Ocean City, Maryland, and Vicinity Water Resources Study

Final Integrated Feasibility Report and Environmental Impact Statement

US Army Corps of Engineers
Baltimore District

June 1998

Ocean City, Maryland, and Vicinity
Water Resources Study

FINAL

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and Environmental Impact Statement

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NOTE TO READER: In order to allow concerned resource agencies and the public an opportunity to evaluate the project with full and convenient access to the environmental, economic, and engineering documentation prepared for the study, the EIS for this project has been integrated into this feasibility report in accordance with Engineer Regulation 1105-2-100 (December 28, 1990). Sections required for compliance with the National Environmental Policy Act (NEPA) are noted by an asterisk (*) in the Table of Contents.

This EIS was prepared to address impacts of ***four*** components of this ***study (1) short-term restoration of the northern end of Assateague Island,*** (2) long-term sand management, (3) navigation improvements, and (4) environmental restoration in the coastal bays. The interim EIS is included in Appendix D of this report.

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Worcester County, Snow Hill, Maryland
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ABSTRACT: This report/EIS presents the findings of a study to determine the feasibility of implementing a ***short-*** and long-term sand management plan, implementing navigation improvements, and restoring fish and wildlife habitat in the coastal bays. It provides the findings of economic, social, environmental, and engineering analyses that were used to select a recommended plan of action for each component. The potential impacts, if any, to cultural and environmental resources are evaluated herein in accordance with NEPA and Section 106 of the National Historic Preservation Act of 1966.

Ocean City, Maryland, and Vicinity
Water Resources Study

Acknowledgments

The U.S. Army Corps of Engineers would like to thank the numerous agencies and individuals who participated in this study. Although it is not possible to identify by name all the individuals who provided assistance in the development of this report, we would like to specifically acknowledge the assistance of the following individuals who provided important insights into the needs of the study area as well as critical technical guidance in the identification of problems and potential solutions. The assistance provided by these individuals was extremely valuable in enabling the U.S. Army Corps of Engineers to complete this report.

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APPENDICES

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List of Acronyms

ac	Acre
AINS	Assateague Island National Seashore
CEDEP	Corps of Engineers Dredge Estimating Program
CEQ	Council of Environmental Quality
CERC	Coastal Engineering Research Center
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
Corps	United States Army Corps of Engineers
District	Baltimore District, United States Army Corps of Engineers
DO	Dissolved Oxygen
EIS	Environmental Impact Statement
EMAP	
EO	Executive Order
Fa	Fallsington Sandy Loam
FAA	Federal Aviation Administration
FCSA	Feasibility Cost-Sharing Agreement
FWS	United States Fish and Wildlife Service
FY	Fiscal Year
GIS	Geographic Information System
ha	hectare
HEP	Habitat Evaluation Procedures
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic and Radioactive Waste
HU	Habitat Unit
IWR	Institute of Water Resources
LONGSHOR	longshore transport model
m^3	Cubic meters
M-CACES	(3, p. 47) ????
MCBP	Maryland Coastal Bays Program
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of the Environment
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MOA	Memorandum Of Agreement
MW	Mean Water
NED	National Economic Development
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NO_X	oxides of nitrogen
NPS	National Park Service
NRCS	Natural Resource Conservation Service

List of Acronyms

NW	northwest
NWI	National Wetlands Inventory
OCSLA	Outer Continental Shelf Lands Act
OCTI	Offshore and Coastal Technologies Incorporated
PAR	Planning Aid Report
PED	Preconstruction, Engineering and Design
PMP	Project Management Plan
ppt	parts per thousand
PSP	Project Study Plan
RCRA	Resource Conservation and Recovery Act
SaA	Sassafras sandy loam
SAV	Submerged Aquatic Vegetation
SBEACH	Cross-shore beach profile storm response model
SE	Southeast
SI	Suitability Index
STAC	Scientific and Technical Advisory Committee
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
VIMS	Virginia Institute of Marine Science
VOC	Volatile Organic Compounds
WdA	Woodstown sandy loam
WIS	Wave Information Study
WMA	Wildlife Management Area
yd^3	Cubic yards

EXECUTIVE SUMMARY

The watershed area of Ocean City, Assateague Island, and the Maryland coastal bays offers many attractions that draw millions of seasonal visitors and part-time residents, as well as growing numbers of new permanent residents. The area offers a wide variety of recreation opportunities and activities, and the wide open bays are home to many birds, fish, and other wildlife. In addition to tourism, the region and the State of Maryland benefit economically from a substantial fishing industry that is based in Ocean City.

The National Seashore and State Park, on nearby Assateague Island, is a unique feature of the study area and a national treasure, one of the few natural barrier islands remaining in the nation. It was the intent of Congress in establishing Assateague Island National Seashore that the park (1) provide a protected enclave for the complex plant and animal communities, both terrestrial and aquatic, that characterize the Mid-Atlantic Coast, and (2) fully illustrate the natural processes of change that shape the coastal environment. Located within a 3-hour drive of nearly 45 million people, the National Seashore offers an unspoiled setting and a unique opportunity for visitors to enjoy and be educated about the nature of barrier islands as well as about Assateague's unique and, in some cases, endangered wildlife. The island has gained world renown for its population of feral horses popularized by the publication of *Misty of Chincoteague*, a book about the island's wild ponies, and by the book's many sequels. Assateague Island also serves as a unique "natural laboratory" for the scientific community to conduct investigations relating to barrier island flora, fauna, ecology, and island geomorphology and coastal processes. The mission of Assateague Island National Seashore is to preserve these unique coastal resources and the natural ecosystem conditions and processes upon which they depend, provide appropriate resource-based recreational opportunities compatible with resource protection, and educate the public as to the value and significance of the area. Since 1965, the National Park Service (NPS) has succeeded in this endeavor, maintaining the island in close to its natural state while providing access to millions of visitors attracted to the island's natural setting and wildlife. This access to the public has allowed unique educational opportunities, both formal and informal, to visitors of all ages, that will cease to exist if the island continues to degrade.

Extensive population, development, large-scale agricultural operations, and other factors are jeopardizing the quality of water resources in the coastal bay watershed. Problems include degrading water quality, loss of wetlands, loss of nesting habitat for waterbirds, increasing sediment in the coastal bays, excessive erosion of the Assateague Island National Seashore, navigation difficulties, and increased storm damage. During this study, a comprehensive investigation of various water resource problems has been performed, and solutions to improve the ecosystem as a whole have been developed. The four components of the project investigated are (1) short-term restoration of Assateague Island, (2) long-term sand management of

Assateague Island and Ocean City, (3) navigation improvements, and (4) environmental restoration in the coastal bays.

One cause of some of the water resource problems is the disruption of sediment movement caused by the jetties that stabilize the Ocean City Inlet. These jetties were constructed by the U.S. Army Corps of Engineers in 1934, after the inlet formed during a major storm in 1933. Since its formation more than 60 years ago, the inlet has functioned as a thoroughfare for boating traffic between the ocean and the coastal bays. Although they have provided fishermen and other boaters access to the coastal bays, the jetties have disrupted the sediment supply between Ocean City and Assateague Island. Prior to the formation and stabilization of the inlet, the sand generally traveled from Ocean City south to Assateague Island. Since their construction, the jetties have rerouted a large portion of the sand that would have otherwise reached Assateague. This disruption in the natural longshore transport of sediment between Ocean City and Assateague Island has caused adverse physical, biological, and economic impacts to the area, particularly to the northern 11 km (6.8 miles) of the island. The island overwashes frequently, and the shoreline has eroded back towards the mainland at an accelerated rate. The disruption in sediment transport has also caused the loss of salt marshes and subtidal habitat on the bay side of the island, the infilling and reduction in size of Sinepuxent Bay, and a decrease of habitat diversity on the island. It has contributed to navigation difficulties through the inlet and back bays and has increased the vulnerability of mainland communities to storm damage.

Navigation problems in the back bays and the Ocean City inlet are the result of channel shoaling and boaters' needs for deeper depths to navigate. This shoaling causes delays for commercial fishermen and recreational boaters attempting to navigate the channels of the Ocean City harbor and inlet and the Shantytown Channel. Watermen whose boats have a draft too great to navigate the shoaled channels are forced to navigate with the tides to minimize damage to their vessels. Damage they are unable to avoid and time delays, cause financial impacts to the fishermen.

Environmental degradation from agriculture, development, and erosion has destroyed many thousands of acres of fish and wildlife habitat in the watershed. These losses include more than ***700*** hectares (ha) (***1,750*** acres [ac]) of salt marsh in the coastal bays watershed and more than 10,100 ha (25,000 ac) of forested wetlands. Ecosystem functions that maintain environmental quality have also been lost. Beach-nesting bird species have been deprived of more than 80 percent of their historical nesting habitat by development on Fenwick Island and recreational use of Assateague Island, and waterbird colonies on dredged material islands in Sinepuxent and Chincoteague Bays are threatened by severe erosion. This study has included extensive analysis of these and other environmental problems and possible solutions to them.

These many problems--the sediment supply shortage to Assateague Island, the environmental degradation, and the navigation problems--are interrelated. Therefore, in conducting this study, the study team looked at multi-purpose solutions that would address all the problems described above. The degradation of Assateague Island was determined to be an urgent problem; therefore, an interim study was accelerated and completed in May 1997 so that a project to address the island's immediate needs could be implemented expeditiously. The short-term restoration of Assateague Island recommends the placement of 1.4 million m^3 (1.8 million yd^3) of sand which also serves to partially mitigate for past sediment starvation that began with construction of the jetties in the mid-1930's. This project, a one-time renourishment of the island, is described in depth in an interim report included as an appendix to this report.

Solutions were also investigated to address the continuing sediment deprivation of Assateague Island, navigation needs, and environmental degradation. Analysis of the sediment budget indicated an annual sediment shortfall of approximately 145,000 m^3 (189,000 yd^3) of material to Assateague Island caused by the presence of the jetties. This shortfall will be addressed through long-term sand management. The recommended plan is for the "mobile bypassing" of sand that would naturally have reached the island had the jetties never been built. Mobile bypassing will involve using a shallow mobile hopper dredge to remove sand that has been redirected to a number of sites, and then bypassing it to Assateague Island. This dredging will take place each year to more closely mimic natural processes. Sand will be bypassed from the updrift fillet, ebb shoal, the navigation channels and flood shoals. In order to avoid the creation of new problems by taking too much sand from any one source or too frequently from the same source (thus further disturbing the balance of the area), the project will be monitored annually. A team of decision makers led by the Corps, consisting at a minimum of all the project sponsors (the NPS, the State of Maryland, Worcester County, and the Town of Ocean City), will determine each year how much material can be taken from each of the available sources. Their decision will be based on the monitoring results, which will indicate the rate at which the sources are being naturally replenished after dredging.

Recommended navigation improvements of the harbor and inlet consist of deepening the harbor channel from an authorized depth of 3.07 m (10 feet) to a depth of 4.3 m (14 feet), and deepening the inlet channel from an authorized depth of 3.07 m (10 feet) to a depth of 4.9 m (16 feet). This dredging will remove approximately 68,000 m^3 (88,000 yd^3) of material from the harbor and 46,000 m^3 (60,000 yd^3) from the inlet. The project will be implemented through Section 107 of the River and Harbor Act, as amended. Material dredged from the harbor and inlet may be used in the environmental restoration project and in the long-term sand management project. It is expected that the shoaling rates in the proposed deeper channels will be similar to the existing shoaling rates and no additional maintenance dredging will be required. In addition, with the implementation of the long-term sand management component, maintenance dredging of the inlet should decrease significantly. Although there is no Federal interest in implementing a navigation project for Shantytown Channel, since the high maintenance cost outweighs the benefits, material from this channel may potentially be removed and bypassed to Assateague Island as part of the long-term sand management.

The recommended environmental restoration plan includes restoring a total of 5 ha (12 ac) of salt marsh at the Isle of Wight Wildlife Management Area and ***3.4*** ha (8.5 ac) of salt marsh at Ocean Pines, stabilizing the eroding South Point Island to its 1997 size of approximately 0.93 ha (2.3 ac), constructing a new 1.2 ha (3 ac) island in proximity to South Point to create vegetated habitat for colonial waterbirds, and creating a 1.2 ha (3 ac) island near Dog Island that will be bare substrate with a shell surface for colonial waterbird nesting. The island created near Dog Island will also include three additional cells that will be available to local citizens, businesses, and government for the placement of material dredged locally. Thus, an additional 1.2 ha (3 ac) area of salt marsh will be added in the near future, and up to 8 ha (19 ac) area could eventually be created, increasing the size of this island to as much as 10 ha (25 ac). The areas of restored salt marsh will receive tidal inflow and will provide nursery habitat for a variety of aquatic creatures. Stabilizing South Point Island will protect habitat for the Brown Pelican colony nesting there, and the additional areas will create and stabilize habitat for colonial waterbirds such as the Least Tern.

The long-term sand management and environmental restoration projects were evaluated as having economic project lives of 25 years; the navigation project was evaluated as having an economic life of 50 years. The estimated cost for the long-term sand management, in support of the restoration of Assateague Island is $25,243,000. The first year cost is estimated to be $1,385,000. It is assumed that the first year will be constructed in year 2001. The cost includes $313,000 (contingency included) for lands and damages. These costs are also included in the $17,200,000 short-term restoration project. If the short-term project is constructed, the long-term project would be reduced by this amount. The estimated total cost of the long-term sand management in support of the Atlantic Coast of Maryland Shoreline Protection Project is $41,000 annually. The estimated cost for navigation improvements is $1,672,200. The estimated amount for environmental restoration projects is ***$5,746,600***.

The authority to implement the Assateague Island components of the project, both short-term and long-term sand management, were provided by Section 534 of the Water Resources Development Act of 1996. This Act directed the Corps to implement the restoration of Assateague Island pursuant to Section 111 of the River and Harbor Act of 1968. In addition, the Act authorized the expenditure of $35 million dollars for both the short- and long-term restoration of Assateague Island. As stated, the short-term restoration project is estimated at $17.2 million. At an annual cost of more than $1.1 million for long-term sand management, the project as authorized will carry the project through to fiscal year 2011, assuming the project is fully Federally funded. For the 25 year project duration, the estimated long-term sand management cost is $25,243,000 or $43,773,000 fully funded. Therefore, Congressional project reauthorization of the project is recommended. It stated that the Secretary shall coordinate with affected Federal and State agencies and shall enter into an agreement with the Federal property owner to determine the allocation of the project costs. The Corps is currently coordinating with NPS, the State of Maryland, Worcester County, and the Town of Ocean City to define project implementation responsibilities for both the short-term restoration of Assateague Island and the long-term sand management. All of the project sponsors support the recommended project. The NPS, who administers the Assateague Island National Seashore, has agreed to enter into a Memorandum of Agreement with the Department of the Army.

The deepening of the inlet and harbor channels will be implemented through navigation provisions of the Corps' Continuing Authorities Program, as authorized by Section 107 of the River and Harbor Act of 1960, as amended. The Maryland Department of Natural Resources (MD DNR), Worcester County and the Town of Ocean City support the project. As directed by Section 201 of the Water Resources Development Act of 1986, as amended, during construction, the non-Federal sponsor will pay 10 percent of the costs of construction of the general navigation improvement when the project depth does not exceed 20 feet. The non-Federal sponsor will repay with interest, over a period not to exceed 30 years, an additional 0 to 10 percent of the total cost of depending upon the amount of credit given for the value lands, easements, rights of way and relocations (LERRDs) following project completion.

The environmental restoration projects will be implemented under the general authority of Section 206. MD DNR, Worcester County and the Town of Ocean City support the four restoration projects. The projects will be cost-shared 65/35 with the non-Federal sponsors.

Public involvement and agency coordination for the Ocean City Water Resources Study was designed to be an integral part of the planning process. The purposes of the public involvement program included informing the public and decision makers as required by NEPA; gathering useful information; coordinating with citizens, interest groups, and agencies; assessing support for the project; providing a mechanism for citizen input to the planning process; and explaining the use of tax dollars to the taxpaying public. Public involvement participants included the project partners; natural resource management, regulatory, and planning agencies; citizen and interest groups; and the general public.

Currently, there are a number of ongoing studies and projects in the study area. The action that is relevant to this Corps study is the acceptance of the Maryland coastal bays into the U.S. Environmental Protection Agency's National Estuary Program (NEP) in 1995. Under the NEP, the MD DNR has organized the Maryland Coastal Bays Program (MCBP). This program is charged with protecting and preserving the coastal bays to ensure ecological and economic prosperity in the region. Over a 3-year period, the MCBP will develop a Comprehensive

Conservation Management Plan. The plan will include an in-depth examination of the problems besetting the coastal bays and a set of agreed-upon solutions. Participants in the MCBP include numerous Federal, state, and local agencies; special interest groups; and private citizens. The U.S. Army Corps of Engineers is an active participant in the program and the recommended solutions described in the report support the goals and objectives of this program.

This project will stabilize one of the few remaining functioning barrier islands on the Atlantic coast; restore a unique national treasure, the Assateague Island National Seashore; protect the habitat of the famed wild ponies of Assateague; restore lost salt marsh habitat for aquatic creatures; restore lost island habitat for colonial waterbirds; and protect habitat for Brown Pelicans. It will also improve navigation through the Ocean City harbor and inlet and will help alleviate the shoaling problems in the coastal bays thus providing economic benefits to the fishing industry. In all these efforts, the project addresses multiple and interrelated water resource problems in a way that (1) optimizes benefits by linking dredging with restoration and (2) saves money. The project fulfills Congress' intention to mitigate for impacts caused by past Corps construction to Assateague Island and has the support of all its sponsors as well as the public.

Ocean City, Maryland, and Vicinity
Water Resources Study

DRAFT Integrated Feasibility Report
and Environmental Impact Statement

SECTION 1

INTRODUCTION

This document is the second of two prepared as part of the Ocean City, Maryland, and Vicinity Water Resources Feasibility Study. The study was initiated in July 1995, following the completion of the first phase of the study, the reconnaissance phase. The reconnaissance report, dated May 1994, documented the results of a comprehensive investigation of the water resources problems in the Ocean City area. The report included preliminary evaluations of various plans related to environmental restoration, navigation, storm protection, and water resources infrastructure for the study area. Four project components were specifically identified to be investigated further during the second phase. These components were (1) the short-term restoration of the northern end of Assateague Island; (2) long-term sand management along Assateague Island and Ocean City; (3) navigation improvements; and (4) environmental restoration in the coastal bays.

These four components have been investigated together as one project. We realize the importance of studying the problems in the region as a whole and looking for long-term solutions. Due to the vulnerability of Assateague Island and the imminent threat of its breaching (which would create an additional inlet), that portion of the project was accelerated. The interim report, released in May 1997, focused on finding a short-term plan to restore Assateague Island, reducing the threat of a breach, and partially mitigating for past sediment starvation. The interim report is an element of this report and is included as Appendix D. This second report includes a long-term plan to ensure that Assateague Island does not continue to degrade; it also focuses on the issues of long-term sand management, navigation, and environmental restoration.

This report documents the recommendations for these three issues and includes the documentation necessary to meet the requirements of the National Environmental Policy Act (NEPA). It is considered an integrated Environmental Impact Statement (EIS) because the information required for the EIS is included throughout the report. This EIS was prepared to address specific impacts of long-term sand management, navigation improvements, and ecosystem restoration in the coastal bays. The short-term restoration of Assateague Island EIS was prepared as a part of the interim report and is an element of this report (Appendix D). Because the Assateague Interim report is included as an appendix, only a brief description is included in this report, wherever such description is needed to demonstrate the interconnectedness among all four components. A brief summary of the findings of the Assateague report is included here in Section 1.5.

1.1 STUDY PURPOSE

Due to the changing coastal dynamics and the dense population and development, the Town of Ocean City, Assateague Island, and the adjacent mainland areas and bays are experiencing a variety of water resource problems. The coastal environment has been degraded by inlet and shoreline stabilization, intense development, tourism, agriculture, and other factors influenced by man.

In the past, the U.S. Army Corps of Engineers constructed a number of projects that have impacted the coastal bay area. One of the most significant was the construction of jetties from 1933 through 1935 to stabilize the Ocean City Inlet, which was formed by the hurricane of 1933. Designed and built to provide safe and effective navigation through the inlet between the coastal bays and the Atlantic Ocean, the jetty system has also disrupted the natural movement of sand along the Atlantic coast. In effect, the system has acted as a sand trap, interrupting the flow of sand to Assateague Island for more than 60 years. The primary effect of the jetty-induced interruption of sand to Assateague is that the island has been deprived of a volume of sand in the magnitude of 6.6 million m^3 (8.6 million cubic yards). Because of its diminished volume, the island no longer functions as an effective barrier island. At the time this draft report was initially prepared, in September 1997, results of the study indicated that the next significant coastal storm would cause the island to breach along its northern section. In February 1998, northeasters caused additional damage to the island, and subsequent storms will further compound the problem, possibly leading to a breach as early as 1998. The sand deprivation in the area has also induced other problems throughout the surrounding ecosystem. In addition to diminishing the functioning of the barrier island, sand deprivation caused by the jetty system contributes to various problems in the coastal bays.

The purposes of this study are twofold: (1) to investigate specific water resource related problems in Ocean City, Maryland, and its vicinity and (2) to investigate the feasibility of solutions to these problems. The issues under investigation include excessive erosion of Assateague Island, shoaling of the coastal bays, navigation difficulties, degrading water quality, loss of wetlands, loss of nesting habitat for waterbirds, and storm damage. These problems are interrelated and are being evaluated comprehensively as the four components of this study: (1) the short-term restoration of Assateague Island, (2) long-term sand management, (3) navigation improvements, and (4) environmental restoration in the coastal bays. The overall project goal is to restore the coastal bay ecosystem by restoring coastal functions and wildlife habitat, while protecting and improving the economic resources.

The project team pursuing this goal with the U.S. Army Corps of Engineers are the National Park Service (NPS), the Maryland Department of Natural Resources (MD DNR), Worcester County, and the Town of Ocean City, with MD DNR being the official sponsor of the study.

1.2 STUDY AND PROJECT AUTHORITY

This study was authorized by a resolution of the Committee on Environment and Public Works of the United States Senate, adopted 15 May 1991, which states the following:

> *"RESOLVED BY THE COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS OF THE UNITED STATES SENATE, that the Secretary of the Army is hereby requested to review existing reports of the Chief of Engineers for the Atlantic Coast of Maryland with a view to study, in cooperation with other Federal agencies, the State of Maryland, its political subdivisions and agencies and instrumentalities thereof, the changing coastal environment of the barrier islands, the Ocean City Inlet, and Chincoteague, Sinepuxent, Assawoman, and Isle of Wight Bays and adjacent mainland areas. Included in this study will be the development of physical, environmental, and engineering data on coastal changes and processes to evaluate needed water resources improvements to navigation, flood control, hurricane protection, erosion control, wetlands protection, water supply, and other allied purposes to preserve and enhance the water resources infrastructure which is being severely taxed and degraded by growth, development and other factors."*

The project to restore Assateague Island was authorized by the Water Resources Development Act of 1996, adopted September 25, 1996, which states:

> "(a) *PROJECT TO MITIGATE SHORE DAMAGE.-The Secretary shall expedite the Assateague Island restoration feature of the Ocean City, Maryland, and vicinity study and, if the Secretary determines that the Federal navigation project has contributed to degradation of the shoreline, the Secretary shall carry out the shoreline restoration feature. The Secretary shall allocate costs for the project feature pursuant to section 111 of the River and Harbor Act of 1968 (33 U.S.C. 426I; 82 Stat. 735).*

(b) COORDINATION. - In carrying out the project under this section, the Secretary shall coordinate with affected Federal and State agencies and shall enter into an agreement with the Federal property owner to determine the allocation of the project costs.

(c) FUNDING. - There is authorized to be appropriated to carry out this section $35,000,000.”

1.2.1 Other Study Authorizations

The Continuing Authorities Program (CAP) establishes a process by which the U.S. Army Corps of Engineers can respond to a variety of water resource problems without the need to obtain specific Congressional authorization for each project. This process decreases the amount of time required to budget, develop, and approve a potential project for construction. The Baltimore District U.S. Army Corps of Engineers has constructed numerous small projects under the CAP, and has developed a wide diversity of technical experience in solving problems associated with shoreline and streambank erosion, navigation, flood control, and environmental restoration.

The following is a description of some authorizations under the Continuing Authorities Program.

