salinity depths <6 m	Pelagic and bottom waters <15 C, 4-30% salinity depths < 6m	Bottom habitats Mud, sand Temp <28 C 0.1-10m depth 5-33% salinity	Bottom habitats Mud, sand, gravel Temps <25 C 1-100 m depth 15-33% salinity

Table 6-3
Habitat Utilization Of Identified EFH Species And Summary Of EFH Designation In The 10' x 10' Squares #26 And #33 (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Yellowtail flounder (*Pleuronectes ferruginea*)	Surface waters Temp <15 C 30-90 m depth salinity 32.4-33.5%	Surface waters Temp < 15 C Depths 20-50 m Salinity 32.4-33.5%	Bottom habitats Sand, mud Temp < 15C Depths 20-50 m Salinity 32.4-33.5%	Bottom habitats Sand, mud Temp < 15C Depths 20-50 m Salinity 32.4-33.5%
Windowpane flounder (*Scopthalmus aquosus*)	Surface waters, peaks in May and Oct.	Pelagic waters, peaks in May and Oct.	Bottom (mud or fine sands)	Bottom (mud or fine sands), peak spawning in May
Atlantic sea herring (*Clupea harengus*)			Pelagic waters and bottom, < 10 C and 15-130 m depths	Pelagic waters and bottom habitats;
Monkfish (*Lophius americanus*)	Surface waters, Mar. – Sept. in temps of 15 C and depths from 25 – 1000 m	Pelagic waters w/ temps. of 15 C and depths of 25 – 1000 m		
Bluefish (*Pomatomus saltatrix*)			Pelagic waters	Pelagic waters
Whiting (*Merluccius bilnearis*)	Surface waters year round, peaks Jul-Sep Temps below 20C Depths 50-150m	Surface waters Year round Peaks Jul-Sep Temps below 20C Depths 15-150m	Bottom habitats Temps below 22C Depths 30-325m	Bottom habitats Temps below 13 C Depths 30-325 m
Atlantic butterfish (*Peprilus tricanthus*)	Pelagic waters		Pelagic waters in 10 – 360 m	Pelagic waters
Summer flounder (*Paralicthys dentatus*)		Pelagic waters, nearshore at depths of 10 – 70 m from Nov. – May	Demersal waters (mud and sandy substrates)	Demersal waters (mud and sandy substrates). Shallow coastal areas in warm months, offshore in cold months

Table 6-3
Habitat Utilization Of Identified EFH Species And Summary Of EFH Designation In The 10' x 10' Squares #26 And #33 (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
Scup (*Stenotomus chrysops*)	n/a	n/a	Demersal waters	Demersal waters offshore from Nov – April
Black sea bass (*Centropristus striata*)	n/a		Demersal waters over rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas	Demersal waters over structured habitats (natural and man-made), and sand and shell areas
Surfclam (*Spisula solidissima*)	n/a	n/a	Throughout substrate to 3' in depth	
King mackerel (*Scomberomorus cavalla*)	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone
Spanish mackerel (*Scomberomorus maculatus*)	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
Cobia (*Rachycentron canadum*)	Pelagic waters with sandy	Pelagic waters with sandy	Pelagic waters with	Pelagic waters with

Table 6-3
Habitat Utilization Of Identified EFH Species And Summary Of EFH Designation In The 10' x 10' Squares #26 And #33 (NOAA, 1999)

Managed Species	Eggs	Larvae	Juveniles	Adults
	shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
Dusky shark (*Charcharinus obscurus*)		Shallow coastal waters	Coastal and pelagic	Coastal and pelagc
Sandbar shark (*Charcharinus plumbeus*)		Shallow coastal waters	Coastal and pelagic waters	Shallow coastal waters
Tiger shark (*Galeocerdo cuvieri*)		Shallow coastal waters	Coastal and pelagic	Coastal and pelagic

A review was completed of EFH designations and the corresponding 10' x 10' squares that encompass the waters in the vicinity of dredged hole #5, dredged hole #6, and Double Creek Channel. The following is an evaluation of potential effects on EFH species associated with the alternatives evaluated at dredged holes #5 and #6:

Atlantic cod: no adverse effect is anticipated as adult fish are anticipated to avoid the project areas during the temporary period when turbidity is high and feeding habitat is disrupted.

Red hake: no adverse effect is anticipated on eggs and larvae because these life history stages are pelagic in surface waters. Juveniles are anticipated to move away from the project areas during the temporary construction period, when turbidity is high.

Witch flounder: no adverse effect is anticipated on eggs because they are pelagic and impacts, relating to turbidity, will be temporary only.

Winter flounder: no adverse effect is anticipated on adult and juveniles because both stages can move away from the project impact area. Minimal adverse effect on eggs and larvae as they are demersal at these life stages; materials would only be deposited on the sites during non-restricted time periods.

Yellowtail flounder: no adverse effect is anticipated on larvae because they are pelagic and impacts, relating to turbidity, will be temporary only.

Windowpane flounder: no adverse effect is anticipated on eggs and larvae, as they are pelagic and work will be conducted on the bottom during the temporary construction period. No adverse effect on juveniles and adults as they are anticipated to move away from the project area during the temporary construction period.

Atlantic sea herring: no adverse effect is anticipated as adults and juveniles can move away from the project area during the temporary construction period.

Monkfish: no adverse effect on eggs and larvae is anticipated because these life history stages are pelagic and work will be completed on the bottom during the temporary construction period.

Bluefish: no adverse effect on juveniles and adults is anticipated because these life history stages can move away from the project area during the temporary construction period.

Whiting: no adverse effect is anticipated for any life stages. Eggs and larvae occur in surface waters and construction activities take place at the bottom. Juveniles and adults occur in bottom habitats but are able to move from the project area during the temporary construction period.

Atlantic butterfish: no adverse impacts are anticipated. All life history stages are pelagic and construction activities will take place on the bottom.

Summer flounder: no adverse effect is anticipated on eggs and larvae because they are pelagic and work will be conducted on the bottom during the temporary construction period. No adverse effect is anticipated on juveniles and adults because they can leave the construction area.

Scup: no adverse effect on juveniles and adults is anticipated because they can move out of the area during the temporary construction period.

Black sea bass: no adverse effect is anticipated on juveniles and adults as they can move out of the area during the temporary construction period.

Surfclam: surfclams are found on the continental shelf out to approximately 25 miles. No adverse effects to these populations are expected, as they do not currently exist in the direct vicinity of dredged hole #5, dredged hole #6, and Double Creek Channel. The existing benthic populations of benthos at dredged hole #5, dredged hole #6, and Double Creek Channel are generally sparse; the proposed projects would significantly improve conditions for benthos.

King mackerel: no adverse effect on all life stages is anticipated as all life stages of this species are pelagic and construction activities will take place on the bottom.

Spanish mackerel: no adverse effect is anticipated for all life stages as they are all pelagic and construction activities will take place on the bottom.

Cobia: no adverse effect is anticipated for all life stages as they are all pelagic and construction activities will take place on the bottom.

Dusky shark, Sandbar shark, and Tiger shark: most shark species typically have eggs and larvae in shallow coastal waters. The vicinity of the projects is within a habitat area of particular concern (HAPC), for sandbar shark as mapped by NOAA (NOAA 1999). None of these shark species however, are likely to exist within the relatively small areas of dredged hole #5, dredged hole #6, and Double Creek Channel; therefore impacts to shark eggs and larvae are unlikely. No adverse effects are anticipated for juveniles or adults as these stages are expected to move out of the construction area during the temporary construction period.

In conclusion, of the 20 species identified with Fishery Management Plans, the proposed project could only minimally impact the egg and larval stages of winter flounder. However, the total impact to EFH is considered minimal, due to the fact that the site comprises only approximately 12 acres of existing depauperate habitat. Only one flounder was caught during preliminary field studies at dredged hole #6, suggesting this is not an abundant species currently existing at the site. Additionally, impacts would be minimized by implementation of the projects from the beginning of June to the end of December of the year (note also that NJDEP has also imposed restrictions on dredging-related projects in Bay-area waters from 1 June to 15 October, to protect SAV). Most importantly, any temporary impacts would be greatly offset by the potential long-term benefit to physical habitat for both benthos and fish, and ultimately, to the condition of area EFH physical habitat.