Small Navigation Projects (Section 107, River and Harbor Act of 1960, as amended). The Corps of Engineers may construct small river and harbor improvement projects not specifically authorized by Congress when they will result in substantial benefits to navigation. The Federal share may not exceed $4 million. Each project must be complete in itself and must not commit the United States to any additional improvement to ensure successful operation. During construction, the non-Federal sponsor pays 10 percent of the costs of construction of the general navigation improvement when the project depth does not exceed 20 feet. The non-Federal sponsor repays with interest, over a period not to exceed 30 years, an additional 0 to 10 percent of the total cost of depending upon the amount of credit given for the value lands, easements, rights of way and relocations following project completion.

Project Modifications for Improvement of the Environment and Aquatic Ecosystem Restoration (Section 206, Water Resources Development Act of 1996, as amended). The Corps of Engineers is authorized to implement an aquatic ecosystem restoration and protection project if the project improves the quality of the environment, is in the public interest, and is cost effective. The Federal share may not exceed $5 million. The maximum annual Federal appropriation limit for this authority is $25 million. Project construction cost sharing is 65 percent Federal, 35 percent non-Federal.

Implementing Ecosystem Restoration Projects in Connection with Dredging (Section 204, Water Resources Development Act of 1992, as amended). The Corps of Engineers is authorized to implement projects for the protection, restoration, and creation of aquatic and ecologically related habitats, including wetlands, in connection with construction, operation, or maintenance dredging of an authorized Federal navigation project. Although there is no per-project limit, the maximum annual Federal appropriation limit for this authority is $15 million. Project construction cost sharing is 65 percent Federal, 35 percent non-Federal.

Project Modifications for the Improvement of the Environment (Section 1135(b), Water Resources Development Act of 1986, as amended). The Corps of Engineers is authorized to investigate, study, modify, and construct projects for the restoration of fish and wildlife habitats where degradation is attributable to existing Federal water resource projects previously constructed by the Corps of Engineers. The Federal share in such projects may not exceed $5 million. Project construction cost sharing is 75 percent Federal, 25 percent non-Federal.

Mitigation of Shoreline Erosion Damage Caused by Federal Navigation Projects (Section 111 , River and Harbor Act of 1968). The Corps of Engineers is authorized to investigate, study, and construct projects for the prevention of shore damage attributable to Federal navigation works. Projects where the cost is limited to $2 million or less do not require Congressional approval. Project costs are shared in the same proportion as implementation costs (including LERRD) for the navigation project or project modification that caused the shore damage.

In addition to the CAP authorities listed above, potential projects could be constructed through Congressional authorization as new start projects.

1.3 STUDY AREA

The study area, which encompasses approximately 780 km^2 (300 square miles), includes the Town of Ocean City and adjacent areas of Worcester County, including the Ocean City Inlet, Assateague Island, and Assawoman, Little Assawoman, Isle of Wight, Sinepuxent, and Chincoteague Bays. The Maryland portion of the watersheds of the aforementioned bays, which includes the eastern portion of Worcester County, was investigated. Also included were the shoals within 17.7 km (11 miles) offshore of Assateague Island. Figure 1-1 shows a map of the study area.

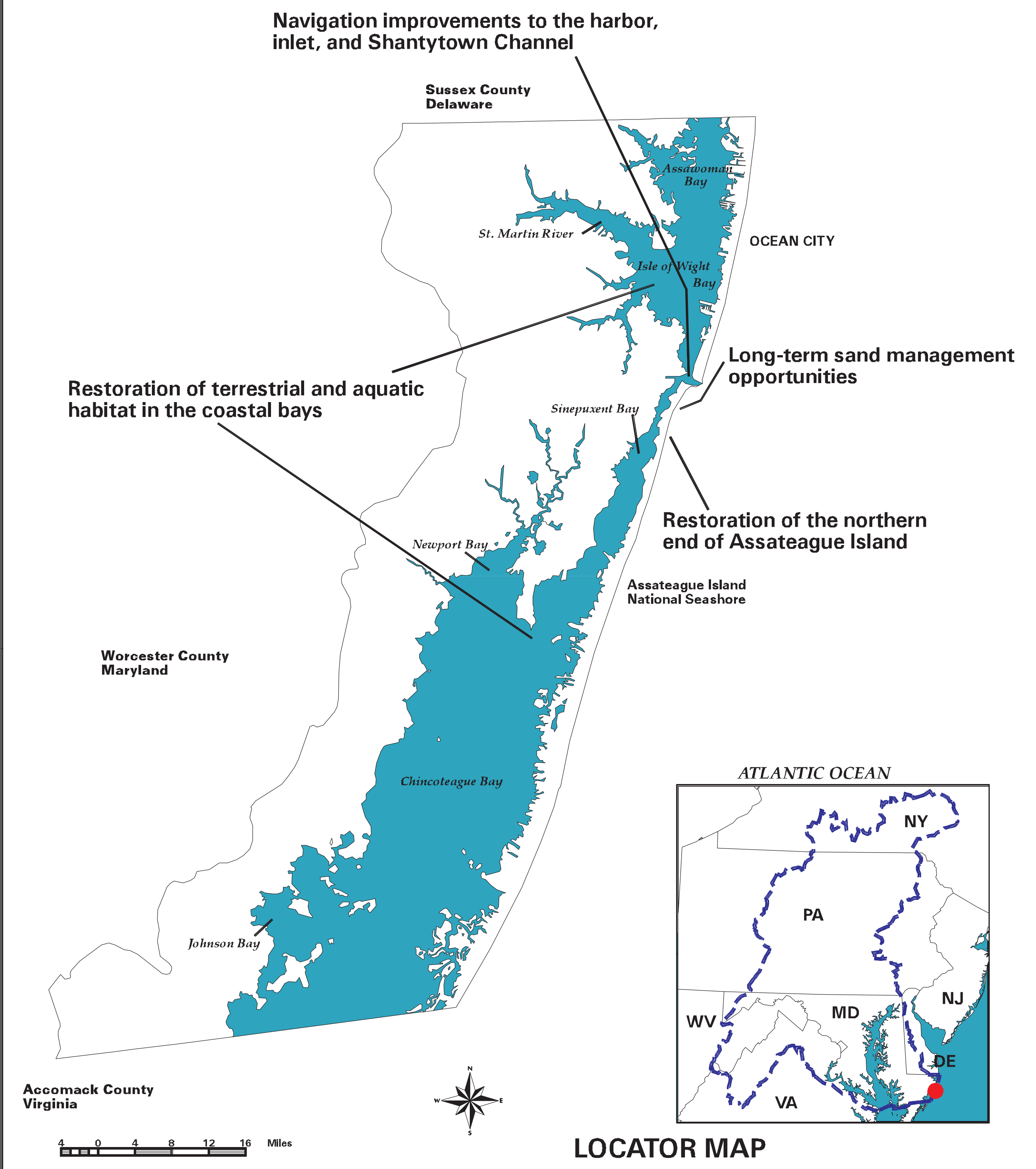
1.4 STUDY PROCESS

The Corps of Engineers uses a study process that has two phases: the reconnaissance phase and the feasibility phase. The reconnaissance phase entails completion of the reconnaissance report, preparation of a project study plan (PSP), and negotiation of a feasibility cost-sharing agreement (FCSA) if a feasibility study is warranted. The reconnaissance phase is a preliminary phase during which problems are identified, potential solutions are determined, and a Federal interest in a potential project is identified. If feasible solutions exist and non-Federal sponsors are interested in cost-sharing more detailed investigations, then the study proceeds into the feasibility phase. The feasibility study is cost-shared 50/50 with at least one non-Federal sponsor. Non-Federal sponsors can include state, county, or local governments, or private interests. The PSP describes the tasks required during the feasibility study and the corresponding costs for those tasks, and is the tool by which the FCSA is negotiated with the non-Federal sponsor(s). During the feasibility phase, new data can be collected through methods such as surveys, soil borings, and current measurements. More detailed designs and cost estimates are prepared, and the most economically justified (benefits>costs) and environmentally acceptable solutions are recommended.

If Corps of Engineers projects are justified, the preconstruction engineering and design (PED) phase follows, when final engineering and designs are completed, as well as construction plans and specifications. Construction follows the PED phase. For traditional Corps-implementable projects, the cost of the PED and construction phases is shared between the non-Federal sponsor and the Federal Government. The cost-sharing varies according to project purpose.

1.5 SUMMARY OF THE INTERIM ASSATEAGUE REPORT, THE SHORT-TERM RESTORATION OF ASSATEAGUE ISLAND

Assateague Island, a natural barrier island that contains Assateague Island National Seashore and State Park, has been excessively eroded over the past 60 years by the disruption of the longshore transport system. This disruption began with the construction of the jetties to stabilize the Ocean City Inlet in the mid-1930's. The jetties' presence caused the rerouting of sand that once naturally nourished the island, resulting in the sediment starvation of Assateague, its subsequent erosion problems, and a variety of other problems including aesthetic impacts, a loss of salt marshes, and a decrease of habitat diversity, among others.



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Study Area and Project Components

Date: 15-AUG-1997
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Figure 1-1

By the close of the study, it was clear that the stability of the island was severely threatened, so much so, in fact, that the next major storm was predicted to breach the island, an event that would cause significant losses to the National Park and wetlands, as well as other impacts The Assateague report focused on the anticipated breaching problem and on a short-term plan to address it, pending the completion of the remainder of the feasibility study. This recommended short-term plan involves placing approximately 1.4 million m^3 (1.8 million cubic yards) of sand on Assateague Island. The borrow area to be used is Great Gull Bank, an offshore shoal. The area designated to receive the material is between 2.5 km (1.6 miles) and 11.3 km (7 miles) south of the inlet. Also, the plan includes a low storm berm to be constructed to an elevation of 3.3 m (10.8 ft) National Geodetic Vertical Datum (NGVD) (averaging 0.8 m in height) in the portion of the beach between 3 km and 10 km (2 miles and 6.2 miles) south of the inlet. A monitoring and action plan has been developed to observe and protect the project area against possible negative impacts for a period of at least 5 years after the short-term plan would be implemented or until the long-term plan is in place. The estimated cost for the short-term project, including 5 years of monitoring, is $17.2 million. The interim Assateague report is included as an appendix to this report (see Appendix D).

The draft interim Assateague Island EIS was released to the public in May 1997. Public comments are currently being incorporated into the interim report. That report is planned to be finalized during the public comment period of this document and included as an appendix of this report once finalized.

1.6 OTHER FEDERAL AND LOCAL ACTIONS

1.6.1 U.S. Army Corps of Engineers Projects

In 1927 Congress authorized the Corps to construct an inlet, protected by jetties, between the Atlantic Ocean and Sinepuxent Bay at a point about 8 km (5 miles) south of Ocean City, and to construct navigation channels. However, no inlet was constructed because a 1933 storm created a natural inlet at the southern tip of the present Ocean City. Following inspection of the breakthrough, the District Engineer proposed that the inlet be stabilized, and the Public Works Administration allotted funds for the immediate construction of the north jetty, which was completed in October 1934. Construction of the south jetty began in October 1934 and ended in May 1935 under the Emergency Relief Program of 1935. A House of Representatives resolution, dated 3 June 1935, authorized the Corps to review navigation in the area. As a result, the Corps constructed an inlet channel, 3 m (10 ft) deep and 60 m (200 ft) wide between the Atlantic Ocean and Sinepuxent Bay; a channel 3 m (10 ft) deep, 30 m (100 ft) to 45 m (150 ft) wide and 900 m (3,000 ft) feet long from the inlet channel to form a harbor with two turning basins of the same depth; and branch channels 6 feet deep into Sinepuxent Bay and Isle of Wight Bay. The resolution also allowed for the raising of the north jetty to an elevation of 9 feet above mean low water. These improvements were completed in 1936. At various times since the jetties' construction, they have been rehabilitated. The jetties have been raised, sand-tightened, and an adjacent scour hole has been filled in; these most recent rehabilitation projects took place in 1984 and 1985.

In the 1960's, Congress authorized the Corps to study storm protection for the Atlantic Coast of Maryland and Assateague Island. This study led to the construction of the Atlantic Coast Shoreline Protection Project in 1991. The project was designed to provide protection against wave and erosion damage associated with a 100-year storm on the Atlantic Ocean. The project involved the placement of sand on the beach, the construction of vegetated dunes, and the construction of a bulkhead. Periodically the beach is nourished, and dunes are maintained as needed. The project was designed to have a 4-year renourishment cycle.

To address the scouring and deterioration of a bulkhead on the bay side of Ocean City in 1989, the Corps constructed stone toe bulkhead protection and a tie-back system near Chicago Avenue.

1.6.2 State and Local Actions

Currently, there are a number of ongoing studies and projects in the study area. The action that is relevant to this Corps study is the acceptance of the Maryland coastal bays into the U.S. Environmental Protection Agency's National Estuary Program (NEP) in 1995. Under the NEP, the MD DNR has organized the Maryland Coastal Bays Program (MCBP). This program is charged with protecting and preserving the coastal bays to ensure ecological and economic prosperity in the region. Over a 3-year period, the MCBP will develop a Comprehensive Conservation Management Plan. The plan will include an in-depth examination of the problems besetting the coastal bays and a set of agreed-upon solutions. Participants in the MCBP include numerous Federal, state, and local agencies; special interest groups; and private citizens. Since the Corps of Engineers is conducting similar work in the area, and data is being shared by both the Corps study and the MCBP, the Corps is an active participant in the program.

Another state and local action worthy of mention is the dredging of non-Federal channels throughout the coastal bays. The State dredges its own channels in Isle of Wight Bay as necessary; there are also numerous private channels to marinas and piers that individuals are permitted to dredge periodically.

SECTION 2

EXISTING CONDITIONS AND AFFECTED ENVIRONMENT

2.0 INTRODUCTION

An understanding of the natural and human environment of the study area is important to identify and evaluate the problems affecting the area. This section focuses on the physical environment and biological resources of Assateague Island, Ocean City Harbor and Inlet, and several specific sites in the coastal bays: Ocean Pines, Isle of Wight, Dog Island Shoals, and South Point Spoils. This document incorporates by reference the discussions related to Assateague Island and the coastal bays contained in the Assateague report, which is available in Appendix D.

The Ocean City Water Resources study area is approximately 780 square kilometers (300 square mi.) in size. It includes the Atlantic Ocean waters and sea floor along Assateague Island and southern Ocean City, Assateague and southern Fenwick Islands, Isle of Wight Bay, Assawoman Bay, Sinepuxent and Chincoteague Bays, and the mainland of the coastal bays watershed (Figure 2-1). The coastal bays watershed is defined on the west by low hills that separate the coastal bays drainage from the Pocomoke River watershed. The northern and southern limits are the Maryland boundaries with Delaware and Virginia, respectively. The seaward limit of the study area is defined by the location of Great Gull Bank, an offshore shoal located about 8 km (5 miles) east of the inlet in the Atlantic Ocean.

Notable shoals occur on the ocean and bay sea floor in the study area. These shoals include the ebb tidal shoal, which lies in close proximity to the Ocean City inlet, and a series of offshore shoals that are oriented southwest/northeast on the seafloor. Within the coastal bays, flood-tidal shoals occur in close proximity to the inlet. The inlet connects the waters of the bays to the ocean and provides a pathway for the waters to mix. Assateague and Fenwick Islands form the Maryland shoreline; although Assateague is an island, Fenwick is actually a spit. Assateague is undeveloped and is preserved as open space under the administration of the U.S. National Park Service (NPS), U.S. Fish and Wildlife Service (FWS), and the State of Maryland. Fenwick, however, is fully developed as a tourist resort, and contains the town of Ocean City. The two “islands” serve to enclose and protect the coastal bays. The bays are shallow and are bordered on their margins by salt marshes and residential developments. The mainland of the study area has residential development in close proximity to Ocean City and the coastal bays, but is otherwise largely rural, consisting of farms and forest.

Harbor and Inlet

Ocean City Harbor was created in 1935. The inlet formed naturally in 1933, but was subsequently stabilized by jetties in 1934/35. Since their creation, the inlet and harbor continue to be dredged to the federally authorized dimensions of 3 meters (10 ft) deep and 61 meters (200 ft) wide (see Figure 2-2).

Dog Island Shoals

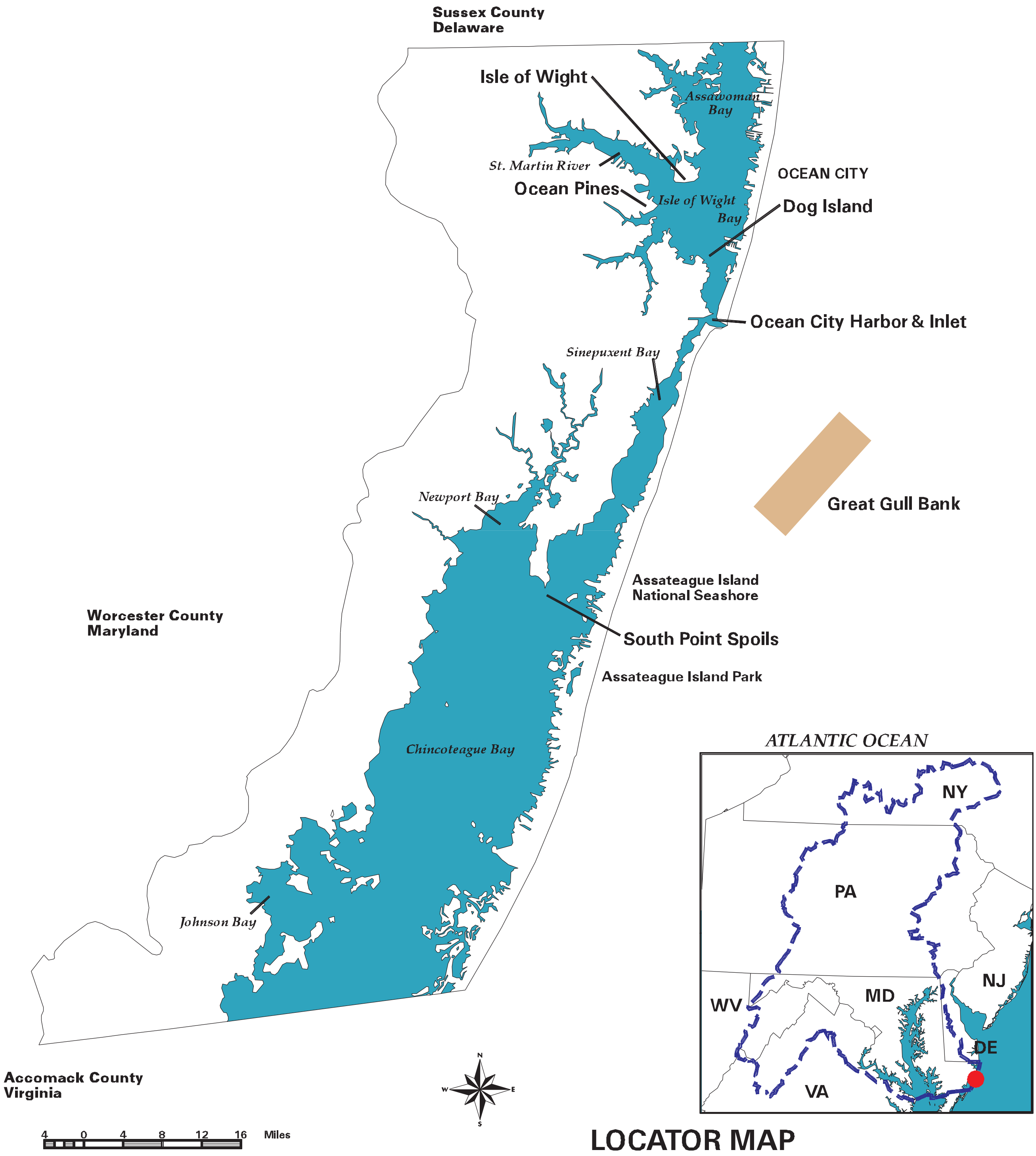
The Dog Island Shoals area is a large expanse of shallow water located at the southern end of Isle of Wight Bay (Figure 2-3). Dredged channels provide for navigation through this area. The southern Fenwick Island bay shoreline adjacent to the shoals is entirely developed, with the majority of the shoreline bulkheaded. The mainland shoreline adjacent to the shoals is largely stabilized with riprap, although small parcels of salt marsh and beach still occur there. Dog Island itself is a small marsh island located along the mainland shoreline within the shoal area; it is owned by the state and is contained within the Sinepuxent Bay Wildlife Management Area.

Isle of Wight

The Isle of Wight is a 90-hectare (ha) (223-ac) island located 3.2 kilometers (2 mi.) west of Ocean City at the meeting point of Isle of Wight and Assawoman Bays; the St. Martins River lies to the west of the island (Figure 2-3). The island is crossed by Route 90, which provides one of two links between Ocean City and the mainland in Maryland. The island is primarily state-owned, with the majority of it being a Maryland Department of Natural Resources (MD DNR) wildlife management area. The State Highway Administration owns Route 90 and a right-of-way along the highway. Worcester County owns a 0.4 hectare (1 ac) parcel along the southern shoreline that formerly possessed a public boat ramp. The boat ramp is no longer functional. The southwestern shoreline is in a natural condition. In contrast, the southeastern shoreline of the Isle of Wight is completely stabilized with concrete riprap, concrete bulkheads, and steel sheet pile. The sheetpile is failing, and is considered hazardous to public safety. Concrete structures associated with a former concrete slab production facility also occur on the site. The southeastern shoreline has been targeted by the MD DNR for potential improvements to reduce public safety risks, and to enhance the value of the site for recreational activities such as fishing, crabbing, and hiking.

Ocean Pines

Ocean Pines is a large residential development located along the western shoreline of Isle of Wight Bay between the St. Martins River and Manklin Creek (Figure 2-3). Older portions of the development possess many artificial canals that were constructed prior to the 1970's. These canals provide protected waterways and docking space for residences along the canals. Some of the older portions of the development are built on filled salt marshes and forested wetlands; newer sections incorporate setbacks and open-space parcels to protect these resources.