6.4.3.3 Benthos

Benthic organisms inhabiting the vicinity of dredged holes #5 and #6 and Double Creek Channel include a variety of polychaete worms, amphipods, isopods, bivalves, oligochaete worms and gastropods. Hydromedusae (*Rathkea octopunctata*), (*Sarsia* spp.), and *Turritopsis nutricula*); and the mysid shrimp (*Neomysis americana*), and grass shrimp (*Palaemonetes* spp.) also occur in the vicinity. The study area also supports numerous species of shellfish, including hard clam (*Mercenaria mercenaria*), soft-shell clam (*Mya arenaria*), Atlantic razor clams (*Siliqua costata*), blue mussels (*Mytilus edulis*), Atlantic ribbed mussel (*Geukensia demissa*), bay scallop (*Argopecten irradians*), and blue crab (*Callinectes sapidus*).

The community composition of each dredged hole and surrounding shallow areas were similar to each other, between seasons, and at the various depths (Versar, 1999). In general, arthropods, specifically amphipods (small shrimp type crustaceans) and polychaete worms dominated the benthic community. This was true in both seasons, at both dredged holes, as well as at the different depths within the dredged holes. The numerically dominant amphipods were in the genus *Ampelisca* spp., while the numerically dominant polychaetes were in the Capitellidae family (i.e., *Capitella capitata* and *Mediomastus ambiseta*). In addition, the majority of the epifaunal species collected from the area were amphipods.

Diversity (as measured by mean number of taxa) was the greatest in the shallow habitats of both areas. Mean number of taxa ranged from 29 to 33 at both shallow areas in both seasons. Diversity in the deepest areas of each dredged hole was extremely low in both seasons, and only ranged between a mean of 0.7 to 3.3. The intermediate depths also had depressed diversity with a mean range between 10 and 15.

Mean total abundance was greatest in the shallow areas near dredged holes #5, which also had the greatest number of amphipod crustaceans. Abundance at the shallow areas near dredged hole #6 was about one third that at dredged hole #5. Mean abundance at the intermediate depths of dredged hole #5 in the summer was over three times higher than in the spring and it was about the same in both seasons for dredged hole #6. The numerical dominants in the summer at dredged hole #5 were the amphipods in the genus *Ampelisca* spp. Mean abundance was extremely depressed in the deepest areas of the Sites. Mean abundance at these depths ranged from $8/m^2$ to $15/m^2$. Recruitment in the spring was also extremely depressed and only ranged from 22 to $197/m^2$.

The number of large taxa collected in the samples was also examined, and for this summary, large taxa were defined as species with lengths greater than 2 cm. Sites containing many large individuals generally suggest the presence of a long-lived, established benthic community subjected to little stress. The shallow areas near both dredged holes contained numerous large taxa while the intermediate area contained some large taxa. No large taxa were collected from the deep areas of either dredged hole.

Total biomass in the shallow and intermediate areas of dredged hole #6 were dominated by the clam *Mercenaria mercenaria*. One, 4 or 5 year old, clam was found at one sampling site each in both the shallow and intermediate areas. Because the sampling gear does not sample efficiently for these large clams and because their presence in the sample skew the biomass results, the weights of these two clams were dropped from further biomass summaries.

Mean total biomass in the deep areas was essentially zero. This was true in both seasons and at both dredged holes. As with abundance, mean total biomass was greatest in the shallow areas of both dredged holes, ranging between 2 and 5 g/m^2.

Mean amphipod abundance within each dredged hole was examined for two reasons. First, amphipods were the numerically dominant taxa within the area, and second, these organisms are important prey to the resident fish populations of the area. The shallow areas near dredged hole #5 supported the most amphipods. However, both intermediate depth areas supported larger populations of amphipods in the spring and summer than other taxonomic groups. Dredged hole #6 averaged higher numbers of amphipods than its nearby shallow area. Higher numbers of amphipods in dredged hole #6 may be a function of higher concentrations of dead submerged aquatic vegetation (SAV) (because dredged hole #6 is deeper than dredged hole #5) which could be providing a food source for these organisms.

6.4.4 Vegetation and Land Cover

Minor establishment of new SAV beds may occur around the margins of the restoration site where water depths are sufficiently shallow. SAV, however, is not likely to become established across the majority of the project area due to excessive water depths. Because of the biophysical requirements of the plants, and the existing water quality conditions in the vicinity of the proposed project, SAV establishment is not likely in water depths of greater than about 2 meters (6 feet) (Harriott and Burton 1996). Because of the fact that the project is located in open water, no adverse effects on existing vegetation or land cover are expected as a result of the proposed action. It is expected that all equipment required for implementation of the project at dredged hole #6 would be brought to the sites by water.

6.4.5 Threatened and Endangered Species

NJDEP Division of Fish Game and Wildlife indicated that there are no known endangered or threatened species in the vicinity of dredged hole #6 or Double Creek Channel that are likely to be affected by the project at dredged hole #6 (Jenkins, 1999, Pers. Comm.). Further, the USFWS indicated in their Planning Aid Report (USFWS 1999) that other than an occasional transient bald eagle (*Haliaeetus leucocephalus*) or peregrine falcon (*Falco peregrinus*), it was their opinion that no specific Federal-listed or State-listed species occur in the vicinity of dredged hole #6 or Double Creek Channel, with the potential exception of several species of sea turtles; these include the Federal threatened loggerhead (*Caretta caretta*), the endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and endangered green sea turtles (*Chelonia mydas*). The NMFS was contacted as part of the scoping process for the proposed project. NMFS had no specific information or comments regarding threatedned or endangered species in the immediate vicinity of the proposed project (Anita Riportella, pers comm., Dec. 6, 1999).

Implementation of the proposed action is not anticipated to pose either adverse impacts or cause beneficial effects to threatened and endangered species in the vicinity of the project, including sea turtles. Restoration at dredged hole #6 would not completely fill the dredged hole, leaving some vertical relief and heterogeneity to the Barnegat Bay ecosystem. Following the guidance by NJDEP that limits dredging and filling projects between 1 June and 15 October will help to minimize impacts on adjacent SAV. Because of the unavailability of SAV in the region after the end of October, grazing sea turtles would not likely be present in the vicinity of the project when it is implemented. Increases in benthic invertebrate production will be localized and are not expected to dramatically increase the size of the local fishery, or to attract bald eagles, sea turtles, or other species of special concern to the vicinity of the projects.

6.4.6 Wetlands

No tidal marsh or other terrestrial wetlands occur in the immediate vicinity of dredged hole #6 or Double Creek Channel; therefore, no adverse effects to these resources are expected. No SAV beds apparently occur in the vicinity of dredged hole #6 or within Double Creek Channel. Best Management Practices mandated by conditions contained in all the required permits (i.e., 401 Water Quality Certificate, Coastal Zone Management certification) would also minimize these impacts during implementation of the project at dredged hole #6. It must be noted that, in measures to protect SAV, NJDEP has established a policy limiting all dredging and fill projects in Barnegat Bay from 1 June to 15 October (i.e., projects are restricted during this window). All activities relating to this project would be scheduled to strictly adhere to this restriction, to further reduce potential impacts on SAV.

6.4.7 Air Quality

In the short-term, employee vehicles and construction equipment may cause a temporary increase in emissions of volatile organic compounds, nitrogen oxides, sulfur dioxide, and carbon monoxide. However, emissions produced during construction are not expected to exceed ambient air quality standards for the area. No long-term impacts to local air quality are expected from the proposed projects.

6.4.8 Hazardous and Toxic Materials

Although localized areas of contaminated sediment may be present within portions of Barnegat Bay, a review of several reports indicates that contaminated sediments are not a widespread problem in Barnegat Bay (Burton and Kelly 1998: Burton and Farrar 1999; Farrar and Burton 1999). In addition, no hazardous, toxic, or radioactive materials are known to occur in the vicinity of dredged hole #6 or Double Creek Channel and therefore, no impacts are expected. Fill materials with less than 90 percent sand will be tested to confirm that they do not contain elevated levels of hazardous or toxic materials.

Geotechnical investigations indicated that material in Double Creek Channel is between 60% and 70% sand. Therefore, analytical testing was performed on the material. Analytical tests showed that the sediment does not contain elevated levels of hazardous or toxic materials. The geotechnical and analytical reports are included in Appendix D.