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Ocean City Water Resources Feasibility Study

Existing Features

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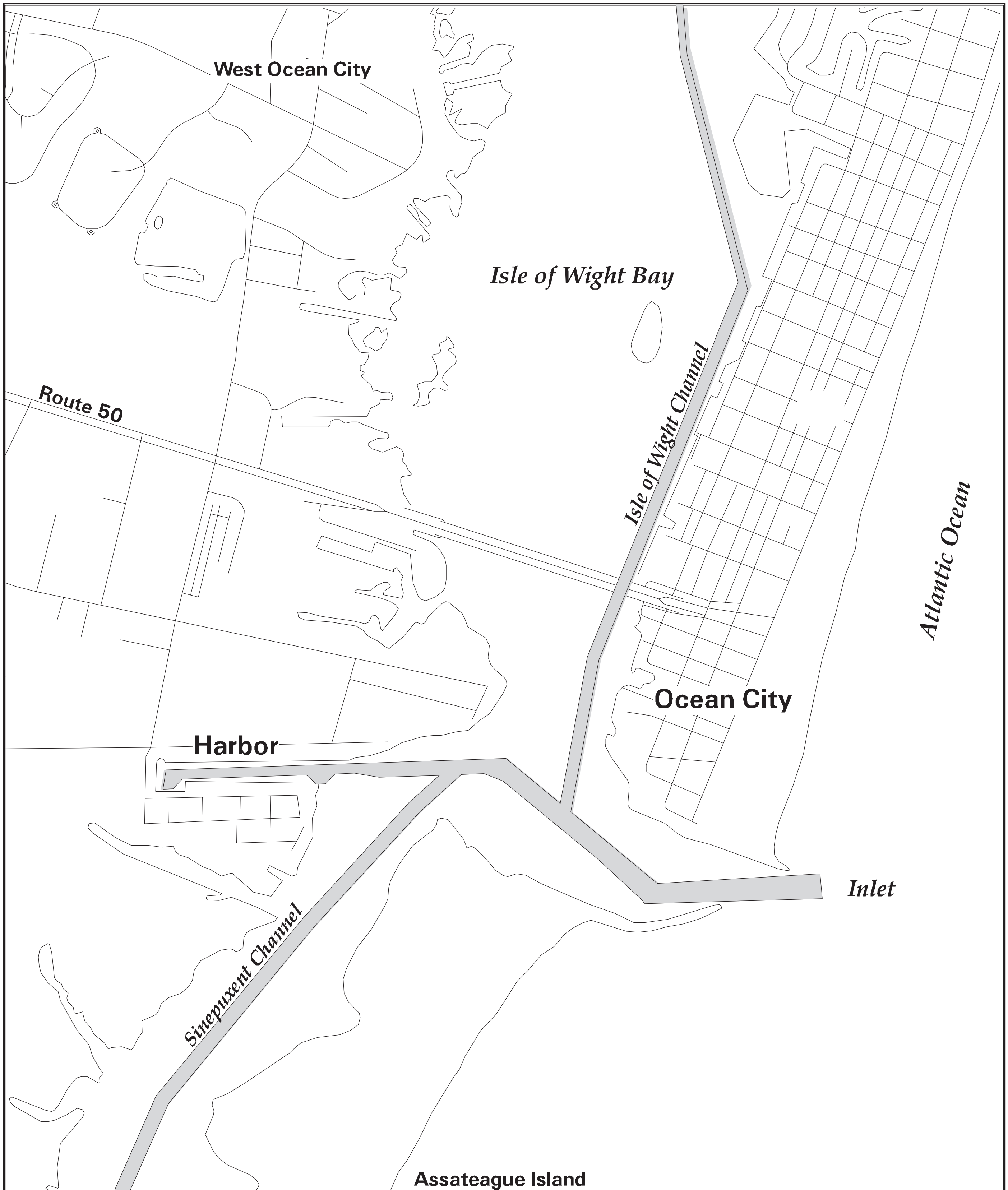
Figure 2-1



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Ocean City Water Resources Feasibility Study

Ocean City Harbor, Inlet, and Federal Channels

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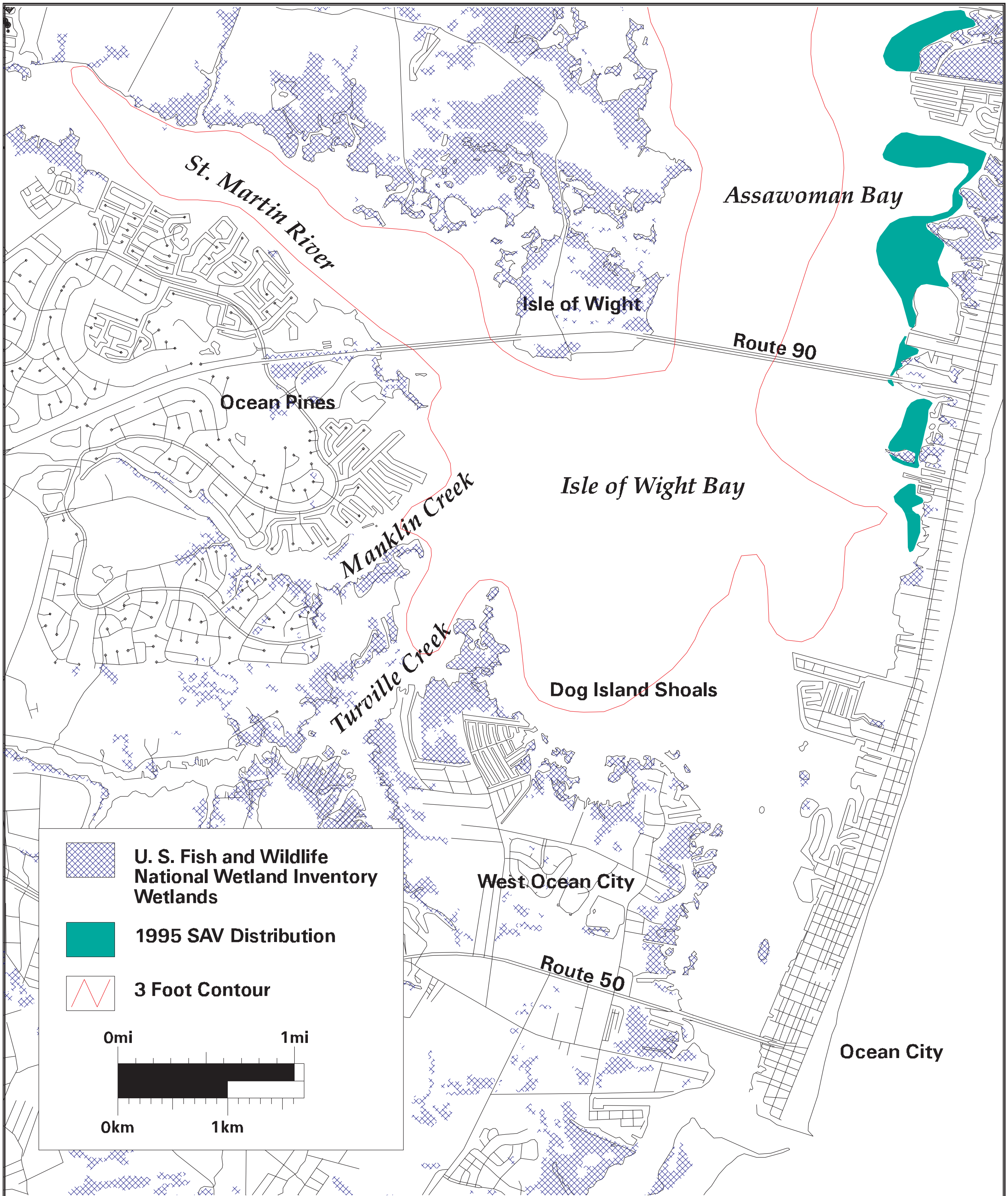
Figure 2-2



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Baltimore District

Ocean City Water Resources Feasibility Study

Location Map: Dog Island Shoals Isle of Wight, and Ocean Pines

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Figure 2-3

South Point Spoils
South Point Spoils is a 0.9-hectare (2.3-ac) island located in shallow water nearly 1.5 kilometers (0.9 mi.) from nearest land at the northern end of Chincoteague Bay (Figure 2-4). The island was formed by the Corps of Engineers in 1935 from dredged material side-casted from the newly created Sinepuxent Channel, which lies 230 meters (750 ft) northwest of the island. Smaller dredged material islands constructed at the same time lie to the northeast and southwest of South Point Spoils. The isolated location of the island in the relatively pristine waters of Chincoteague Bay makes the island ideally suited as nesting habitat for waterbirds, and the island possesses a regionally significant colony of herons and egrets. Until recently, the island supported the northernmost colony of Brown Pelican on the Atlantic coast; changes in island size and character caused by erosion may have caused the pelicans to abandon the site. The island is surrounded by perennial and ephemeral beds of submerged aquatic vegetation (SAV). It is owned by the state of Maryland and is part of the Sinepuxent Bay Wildlife Management Area.

This report was compiled using existing information, contacts with scientists and resource agency personnel, and recent research by the Corps of Engineers Waterways Experiment Station (WES), Coastal and Hydraulics Lab (CHL). The general features of the coastal bays watershed, Assateague Island, and the coastal ocean were discussed in the Assateague report. In an effort to reduce the length of this document, information contained in the Assateague report is referenced in some cases. The reader may wish to refer to a copy of that report, located in Appendix D, to clarify some of the discussion contained here. A list of all the written references used in preparing this report can be found in Annex E. Records of personal contacts can be found in Annex A, Part 7. The CHL reports can be found in Annex A.

2.1 PHYSICAL ENVIRONMENT

This section addresses the character and processes of the physical environment that are critical to an understanding of the study area. Because of its location on the coastline, dynamic physical conditions characterize the study area's aquatic and terrestrial environment.

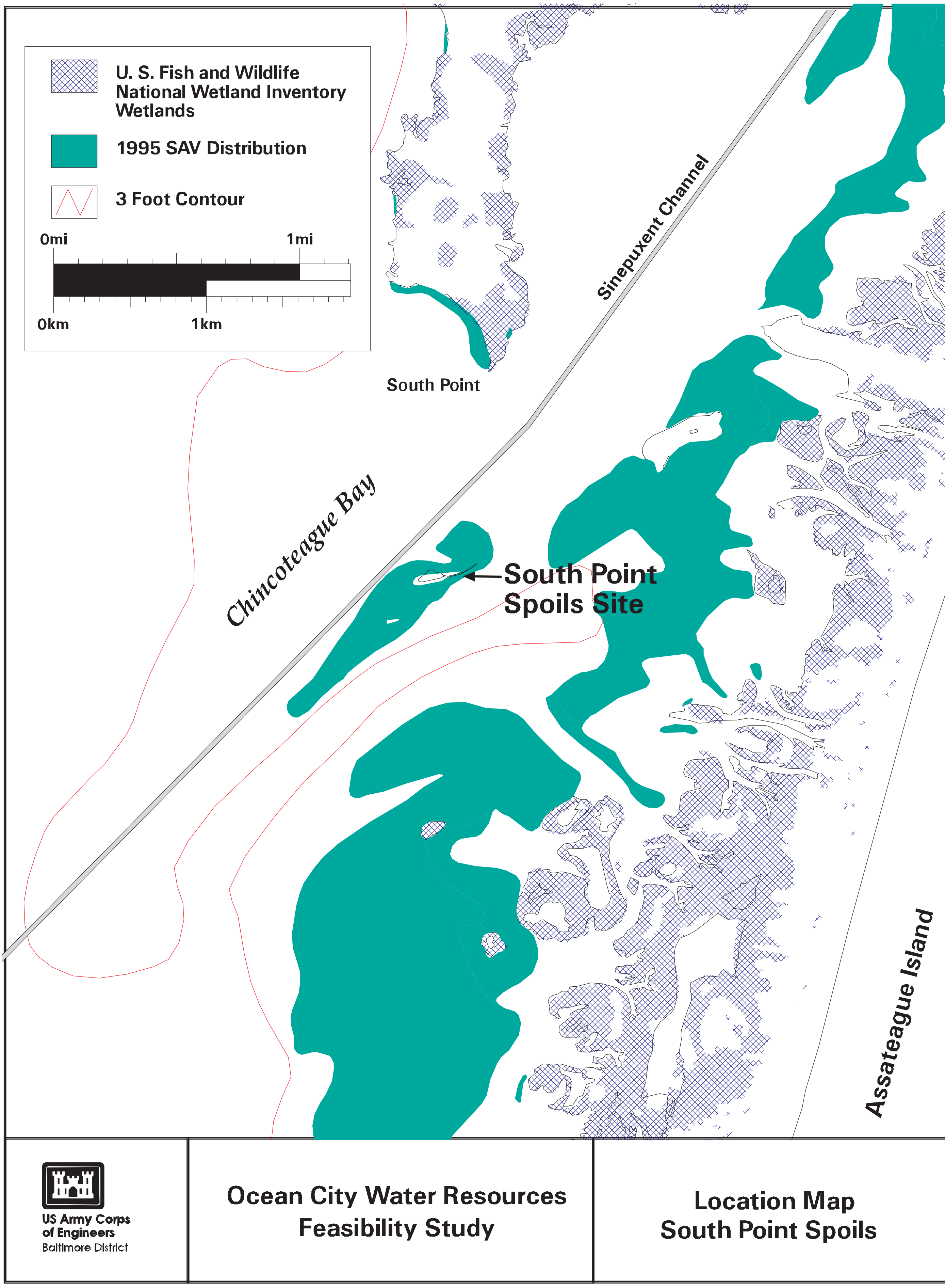
2.1.1 Surficial Geology and Sedimentary Processes

The study area lies within the coastal plain physiographic province. Unconsolidated sediments consisting of gravel, silt, clay, sand, and shell underlie the entire study area. Sediments that occur at the surface are of interest for a variety of reasons. Within the terrestrial environments of the study area, sediments serve as the parent material from which area soils have formed. On the seafloor, surficial sediments play an important role in controlling the aquatic life that is likely to utilize an area. In the bays, the grain size of bottom sediments is an important initial criterion to use in determining whether the sediment is likely to be polluted, since pollutants (such as toxic metals and organics) are usually found in fine-grained sediments. On the seafloor of the coastal bays an important distinction can be made between recently deposited sediments (those deposited since the end of the last Ice Age some 10,000 years ago) and older sediments. Older sediments are typically compacted, and, where exposed at the surface, have a relatively high-bearing load (can support weight). In contrast, recently deposited materials when fine-grained are vulnerable to compaction when heavy weight is placed on top of them. Recently deposited sediments can be many meters in thickness in the channels. Sedimentary processes of interest to this report focus on erosion and deposition that occur as a result of wind-driven waves and tidal currents. Within tidal channels where strong currents occur, erosion and deposition of sediments can occur from the water surface to the channel bottom. Outside of tidal channels, erosion and deposition processes are limited by the depth to which wave energy can effectively disturb the bottom. In the ocean, this depth is about 6.4 m (21 feet); in the quieter coastal bays, this depth is about 1.8 meters (6 ft). Over short periods of time, individual storm events play a large role in the movement of sediments. Over longer periods of time, factors such as rising sea level and cumulative impacts to the sediment transport system such as those caused by the construction of jetties at Ocean City Inlet and beach nourishment of Ocean City become increasingly important.

The Ocean City inlet was formed in a breach caused by a hurricane in 1933. The Corps of Engineers stabilized the 1933 breach by constructing the north jetty in 1934 and the south jetty in 1935. This reduced the volume of sediment delivered to Assateague Island from the north via the longshore transport system, and induced accelerated erosion and retreat of the northern end of the island. Island retreat has been most pronounced in the northernmost 6.5 kilometers (4 mi.); however, accelerated retreat rates may extend to 13 kilometers (8 mi.) south of the jetties. Other changes resulting from stabilization of the inlet included accumulation of sand and seaward shoreline movement on the updrift Ocean City beach in a fillet at the north jetty, development of an ebb-tidal shoal on the ocean side of the inlet, and formation of a dual flood-tidal shoal within the coastal bays.

2.1.1.a <u>Assateague Island Nearshore</u>. Natural barrier island morphology is caused by a variety of depositional and erosional processes. Major sedimentary environments that can occur on barrier islands proceeding from ocean to bay include the beach, dunes, barrier flats and washover fans, salt marshes, and tidal flats. Northern Assateague Island is sediment starved. As a consequence, the island experiences frequent overwashes, and barrier flats, washover fans, and tidal flats are disproportionately represented at the expense of dunes and salt marsh.

In areas such as Assateague Island where tidal range is 1 meter (3 ft) or less and storm frequency is high, overwash would be a regular event even if stabilization had not occurred. On northern Assateague in the reach from 3 to 10 kilometer (1.9 to 6.2 mi.) south of the inlet, overwash occurs as many as 20 or more times per year. Overwash frequently extends to the bayshore. As a result, the island's width on the northern end is maintained within a relatively constant range, even though the island is actually retreating. Prior to inlet stabilization, maximum heights on the



U. S. Fish and Wildlife National Wetland Inventory Wetlands
1995 SAV Distribution
3 Foot Contour
0mi
1mi
0km
1km
South Point
Sinepuxent Channel
Chincoteague Bay
South Point Spoils Site
Assateague Island
US Army Corps of Engineers
Baltimore District
Ocean City Water Resources Feasibility Study
Location Map
South Point Spoils
Date: 15-AUG-1997
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Figure 2-4

island may have been 1.5 to 1.8 meters (5 to 6 ft) higher, and overwash events rarely reached across the island to the bayside.

Prevailing waves produce a net southerly current along the Maryland shoreline. This current of water transports sand in a southerly direction in what is known as the longshore transport system. Sand transported southward from eroding coastal headlands located near Bethany Beach, Delaware, and sand exhumed from the seafloor both formed and maintains Assateague and Fenwick Islands. Prior to inlet stabilization, a constant flow of sediment was available to Assateague. Construction of the Ocean City jetties to stabilize the newly formed inlet in the 1930's interrupted the southerly flow of sediment and induced sediment starvation of Assateague. Because of disruption to the natural flow of sediment caused by the ebb shoal, net longshore transport along the northernmost 6.3 km (3.9 miles) of the island is northerly. South of this point, net southerly flow of sediment resumes. This "nodal point" is considered in greater detail in Appendix A2.

Because this interruption in sediment flow has caused severe detrimental impacts to Assateague Island, the movement of sand along the shoreline has been thoroughly investigated for this report. The longshore transport system moves tremendous volumes of sand along the coastline and into and out of the coastal bays. On an annual basis, approximately 115,000 cubic meters (150,000 yd^3) of sand moves from Fenwick Island into the Ocean City Inlet; 53,000 cubic meters (69,000 yd^3) is transported from the ebb shoal to Assateague Island; and approximately 83,000 cubic meters (110,000 yd^3) is transported from Assateague Island into the Ocean City Inlet system. The volume of sand being lost annually to Assateague Island is approximately 145,000 cubic meters (190,000 yd^3). This volume accounts for the loss of material from Assateague Island into the inlet system. The sediment budget is discussed in detail in Appendix A2 of this report.

Other natural factors are at work that contribute to the destabilization of Assateague Island when considered over a long-term perspective. Along the U.S. east coast, barrier islands are generally migrating landward in response to rising sea-level. Sea-level rise rates vary from location to location as a result of many physical environmental factors. Sea level is currently rising at a relatively rapid rate –in excess of 3 millimeters (0.12 in) per year (0.3 meters [1 ft] per 100 years) – in Maryland. This rate of rise could increase substantially if predicted global warming occurs. Barrier islands can fail if the rate of sea-level rise increases too much relative to the supply of available sediment and the slope upon which the island is migrating. As a consequence of physical environment conditions, the island was losing sediment volume even prior to jetty construction; however, the jetties greatly increased the rate of sediment loss (See Appendix A of the Assateague report for additional information).

When considered over a short-term perspective, barrier landward migration is achieved during storm conditions by inlet dynamics and overwash events. When a new inlet forms, large quantities of sand are carried into the back bays and form flood-tidal shoals. When an inlet finally closes over time, salt marshes typically form on the flood-tidal shoal deposits. Barriers can retreat landward as a unit over the top of salt marsh and back bay deposits. If the sediment supply is cut off, as has occurred at Assateague Island, the systematic retreat of a barrier island unit can be jeopardized.

2.1.1.b Ocean City Updrift Fillet. The fillet is a triangular-shaped wedge of sand that lies along the southernmost Fenwick Island shoreline (see Figure 2-5). It formed as a direct consequence of sand being impounded on the updrift side of the north jetty at the inlet. The jetty was fully impounded by 1972. The fillet extends from the jetty north for a distance of 2,100 meters (7,000 ft) and contains approximately 2.2 million cubic meters (2.8 million yd^3) of sand.

Sediments on the seafloor and beach along the Ocean City shoreline consist primarily of medium to fine sand. Historically, sediments that formed the beach at Ocean City were derived from local updrift sources. Currently, sediments that make up the beach at Ocean City consist to a substantial degree of material dredged from the Ocean City borrow areas, which are offshore shoals. Small shore-attached shoals occur on the seafloor off the fillet. The sediments of these small shoals become coarser in the northerly direction. The sediments of the shore-attached shoals are less coarse than those of the offshore shoals. The sediments and evolution of the fillet are discussed at length in Appendix A6.

2.1.1.c Tidal Shoals.

The Flood-tidal Shoals

Following the 1933 breach, the incoming flood tide deposited sediment to form shoals in the coastal bays near the inlet (Figure 2-5). These flood-tidal shoals include a large shoal located north of the inlet and a smaller section located south of the inlet. The southern part of the flood shoal is located in northern Sinepuxent Bay, near the inlet, and has an area of 10 hectares (25 ac). The northern part of the flood shoal extends from immediately south of Route 50 for 2.5 kilometers (4 mi.) north of Route 50 into Isle of Wight Bay, and has an approximate area of 100 hectares (250 ac). Skimmer Isle near Route 50 is an emergent part of the northern flood-tidal shoal. The southern flood shoal has diminished in area and volume since its formation as Assateague Island migrated landward, while the northern flood shoal continues to grow. Shantytown Channel and marinas at the southern end of Ocean City may have high sedimentation rates because of their location adjacent to the flood-tidal shoal. As of 1995, the south flood shoal was approximately 9 percent of the size of the north flood shoal. See Appendix A6 for a discussion of the evolution, sediments and processes characterizing the tidal shoals.

Sedimentary Processes and Bathymetry

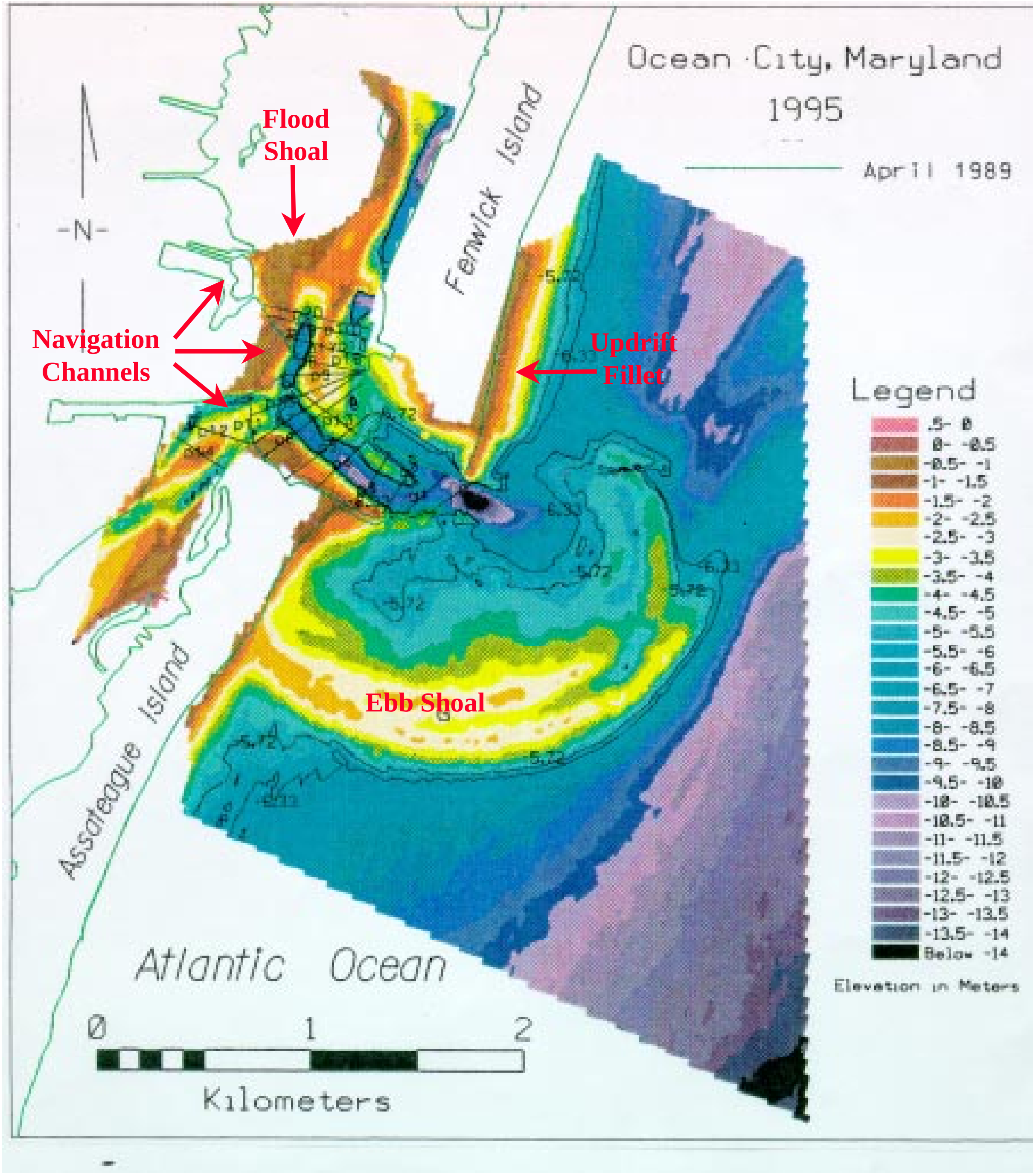


Figure 2-5

Since these shoals have formed in high-energy environments in which there are strong tidal currents and waves, they consist primarily of sand. Fine-grain sediments are winnowed away. Navigation channels adjacent to the flood shoals also possess coarse sediments because strong tidal currents winnow away finer-grained sediments at these locations. The sediments of the flood-tidal shoals are discussed in more detail in Appendix A7.

The Ebb Shoal

Following stabilization of the inlet in the 1930's, as the north jetty impounded sand from the net southerly drift and as Assateague Island retreated, a large crescent-shaped shoal has formed which is offset to the south of the jetties (Figure 2-5). The ebb shoal traps sand that is moving south from Ocean City, as well as capturing sand being moved out of the coastal bays on the ebb-tide. The ebb shoal continues to act as a sink for sediment, and is growing in volume. Ocean City beach nourishment which began in the 1980's has augmented the growth of the ebb shoal. By 1995, the shoal had grown to 1,450 meters (4,750 ft) offshore and to approximately 2,300 meters (7,500 ft) alongshore. In the same year, the total volume of the shoal was approximately 10 million cubic meters (13 million yd^3) of sediment. Over the 62 years since the shoal's formation, the average rate of growth has been 166,500 cubic meters per year (217,800 yd^3/yr). The historic record of the evolution of the ebb shoal is discussed at length in Appendix A6.