6.4.9 Water Resources

Hydrologic effects to surface water as a result of implementation of the proposed projects are expected to be temporary in nature. Suspended solids could temporarily reduce visibility in the water surrounding dredged hole #6 and Double Creek Channel during and after implementation of the projects. Best Management Practices mandated by conditions contained in all the required permits (i.e., 401 Water Quality Certificate, Coastal Zone Management certification) would also minimize these impacts during implementation of the project at dredged hole #6. Additionally, owing to the tidal action and currents of the bay, it is likely that these potential effects would be short-lived. No adverse effects to current patterns and flow, velocity, stratification, or other aspects of hydrology are expected, either in the immediate vicinity of dredged hole #6, or in Barnegat Bay.

6.4.10 Geology and Soils

6.4.10.1 Stratigraphy/Aquifers

The restoration alternatives evaluated would add a layer of clean, sandy dredged materials to the existing dredged hole #6 and remove clean, sandy material (60%–70% sand) from Double Creek Channel. This is not anticipated to cause adverse effects to existing stratigraphy or aquifers.

6.4.10.2 Soils

The restoration activities would remove clean sandy material (60%–70% sand) from the Double Creek Channel and deposit them on top of the existing substrate at dredged hole #6 (originally disturbed during excavation of the dredged holes). While it is possible that a small quantity of these new materials could be eroded and moved off site to surrounding areas due to wave action and currents, the actions are not anticipated to cause adverse effects to existing soils materials.

6.4.11 Recreational Resources

An improvement to existing recreational facilities for small boating activity is anticipated with the proposed project, as Double Creek Channel is expected to be improved for navigation. Other navigation channels within Barnegat Bay are not expected to be impacted by project implementation. The environmental restoration alternative for dredged hole #6 is anticipated to provide long-term benefits to benthic habitat in this portion of Barnegat Bay. With better habitat, fish and shellfish populations are likely to increase, thereby benefiting related recreational angling and harvesting activities. Creating mounds within the dredged holes will have the added potential benefit of creating more habitat heterogeneity and may increase the amount of refuge area for juvenile weakfish, soft crabs, and other recreationally important species that inhabit the dredged holes.

6.4.12 Cultural Resources

No prehistoric or historic cultural resources have been identified within the restoration area for dredged hole #6 or Double Creek Channel. In addition, any unidentified cultural resources in the immediate vicinity of dredged hole #6 would have been damaged considerably or destroyed during previous dredging operations in which the dredged hole were created. Therefore, no impacts to cultural resources are anticipated. The NJSHPO concurred with the District’s “no historic properties effected” opinion letter dated June 18, 2000 (see Annex D).

6.4.13 Socioeconomic Resources

6.4.13.1 Population

The filling alternative for dredged hole #6 to restore bay habitat is not expected to increase or decrease the human population within the respective project area.

6.4.13.2 Schools

No schools are located within the project area and the proposed restoration project is not anticipated to negatively affect area schools.

6.4.13.3 Regional Economic Development

The proposed restoration project is anticipated to improve localized benthic habitat and recreational opportunities. Because of the small size of this restoration area, regional economic development is not expected to significantly change.

6.4.14 Aesthetic/Visual Resources

Owing to their underwater locations, neither the dredging at the Double Creek Channel nor the restoration at dredged hole #6 are expected to adversely affect aesthetic or visual resources in the near or far vicinities of these areas. Equipment required to implement the project would be brought in by water, and would be removed from the area upon completion of the work. The proposed action is therefore not expected to adversely affect aesthetic or visual resources in the immediate vicinity of the proposed project.

6.5 Project Cost Estimate

The estimates of annual charges for the selected plan is based on an economic project life of 50 years and an interest rate of 5.875%. The annual charges include annualized first cost and interest during construction, and post construction monitoring costs. It is noted that interest during construction was developed for the first cost of the project constructed over a two-month period. The annualized cost of the selected plan is $128,000. Table 6-4 shows the cost estimate for the selected plan.

Post construction monitoring costs include environmental monitoring over a 3-year period. Annual monitoring costs for the hole are $27,820 per year, for three years.

The estimated cost for each major subdivision or feature of the recommended project includes an item for "contingencies". The item for "contingencies" is an allowance against some adverse or unanticipated condition not susceptible to exact evaluation from the data at hand but which must be expressed or represented in the cost estimate. Fifteen percent was applied to fill placement work to account for concerns about pumping distances and source area selection, and to account for larger required fill quantities at the time of construction. Twelve percent was applied to mobilization, demobilization, and preparatory work to account for concerns about availability of dredges and for variances in the travel distance for the dredge plant.

Preconstruction Engineering and Design costs include local cooperative agreements, environmental and regulatory activities, general design memorandum, preparation of plans and specifications, engineering during construction, A/E liability actions, cost engineering, construction and supply contract award activities, project management, and the development of the PCA. P, E & D costs were estimated as a lump sum of $116,673 for the initial fill construction, and is based on similar Corps of Engineers projects of the same magnitude. A contingency factor of 15% was used on all P, E & D costs.

Construction Management costs include contract administration, review of shop drawings, inspection and quality assurance, project office operation, contractor initiated claims and litigations, and government initiated claims and litigations. S & A related costs were estimated as a lump sum of $133,876 for the initial fill construction and is based on similar Corps of Engineers projects of the same magnitude. A contingency factor of 15% was used on all S & A costs.

IDC (Interest During Construction) was included in all costs incurred at or prior to the time of construction. A rate of 5.875% was used for all IDC calculations. The calculation of IDC is shown in Appendix E. As no maintenance is required following construction, and the ecological monitoring has been accounted for, the OMRR&R is $0.

Table 6-4 - Total First Cost - Selected Plan Price Level: Oct 02
Alternative 6: Fill Dredged Hole No. 6 to -18 Ft. NAVD
Plan Code B5

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages						
01.B	Post Authorization Planning						
01.B.2	Required Easements	1	Job	LS	$0	$0	$0
01.B.8	Surveys Appraisal & Admin	1	Job	LS	$0	$0	$0
	Total Lands and Damages				$0	$0	$0
09.	Channels and Canals						
09.01.01	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$500,257	$60,031	$560,288
09.01.16	Pipeline Dredging						
09.01.16.01	Excavation and Placement	125,000	CY	$7.48	$935,000	$140,250	$1,075,250
09.01.99	Associated General Items						
09.01.99.01	Turbidity Control Curtains	2,500	LF	$12.44	$33,275	$6,655	$39,930
	Total Channels and Canals				$1,468,532	$206,936	$1,675,468
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$116,673	$17,501	$134,174
31.	Construction Management						
	(S & A)	1	Job	LS	$133,876	$20,081	$153,957
	Total Project First Cost				$1,719,081	$244,518	$1,963,599
	(Rounded)				$1,720,000	$245,000	$1,965,000

7.0 LOCAL COOPERATION

7.1 Cost Allocation and Apportionment

A non-Federal sponsor is required to provide at least 25 percent of the implementation costs of the construction of this project. The provision of work in-kind can be credited against the sponsor's cost-sharing requirement as specified under EC 1105-2-206, paragraph 6, which states, "Work in-kind will be credited to non-Federal sponsor's share of the total project modification costs within the following limits … Work in-kind may be accepted as long as it does not result in any reimbursement to the non-Federal sponsor". NJDEP is the non-Federal sponsor. Table 7-1 shows the cost sharing for the selected plan.

Table 7-1
Cost Sharing for Selected Plan

Item			Cost		
Construction			$1,965,000		
Lands, Easements, Rights-of Way, Relocations, Disposal Areas (LERRD)			$0		
Project Feature	Federal Cost	%	Non-Federal Cost	%	Total Cost
Initial Project Costs	$1,473,750	75	$491,250	25	$1,965,000
Monitoring	$62,595	75	$20,865	25	$83,460
Total	$1,536,345	75	$512,115	25	$2,048,460

7.1.1 Local Cooperation/Project Cooperation Agreement

A fully coordinated Project Cooperation Agreement (PCA) package (to include the Sponsor's financing plan) will be prepared subsequent to the approval of the feasibility phase and will reflect the recommendations of this Early Action Report. NJDEP, the non-Federal sponsor, has indicated support of the recommendations presented in this EAR and the desire to execute a PCA for the recommended plan.