Surface sediments of the ebb shoal possess a range of grain-size distributions as a function of location. Sediments near the inlet are coarsest and consist of shell and coarse sand. Sediments along the shoal crest are largely medium sand, while sediments in deeper waters of the ebb-shoal, on its seaward side, consist of fine sands. The sediments of the ebb shoal are discussed in more detail in Appendix A6.

2.1.1.d Great Gull Bank Offshore Shoal. The Great Gull Bank is one of several shoals located offshore of the barrier islands. The shoal is located about 8 kilometers (5 mi.) east of Assateague Island in the Atlantic Ocean. The shoal is oblong in shape and is oriented southwest/northeast. The shoal covers an area of approximately 4,900 hectares (1,980 ac). Maximum length and width are about 6 kilometers (9.6 mi.) and 1.8 kilometers (2.9 mi.) respectively. The shoal contains 42.8 million cubic meters (56 million yd^3) of sand of which about 22 million cubic meters (29 million yd^3) is usable for beach fill .

2.1.1.e Ocean City Harbor and Inlet. Ocean City Harbor was created by excavating into the mainland in 1935. Since its creation, the harbor has been repeatedly dredged (see Figure 2-2). Because the harbor lacks strong currents and waves, minimal sand transport into harbor waters occurs. Instead, silt and clay accumulates in the harbor following each dredging cycle. Fine-grained sediments of several centimeters' thickness overlie thick sands in the near subsurface. A report discussing characteristics of harbor sediment is included in Appendix A7.

Inlet bottom sediment patterns result from the complex interaction of inlet currents with bay and ocean waves. Sediments in the inlet generally consist of coarse-grained sand due to tides and currents scouring away finer-grained sediments. Sediment carried into the coastal bays by the flood tide accumulates in the back bays near the inlet in deposits known as flood-tidal shoals or deltas. The islands near the Route 50 bridge west of Ocean City were formed by this process. Sediment has also accumulated on the seaward side of the inlet; this is known as an ebb-tidal delta or shoal. Inlets typically form during storm events, as did the Ocean City Inlet in 1933. Inlets can form either from the ocean or the bay side of an island. Physical factors such as width and height of the island, magnitude and duration of the storm, depth and size of the back bay, and number of existing inlets determines vulnerability of a barrier island to breaching. Once formed, these inlets typically migrate in a southerly direction for a period of time, and eventually shoal in and close. Without intervention from man, inlets on Fenwick and Assateague Island would open and close naturally in a cycle taking from several years to decades to complete.

2.1.1.f Dog Island Shoals. This area lies at the northern extent of the northern flood-tidal shoal (see Figure 2-3), and tidal sedimentary processes dominate local surface geology expressions. Tidal currents form and maintain a branching pattern of channels and associated shoals. Flood-tidal currents carry sediments into the area from the ocean, and ebb-tidal currents then drag some of this sediment seaward. Tidal currents scour the bottom and maintain a series of shifting natural channels through the shoal sediments. At the northernmost extent of the shoal some reworking of sediments by waves, driven by winds from the north, also occurs.

The bay bottom sediments in the Dog Island Shoals vicinity consist of poorly graded fine to medium-fine sand. Minimal fine-grained sediment occurs; silts and clays typically constitute only about 14 percent of the surficial sediments. The site is underlain by recent sediment deposits of about 2 meters (6.5 ft) thickness.

Several small marsh islands occur along the western side of the northern flood-tidal shoal adjacent to the mainland. It is after one of these islands - Dog Island - that the shoals have been named for this report. Dog Island was formed by irregular erosion of the mainland, and the island continues to erode. Dog Island was formerly accompanied by a smaller island in close proximity named Bitch Island. Bitch Island eroded from about 2 acres in size in 1850 to less than 1 acre in size by 1964. It has since vanished. Dog Island eroded from a size of about 3.4 hectares (8.5 ac) in 1850 to a size of about 0.6 hectares (1.5 ac) by 1964. It is now less than 0.2 ha (0.5 ac) in size and will probably vanish in the first half of the next century.

2.1.1.g Isle of Wight. Isle of Wight has formed as the rising sea gradually floods the land. Since it is a natural high point, it has become an island (see Figure 2-3). Shoreline erosion and marsh failure are severing the Isle of Wight from the mainland. The marshes on the north side of the island are broken by many interconnected tidal ponds, but were more continuous in the past. Marsh failure here is presumed to be caused by lateral erosion and the failure of marsh development to keep pace with rising sea level, a trend which contributes to the formation of interior ponds. Along the southern shoreline, erosion averaged 0.35 meters (1.2 ft) per year between 1850 and 1972. This rate is characterized by the MD DNR as slight to low.

The bay bottom sediments south of the island consist of poorly graded sand with silt, with a minor amount of organic matter. In the shallow waters south of the Isle of Wight, recently deposited sediments form only a thin veneer over older, compacted sediments. Recently deposited bottom sediments at the Isle of Wight derive largely from waves reworking underlying geological material. Finer-grained sediments in the shallow water depths are winnowed away by wave action. Additional information on bottom sediments at the site can be found in Appendix B - Geotechnical Analyses.

2.1.1.h. Ocean Pines. The upland areas of Ocean Pines are underlain by older compacted sediments that consist largely of silty sand, although clays and peats are also present in the subsurface (see Figure 2-3). In areas of Ocean Pines where tidal marsh occurs, a layer of tidal marsh sediments consisting of fine-grained sediments and salt marsh plant remains has been deposited on top of the older silty sands that underlie the area. In certain areas that were formerly tidal marsh, dredged spoil was deposited over the tidal marsh sediment.

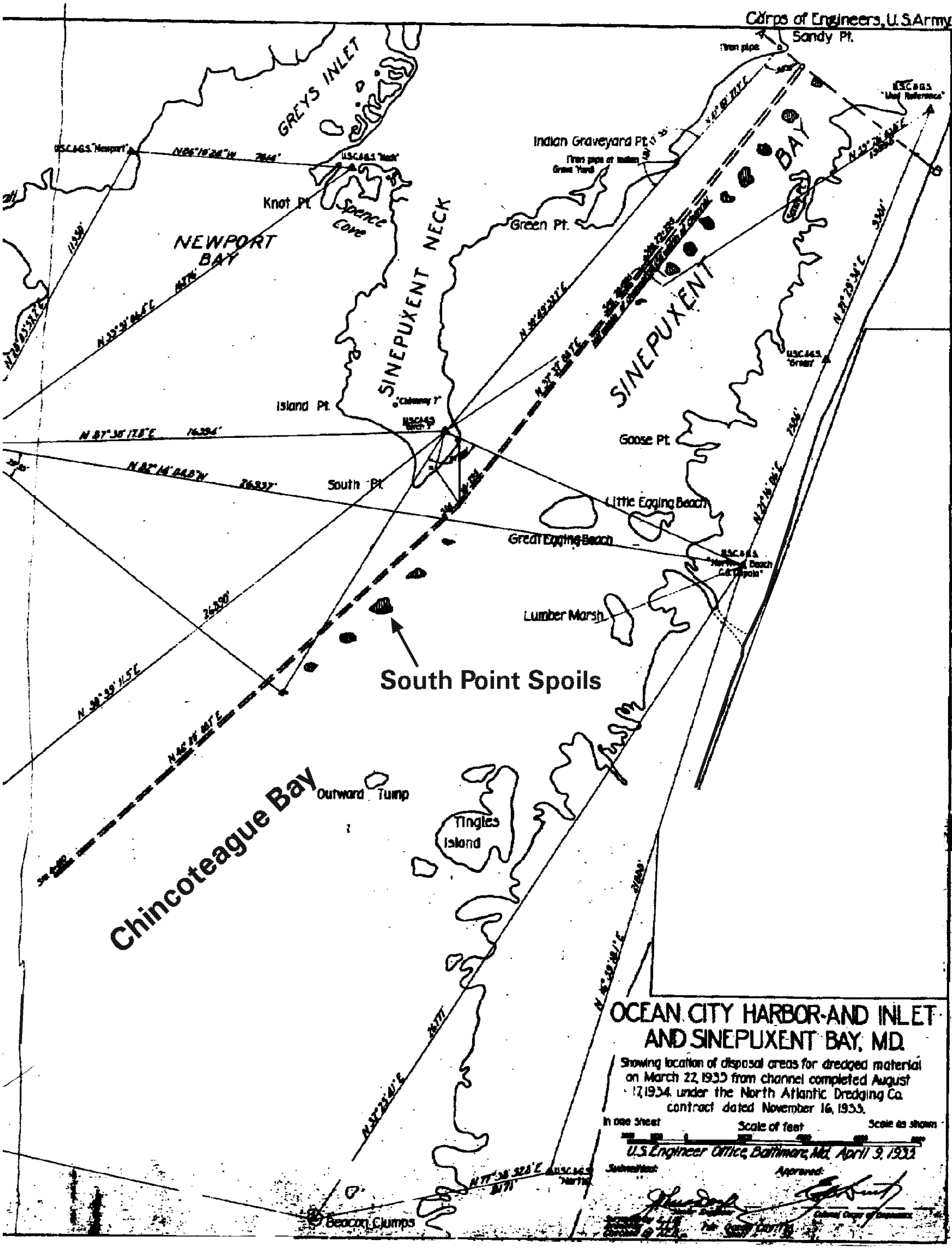
2.1.1.i South Point Spoils. Surficial sediments on the bay bottom in the site vicinity consist predominantly of sand, with local patches of sandy silt and silty sand occurring within several hundred meters of the island (see Figure 2-3). Sediments in the Sinepuxent Channel adjacent to the site contain a high proportion of fine-grained sediments. The orientation of shoals in the area indicates that net transport of sediments in the area is to the southwest.

South Point Spoils island was originally created by the Corps of Engineers by side-casting material dredged from the bay bottom during the creation of the Sinepuxent Channel in 1934/35 as illustrated in Figure 2-6. At that time sidecasting of dredged material taken from channels was a common practice. There were originally 29 islands created along the length of the Sinepuxent Bay Channel. Erosion has taken a severe toll on all these artificial islands, and only four small remnant islands, including South Point Spoils, still exist. Additions of dredged material to the island in the years following its creation served to prolong South Point Spoils' life. An additional factor contributing to the survival of South Point Spoils and the small islands to the southwest and northeast of it is the position of these islands upon a shoal that is oriented parallel to the long axis of Chincoteague Bay - which is also the direction of greatest fetch. The shoal serves to dissipate the energy of waves from the northeast and southwest before they strike the island.

South Point Spoils is eroding; the west and northwestern sides of the island show the greatest evidence of erosion. South Point Spoils island was originally about 2 hectares (5.2 ac) in size. Additional material was probably added to the island during channel dredging in 1963 and perhaps in 1946. The island's size at several times from 1935 and 1996 is shown in Table 2-1. Since it is not known how much material was added subsequent to the island's creation, it is not possible to calculate an erosion rate. However, no material was added after 1964, and it is possible to characterize the loss rate from 1964 through 1997. During this period of time, the island lost 0.8 hectares (1.9 ac), or somewhat less than half its total area, at an average rate of 0.02 hectares (0.06 ac) per year. The erosion rate will likely accelerate as the island decreases in size and the edge to interior ratio increases. The island is expected to vanish sometime in the first half of the 21st century.

Table 2-1. South Point Spoils Island Sizes

Year	Size (acres)	Information Source
1935	5.2	Corps Dredging Chart
1964	4.2	County Soil Survey
1987	2.7	VIMS Aerial Photos
1997	2.3	Md. DNR Site Survey



US Army Corps of Engineers Baltimore District	**Ocean City Water Resources Feasibility Study**	**Historic Dredge Material Islands Along Sinepuxent Channel**

Date: 13-AUG-1997
/harold2/pmn/ocity/report/oldmap.map

Figure 2-6

2.1.2 Physiography and Topography

2.1.2.a Assateague Island. The ocean shoreline of Fenwick and Assateague Islands is gently curving; ocean waves and currents maintain the smooth ocean shoreline. The bayside shoreline is scalloped and lobate; islands and lobes on the bayside of the barriers mark the location of relict tidal inlets and past washover events. Assateague Island is naturally much narrower at its northern end than at its southern end. Over the island's 61-kilometer (38-mi) length, it ranges in width from about 270 meters (900 ft) at the northern end to about 1.6 kilometers (1 mi.) near the Virginia border. This configuration appears to occur as a result of differences in physical environment conditions between the northern and southern ends of the island. These include differences in distribution of wave energy, plus perhaps differences in steepness of the topography upon which the island is retreating. At the northern end of the island the mainland shoreline, which is relatively steep, lies in close proximity to the island. On the southern end of the island, the mainland lies at a much further distance from the island. Other factors being equal, barrier islands tend to be closer to the mainland when the mainland slope is steeper. Both water and wind energy play a role in determining the island's topography. Berm elevations on the island are controlled by tides and waves, and range from 2.3 to 2.8 meters (8 ft to 9 ft) above the 1929 National Geodetic Vertical Datum (NGVD)[1]. Historically, the ocean side of Assateague and Fenwick Islands was fringed by a series of low and comparatively stable dunes. Historic photos suggest that dune relief may have exceeded 1.5 meters (5 ft), and, therefore, maximum island elevation may have been about 4 to 4.5 meters (13 ft to 15 ft) NGVD. Since that time, Assateague's topography has been impacted both by accelerated retreat and by dune building. Beginning in the 1930's, extensive artificial dunes were built along much of the U.S. Atlantic Coast, including substantial portions of Assateague Island. The Corps of Engineers erected sand fence to build dunes on northern Assateague in 1962. The National Park Service built dunes on Assateague in the late 1960's and possibly into the 1970's. However, dunes have

[1] Elevations and depths are given either a stated or implied vertical reference point. Several reference points are used in this report. Elevations on land and water depths are typically referenced to either National Geodetic Vertical Datum (NGVD), Mean Lower Low Water (MLLW), or mean water. NGVD was developed in 1929 by estimating mean sea level at 29 sites along the North American coast for the preceding two decades. Zero elevation equals mean sea level at those sites in 1929. Sea level has risen by approximately 0.2 meters (8 in) along the Maryland coastline since that time. Thus, a site with an elevation of 0.2 meters NGVD is at about today's mean sea level. Mean water is the average elevation of water between high and low tides, or approximately 0.2 meters NGVD. The Corps of Engineers uses MLLW because unlike NGVD, it can be measured in the field at a site. Two low tides occur per day in the study area, and the water surface typically does not drop to exactly the same elevation on both low tides. MLLW is the lowest average elevation of the water surface at the lowest of the two low tides. Nautical charts for the mid-Atlantic coast are generally prepared utilizing MLW (mean low water) rather than MLLW because the actual difference between MLLW and MLW is minor from a navigation perspective.

not been maintained since that time in the National Seashore other than in developed areas. Sediment starvation has significantly contributed to the destruction of both constructed and natural dunes from 3 kilometers to 10 kilometers (1.9 to 6.2 mi.) south of the inlet on northern Assateague Island. Maximum elevations on northern Assateague actually occur on dredged material deposited by the Corps prior to the 1970's. See Appendix A2 of the Assateague report for a chronology of engineering efforts on Assateague Island.

2.1.2.b Isle of Wight. The island is relatively flat. The highest elevation of the island occurs along the roadbed of Route 90 and is about 4.6 meters (15 ft) NGVD. Maximum elevations on fill in the southeastern portion of the island range from 1.5 to 2.7 meters (5 to 9 ft). Natural surface elevations in the forested area immediately north of the filled area range from 0.9 to 2.1 meters (3 to 7 ft). The majority of the southeastern portion of Isle of Wight Wildlife Management Area (WMA) lies below the projected elevation that the coastal bays will reach in a 100-year flood event.

2.1.2.c Ocean Pines. Elevations in the tidal marshes at Ocean Pines are approximately mean high water (MHW) and lie at about 0.4 meters (1.5 ft) NGVD. The natural upland landward of the marshes has maximum elevations of about 3.0 meters (10 ft) NGVD. The Ocean Pines sites are within the 100-year flood area.

2.1.2.d South Point Spoils. Elevations on the island range from about mean high water in the salt marsh to a maximum of about 1.2 to 1.8 meters (4 to 6 ft) above sea level.

2.1.3 Soils

Soils are classified into series according to their properties. Soil series typically occur in distinct patterns on the landscape, known as "associations." The soil series and associations found in an area are important because they influence what plants and animals can utilize the area. Five soil associations occur in the coastal bays watershed: Fallsington-Woodstown-Sassafras, Mattapex-Matapeake-Othello, Othello-Fallsington-Portsmouth, Pocomoke-Rutlege-Plummer, and tidal marsh-coastal. All of Assateague Island, Fenwick Island, and portions of the mainland shoreline along the bays consist of the tidal marsh-coastal beaches association. The Fallsington-Woodstown-Sassafras soil association is located west of the mainland tidal marsh-coastal beach soil association. This association is found on the level to steep fields and wooded areas throughout the eastern portion of mainland Worcester County, totaling 40 percent of the county. The soils are primarily sand and fine sand, containing moderate amounts of clay and silt. The surface layer in these areas is generally sandy loam. Soils of the Mattapex-Matapeake-Othello Association include deep well-drained soils that have a high capacity to hold plant nutrients and moisture. They occur over limited areas in the vicinity of Berlin and South Point.

Wetland (hydric) soils and shallow water sediments possess oxygen in their surface layers, but are typically anaerobic (lack oxygen) below the surface for a portion of the growing season. The close proximity of these two very different physical environment conditions allows bacterial processes to occur that can convert biologically available organic nitrogen (an important nutrient that in excess concentrations is a common pollutant) to harmless nitrogen gas. This process can improve water quality.

2.1.3.a Assateague Island. As stated above, Assateague Island consists of the tidal marsh-coastal beaches association. These areas are predominantly level or nearly level and are subject to intermittent flooding by tidal water. Coastal beach soils consist largely of sand and typically have poor nutrient content and water-holding capacity. Tidal marsh soils consist of plant remains and mineral sediment; where exposed they are gray or black in color. These soils are saline to brackish.

2.1.3.b Isle of Wight. Soils along the southeastern shoreline consist of up to 2.7 meters (9 ft) of fill consisting of dredge spoil, gravel, and concrete and asphalt rubble. Soils underlying the fill were Matapeake fine sand loam, Fallsington sandy loam, and tidal marsh. The Fallsington series of soils includes potentially hydric soils. Tidal marsh soils are hydric by definition. However, the hydric functions of both of these soils has been impaired as a consequence of the fill placed on the island.

2.1.3.c Ocean Pines. Soils in the northern parcel are classified as Tidal Marsh. The northern parcel is closely bordered on the south by soils of the Sassafras Sandy Loam and Woodstown sandy loam series. The Sassafras sandy loam is one of the soils best suited to farming in the county, and this area was formerly in agriculture. The depth to the seasonal high water table is typically more than 1.5 meters (5 ft) in the Sassafras sandy loam. The Woodstown sandy loam seasonal high water table typically occurs at 0.45 to 0.76 meters (1.5 to 2.5 ft) below the surface. Soils in the southern parcel are classified as Tidal Marsh and Fallsington sandy loam. Tidal marsh comprises about 0.6 hectares (1.6 ac) of the southern parcel. The northernmost 0.4 hectares (0.9 ac) of the parcel are comprised of Fallsington sandy loam. Fallsington sandy loam soils are hydric and have a 0- to 0.3-meter (0- to 1-ft) depth to the seasonal high water table during the period of December through May, but don’t flood at the surface.

2.1.3.d South Point Spoils. The soils which occur on South Point originated from the placement of dredged material taken from the Sinepuxent Channel in 1934. These soils are classified as Made Land.

2.1.4 Bathymetry

2.1.4.a Offshore Shoals and Atlantic Ocean. Within the study area, water depths reach a maximum of about 23 meters (75 ft) in the Atlantic Ocean, and become shallow proceeding landward. The major bathymetric features of the seafloor on the Maryland inner continental shelf are a pervasive topography of swales and oblong-shaped ridges (offshore shoals). These occur on the seafloor both within and outside of the study area boundaries. While each shoal is somewhat unique they share many common features. Within study area waters, the offshore shoals crest at 4.5 to 11 meters (15 ft to 35 ft) in height above the adjacent seafloor (Figure 2-5). The offshore shoals in the study area range in length from 3.2 to 8 kilometers (2 mi. to 5 mi.), and in width from 1.6 to 2.5 kilometers (1 mi. to 2 mi.). Side slopes are gentle and range from about 0.2° to 7.0°. The seaward flank is steeper than the landward flank. The offshore shoals have a predominant northeast/southwest orientation. For this study, Shoal B, Shoal C, Little Gull Bank, and Great Gull Bank were investigated as sand sources for the restoration of Assateague Island (see Appendix B of the first Assateague Report for additional information). Of these shoals, Great Gull Bank is of particular interest to the study because of the sand resources it contains. Water depths at Great Gull Bank range from 5.8 meters (19 ft) on the crest to 9.2 meters (30 ft) in adjacent waters.

2.1.4.b <u>Assateague Island and Ocean City Fillet</u>. The fillet possesses depths and a bathymetric slope typical of the Fenwick Island shoreline. Water depths increase gradually proceeding offshore. Depth increases to about 1.8 meters (6 ft) MLW typically at 65 to 125 meters (200 to 400 ft) off the beach. Water depths along Assateague Island increase gradually proceeding seaward and reach depths of 3 meters (10 ft) at approximately 125 to 150 meters (410 to 500 ft) offshore.

2.1.4.c <u>Ebb Tidal Shoal</u>. The ebb shoal is a prominent bathymetric feature (Figure 2-5). Shallow water along the shoal crest extends seaward for more than 1.6 kilometer (1 mi.) offshore of Assateague Island. Water depths along the shoal crest range from 1.5 to 3 meters (5 to 10 ft) MLW. Depths are typically on the order of 4.6 meters (15 ft) along the sloped sides of the shoal.

2.1.4.d <u>Ocean City Harbor and Inlet</u>. In the inlet throat, a large portion of the channel floor is deeply scoured by the large volume of water transferred during the short duration of the semi-diurnal tides; water depths within the inlet throat locally exceed 7 meters (23 ft). A portion of the inlet is maintained by dredging for navigation purposes. The inlet connects to a series of maintained navigation channels and the harbor in the coastal bays (Figure 2-5). The Ocean City Harbor is maintained at a depth of 3 meters (10 ft) by dredging.

2.1.4.e <u>Coastal Bays</u>. The coastal bays are predominantly shallow. Of a total surface area of 28,200 hectares (69,700 ac) approximately 12,500 hectares (31,000 ac) are less than 1 meter deep. The majority of the bays range from 0 to 2 meters (0 ft to 7 ft) in depth with average depths of 0.7 to 1.2 meters (2.3 to 4 ft). In the northern coastal bays (Assawoman and Isle of Wight Bays) shallow waters less than 0.9 meter (3 ft) MLW deep predominate, while in the southern bays (Sinepuxent, Chincoteague, and Newport Bays), water deeper than 0.9 meter (3 ft) predominates. The average water depths and percentage of water in each bay that is shallow (less than 0.9 meter [3 ft] deep at MLW) is shown in Table 2-2. Deeper water occurs in close proximity to the inlet, in natural and dredged channels, and locally in the coastal bays in areas dredged to provide sediment for emergency beach replenishment of Fenwick and Assateague Islands in 1962. Residual holes from that operation are still as deep as 5 to 10 m (16 to 33 ft).

Table 2-2 Coastal Bays Average Depths and Percent Shallow Water.

Bay	Average Depth (meters)	Average Depth (ft)	Percent Shallow Water (<3 ft Deep MLW)
Chincoteague	1.2	4.0	40
Newport	1.2	4.0	30
Isle of Wight	1.2	4.0	60
Assawoman	1.0	3.3	55
Sinepuxent	0.7	2.3	95

2.1.4.f Dog Island Shoals. A broad expanse of Dog Island Shoals possesses water depths of less than 0.9 meters (3 ft) MLLW. Deeper water occurs in several active tidal channels.

2.1.4.g Isle of Wight. The waters along the southeastern side of the Isle of Wight are less than 0.6 meter (2 ft) deep MLLW along the shoreline and deepen proceeding away from the island to depths of about 0.9 meter (3 ft) MLLW at a distance of several hundred feet offshore. The bottom gradient is very gentle, with slopes on the order of 0.2 percent bayward.