In the event that the recommended project is approved, the non-Federal interests will be required to do the following:

a. Provide without cost to the United States all necessary land, easements, and rights-of-way, access routes, and relocations of utilities necessary for project construction and subsequent operation and maintenance.

b. Provide, during the period of implementation, a cash contribution or in-kind services in the amount necessary to make its total contribution equal to 25 percent, currently estimated to be $512,115.

c. Hold and save the United States free from claims for damages, which may result from construction of the project, except damages due to the fault or negligence of the United States or its contractor.

d. Execute the Assurance of Compliance pertaining to Title IV of the Civil Rights Act of 1964 (Public Law 88-352, 78 Stat. 241,252).

7.2 Financial Analysis

New Jersey Department of Environmental Protection, the non-Federal sponsor, is willing and able to share the costs of the project implementation. For the dredged hole #6 project, the non-Federal share of the construction costs is currently estimated to be $512,115. NJDEP has budgeted to fund the non-Federal share of the project costs.

The letter of intent from the local sponsor to sign the PCA has been received by the Corps of Engineers.

8.0 CONSTRUCTION AND FUNDING SCHEDULE

The construction and preconstruction sequence and time schedule of the Selected Plan are given in Section 17 of Appendix D - Engineering Technical Appendix of this report. The schedule is based on the timeliness of the report's approval and allocation of funds by Congress, the foregoing construction procedures, and the ability of local interests to implement the necessary items of local cooperation. These items of local cooperation are principally the required real estate easements and provision of cost sharing.

9.0 FINDINGS AND CONCLUSIONS

As many as 38 depressions were created in New Jersey estuaries between Manasquan Inlet and Townsends Inlet when sand was mined for construction fill material (houses, highways and bridges) and to repair storm damaged beaches (Murawski 1969). Of these 38 depressions, 21 are located within the Barnegat Bay estuary, including 5 in Little Egg Harbor (U.S. Fish and Wildlife Service (USFWS) 1999). Field sampling of water quality, benthic macroinvertebrate condition, and fish utilization was performed to evaluate existing conditions and for input into the analysis. This element of the study documented that benthic macroinvertebrate abundance, biomass, and diversity was poorest in the deepest bottom sediments while improved conditions were observed in the intermediate depths. Optimal benthic community conditions were observed in the shallow water regions. Water quality measures in the spring and summer showed that bottom DO levels averaged about 4.0 mg/L in the deeper hole (dredged hole #6) and bottom DO averaged 5.0 mg/L in the shallower dredged hole (dredged hole #5). Occasional measurements under 3.0 mg/L were observed. No salinity stratification was observed in either dredged hole.

Fish trawls and gill net sampling indicated that fish (primarily weakfish adults and juveniles) were using the habitat created by the dredged holes. Primary usage was at intermediate depths (12 to 20 feet below the water surface). The benthic data were used to estimate the increase in abundance, biomass, and diversity that may be expected if the dredged holes are filled with dredged material. The data suggest that the greatest benthic community benefit would occur if the dredged holes were completely filled to levels occurring naturally in Barnegat Bay. However, because large numbers of juvenile weakfish and other species also use the dredged holes as refuge habitat, only partial filling of the dredged holes is recommended.

An incremental analysis was performed using IWR-PLAN to compare alternative plans for filling the dredged holes. Filling methodology consisted of hydraulic dredging and placement from Double Creek Channel. Placement methodology would allow for creation of relief within the dredged holes to enhance fish habitat and maximize the potential for a healthy benthic environment. The purpose of the comparison was to select the most cost-effective plan with respect to optimal benefit to habitat. The analysis concluded that the optimal plan is not to fill dredged hole #5 and to fill dredged hole #6 to –18 feet NAVD. Total first costs were estimated to be about $1,965,000 for construction and $83,4608 for monitoring. With a discount rate of 5.625% the annualized cost are estimated as $128,000.

10.0 RECOMMENDATIONS

10.1 Overall Assessment

In making the following recommendations, the Philadelphia District has given consideration to all significant aspects in the overall public interest including environmental, social and economic effects, as well as the engineering feasibility and compatibility of the project with policies, desires, and capabilities of the State of New Jersey and other non-Federal interests. Filling of dredged hole #6 to –18 feet with material dredged from Double Creek Channel in Barnegat Bay is the recommended plan. Hydraulic dredging and placement is technically sound, cost-effective, and socially and environmentally acceptable. The selected plan for dredged hole #5 is no action. The selected plan has support from the non-Federal sponsor and environmental interests.