2.1.4.h Ocean Pines. The marshes at Ocean Pines are surrounded by shallow waters of Turville and Manklin Creeks. Several ditches pass through the Ocean Pines marshes. These ditches were created prior to the mid-1960's.

2.1.4.i South Point Spoils. The existing island lies on a large shallow water shoal oriented southwest to northeast (Figure 2-6). Part of this shoal is natural and was formed from flood-tidal shoal sediments deposited here from a historic inlet that formerly existed in close proximity to the site. The extended northeast/southwest portion of the shoal that extends parallel to the Sinepuxent Channel was augmented by sidecasting of dredged material when the Sinepuxent Channel was created in 1934. Water depths increase proceeding away to the northwest and southeast from the shoal in the vicinity of the existing island. The greatest water depths in close proximity to the area occur in the Sinepuxent Channel to the NW of the island where 1.2 meters (4.0 ft) MLLW depths occur. A natural trough of comparably deeper water also occurs to the SE of the shoal. Water depths in close proximity to the Sinepuxent Channel to the NW of the existing island range between 0.9 to 1.2 meters (3 to 4 ft) MLLW.

2.1.5 Hydrology

In this section, a characterization of the salinity, temperature, and movements of the waters of the ocean and bay waters of the study area is provided. The ocean and bay waters of the study area have a semidiurnal tide, which means two high and two low waters occur each day.

2.1.5.a Atlantic Ocean. The mean astronomical tidal range in the ocean waters of the study area is approximately 1 m (3.3 feet). The salinity ranges from about 30 to 33 parts per thousand (ppt). In areas of greater water depth, there may often be a slightly higher salinity on the bottom compared to the surface. Ocean water temperatures generally reach a minimum of about 3° to 5°C (37° to 41°F) in late February or early March. Homogeneous temperatures characterize the entire water column at that time of year. Continental shelf waters undergo progressive thermal stratification from spring through summer, when the thermocline reaches a depth of 9 meters (30 ft) to 12 meters (39 ft). At coastal locations within the 20 meters (66 ft) contour, the stratification is somewhat less intense as the shallower depths permit some turbulent mixing through the water column. Surface water temperatures in the ocean reach a maximum during August and early September of about 21°C (70° F), and rarely exceed 23°C (73° F). Bottom waters below the thermocline are somewhat cooler at this time by up to approximately 10°C (18° F). In autumn, the water column becomes increasingly equalized from the surface downward as it cools. The water circulation in this region of the inner continental shelf is characterized by a general southward movement of the surface and bottom water throughout the year. However, from April to September, the surface water movement may periodically reverse and move northward in association with the prevalence of south winds.

Waves occur much more frequently from the southeast quadrant than they do from the northeast; however, the waves from the northeast tend to be higher. The predominant southerly littoral drift along this segment of ocean coast is a result of waves from the northeast and east quadrant. The average measured wave height off Ocean City is 0.7 meters (2.3 ft). Average wave heights vary seasonally: the lowest monthly average wave occurs in July and August; the highest monthly average wave occurs in December through February. The largest measured wave was 4.4 meters (14 ft); this occurred during the January 1992 storm. Although not directly measured, hindcasts have determined that wave heights reached 7.5 meters (19 ft) during the March 1962 northeaster. See Appendix A of this report for additional information.

2.1.5.b Coastal Bays. The Maryland coastal bays include five bays: Assawoman, Isle of Wight, Sinepuxent, Chincoteague, and Newport. The drainage area for the Maryland coastal bays within Worcester County is 45,250 hectares (111,810 ac); portions of southeastern Delaware and northeastern Virginia also lie within the watershed. The water surface area of the coastal bays within Maryland is 26,580 hectares (65,680 ac).

The tidal range within the coastal bays in the study area is dependent on proximity to the Ocean City Inlet. The mean neap and spring tide range is 1.1 meters (3.6 ft) and 1.3 meters (4.3 ft), respectively, at the Ocean City fishing pier. The tide attenuates along the coastal bays behind Fenwick and Assateague Islands proceeding away from the inlet. The mean neap and spring tide range at Isle of Wight Bay is 0.7 meters (2.3 ft) and 0.8 meters (2.6 ft), respectively. At the northern end of Assawoman Bay, the mean tide range is about 0.3 meters (1 ft). The mean tide range is about ***0.2 meters (0.6 ft)*** at South Point Spoils and reaches a minimum of 0.1 meters (0.3 ft) in Chincoteague Bay at Public Landing. Due to the low tidal range the coastal bays possess a relatively constant water surface area at the full range of tide. Along the western margins of the bays, wind conditions have a greater effect on water levels than do the astronomical tides. Greater tidal fluctuations are caused by prolonged or high winds. The projected water surface elevation of the coastal bays during a 100-year flood event would submerge all mainland shoreline areas less than 1.8 meters (6 ft) in elevation.

Saltwater from the ocean enters the coastal bays through the Ocean City and Chincoteague Inlets. Salinity generally decreases with distance from the inlets, but high salinities of 25 to 32 ppt prevail throughout much of the coastal bays. Hypersaline conditions may exist during late summer and early autumn due to low freshwater flows and evaporation. Prior to the opening and stabilizing of the Ocean City Inlet, low salinity conditions prevailed in the coastal bays.

Water temperatures in Chincoteague Bay range from about 0°C (32°F) to 29°C (84°F) during the year, with an average annual water temperature of about 13°C (56° F). Temperature averages for the upper bays are similar, except that temperatures in the tidal tributaries in summer can exceed 32°C (90° F).

Circulation patterns and currents within the coastal bays are dependent on proximity to the Ocean City Inlet and wind conditions. Approximately 85 percent of tidal waters entering Ocean City Inlet on the flood tide go north into Isle of Wight and Assawoman Bays, while the remaining 15 percent enters Sinepuxent and Chincoteague Bays. In channels near the inlet strong currents are produced by movement of tidal waters. Currents in excess of 9.3 kilometers per hour (5.8 mph or 5 knots) occur near the inlet, but drop off rapidly moving away form the inlet. Shallow water depths through most of the coastal bays promote thorough vertical mixing of the water column.

2.1.5.c <u>Groundwater in the Coastal Bays Mainland</u>. Groundwater discharging into the coastal bays is recharged within the coastal bays watershed; therefore, the quality of groundwater is predominantly a function of land use in the watershed. Groundwater flow in the surficial (water table) aquifer typically mirrors surface topography. In ditched areas (such as farmland), the flow pathways of groundwater in the surficial aquifer are generally short and localized during times of year when the water table is high, and groundwater discharges into ditches. During times of year when the water table is lower and ditches dry up, groundwater flow pathways lengthen. In portions of the watershed where surface stream ***and ditch*** networks are minimal, the irregular mainland to bay shoreline probably creates an extensive estuarine-groundwater interface, and subsurface discharge from the surficial aquifer may occur through direct seepage into tidal waters.

2.1.6 Climate

Worcester County has a humid continental climate modified by its nearness to the Atlantic Ocean and Chesapeake Bay. The general atmospheric flow is from west to east. However, alternating pressure systems create variability in weather patterns. Average annual precipitation at Ocean City is 124 cm (49 inches), with about 25 cm (10 inches) of snow occurring annually. Heavy precipitation occurs mostly in the warmer portion of the year from thunderstorm activity. Droughts can occur throughout the year, but are most likely during the summer months. The prevailing winds are from the west to northwest, except during the summer months, when they are southerly. Seasonal variation in wind direction and corresponding wave direction controls the direction that sediment is transported along the coastline (see Appendix A8 for additional information). Winds and waves from the south during May, June, July, and August promote northerly movement of sediment during these months. During the remainder of the year, the predominant transport direction is to the south. Onshore winds from the northeast, east, and southeast occur one-fifth of the time. Direct onshore winds can elevate nearshore waves and coastal water levels during storm events, increasing storm damages. Winds from the east and northeast tend to be of the highest magnitude. The average annual temperature at Ocean City is 14°C (57°F). Air temperatures over the coastal ocean typically run 1° to 3°C (5° to 10° F) cooler than temperatures on the coast.

Most coastal storms causing erosion and other damage in the study area are northeasters. These storms can produce damaging storm waves for a duration of up to several days; they occur most frequently between December and April. Hurricanes and tropical storms also impact the study area, although less frequently. Ocean City has been hit by a number of these major storms this century, including hurricanes in 1902 and 1933, the Ash Wednesday 1962 northeaster, the Halloween 1991 northeaster, the January 4, 1992 northeaster, and the December 1992 northeaster. The winds and waves during the 1933 hurricane were estimated at 160 kilometers per hour (100 mph) and 6 meters (20 ft), respectively. The 1962 northeaster caused the greatest storm damage to Ocean City: water covered Fenwick Island for two days at depths of up to 2.4 meters (8 ft).

2.2 AIR QUALITY

Maryland is divided into six air quality control areas. The coastal bays and Worcester County are contained in the Eastern Shore area. Ambient air quality is determined by measuring the ambient pollutant concentrations of particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, and ozone, and comparing the concentration to the corresponding standards as determined by the U.S. Environmental Protection Agency. Analysis of the 1994 data from the monitoring station nearest to the coastal bays in Salisbury, Wicomico County, determined that the area is an attainment area for all criteria pollutants. However, because the project area is in an ozone transport region, it is regulated as a moderate ozone non-attainment area.

2.3 WATER QUALITY

Overall water quality in the open water areas of the coastal bays is reasonably good. Water quality problems do occur, however, in a number of the tidal tributaries and in the artificial lagoons. Excessive nutrients cause eutrophication in several of the tidal tributaries. Eutrophication occurs when high nutrient concentrations promote excess growth of algae (phytoplankton). Algae grow and reproduce rapidly and only live for a brief period of time. When the algae die they undergo decay, and oxygen in the water is consumed by microbes. Under severe conditions, water can become anaerobic (devoid of oxygen). Of nutrients important in the characterization of water quality, nitrogen is of particular relevance for the coastal bays. Phytoplankton in the coastal bays are nitrogen-limited, this means that their growth and reproduction potential is limited by a shortage of nitrogen in nutrient form. Nitrogen enrichment of the water column occurs as a result of excessive nutrient input to the bays from groundwater seepage, surface water runoff, and in precipitation from the atmosphere from human sources. If nitrogen concentrations in the water were to decrease, water quality would improve. At present, it is unclear whether water quality is improving or getting worse within the coastal bays.

Several factors are of importance in evaluating water quality, including dissolved oxygen and fecal coliform count. Finfish and shellfish require oxygen to breathe. Oxygen in aquatic environments occurs in dissolved form in the water. Dissolved oxygen is measured in milligrams per liter. Concentrations of less than 5 mg/l are considered harmful to aquatic life. Fecal coliform measurements provide evidence of contamination by sewage. Fecal coliform are bacterial organisms that occur within the digestive tracts of humans and other animals.

2.3.a Atlantic Ocean. No significant water quality problems have been reported from the study area’s ocean waters. The State of Maryland has designated all of its coastal waters (i.e., to the 3-mile limit) as Use II, shellfish harvesting waters. No water quality impacts that would threaten this designation have been reported. However, there is an area off 64th Street in Ocean City where shellfish harvesting is prohibited as a precautionary measure due to the discharge of the city's wastewater treatment plant. The restricted area encompasses the oceanside waters between 55th Street and 73rd Street, and extends offshore for 1.5 miles.

2.3.b Ocean City Harbor and Inlet. The water quality in the inlet is considered good. There are no major point source discharge locations. There is one small regulated discharge from a seafood packaging plant in the commercial harbor. No sites of uncontrolled toxic wastes or other notable sources of chemical contamination exist. The inlet is regularly flushed by ocean waters.

2.3.c Dog Island Shoals. The water quality of Dog Island Shoals is modified by the site's close proximity to the inlet. Dissolved oxygen (DO) in the water column at Dog Island ranges from 12.5 to 4.5 mg/l. Relatively low fecal coliform counts characterize the area as a result of regular tidal flushing with ocean water carried in through the inlet.

2.3.d Isle of Wight and Ocean Pines. The Isle of Wight is bordered by the St. Martins River; Ocean Pines occurs close to the mouth of the St. Martins. The St. Martins River watershed is probably the most important pollutant-producing subwatershed to the bays on both a total load and unit area basis. Northwesternmost Isle of Wight Bay receives these pollutants. Fecal coliform concentrations in Isle of Wight Bay waters in the vicinity of Ocean Pines and Isle of Wight occasionally reach very high levels, presumably following precipitation events. Dissolved oxygen concentrations however, remain generally good. During the warmer half of the year (May through October), dissolved oxygen typically ranges from a high of 12.8 mg/l to a low of 4.0 mg/l.

2.3.e South Point Spoils. South Point Spoils lies in uppermost Chincoteague Bay. Water quality within Chincoteague Bay is considered to be generally better than that of the northern bays. Water quality at South Point Spoils may be somewhat impaired periodically by its close proximity to Newport Bay, which lies about 3.2 kilometers (2 mi.) away. Newport Bay is one of the more polluted of the coastal bays tidal tributaries. Dissolved oxygen at South Point ranges from 12.5 to 4.6 ppt during the spring, summer, and fall.

2.4 BIOLOGICAL RESOURCES

The study area is a composite of ecosystems – marine, estuarine, terrestrial, and to a minor extent, freshwater aquatic. Although distinct, these ecosystems are interlinked, and changes in the physical environment or biota of one ecosystem can have a profound impact on the other ecosystems of the study area. They support a diverse assemblage of biological resources.

2.4.1 Submerged Aquatic Vegetation (SAV)

Two species of SAV occur in the coastal bays: eel grass (*Zostera marina*); and widgeon grass (*Ruppia maritima*). SAV that occurs in patches with high percent bottom cover (density) are considered "beds". SAV beds provide spawning, nursery, feeding, and refuge habitat for numerous species of finfish and shellfish. SAV provides food for migratory waterfowl. It impacts water quality by cycling nutrients and increasing sediment stability, thereby increasing water clarity. SAV in the coastal bays is presently at its greatest known documented extent: coverage nearly doubled in area from 1986 to 1995 (Table 2-3), and apparently quadrupled from 1970 through 1995. Eel grass was abundant in the coastal bays in the early 1900's, but declined to very low levels during the worldwide eel grass epidemic of the 1930's. Present distribution of SAV in the coastal bays is in part a result of natural recovery patterns from the eel grass blight, although water quality limits where recovery can occur. SAV has been systematically mapped by the Virginia Institute of Marine Science (VIMS) since 1986. Prior to this time, historical records are limited and no maps of SAV distribution are available. The shallow depths and low tidal range that characterize much of the coastal bays favor SAV bed development, since much of the bay bottom is within the photic zone (depth that light can penetrate in intensity sufficient for SAV to grow). The photic zone for SAV in the coastal bays extends to approximately 1 meter (3.3 ft) in depth. It is unclear how pervasive within the coastal bays SAV would be were there no human perturbations to the environment. The shallow depths of the bays suggest that SAV beds should be a major ecological feature. SAV currently covers about one-sixth of the bottom of the coastal bays; it covers about one-third of the bottom where water depths are less than 1 meter (3.3 ft). If SAV were to recolonize all waters less than 1 meter deep, then it would occupy an additional 8,000 hectares (20,000 ac). Continued natural recovery and expansion of SAV beds in the coastal bays can be expected, provided the level of water quality and other limiting factors, such as physical damage by boats, remains constant or improves.

Table 2-3: Total acreage of SAV in the coastal bays.

Year	Total SAV in Coastal Bays (ha)	Total SAV in Coastal Bays (ac)
1996	4,524	11,179
1995	3,758	9,287
1994	4,118	10,174
1993	3,577	8,838
1992	3,323	8,211
1991	2,746	6,784
1990	2,494	6,163
1989	2,310	5,708
1986	2,134	5,273
1970	~1,010	~2,500

2.4.1.a Dog Island Shoals. In the years that the coastal bays have been surveyed by VIMS, SAV has not occurred here. A cursory site survey in summer 1996 failed to locate SAV in the vicinity of the proposed island construction area. An additional survey of the site conducted in October 1997 also failed to locate any SAV. Monthly finfish surveys of the site in 1997 did not recover any SAV. SAV is presumably absent because the site possesses strong tidal currents, waves, and dynamic substrate conditions.

2.4.1.b Isle of Wight. SAV has not been mapped at this site in the years that the coastal bays have been surveyed by VIMS. A cursory site survey in summer 1996 failed to locate SAV within the proposed island construction area. An additional survey of the site conducted in December 1997 failed to locate SAV. Monthly finfish surveys of the site in 1997 failed to recover SAV. SAV is presumably absent from the site because of poor water clarity resulting from nutrient loading in the St. Martins River and lack of propagules.

2.4.1.c Ocean Pines. SAV has not been mapped in the waterways adjacent to the area site in the years that the coastal bays have been surveyed by VIMS. It is expected that poor water clarity and lack of propagules in this area limits the ability of SAV to become established.

2.4.1.d South Point Spoils. SAV beds have continuously occurred in the vicinity of the existing island since 1986, and likely occurred in the area for many years prior. Table 2-4 provides information on the size of the perennial bed at this site as recorded in the VIMS surveys. Species occurring at the site are eel grass and widgeon grass. SAV beds on the east side of Chincoteague

Bay generally occur in water depths less than 1 meter (3 ft), although eel grass does occur to about 2 meters (6.5 ft) deep in the area, at least seasonally. Eel grass sprouts from seed annually at depths greater than 1 meter (3 ft), but typically suffers high mortality over the summer due to poor water clarity. Eel grass is not able to form persistent beds with high percent cover at greater than 1 meter (3 ft) deep. Low-density and ephemeral beds likely occur over a broad expanse of Chincoteague and Sinepuxent Bays well outside of the mapped beds, including the waters surrounding South Point Spoils. Bed size of the South Point Spoils beds have increased by about 25 percent over the period of record, although density appears to be decreasing. The cause of the apparent decrease in density is not known. Interestingly, the SAV beds of South Point Spoils, as well as those along the Sinepuxent Channel west of Sandy Point Island, may owe their existence to placement of dredged material in the 1930's (See Figure 2-6). Placement of dredged material created shoals that brought a large portion of these areas to within the photic zone. SAV survey reports of the site are contained in Annex A, Part 4.

Table 2-4: Total acreage of SAV in the South Point Spoils shoal.

Year	Size (ha)	Size (ac)
1995	50.5	125
1994	51.0	126
1993	49.5	122
1992	49.1	121
1991	42.2	104
1990	41.2	102
1986	44.5	110

2.4.2 Wetlands

Tidal and nontidal wetlands occur in the coastal bays watershed. The majority of the tidal waters of the coastal bays are brackish. Tidal wetlands that occur where salinities are brackish (0.5 to 30 ppt) include salt and brackish marshes and scrub-shrub wetlands. For the purposes of this report these will all be included under the category of salt marsh. Salt marshes include areas that are regularly flooded each tidal cycle, and areas that are only irregularly flooded during high tides. The former of these are known as regularly flooded salt marshes, the latter of these are known as irregularly flooded salt marshes. The marsh surface of regularly flooded marshes is accessible to aquatic life during each high tide. In contrast, the surface of irregularly flooded salt marshes is less frequently accessible to aquatic life. The bayside edge of irregularly flooded salt marshes is typically scarped and erodes irregularly, producing many small coves which supply valuable habitat to aquatic life. The majority of the salt marshes occurring along the fringe of the coastal bays are irregularly flooded.

Approximately 6,700 hectares (16,600 ac) of salt marsh occur on the shoreline of the coastal bays. Most of this area is concentrated along the Chincoteague Bay shoreline, including the bayside of Assateague Island. Approximately 1,000 hectares (2,500 ac) out of the total salt marsh acreage occurs in the northern coastal bays. Prior to extensive development in the region, approximately 1,800 hectares (4,500 ac) of salt marsh historically occurred in the northern bays. Additional information on historical wetlands and wetlands losses can be found in Annex A, Part 5.

Nontidal wetlands in the study area are predominantly in forest and shrub cover. For the purposes of this report, these will be called forested wetlands. Approximately 2,100 hectares (5,300 ac) of forested wetlands occur on the mainland. Prior to extensive ditching for agriculture, approximately 22,800 hectares (56,300 ac) of forested wetlands may have historically occurred in the watershed of the coastal bays. More information on wetlands losses can be found in Annex A, Part 5. Additional information on forested wetlands of the coastal bays watershed can be found in the Assateague report, located in Appendix D of this document.

Salt marshes and forested wetlands naturally perform numerous functions that greatly benefit people and fish and wildlife. A number of the functions performed by these wetlands are critical to maintenance of good environmental quality. Good environmental quality, in turn, maintains the character of the area as a desirable place to live, and Ocean City as a thriving tourist destination. Salt marshes serve as nurseries for juveniles of many commercial and recreational fish species, and provide habitat for wildlife such as waterfowl. Salt marshes can provide storm protection and erosion control for the mainland. Salt marshes contribute towards maintaining good water quality by transforming some pollutants into harmless materials, and serve as a sink for fine-grained sediments to which pollutants adhere. But perhaps of greatest importance, salt marshes are one of the most productive ecosystems on earth. They produce a tremendous amount of organic material (primarily salt marsh plants) that supports the estuarine foodweb. The magnitude of the beneficial functions performed by salt marsh ecosystems is largely dependent upon their spatial coverage. Forested wetlands possess the ability to sequester and transform pollutants, ameliorate agricultural runoff, provide plant and wildlife habitat, and regulate nutrient exchange between terrestrial and aquatic ecosystems. For the most part, the functions of forested wetlands are either severely impaired or completely lost when they are drained.

2.4.2.a <u>Assateague Island</u>. Large salt marshes occur on the bayside of Assateague and on bay islands in areas that breached and healed in the past from the state park south. Prior to the formation and stabilization of the Ocean City Inlet, salt and fresh tidal marsh occurred on the bayside along much of the length of Assateague and Fenwick Islands. Since the jetties were constructed, accelerated retreat and overwash has destroyed most of the salt marsh that formerly occurred on the northern end, and only limited areas of salt marsh occur in that area today. Within the northern end of the island from 3 to 10 kilometers (1.9 to 6.2 mi.) south of the inlet occur a number of non-vegetated or sparsely vegetated wetlands on the flats of the bayside and island interior. These areas provide habitat for invertebrate species, which in turn provide food for shorebirds and waterbirds. From the state park southward, the island also possesses fresh marsh and woodland wetlands in interior areas of the island, in swales between dunes, and in association with ponds.

2.4.2.b Dog Island Shoals. Most of the shoal area consists of nonvegetated shallow water. Dog Island itself is an island comprised entirely of irregularly flooded brackish marsh. Vegetation on the island includes short-form cordgrass (*Spartina alterniflora*) and reed grass (*Phragmites australis*).

2.4.2.c Isle of Wight. Historically, much of the shoreline of Isle of Wight was fringed by tidal marsh. As much as 2 hectares (5 ac) of salt marsh along the southeastern shoreline of the island was filled at about the time that the Route 90 bridge was constructed (prior to the enactment of laws that today protect tidal wetlands). Salt marsh occurs along the southwestern shoreline and in a very small parcel on the southeastern shoreline. The northern part of the island possesses a large area of salt marsh.

2.4.2.d Ocean Pines. Disturbed and filled salt marsh at Ocean Pines are occupied by nearly monotypic stands of reed grass. Monotypic reed grass stands are commonly associated with physically disturbed sites where dredged material was placed. Reed grass probably became established at the site following placement of dredged material in the area during the early 1960's. Once present, reed grass tends to persist. Disturbed sites in Delaware and New Jersey upon which reed grass has taken hold have been under dominance by the species for decades.

Natural salt marsh adjacent to the sites is vegetated by salt hay (*Spartina patens),* needlerush (*Juncus roemerianus*), spike grass (*Distichlis spicata*), sea lavender (*Limonium carolinianum*) and short-form saltmarsh cordgrass (*Spartina alterniflora*). The salt marshes are bordered on their upland by shrubs such as marsh elder (*Iva frutescens*) and high tide bush (*Baccharis halimifolia*).

2.4.2.e South Point Spoils. Much of the island is dominated by reed grass. A small area of saltmarsh cordgrass and salt hay occurs on the northeast end of the island.

2.4.3 Upland Vegetation

2.4.3.a Assateague Island. Three general zones of upland vegetation occur on Assateague Island: dune grassland, shrubs, and woodland. Much of the northern end of Assateague from 3 kilometers to 10 kilometers (1.9 to 6.2 mi.) south of the inlet is unvegetated open sand due to the high frequency of overwash events; however, dune grassland vegetation occurs sporadically in the area. Shrub vegetation occurs in the northernmost 2.5 kilometers (1.6 mi.) of the island and south of 10 kilometers (6.2 mi.). Assateague Island was historically dominated by dune grassland vegetation interspersed with open sand, and possessed minimal woodland areas. Assateague Island's vegetation was substantially impacted by the grazing of domestic animals from the 1800's through perhaps as late as the 1940's. Feral animals derived from domestic stock also have had a substantial impact on island vegetation, including the island's famous ponies, which continue to be a major factor influencing vegetation. Vegetation distribution on the island has also been impacted by dune construction and to a minor extent by placement of dredged material. Vegetation on Assateague Island is discussed in greater detail in Annex A of the Assateague report.

2.4.3.b Isle of Wight. The filled area along the stabilized southeastern shoreline is vegetated by old field vegetation such as grasses, mints, yarrow (*Achillea millefolium*), golden rod (*Solidago* spp.), wild carrot (*Daucus carota*), and switch grass (*Panicum virgatum*). Within the old field vegetatio, several isolated clumps of winged sumac (*Rhus copallina*), black cherry (*Prunus serotina*), Japanese honeysuckle (*Lonicera japonica*), and eastern red cedar (*Juniperus virginiana*) occur. Small clumps of reed grass also occur in the old field area. Natural forest occurs north of the filled area and includes red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), tulip tree (*Liriodendron* tulipifera), dogwood (*Cornus florida*), holly (*Ilex opaca*), serviceberry (*Amelanchier spp*.), *Viburnum spp.*, and ferns (*Woodwardia spp.*). Species occurring along the forest/old field edge include sassafras (*Sassafras albidum*), black cherry, bayberry (*Myrica spp.*), and loblolly pine (*Pinus taeda*).

2.4.3.c Ocean Pines. Upland vegetation bordering the salt marsh and filled salt marsh now vegetated by reed grass includes loblolly pine, bayberry, holly, black cherry, sweet gum, winged sumac, Devil's walking stick (*Aralia spinosa*), and raspberry (*Rubus* spp.). Many of the upland species occurring on and adjacent to the sites are bird-distributed plants.

2.4.3.d South Point Spoils. Much of the eastern end of the island is dominated by reed grass. Reed grass commonly occurs on dredged material islands. The west-central section of the island is dominated by shrubs and small trees including black cherry, winged sumac, red cedar, sassafras, Devil's walking stick, raspberry, and inkberry (*Phytolacca americana*).

2.4.4 Benthos

Benthos are bottom-dwelling organisms of aquatic ecosystems. Benthic macrofauna in marine and estuarine environments are an important food source for many fish species. Although benthos show some degree of fidelity to particular habitat conditions, these conditions are often widespread and intergrade from site to site in marine and estuarine environments. As a consequence, benthic organisms are typically widely distributed and are only rarely limited in occurrence to a specific habitat type or location. Benthic populations have a high degree of natural population variability from year to year.

2.4.4.a Assateague Island Nearshore and Ocean City Updrift Fillet. Mollusk species likely to be found in the subtidal zone of the outer beach on Assateague and Fenwick Islands include whelks (*Busycon* spp.) and surf clam (*Spisula solidissima*). Crabs likely to be found in the subtidal zone of the outer beach include lady crab (*Ovaliped ocellatus*) and horseshoe crab (*Limulus polyphemus*).

The nearshore benthic communities are dominated by crustaceans such as mole crab (*Emerita talpoida*) and bay possum shrimp (*Neomysis americana*). Mole crab is also common in the intertidal zone. Common species of the upper beach include ghost crab (*Ocypode albicans*) and beach fleas (*Talorchestria* spp.)

2.4.4.b Tidal Shoals (Ebb and Flood). Benthic communities that inhabit these energetic sites are primarily composed of common infaunal species that are relatively tolerant of physical disturbance. Common infaunal benthic organisms occurring on the flood-tidal shoals include sand-burrowing amphipods (genera *Protohaustorius* and *Parahaustorius*) and shellfish such as dwarf tellin (*Tellina agilis*), coquina (*Donax variabilis*), and surf clam. Motile benthos occurring on the surface include a variety of crabs, sand shrimp (*Crangon septemspinosa*), and other species. Horseshoe crab lay their eggs on sandy flats around Skimmer Isle. For additional information, refer to the PAR II prepared by the FWS in Annex A, Part 3.

2.4.4.c Ocean City Harbor. It is likely that annelid worms dominate harbor benthos and that arthropods (such as crabs) and shellfish are relatively lacking. Dead-end canals in the coastal bays typically possess low organism abundance, biomass, and diversity; however, the proximity of the harbor to the inlet currents probably results in somewhat improved conditions. For additional information, see the PAR II supplement in Annex A, Part 3.

2.4.4.d Inlet. Benthic organism density, biomass, and species number are generally low in the vicinity of the inlet. This is due to the presence of a shifting sand bottom substrate associated with high current velocity conditions. Common benthic organisms occurring within the inlet include sand-burrowing amphipods and shellfish such as dwarf tellin, coquina, and surf clam. In contrast, stable attachment substrate such as rocks, pilings, and other submerged structures are extensively colonized by epifaunal forms. Additional information can be found in the PAR in Annex A, Part 3.

2.4.4.e Dog Island Shoals. Hard clam (*Mercenaria mercenaria*) densities in the deeper waters of Dog Island Shoals site are among the highest in the coastal bays region. Benthic organisms occurring at Dog Island Shoals in high numbers include shellfish such as dwarf tellin and dwarf surf clam, and sand-burrowing amphipods. Additional site-specific information is contained in Annex A, Part 4. For additional information on benthos in this area, see the FWS PAR II in Annex A, Part 3.

2.4.4.f Isle of Wight. Hard clam occurs at the site in densities greater than or comparable to adjacent areas of the bay. Other mollusks occurring in high numbers at the site include small surf clam (*Mulinia lateralis*) and amethyst gem clam (*Gemma gemma*). Numbers of mollusks tend to increase proceeding offshore. Additional site-specific information is contained in Annex A, Part 4.

2.4.4.g South Point Spoils. This area affords a high diversity of benthic habitats, ranging from SAV beds to bare sandy mud or gravel. In spite of this and its location in northern Chincoteague Bay (known for its pure water compared to that in the general area), the site has relatively low molluscan density and species diversity. Hard clam densities in the vicinity of South Point Spoils are comparable to adjacent areas of the bay. Mollusks occurring in high numbers at the site include the gastropod (snail) crenate pyram (*Pyramidella crenulata*), and the bivalves, the small surf clam and the amethyst gem clam. Additional site-specific information is contained in Annex A, Part 4.

2.4.5 Plankton

Plankton are small, floating or weakly swimming plants or animals that are an important food source in marine and estuarine ecosystems. Nutrients supplied from coastal runoff and vertical mixing in the water column support a relatively high abundance of phytoplankton out to about 20 meter (65 ft) depth in the ocean. Peaks in phytoplankton populations vary annually, with peak abundances occurring in spring and from late summer to late fall. Zooplankton include those species that spend their entire lives as plankton (holoplankton) as well as the eggs and larvae of many fish and invertebrates (meroplankton). Holoplankton abundance is highest in late spring, summer, and fall. Meroplankton are most numerous during late spring and summer. For additional information, see the PAR in Annex A, Part 3.

2.4.6 Nekton

Nekton are organisms that possess the ability to swim. Nekton include finfish that are caught by commercial and recreational fishermen. Many of these species are important top to mid-level carnivores. A discussion of marine reptiles and mammals occurring in the study area is included in sections 2.4.8 and 2.4.9.

2.4.6.a Assateague Island Nearshore Waters and Ocean City Fillet. Fish species caught by commercial vessels working off Maryland's Atlantic coast include clearnose skate *(Raja eglanteria),* smooth dogfish *(Mustelus canis),* weakfish, summer flounder, windowpane flounder *(Scopthalmus aquosus),* butterfish (*Peprilus triacanthus*), northern kingfish (*Menticirrhus saxatilis*), Atlantic croaker *(Micropogonias undulatus)*, and striped searobin (*Prionotus evolans*).

Nekton of the nearshore must be able to tolerate the currents and turbidity associated with the surf. Bony fish likely to be found in the nearshore of Assateague and Fenwick Islands include weakfish (*Cynoscion regalis*), bluefish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*), northern puffer (*Sphaeroides maculatus*), porcupine fish (*Diodon hystrix*), striped burrfish (*Chilomycterus schoepfi*), and common trunkfish (*Lactophrys trigonis*). Cartilaginous fishes likely to be found in nearshore include spiny dogfish (*Squalus acanthias*), little skate (*Raja erinancea*), barndoor skate (*Raja laevis*), and bluntnose stingray (*Dasyatis sayi*).

2.4.6.b Tidal Shoals (Ebb and Flood). The habitat value of the ebb and flood tidal shoals area for nekton is limited by the relatively high energy conditions of these sites. Summer flounder, spot, croaker (*Micropogonias undulatus*), and weakfish occur on the shoals. For additional information, see the PAR located in Annex A.

2.4.6.c Inlet: Recreational fishing is common around the inlet. Commonly caught species include summer flounder, bluefish, weakfish, sea bass (*Centropristis striata*), tautog (*Tautoga onitis*), spot, croaker, kingfish (*Menticirrhus saxatilis*), hake (*Urophycis* spp.), striped bass, scup (*Stenotomus chrysops*), blowfish (*Spheroides* spp.), and sharks.

2.4.6.d Coastal Bays. The coastal bays have high habitat value as nursery areas for juvenile finfish, including many species that are important commercially and recreationally. Juvenile finfish are typically generalist feeders, and exploit different food sources as they become available. These include some tidal and estuarine residents; however, the majority are marine migrants. Juvenile finfish abundance is typically low in the main channels; shallow, well-protected, and undeveloped areas typically harbor the most individuals. Within the coastal bays, areas near the inlet and areas near locations with high current velocities nearby probably support the greatest numbers and diversity of nekton. Recreationally and commercially sized individuals are typically found in the channels. Some of the significant commercial finfish areas include the edge of St. Martin's River, Newport Bay, 3.2 to 4.8 kilometers (2 to 3 mi.) south of Newport Bay mouth, and off the mouth of Greys Creek. See Annex A, Part 7 for a map of known commercial and recreational fishing grounds.

Of notable concern among finfish using the coastal bays as a nursery ground is summer flounder (*Paralichthys dentatus*). The coastal bays of the Delmarva peninsula are primary nursery areas for summer flounder, where the species is highly abundant. In spite of its local abundance, populations of summer flounder are declining throughout its Atlantic coast range due to overfishing by both commercial and recreational fishermen. Habitat degradation in some of the estuaries elsewhere along the Atlantic coast where summer flounder formerly nurseried is also a contributing factor in the decline of summer flounder.

Summer flounders enter estuaries primarily in the summer months. They reach perhaps their greatest estuarine abundance in the coastal bays both as adults and as juveniles; however, they don't spawn in the area. Summer flounder are common in the coastal bays from April through November, but they reach their greatest abundances in June through August. Summer flounder is perhaps least abundant in Sinepuxent Bay. Habitat requirements of juvenile flounder are not completely known, but juveniles occur most frequently in shallow subtidal and intertidal areas in the lower portions of estuaries. Within the coastal bays, young summer flounder are associated with mud bottoms, while older fish are associated with mud or sand bottoms.

2.4.6.e <u>Dog Island Shoals</u>. The shallow waters of the shoals are relatively unproductive for finfish because of the lack of cover and hard-bottom substrate. Fish species occurring in the area include sand shrimp (*Crangon septemspinosa*) and fish such as Atlantic silversides (*Menidia menidia*). Additional site-specific information is included in Annex A, Part 4.

2.4.6.f <u>Isle of Wight</u>. Nekton occurring off the southern shoreline of Isle of Wight are typical of those occurring in productive shallow waters of the coastal bays. Nekton inhabiting the area in seasonally high abundance include Atlantic herring (*Clupea harengus*), bay anchovy (*Anchoa mitchilli*), spot, weakfish, blue crab (*Callinectes sapidus*), sand shrimp, and grass shrimp (*Hippolyte* spp.). Annex A, Part 4 contains additional site-specific information

2.4.6.g <u>South Point Spoils</u>. Dominant nekton of the SAV beds surrounding the island consist of many species generally considered to be shallow water generalists. Common finfish include Atlantic silversides, fourspine stickleback (*Apeltes quadracus*), rainwater killifish (*Lucania parva*), mummichog (*Fundulus heteroclitis*), killifish (*Fundulus* spp.), sheepshead minnow (*Cyprinodon variegatus*), and spot. Blue crab, sand shrimp, and grass shrimp also occur in abundance in the SAV beds surrounding the island. Species caught in deeper waters in the vicinity of the Sinepuxent Channel northwest of the island include winter flounder (*Pseudopleuronectes americanus*), spot, bay anchovy, and blue crab. Annex A, Part 4 contains additional site-specific information.

2.4.7 Birds

The previous EIS contained general information on birds of the coastal bays watershed. Birds prey on fish, benthic infauna, insects, and seagrasses within the ecosystem and, in turn, release nutrients into these waters in their excretory products. Of particular relevance to this study are colonial waterbirds. Information on bird species that are considered rare can be found in Section 2.5.

Colonial waterbirds are birds whose survival depends on their ability to nest together in large groups, much as humans live in association with other humans. Colonial waterbirds can be divided into two groups or “guilds” based upon where they build their nests. A guild is defined as a group of species that utilize a common habitat resource. Egret, heron, ibis, and cormorant are colonial waterbird species that typically nest in shrubs or trees. The other guild includes species that nest on bare substrates. The bare-substrate nesting guild includes many species that are rare. The bare-substrate nesters are discussed in Section 2.5, “Rare, Threatened, and Endangered Species.” Some species such as Brown Pelican are members of both guilds and will nest on bare substrates or in vegetation. Members of the vegetation-nesting colonial waterbird guild prefer to nest on isolated estuarine islands, but also form colonies in wetland and upland habitats on the mainland. The optimum island size for many species of colonial waterbirds is between 2.0 and 10.1 hectares (5 and 25 ac). These species' nests are vulnerable to human disturbance and also to predation, but to a lesser extent than colonial waterbirds that nest on bare substrate. Vegetation-nesting colonial waterbirds show strong fidelity to colony sites, and reuse existing sites unless the sites are badly degraded. This guild has suffered a significant loss of island nesting habitat on a regional scale due to erosion and interruption of natural island-forming processes. In the 1970's there were five active colony sites in the coastal bays watershed for herons and egrets; now there are just three, located on small islands in the coastal bays. No heron, egret, or pelican colonies occur on northern Assateague or on the mainland. Foraging habitat is abundant, however.

2.4.7.a <u>Dog Island Shoals</u>. A colony of vegetation-nesting colonial waterbirds that includes several hundred breeding pairs of egrets, heron, and Glossy Ibis occurs on the east side of the shoal on Heron Island adjacent to Mallard Island. Dog Island itself possesses a small colony of Common Tern. A wide variety of shore and waterbirds occur as transients on intertidal flats in the Dog Island Shoals area.

2.4.7.b <u>Isle of Wight</u>. Due to the stabilized condition of the southeastern shoreline and the presence of fill-degraded habitat on the island interior in close proximity to the shoreline, habitat quality is poor for most species of birds.

2.4.7.c <u>South Point Spoils</u>. The island contains a colony of regionally critical importance, providing habitat for approximately 1,500 breeding pairs of colonial waterbirds. The colony includes breeding pairs of egrets, herons, gulls, Double-Crested Cormorant, Glossy Ibis, and American Oystercatcher. Until recently, the island supported the northernmost colony of nesting Brown Pelicans along the Atlantic Coast. Although this was the only breeding site utilized by the Brown Pelican in the state of Maryland, it is given no status as a rare species in the state since it is considered to be an expanding population.

2.4.8 Mammals

A complete list of mammals that may occur within the study area is provide in Annex A of the Assateague report. This section includes only site-specific listings.

2.4.8.a Assateague Island. Fifteen species of mammals occur within the terrestrial habitats on Assateague. Mammal diversity and density are limited on the northern end of Assateague Island because of the lack of food, cover, and freshwater. Perhaps most notable of these with regard to this study are domestic horse (*Equus caballus*), red fox (*Vulpes vulpes*), and raccoon (*Procyon lotor*). Horses have a significant effect on the vegetation of the island, and may influence island character by eating vegetation that might otherwise promote dune growth. Red fox and raccoon are notable as predators of birds that nest on the island. Red fox and raccoon are more commonly encountered in areas of the island possessing vegetation.

2.4.8.b Dog Island Shoals. Bottlenose dolphin (*Tursiops truncatus*) is common in waters of the area. Harbor seals (*Phoca vitulina*) loaf at Dog Island in winter. Because of the small size and isolated location of islands occurring on the shoals, they are of minimal value to terrestrial mammals.

2.4.8.c Isle of Wight. The habitat value of the southeastern shoreline is low because fill has destroyed the salt marsh and stabilization features have usurped the natural shoreline. The remainder of the Isle of Wight provides habitat for mammals typical of the region, including deer (*Odocoileus virginanus*), rabbit (*Sylvilagus floridanus*), squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), muskrat (*Ondatra zibethica*), opossum (*Didelphis virginiana*), and fox (*Vulpes fulva* and *Urocyon cinereoargenteus*).

2.4.8.d Ocean Pines. Mammals typical of salt marshes would be expected in the salt marshes of Ocean Pines. Species that would be likely to utilize this site include raccoon, meadow vole (*Microtus pennsylvanicus*), marsh rice rat (*Oryzomys palustris*), and muskrat.

2.4.9 Reptiles and Amphibians

A complete list of reptiles and amphibians that may occur within the study area is provide in Annex A of the Assateague report. This section includes only site-specific listings.

2.4.9.a Assateague Island. Assateague Island supports 23 species of amphibians and reptiles. Habitat quality and quantity for terrestrial, wetland, and freshwater aquatic reptiles and amphibians on the northern end of Assateague are limited because of the lack of vegetation and habitat diversity. A list of species occurring on Assateague can be found in Annex A, Part 3 of the Assateague report.

2.4.9.b Dog Island Shoals. Transient sea turtles occur in the shoal waters. A discussion of these is included in Section 2.5. Diamondback terrapin (*Malaclemys terrapini*) is a common inhabitant of the coastal bays. It may nest within dredged spoil on Dog Island; however, the value of the site as nesting habitat for this species is limited because of the island's small size and the intense boat traffic in the area.

2.4.9.c Isle of Wight. Isle of Wight would be expected to support species typical of the coastal bays watershed. A species list is included in Annex A of the first EIS. Due to the degraded condition of the southeastern shoreline, it is expected that the site offers habitat of poor quality to reptiles or amphibians. Route 90, which bisects the island, presumably causes substantial carnage of island reptile and amphibian residents.

2.4.9.d Ocean Pines. Reptile species occurring in salt marshes of the area are likely to include diamondback terrapin and northern water snake (*Nerodia sipedon*). Species typical of upland areas adjacent to the salt marshes are listed in the annex of the Assateague report.

2.4.9.e South Point Spoils. Due to the isolated nature of the site in the bay, no amphibians are expected to occur here. Reptiles occurring on the island are limited to diamondback terrapins, which nest on the island.

2.5 RARE, THREATENED, AND ENDANGERED SPECIES

A complete list of these species known to occur in the study area watershed was provided in Annex A of the Assateague report. The following section includes a discussion of the sites of particular interest for this report.

2.5.a Assateague Island. Table 2-5 provides a list of the rare species occurring on Assateague Island. Northern Assateague Island is perhaps most significant from an ecological perspective because it possesses a notable concentration of rare beach-nesting bird species, including Piping Plover, Least Tern, and American Oystercatcher. The frequent overwash is hostile to all but a few plant species, and even these grow only sparsely; much of the island from 3 to 10 kilometers (1.9 to 6.2 mi.) south of the inlet lacks any vegetation. These conditions limit the suitability of the area for most species of animals, but provide nearly perfect habitat for beach-nesting bird species. Historically, sparsely vegetated and bare sand barrier island habitat was abundant along the U.S. Atlantic coast, often in association with natural inlets. Development of the barrier islands as resorts, and shoreline and inlet stabilization, have caused a drastic reduction in the availability of natural overwash-prone and bare sand habitat. Among the rare beach-nesting birds occurring in the area, Piping Plover, federally listed as a threatened species, is of particular relevance and importance for this study. Assateague Island is of regional significance as a breeding ground for this species; nests and foraging areas are concentrated on the island's northern end. Between 14 and 61 breeding pairs nested on northern Assateague Island between 1986 and 1996. Additional information on the Piping Plover can be found in the Biological Assessment provided in Annex A of the Assateague report, and in Annex A of this report. A nesting colony of up to several hundred pairs of the state-threatened Least Tern is also located on the northern end of the island.

The northern end of the island also supports populations of the white tiger beetle (*Cicindela dorsalis media*). This state-listed endangered species occurs on beaches in the northernmost 5 kilometers (3 mi.) of the island, with a notable concentration of individuals from 1 to 2 kilometers (0.6 to 1.2 mi.) south of the inlet. An area of lesser concentration also occurs from 4 to 5 kilometers (2.5 to 3.1 mi.) south of the inlet.

2.5.b Tidal Shoals and Inlet. The coastal Atlantic Ocean waters of Maryland are not noted for the regular presence of rare animal species; however, transient and migrant whales and sea turtles are encountered in the waters of the study area. A list of these species is provided in Table 2-1. A Biological Assessment focusing on threatened and endangered sea turtles and mammals was prepared by the Baltimore District and is included in the Assateague Report, located here in Appendix D.

The northern flood-tidal shoal contains Skimmer Isle. This island supports a regionally significant colony of beach-nesting waterbirds. Nearly 1,000 pairs of terns, Black Skimmer, and Herring Gull occur on the island. The island hosts the northernmost colony of Royal Terns on the Atlantic coast. The Black Skimmer and Royal Tern are listed as threatened and endangered respectively by the State of Maryland.

2.5.c Isle of Wight There are no records of state rare species along the southeastern shoreline, but there are state-rare species occurring on the Isle of Wight. The northern pine snake (*Pituophis melanoleucus*) may occur on the island. It is considered to be state-rare, but is not listed as threatened or endangered by the state or Federal government. The downy milk pea (*Galactia volubilis*), a state endangered plant, has been documented to occur on the island about 0.4 kilometers (0.25 mi.) north of the southeastern shoreline. It occurs on dry, shaded soils.

2.5.d Dog Island Shoals No endangered or threatened species are known to be present in the area other than transients.

2.5.e Ocean Pines No endangered or threatened species are known to be present in the area other than transients. Transient species likely to utilize salt marshes of the area include Northern Harriers, which are state rare (breeding).

2.5.f South Point Spoil. No threatened or endangered species are currently present on the island other than transients.

2.5.g Beach-nesting Waterbirds This guild of birds includes a variety of species that nest on isolated islands with bare or sparsely vegetated substrates. This guild includes species that nest in colonies such as tern, gull, and skimmer, as well as solitary nesters such as Piping Plover and American Oystercatcher. These species' nests are very vulnerable to predators and human disturbance. Nesting success occurs when and where predator access and human disturbance are minimal. This guild has suffered a significant loss of nesting habitat on a regional scale due to loss of beach habitat to human development and activity. As a consequence of nesting habitat loss, many of these species are federally and/or state listed as rare, threatened, or endangered. Foraging habitat is abundant, however.

The location and character of island habitat is critical in determining which species will nest on a site. Several species, including terns and skimmers, will nest on both barrier islands and bay islands. Some species, like terns, prefer the island to be close to an inlet that offers optimal feeding habitat. Other species, such as the Piping Plover, will nest only on natural barrier islands.

A regional gradient of nesting habitat scarcity for beach-nesting waterbirds exists on the Delmarva peninsula. Nesting habitat increases in abundance towards Virginia and conversely decreases northward through Maryland and Delaware. Within the study area, there is only limited bare-substrate nesting habitat available. Critical sites include Skimmer Isle in Isle of Wight Bay and northern Assateague Island. Other nesting habitat is sporadically available as bare substrates are created by human activity. These then typically become vegetated and are only viable for a period of several years.