10.2 Non-Federal Responsibilities

Should Congress appropriate funds for construction of the project, the non-Federal sponsor would have to assume non-Federal responsibilities subject to cost sharing, financing, and other applicable requirements of the Water Resources Development Acts of 1986 and 1996 as indicated in the following paragraphs:

10.2.1 Non-Federal Costs

Provide 25 percent of the total project costs assigned to environmental restoration as further specified below:

a. Sponsor Provided Items. Provide monitoring features, that will be required for operation and evaluation of the project; and

b. Ultimate Cost Share. Provide, during construction, any additional costs as necessary to make its total contribution equal to 25 percent of total project costs assigned to environmental restoration.

10.2.2 Operation and Maintenance

Normally, the local sponsor must operate, maintain and repair the completed project, or functional portion of the project, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government. With regard to this specific project, no future efforts to operate or maintain past construction are anticipated;

10.2.3 Hold and Save Clause

Hold and save the United Stated free from all damages arising from the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the United States or its contractors;

10.2.4 Documentation

Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

10.2.5 Investigation of Hazardous Substances

Normally the local sponsor would perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under CERCLA, Public Law 96-510, as amended, 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for the construction, operation, and maintenance of the project. However, for the lands that the Federal Government determines to be subject to navigation servitude, as is the case here, only the Federal Government shall perform such investigations unless the Federal Government provides the Non-Federal Sponsor with prior specific written directions, in which case the Non-Federal Sponsor shall perform such investigations in accordance with such written direction;

10.2.6 Cleanup of Hazardous Substances

Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be necessary for the construction, operation, or maintenance of the project;

10.2.7 Liability for Hazardous Substances

Agree that the Non-Federal Sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, and repair the project in a manner that will not cause liability to arise under CERCLA;

10.2.8 Federal Real Estate Requirements

Due to the absence of real estate requirements for this project, the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, are not germane. There is no need to acquire lands, easements, and rights-of-way, required for the construction, operation, and maintenance of the project, including those necessary for relocations, borrow materials, and dredged or excavated material disposal;

10.2.9 State and Federal Regulations

Comply with all applicable Federal and State laws and regulations, including, but not limited to, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d), and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army;

10.2.10 Cultural Mitigation

Provide 25 percent of that portion of total cultural resource preservation, mitigation and data recovery costs assigned to construction of ecosystem restoration, that there are in excess of 1 percent of the Federal share of the total first cost of the project authorized to be appropriated for ecosystem restoration and protection;

10.2.11 Public Ownership

For so long as the project remains authorized, the Non-Federal Sponsor shall ensure continued conditions of public ownership upon which Federal participation is based;

10.2.12 Local Cooperation Agreement

Recognize and support the requirements of Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element;

10.2.13 Ecosystem Monitoring

Monitor ecosystem restoration project performance on an annual basis for a period of three years and provide the results of such monitoring to the Federal Government;

10.2.14 Assurance of Project Integrity

Prescribe and enforce regulations to prevent obstruction of or encroachment on the Project by structures or persons that would reduce the level of ecosystem restoration and protection it affords or that would hinder operation or maintenance of the Project; and

10.2.15 Use of Federal Funds

Do not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

10.3 Initial Project Costs

Based on 1999 price levels, the total project cost is estimated to be $1,920,600. The Federal share of this cost is $1,440,450 and the non-Federal share is $480,150.

10.4 Project Benefits

The selected plan for environmental restoration of dredged hole #6 has primary outputs based on ecosystem restoration. It has been appropriately formulated based on current guidance, and is recommended for implementation.

10.5 Modifications

The recommendation contained herein reflects the information available at this time and current departmental policies governing formulation of individual projects. It does not reflect program and budgetary priorities inherent in the formulation of individual projects. It does not reflect program and budgetary priorities inherent in the formulation of a national civil works construction program, nor the perspective of higher review levels within the executive branch. Consequently, the recommendation may be modified before transmittal to Congress as a proposal for authorization and implementation funding. However, prior to transmittal to Congress, the Sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Date

Timothy Brown
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District Engineer