Table 2-5

	Common Name	Scientific Name	Federal Status	State Status 1	Occurrence
Plants					
	Seabeach Amaranth	Amaranthus pumilus	Threatened	Extirpated	Historically occurred on Assateague Island
	Seaside Knotweed	Polygonum glaucum		Endangered	Occurs within and south of State Park
Insects					
	White Tiger Beetle	Cicindela dorsalis media		Endangered	Nest on Assateague Island in project area
Birds					
	Piping Plover	Charadrius melodus	Threatened	Endangered	Nest on Assateague Island in project area
	Least Tern	Sterna antillarum		Threatened	Nest on Assateague Island in project area
	Roseate Tern	Sterna dougallii	Endangered	Extirpated	Transient, may have historically nested in the project area
	American Oystercatcher	Haematopus palliatus		Rare/Watch List	Nest on Assateague Island in project area
Sea Turtles					
	Kemp's Ridley	Lepidochelys kempii	Endangered	Endangered	Transient
	Leatherback	Dermochelys coriacea	Endangered	Endangered	Transient
	Green Turtle	Chelonia mydas	Threatened	Threatened	Transient
	Atlantic Loggerhead	Caretta caretta	Threatened	Threatened	Transient, rare nester on Assateague Island
Marine Mammals					
	Fin Whale	Balaenoptera physalus	Endangered	Endangered	Transient
	Right Whale	Eubalaena glacialis	Endangered	Endangered	Transient
[1]	Status for birds refers only to breeding status, migrants may have a different rank				

2.6 Reserves, Preserves and Public Land

Assateague Island National Seashore and State Park

Assateague Island provides a gently curving 38-mile long ocean beach and scalloped bayside shoreline within the National Seashore and State Park. The island is naturally narrower at the north end, widening from less than a quarter of a mile wide near the inlet to about a mile wide near the Virginia border at the south end. The island is covered with broad flat areas, especially at the frequently overwashed north end, and low dunes, both natural and constructed. Vegetation ranges from sparse grass to the shrubs, trees, and salt marshes typical of a barrier island. The Assateague Island National Seashore and the State Park are located adjacent to one another and both provide high-quality recreational venues despite the cumulative effects of interrupted sand flow to the island, such as narrowing and loss of height, for more than 60 years. The island is discussed extensively in this and the previous EIS.

Isle of Wight Wildlife Management Area

The Isle of Wight is managed for active and passive recreation by the MD DNR.

Sinepuxent Islands Wildlife Management Area

Dog Island, South Point Spoils, and other small islands located within the bays are managed by the state for activities such as bird watching, boating, and fishing.

2.6.1 Recreation

Assateague Island

The Assateague Island National Seashore and State Park attract many visitors throughout the year. Heaviest use is during the warm months when thousands of recreationists swim, boat, fish, and camp on the island. Recreational use of the island was covered in the first EIS.

Ocean City Updrift fillet

The area is used extensively during warmer weather months by beach visitors. The area is noted as one of the best surfing areas on the Delmarva Peninsula, and is used by surfers year-round.

Dog Island Shoals and South Point Spoils

Both of these sites are within the state Sinepuxent Bay WMA, and are utilized by waterfowl hunters. Recreational fishing is extremely popular in the channels in the vicinity of Dog Island Shoals.

Isle of Wight

There are no recreational facilities on the island; however, the state plans to improve the southeastern portion of the island to provide opportunities for passive recreation. The southern shoreline is used for fishing and crabbing. The southwestern shoreline of the Isle of Wight west of the county boat ramp is in a natural unstabilized condition, and possesses low dunes and salt marsh. It is one of the few publicly owned natural estuarine beaches in the northern coastal bays, and is used by recreational boaters. Hunting is allowed on the portion of the island north of Route 90. Hunting activities focus on waterfowl, deer, and squirrel.

Ocean Pines
The existing and filled salt marshes have minimal recreational value because of dense vegetative growth and muddy marsh soils.

2.7 CULTURAL AND HISTORIC RESOURCES

Since the construction of the Ocean City jetties in the 1930's, the sand migrating southward along the Maryland coastline has been interrupted from its natural depositional practices. The result pertinent to this study has been the formation of a large ebb shoal immediately to the south of the Ocean City jetty. There is an abundance of bathymetrical data that documents that this shoal has been forming during the past 60 years. This report documents in depth the recent nature of these shoals off Ocean City. Due to the recent formation of these shoals (post-1933), it was determined that no eligible cultural resources would be contained within them, and that no cultural resource investigations were warranted.

Dredging to maintain the Ocean City Inlet and the continuous movement of boat traffic has disturbed the sediments in the area since the inlet formed. The Maryland Historic Trust concurred with the findings of the Baltimore District that the documented disturbance in this area negated the need for cultural resource investigations, and that the continued dredging of this area would have no effect on cultural resources.

Ocean City Harbor was created by excavating into the mainland in the 20th century, and the harbor has been repeatedly disturbed since its construction by dredging. The sediments have also been impacted by the continuous movement of boat traffic through the area. The Maryland Historic Trust concurred with the findings of the Baltimore District that the documented disturbance in this area negated the need for cultural resource investigations, and that the continued dredging of this area would have no effect on cultural resources.

The northern portion of Assateague Island has receded to the west substantially during the past 50 years. Therefore, intact cultural sites that may have existed on Assateague Island are currently offshore, and would have been substantially disturbed by the displacement of soils. Although the Maryland State Historic Preservation Office identified the presence of archeological materials on the shoreline of northern Assateague, they concurred with the findings of the Baltimore District that the placement of sand adjacent to the tidal line would mimic natural processes, and would not effect cultural resources in this area (see Annex A, Part 7). Therefore, no cultural resource investigations were conducted for the proposed dredged material placement or sand bypassing activities for this project.

Dog Island Shoals is an area of a former shoal, but erosion within the past 50 years has substantially reduced the size of the island from 8+ acres to 1.5 acres. The placement site is located outside of the historic boundary of Dog Island Shoals, but is on sediments deposited on the location with the past 50 years. Given the fact that the proposed action will place dredged materials in the area naturally shoaling during the past 50 years, it was considered that no National Register eligible resources would be located in the area, and no cultural resource investigations were conducted.

The Ocean Pines site was within the boundaries of a parcel surveyed by Thunderbird Archeological Associates in 1995. A letter dated January 21, 1996, from the Maryland Historic Trust to the Maryland Department of the Environment, found that none of the archeological resources in the project area contacted sufficient integrity to qualify them for listing on the National Register of Historic Places. Therefore, no further cultural resource investigations are warranted.

At the Isle of Wight project location, approximately 4 feet of fill consisting of dredged spoil, gravel, concrete, and asphalt rubble has been placed along the southeastern shoreline. Concrete structures associated with a former concrete slab production facility also occur on the site. The shoreline itself is stabilized with bulkheads and riprap. Given that the entire area has been severely disturbed by natural and manmade processes, no testing was conducted at this site, and the Baltimore District determined that project areas at this location will have no effect on cultural resources.

The soils that occur on South Point originated from the placement of dredged material taken from the Sinepuxent Channel in 1934. These soils are classified as Made Land. South Point Spoils island was originally created by the Corps of Engineers by side-casting dredged material during creation of the Sinepuxent Channel in 1934 and 1935. Given the fact that the South Point Spoils project area is constructed of modern dredged materials, no cultural resource investigations were conducted, and the Baltimore District determined that the alteration of this area would have no effect on cultural resources.

The sole location with the potential for retaining intact cultural resources was at Ocean Pines. The predictive model for prehistoric settlement and land use in Worchester County offered the best potential for the location of cultural resources. The interface of well-drained soils with tidal marsh would have offered an environment suitable for prehistoric utilization with two differing ecozones. The area is currently heavily wooded with loblolly pine, but several unimproved roadways have been cut through the areas for future residential construction. During June 1997, the saltmarsh restoration sites were visited, and several judgmental shovel tests were excavated at each site. Test locations were placed in the upland, well-drained soils. Approximately 0.8 feet of whitish sand was underlain by a gray sand clay. No artifacts were encountered. Therefore, although the location would have been suitable for prehistoric use, there is no evidence of it at this location.

Section 106 compliance for this project has involved a number of meetings as well as correspondence between the Baltimore District and the Maryland Historic Trust. Final concurrence by the State Historic Preservation Officer has not been received, but the Section 106 process will be concluded prior to the completion of the Feasibility Phase of this project.

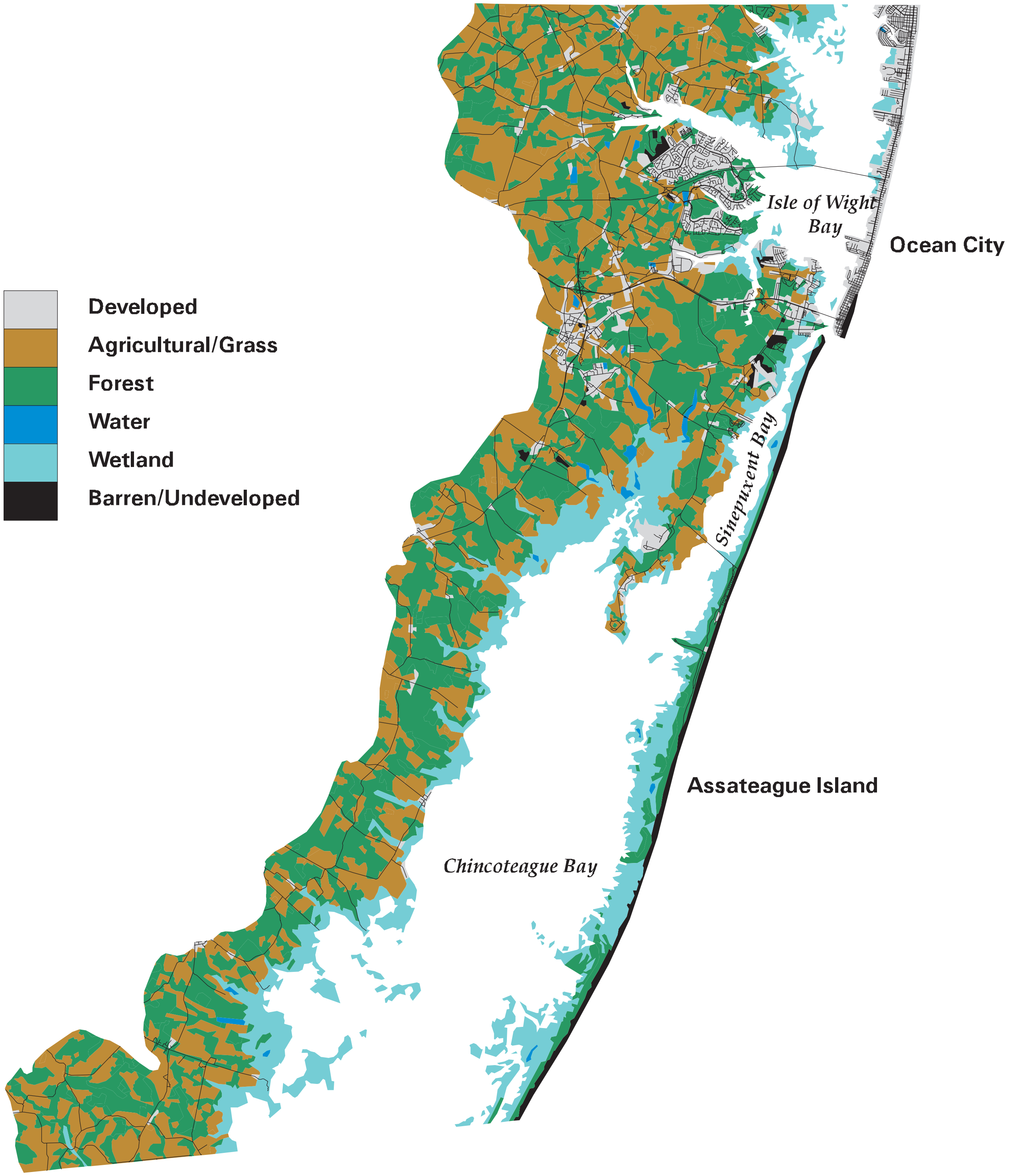
2.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The entire watershed was evaluated for hazardous, toxic and radioactive wastes (HTRW) in the first EIS. No RCRA or CERCLA sites were found in a records search for the project area. Consequently, the Baltimore District has concluded that no further HTRW investigations are needed. More detailed HTRW information was presented in the Assateague EIS.

2.9 COMMUNITY SETTING

2.9.1 Land Use

Land use differs in the region as a function of geographic proximity to heavily developed Ocean City as shown in Figure 2-7. Rapid residential and commercial development occurred in the vicinity of Ocean City beginning in the 1960’s. Bayfront areas also attract residential development. Since 1987, approximately 15,900 acres of agricultural land has been converted from active farming to some other use, such as residential, a loss of nearly 13 percent. Forestry and farming are the predominant land uses on the mainland, and much of the mainland has an open, rural character. Poultry products are Worcester County’s agricultural staple, with most field crop production geared to producing poultry feed. Sand and gravel mining occur in limited areas. In contrast to heavily developed Fenwick Island, Assateague Island is publicly maintained parkland, with three governmental agencies sharing management jurisdiction over the island. Tables 2-6 and 2-7 indicate land use in the study area.



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Landuse

Date: 16-AUG-1997
/harold2/pmn/ocity/report/landuse.map

Figure 2-7

Table 2-6: Summary Characterization of Land Use and Land Cover of the Maryland Portions of the Coastal Bay Watershed

Landuse	Acres	% of Total
Residential	***7,550***	***6***
low density	4,484	4
medium density	752	0.6
high density	1,268	1.0
open urban land	1,013	1.0
forested large lot subdivision	33	0.02
Commercial	***1,694***	***1.4***
Industrial	***76***	***0.06***
Institutional	***195***	***0.20***
Extractive	***86***	***0.07***
Agricultural	***41,571***	***35***
cropland	39,286	33
row and garden crops	180	0.09
pasture	262	0.2
orchards	45	0.04
feeding operations	1,619	1.4
other agricultural	179	0.1
Forest	***46,189***	***39***
deciduous	2,607	2.0
evergreen	4,743	4.0
mixed forest	34,666	29.0
brush	4,173	5.0
Wetlands	***20,125***	***17***
Beaches/Bare Ground	***1,394***	***1***
Water	***829***	***0.7***
Total	119,709	100

Table 2-7: Land Use Surrounding the Upper and Lower Bays in Percent of Total Acres for Each Subwatershed

Land Use

Subwatershed	Agriculture (%)	Forest (%)	Marsh (%)	Developed (%)
Chincoteague Bay	25	40	31	1
Newport Bay	34	42	14	7
Isle of Wight Bay	40	37	4	15
St. Martin River	66	27	1	6
Assawoman Bay	26	23	25	24
Sinepuxent Bay	19	29	33	9

2.9.2 Visual and Aesthetic Values

The aesthetic features of the study area are varied and contrasting and represent a major factor attracting people to the area. The principal aesthetic features of the region are the Atlantic Ocean and the coastal bays, and their associated shorelines. Assateague Island National Seashore (AINS), because of the road access and its natural environment, is considered one of the best beaches in the United States. The land within the barrier islands is flat but by no means lacking in scenic or aesthetic quality. The physical presence of the ocean and its effect on landforms is impressive and the National Seashore provides a 37-mile-long undeveloped ocean beach. The extensive shoreline wetlands of Chincoteague Bay add to the aesthetics of the area. The proximity of the bays and wetlands to the ocean creates a contrast that has been aesthetically pleasing to many residents and visitors.

The aesthetic quality of the study area is influenced by the natural and developed environment. The combination of the two effects are evident in an effective landscaping ordinance adopted in 1984, which has greatly enhanced the previous and recent development. The use of bermed planting areas along the Coastal Highway has improved its aesthetics greatly, as berms are effective at disguising parking lots and other level hard surfaces.

Each of the potential project locations provides a visual experience that is typical of the back bay area. Assateague Island provides nearly pristine beaches; Dog Island Shoals is a shallow water area close to popular fishing and boating locations; Ocean Pines is heavily vegetated with trees, shrubs, and tall stands of common reed; and South Point Spoils is a small remnant island, vegetated with trees, shrubs, and common reed that provide important nesting habitat for many waterbirds.

The only potential project area that is aesthetically problematic is along the southeastern shoreline of the Isle of Wight, where failing sheet pile bulkheads and rough construction rubble can be seen from the water and from the land. This is of particular importance since this site is one of only two highway accesses (Routes 90 and 50) that serve as "gateways" into Ocean City from the mainland.

2.9.3 Prime and Unique Farmland

Several soil types within the Matapeake, Mattapex, Sassafras, and Woodstown Series are classified as prime farmland in recognition of their importance to agriculture (see Annex A, Part 4 for list of prime farmland soils). Assateague and Fenwick Islands lack farm soils, as does the southeastern shoreline of Isle of Wight, Dog Island Shoals, and South Point Spoils. Portions of the upland areas of Ocean Pines contain Sassafras soils. The portion of Ocean Pines occupied by this soil type are either developed or slated for development in the near future.

2.9.4 Wild and Scenic Rivers

There are no federally designated wild or scenic rivers within the coastal bays watershed. The only state nominated river for the Maryland Scenic and Wild Rivers Act within Worcester County is the portion of the Pocomoke River from 1 mile below Whitons Crossing to Snow Hill. However, this river is outside of the coastal bay watershed.

2.9.5 Noise

Noise is of environmental concern because it can cause annoyance and adverse health effects. Noise can impact such activities as conversing, listening to music, working, and sleeping, among others. Noises can also disrupt wildlife behaviors.

Noise in the study area varies from site to site. Assateague Island is undeveloped and is preserved as open space. There are few areas impacted by noise pollution. Fenwick, however, is fully developed as a tourist resort, and contains the town of Ocean City. Typical noise is created by amusement, restaurant, and entertainment facilities, automobiles, and recreational tourists.

Dog Island Shoals is an area of intense recreational boating. The Isle of Wight is located along Route 90. Typical noise is produced by automobiles, boats, and recreational visitors. Ocean Pines is a large residential development currently under development. Noises are produced by trucks and other commercial vehicles, and by automobiles of the local residents. South Point Spoils is an isolated island in the relatively pristine waters of Chincoteague Bay. Noise effects are typically produced by recreational boaters, although to a much lesser degree than Dog Island and Isle of Wight.

2.9.6 Navigation

Commercial and recreational boating are vital to the coastal bay region for attracting visitors and as an economic resource. A number of Federal, state, and locally maintained navigation channels are located in the Ocean City Inlet, Ocean City harbor, Sinepuxent Bay, and Isle of Wight Bay. Many of the commercial vessels dock at the Ocean City harbor, whereas the recreational and charter vessels dock at marinas and private docks throughout the coastal bays (Figure 2-2).

There are four main federally maintained channels within the coastal bays: the Ocean City Inlet (10 ft deep and 200 ft wide from the Atlantic Ocean to Sinepuxent Bay); the harbor (10 ft deep and 150 ft wide from the Sinepuxent Bay through the harbor); Sinepuxent Bay (6 ft deep and 150 ft wide from the inlet to Green Point and thence 100 ft wide in Chincoteague Bay), and Isle of Wight Bay (6 ft deep and 125 ft wide from the inlet channel to a point opposite North 8th Street in Ocean City, then 75 ft wide into the Isle of Wight [Table 2-8]).

The MD DNR services four non-Federal channels: Lower Thorofare, Georges Island (Chincoteague Bay north of Purnell Point), and the 87th Street boat ramp. The State and county jointly maintain the local Thorofare Channel (6 ft deep and 100 ft wide).

Most of the major commercial navigation facilities are located near the inlet. The average vessel in the fishing fleet drafts 12 ft and is 70 to 80 ft in length, with a beam of 20 to 30 ft.

The maintained section of the Shantytown Channel serves the needs of local recreational and commercial boaters. The largest vessels using the channel are five commercial passenger vessels that measure as much as 88 ft in length and draft up to 13 ft; these vessels use the channel most of the year.

Table 2-8: State and Federal Dredging Activity

Channel	Date Last Dredged	Amount Dredged (yd^3)
Federal		
Harbor	1990	20,000
Inlet	1997	30,000
Isle of Wight	1995	62,000
Sinepuxent	1972	6,000
State/Local		
Lower Thorofare	1992	12,500
George Island (Chincoteague Bay north of Purnell Point)	1969	10,000
87 th Street Boat Ramp	1992	11,500

2.10 SOCIOECONOMIC CONDITIONS

2.10.1 Demographics

The strength and rapid growth of the recreation and tourism industry is a primary factor in the recent and projected population growth of Worcester County, which includes the study area. The importance of the tourism and agriculture industries is reflected in occupations and incomes of county residents. Based on 1990 data comparing county populations, lower percentages of county residents were employed in managerial and technical positions, while higher percentages were employed in service, farming, fishing, repair, and as laborers. An 8 percent poverty rate in the county compares with 6 percent in the state overall. The 1995 total population of Worcester County, according to the Maryland Office of Planning, was 37,700, an increase of 7.6 percent over the 1990 population. Approximately 62.2 percent of that number are located within the coastal watershed (east of U.S. Route 113). Total county population is projected to increase to 45,800 by 2015, a 21.5 percent increase over the 20-year period from 1995 to 2015. However, the seasonal population grows to several hundred thousand due to the recreational nature of coastal Worcester county. A large proportion of Worcester's newest population is coming from those over the age of 55 as the county becomes a retirement locale for increasingly larger numbers of people. The vast majority of these new citizens are establishing residence in the coastal bay watershed.

To provide a framework for comparison with Worcester County over this 20-year period, the projected population increase for the entire Lower Eastern Shore of Maryland (Somerset, Wicomico, and Worcester Counties) is projected at 16.8 percent. For the State of Maryland, the projected increase is 17.6 percent. These data indicate that Worcester County population growth is expected to run about 4 percent ahead of the state growth rate over the next 20 years.

2.10.2 Economics

The study area is of critical importance for the economy of the state of Maryland. Vacationers in Ocean City also frequently visit Assateague Island and the coastal bays. More than 10 million people visit the Delmarva Peninsula annually, often for the recreational attractions (boating, swimming, and fishing). There are 736 public boat slips available in the study area for recreational boaters, and a robust charter boat industry provides additional recreational opportunities for sport fishermen and sightseers.

Tourism is a linchpin providing employment opportunities in the study area. Almost 63 percent of the employed labor force in 1993 worked in the retail trade (36.1 percent) or services (26.5 percent) industries. Both of these industries are driven by tourism. According to data compiled by the Maryland Department of Economic and Employment Development, the total civilian labor force in Worcester County in 1993 was 21,632. The unemployment rate for the same year was 11.4 percent. Because of the dynamic influence of tourism on the county economy, unemployment rates vary by as much as 15 percent from summer to winter months.

The poultry processing industry is also a large provider of jobs in the study area. Two poultry processers, Hudson Foods, Inc., and Perdue Farms, Inc., employed 1,350 workers between them in 1993, according to the Worcester County Department of Economic Development.

The output of commercial fishermen also contributes significantly to both the regional and national economies. Watermen using the inlet channels and Ocean City harbor harvest a wide variety of fish and shellfish species for regional and national distribution. Important commercial species harvested and landed in the study area include clams, quahogs, monkfish, swordfish, tuna, flounder, mackerel, and dogfish. The total harvest of all species sold at the Ocean City harbor for 1996 was 19.3 million pounds with a total value of $8.8 million.

In comparison to the entire state of Maryland and the United States, Worcester County income levels are depressed. According to data compiled by Market Statistics, *1994 Demographics USA---County Edition*, 13.5 percent of Worcester County households had an effective buying income under $10,000. Effective buying income is defined as personal income less personal tax and nontax payments. In the state of Maryland in 1994, only 8.4 percent of households were below $10,000. In the U.S., 11.9 percent were below the $10,000 threshold. A similar pattern prevails in the median household, average household, and per capita statistics for 1994.

Worcester County lags behind Maryland by an average of 25 percent, and behind the United States by an average of 15 percent, in these income categories.

2.10.3 Environmental Justice

Executive Order 12989, dated February 11, 1994 (*Environmental Justice in Minority Populations*), requires that proponents of Federal projects assess potential impacts of proposed projects on low income or minority populations. Information on minority and low income populations in the project area follows. The 1994 working-age population (16+) of Worcester county was 31,321, of which 20 percent is classified as minority. Unemployment was 7.4 percent for whites and 17.8 percent for minority populations. Approximately 11 percent of the county population in 1994 was below the Federal poverty level.

2.11 FUTURE WITHOUT PROJECT CONDITION

2.11.a Assateague Island

As the sediment budget and pathways studies completed for this report show (see Appendix A2), little sediment is reaching northern Assateague Island. Without intervention, this sediment-starved condition is expected to continue. It is predicted that, if nothing is done to restore the sediment supply to Assateague Island, the island may continue to be starved of sediment, the net loss of sediment may increase, and the integrity of Assateague Island as a national treasure may continue to deteriorate. The sediment-starved zone is expected to expand southward, and may likely reach to 13 km (8 miles) south of the inlet by the year 2046. It may also increase in area. These conditions virtually assure that the island will breach. The northern 11 km (6.8 miles) of the island is extremely vulnerable, and the next significant storm is expected to breach the island. For purposes of this study, it was assumed that a breach will occur 7.0 to 7.5 km (4.3 to 4.7 miles) south of the Ocean City Inlet within the next 10 years. However, recent events indicate that the breach will occur much sooner, very possibly in 1998. It is feared that if a breach should occur, either it will be filled in quickly using emergency funds, which could adversely affect the environment, or it will not be filled, which could significantly change the dynamics of the bays and inlet.

It is assumed that a new inlet may occur in a form similar to the inlet that formed in 1962 and may or may not remain somewhat stable in its width. The 1962 inlet was 570 m (1870 feet) wide and was subsequently filled by the Corps of Engineers. A breaching event would cause the loss of a portion of Assateague Island National Seashore. Currently, pedestrians may access the entire Assateague Island. However, if a breach were to occur 7 km (11.2 miles) south of the inlet, access to approximately 370 ha (920 ac) of the island would be limited to boats.

If nothing is done to restore Assateague Island and a breach does occur, as is expected in the near future, tens to hundreds of acres of barrier island habitat in the vicinity of the new inlet(s) could be converted to marine habitat. Additional infilling of Sinepuxent Bay may occur. Marine habitat exists in greater abundance than barrier island and estuarine habitat. Additional significant vegetated habitat on the island could likely be converted to bare sand habitat. Impacts of a breach on Piping Plover and other rare species are unknown; rare species habitat quantity and quality could increase or decrease depending on the height and configuration of the post-breach island(s). Within National Park Service lands, the extent of the island closed to public use for part of the year to protect beach-nesting colonial waterbirds is defined by the area that the birds utilize for this purpose. Therefore, as the overwash zone continues to expand in area, the proportion of the island closed to human use during the Piping Plover nesting season will presumably increase in area.

2.11.b South Point Spoils

The island is eroding, and is expected to erode away completely sometime in the first half of the 21st century. With the erosion of this island and many similar areas, nesting habitat for vegetation-nesting colonial waterbirds may decrease substantially in eastern Maryland.

2.11.c Ocean Pines

Without a project, the site is expected to remain in its current reed grass-dominated condition. At current rates of sea-level rise (0.3 m [1 foot] per century), the site would be expected to develop into salt marsh within 200 years, and salt marsh grasses may displace reed grass at that time. If the rate of sea-level rise increases as is anticipated with predicted global warming, salt marsh may develop sooner.

2.11.d Isle of Wight

The site will remain as public property, and the State of Maryland will eventually improve public access to the site and correct safety hazards associated with the failing shoreline protection structures. However, it is not expected that any salt marsh may be created or restored on the island without a Corps project.

2.11.e Dog Island Shoals

If no additional projects are implemented, sand placed to nourish the beaches at Ocean City could continue to flow into the Dog Island Shoals area. Shoaling would continue. Some of these shoals could become emergent above the water surface and could provide several acres of bare-substrate nesting habitat for colonial waterbirds. Any bare substrate that forms could likely become vegetated within a period of several years, and if so, may only provide bare-substrate nesting habitat for a brief period of time. Several acres of salt marsh could also form on the shoals. Dog Island itself, which formed by erosion of the mainland, is likely to erode away completely sometime in the first half of the next century.

SECTION 3

ASSATEAGUE ISLAND/LONG-TERM SAND MANAGEMENT

3.0 INTRODUCTION AND JUSTIFICATION

It was the intent of Congress in establishing Assateague Island National Seashore that the park provide a protected enclave for the complex plant and animal communities, both terrestrial and aquatic, that characterize the Mid-Atlantic Coast, and fully illustrate the natural processes of change that shape the coastal environment. Located within a 3-hour drive of nearly 45 million people, the National Seashore offers visitors a unique opportunity to learn about and experience first-hand the many aspects of a dynamic barrier island as well as the opportunity to pursue many exceptional recreational opportunities. The missions of Assateague Island National Seashore are to (1) preserve these valuable coastal resources and the natural ecosystem conditions and processes upon which they depend, (2) provide appropriate resource-based recreational opportunities compatible with resource protection, and (3) educate the public as to the values and significance of the area.

The value of this island cannot be measured in dollars alone. Assateague Island provides habitat for a wide variety of listed rare, threatened, or endangered species, both state and Federal. In large part, this is due to the fact that the island constitutes the only remaining natural barrier island habitat in Maryland—habitat that once was more abundant, but has now largely disappeared due to development and human disturbance all along the Atlantic Coast. The island also plays a key role in providing resting and foraging habitat for a variety of migratory species, including neotropical migratory songbirds, shorebirds, and several raptor species. Research has shown that concentrations of migratory birds are higher on Assateague than on the adjacent mainland. The value of the island to migratory birds led to its designation as a component of the Western Hemisphere Shorebird Reserve Network, an international register of the most important areas to migratory shorebirds.

In addition to its importance to these species, Assateague Island provides a home to the world-renowned wild horses made popular through the novel *Misty of Chincoteague* and its sequels. These horses are both a major tourist attraction and a lure to scientists, providing a unique opportunity for scholarly research into the behavior, reproductive biology, and population of feral equines.

Both the integrity of the island and the habitat of these species are seriously threatened by sand deprivation and erosion. Over the past 65 years, the project area has experienced numerous storms. Their cumulative impact has been to increase the susceptibility of Assateague to degradation, as its physical integrity diminishes at an accelerated rate. Large overwash flats have expanded on the island, reducing the diversity of habitat on the island. The historical rate of erosion since formation of the inlet in 1933 has increased from an average of 4.8 feet per year to 8.4 feet annually. The physical battering absorbed by the island during storms is a factor, along with the natural rate of erosion and the deprivation of material caused by the jetties, in this increased erosional rate. Over this 65-year period, erosion of 500 feet has occurred. Without action to restore the sediment supply to Assateague, this historical rate is expected to continue into the future. Additional breach events seem inevitable, albeit unpredictable. In the past, it was significant storms that breached the island; however, as Assateague continues to be sediment starved, it is more likely that smaller, more frequent storms will create minor or major breaches in the island. In the northern region, the island's function as a healthy barrier island will be further compromised, if not entirely lost. This could cause emergency repairs to be made, salt marshes and SAV to be destroyed, overwash areas to expand, access to the approximately 900 acres of the unique island to be temporarily lost, storm damages to the island and the mainland to increase, and temporary navigation difficulties to develop.

The recommended plan provides the following benefits:

1. Restores a unique barrier island of national significance to a more natural state
2. Reduces vulnerability of the island to a minor or major breach
3. Promotes habitat diversity
4. Reduces future downdrift erosion and prevents overwash areas from expanding, which would otherwise cause the loss of hundreds of acres of other habitat types
5. Allows for development of salt marsh
6. Reduces infilling of Sinepuxent Bay
7. Protects navigation through Sinepuxent Bay
8. Protects existing estuarine habitat in Sinepuxent Bay (tens to hundreds of acres)
9. Prevents loss of SAV beds (tens of acres)
10. Decreases or maintains existing erosion rate of mainland
11. Allows continued recreation in a unique, natural barrier island setting (7500 visitor days annually, equivalent to $34,000 annually)

This chapter discusses the water resource problems associated with the existence of the jetties and inlet and the continuing sediment starvation that is threatening the integrity of Assateague Island. During the reconnaissance phase, it was determined that there is Federal interest in restoring the island. Several problems were identified and various alternatives were evaluated to address the continued degradation of Assateague. This chapter describes the problems, needs, and opportunities; the goals and objectives; the alternatives and alternative evaluation; the impacts to the project area; and the recommended plan for long-term sand management in and around the inlet that is the most efficient, sustainable bypassing program.

3.1 PROBLEMS, NEEDS, AND OPPORTUNITIES

3.1.1 Problem Statements

The study team established the following problem statements:

1. The jetties at the Ocean City Inlet have created and continue to create a disruption in the longshore transport system, thus causing--

a. the sediment supply to Assateague Island to be greatly reduced. This reduction in sediment results in numerous physical and biological impacts to the area around Assateague Island, including the degradation of a functional barrier island.

b. a substantial amount of sediment to be transported through the Ocean City Inlet, resulting in deposition of the inlet, back bays, and the ebb shoal contributing to navigation difficulties.

2. Ocean City beaches will continue to require sand in the future to maintain the shoreline protection project because of natural shoreline erosion, sea level rise, and emergency needs.

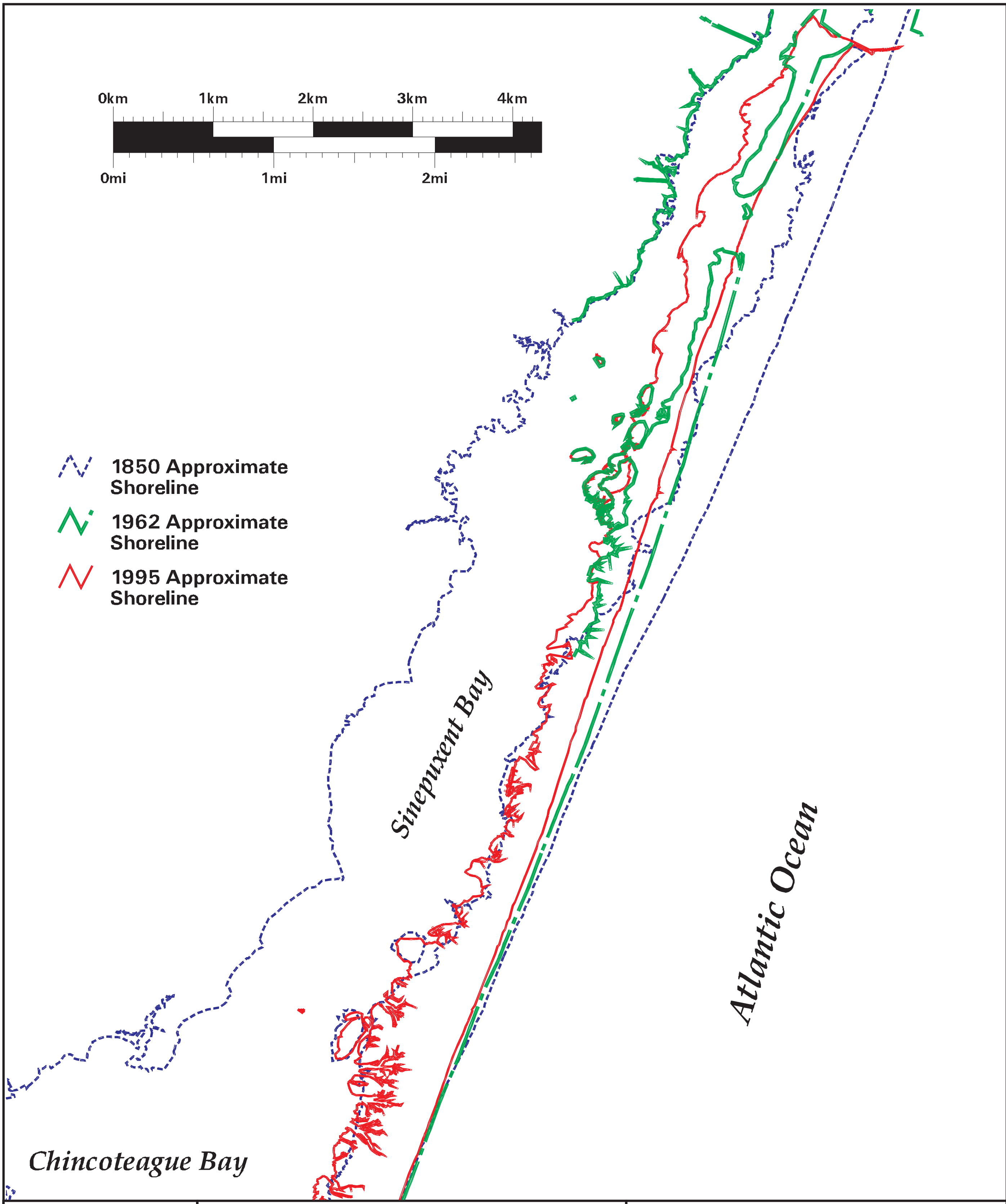
Problem 1a: Since 1934, when the Army Corps of Engineers constructed the jetties, the inlet has functioned as a thoroughfare for boating traffic; however, the jetties have disrupted the sediment supply between Ocean City and Assateague Island. Prior to the formation of the inlet, the sand generally traveled from Fenwick Island to Assateague Island, but the jetties have greatly reduced the flow of sand to Assateague Island. Consequently, the northern 11 km (6.9 miles) of the island are eroding and retreating at an accelerated rate. Erosion rates along the northernmost 10 km (6.2 miles) of Assateague Island escalated from a pre-inlet (1850-1929/33) rate averaging -1.5 $\pm$ 1.7 m/yr (-4.9 $\pm$ 5.6 ft/yr) to -2.9 $\pm$ 2.7 m/yr (-9.5 $\pm$ 8.9 ft/yr) in the post-inlet time period (1929/33-1996, see Figure 3-1 for shoreline change over time). The rapid erosion rate caused a loss of dunes and rendered the island vulnerable to overwash. Based on the erosion rates, is estimated that Assateague Island has been deprived of approximately 6.6 million m^3 (8.6 million yd^3) of material since 1933. Erosion of the island is caused by daily wave action, storm events, and the lack of an adequate sediment supply. It is important to note that the 6.6 million m^3 (8.6 million yd^3) does not include losses due to natural erosion more than the 60 years; it only includes material lost due to the jetties. This disruption in the natural longshore transport of sand between Ocean City and Assateague Island has resulted in numerous physical and biological impacts to the area.

Immediately following stabilization of the inlet, inlet dynamics began forming the updrift fillet and the ebb and flood shoals at the expense of the adjacent beaches (see Figure 2-5). The updrift fillet formed adjacent to the north jetty from sand that was trapped by the jetty. Once it filled, a process that was complete within approximately 5 years, sand was further distributed in new patterns, forming the ebb and flood shoals and additional shoals in the back bays.

As discussed in Section 2.1.1.c, the ebb shoal has grown enormously over the years. On average, the volume of material in the ebb shoal has increased approximately 160,000 m^3 per year (208,000 yd^3/yr) since 1933. The volume of the shoal is currently near 10 million m^3 (13 million yd^3). The ebb shoal significantly impacts the longshore sediment transport process. It has acted as a “sink” for over 60 years, depriving Assateague Island of the sediment needed to sustain the island.

This lack of a sediment supply has caused the northern portion of the island to lose its integrity as a barrier island and has made the island highly susceptible to breaching (see Figures 3-2 and 3-3 for aerial photographs of Assateague Island). The northern portion of Assateague Island has a much smaller volume and lower elevation because of this sediment starvation. It overwashes frequently. The rapid erosion, retreat, and overwash have, in turn, destroyed dunes, dune grassland and salt marshes on the island. Bare sand devoid of vegetation now characterizes much of the northern end. In addition, a substantial amount of sand has been washed over the island into Sinepuxent Bay, making the bay shallower and reducing its size by more than 200 ha (500 acres). The communities along the shoreline of the mainland behind Assateague Island are more vulnerable to storm damage since the barrier island no longer protects them to the degree it once did.

Problem 1b: Due to the presence of the jetties, the sand that is not reaching Assateague Island is being transported either to the ebb shoal or through the inlet during flood tide into the back bays (Isle of Wight, and Sinepuxent). A substantial amount of this sand is settling out and filling up these bays**.** It is estimated that up to 15,000 m^3 (20,000 yd^3) of material enters the back bays annually and remains. This material contributes to navigation problems, mostly for recreational boaters. Nourishing the Ocean City beach adds sediment to the system, and accelerates shoal growth. The ebb shoal has grown extensively and is considered by local boaters an impediment to navigation. Currently, the larger boats must travel east out of the inlet, then north out around the large ebb shoal to eventually travel south.



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

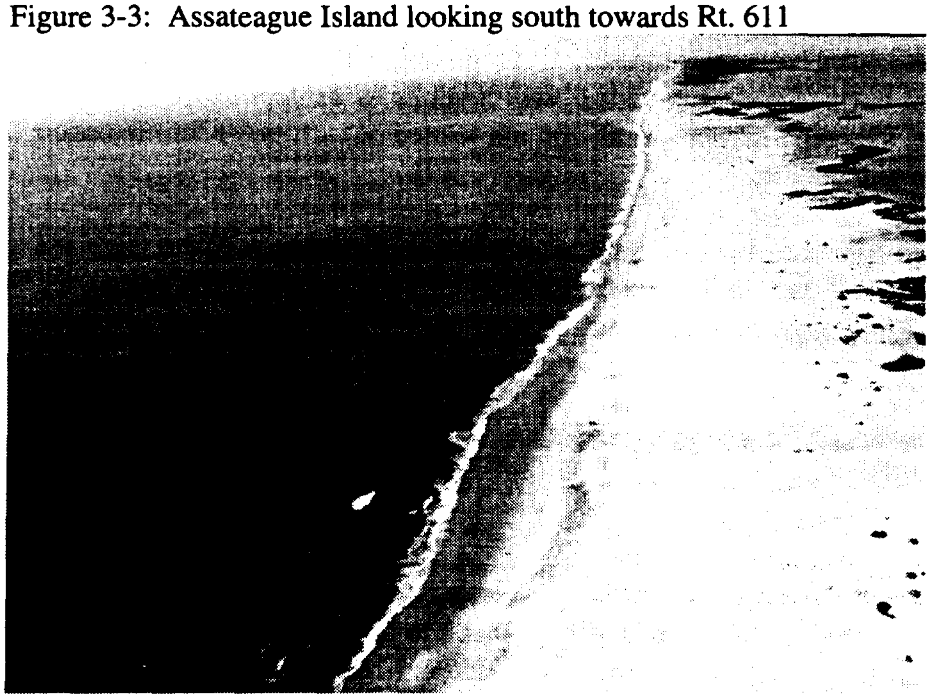
Shoreline Change

Date: 16-AUG-1997
/harold2/pmn/ocity/report/historic.map

Figure 3-1

Figure 3-2: Assateague Island looking 7 km south of Ocean City Inlet

Figure 3-3: Assateague Island looking south towards Rt. 611



Problem 2: The Corps, along with the state, county, and town, maintains a shoreline protection project along Ocean City that also has a continuous need for sand. The largest problem for the Ocean City beaches is that, at times, an emergency supply of sand is needed to rebuild isolated sections of the beach. It is cost prohibitive to pump material from offshore at these times. Currently, when sand is needed after storms to fill in low areas of the beach, called "hot spots," the team of Corps, state, county and local officials must identify other beach areas that have excess sand available for transport. At such times, surveys must be conducted along the entire beach to identify these excess areas, and many times, excess sand is scarce. The excess sand usually must be transported from a number of small reaches to the low points. The Corps investigated the future sand needs of both Ocean City and Assateague Island to determine whether there is a long-term plan that could address the future needs of both.

3.1.2 Needs

There is a need to solve both short-term and long-term problems related to Assateague Island and the disruption in longshore transport. A short-term project needs to be implemented as soon as possible to mitigate for the past erosion on Assateague, to restore the integrity of the island, and to help prevent further degradation and to prevent a breach from occurring in the next few years. A long-term project is needed to prevent similar problems in the future. Even if material is placed on Assateague Island for a short-term solution, the jetties will continue to disrupt the longshore transport, and Assateague will continue to erode at an accelerated rate. If a plan is not implemented to move the material from Ocean City across to Assateague Island, as it should move naturally, the material will continue to enter the inlet, shoaling in the back bays and impacting navigation and the coastal bay environment. This shoaling will continue to change the hydrodynamics of the coastal bays. Assateague Island will continue to be deprived of the sand supply it needs to function as a healthy barrier island, and the related opportunities for education and other benefits it provides will be lost.

In trying to determine the best approach for restoring the sediment to Assateague Island there is a need to consider the entire water system to determine if a long-term solution can incorporate the needs of Assateague Island while providing the need for sand on the "hot spot" areas of Ocean City.

3.2 FUTURE WITHOUT-PROJECT PROBLEMS

3.2.1 Assateague Island

As discussed in Section 2, unless the sediment supply to Assateague Island is restored, the island will continue to be sediment starved. Storm events will continue to impact the physical integrity of Assateague. Additional breach events seem inevitable, although unpredictable. In the past, significant storms breached the island; however, as the island continues to be starved of sediment, most likely smaller, more frequently occurring storms will create minor or major breaches in the island. In fact, a breach is expected to occur at any time, most likely at a point between 3 km (1.9 miles) and 10 km (6.2 miles) south of the inlet. In this area, overwashes occur more than 20 times per year and frequently extend to the bayshore. Within this vulnerable area, the reach from 7.0 to 7.5 km (4.3 to 4.6 miles) is considered to be at greatest risk. Without a continuous sediment supply to fill in the breach, the newly formed inlet would likely remain open unless filled in by man.

A breach would result in the loss of a substantial portion of Assateague Island National Seashore. The seashore is of national significance because it is readily accessible to millions of Americans, providing them a unique opportunity to experience and an undeveloped, functioning barrier island of the Atlantic coast, with its unique wildlife, particularly the famous "wild ponies of Chincoteague," as well as some endangered species. A breach would seriously impact the unique recreational and educational opportunities for relatively isolated shorebird viewing and nature hiking provided on the northern section of the Assateague National Seashore Island. Currently, pedestrians may access the entire island. However, if a breach were to occur 7 kilometers (4.3 miles) south of the inlet, access to approximately 372 ha (920 acres) of the national treasure would be limited to boats. In the northern region, the island's function as a healthy barrier island would be further compromised, if not entirely lost. The loss of these opportunities would result in a loss of 7,500 visitor-days on an annual basis. The monetized loss of this opportunity would be $37,500 on an annual basis, but its environmental loss would be much greater.

It is predicted the breach would convert tens to hundreds of acres of natural terrestrial barrier island habitat to marine habitat. Natural terrestrial barrier island habitat is scarce, since development has occurred along so much of the U.S. coastline. In contrast, the nearshore marine habitat that would replace it is of far greater abundance, and is available even along developed shorelines. Impacts of a breach on Piping Plover and other rare species habitat cannot be determined.

3.2.2 Coastal Bays and Inlet

It is predicted for this study that if a breach occurred, Sinepuxent Bay would be partially filled in and constricted, but would not close completely; the tidal prism would most likely serve to maintain some flow between the Ocean City Inlet and Chincoteague Bay. A breach could occur either from the ocean or bayside of the island. If a breach were to occur from the bayside, the island adjacent to the breach would most likely erode and fill in part of Sinepuxent Bay. These changes would cause substantial short term changes to the coastal bays ecosystem, including disruptions to the food web that would result from short-term loss of SAV beds and mainland salt marsh.

The ebb shoal, although it bypasses some sand to Assateague Island, could continue to grow in size. This could make it more difficult for navigation and could lead to additional damage to vessels.

3.2.3 Mainland

A number of communities located along Highway 611, directly behind Assateague Island, are susceptible to inundation from the effects of storm surge. Four mainland communities landward of Sinepuxent Bay incurred $3.2 million in damages from the January 1992 storm. The damage is caused by storm surge overwashing Assateague Island and flowing through the Ocean City Inlet. A breach would significantly affect the water level in the bay. Breaches generate the largest peak water elevations locally near the breakthrough. Water levels would most likely increase 1.5 to 2.5 m (4.9 to 8.2 feet) directly behind the breach during a storm. The same communities that incurred $3.2 million in damages are expected to incur at least an additional $700,000 in damages from a breach of the northern section of Assateague Island during a storm similar to the January 1992 storm. (See Appendix D for a more detailed discussion.)

3.2.4 Ocean City

The Ocean City beaches will continue to be routinely nourished in the future. If a more flexible method of renourishing the Ocean City beaches is not implemented, the Federal, state and local governments will continue to struggle to identify sources of sand to renourish the low areas of the beach whenever a storm occurs, in order to maintain the design level of protection.

3.3 GOALS AND OBJECTIVES

As part of this study, the Corps further investigated projects relating to the sand starvation and the consequential degradation of Assateague to determine a plan that is feasible from an engineering standpoint, that is environmentally acceptable, and economically justified.

3.3.1 Federal Objective

The Federal objective of water and related land resource project planning is to contribute to the national economic development (NED) consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. This objective was established by the U. S. Water Resources Council's *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* on 10 March 1983.

Water and related land resource project plans are to be formulated to alleviate problems and to take advantage of opportunities in ways that contribute to this objective. Contributions to NED increase the net value of the national output of goods and services, expressed in monetary units (i.e., benefits exceed costs). Contributions to NED are the direct net benefits that accrue in the study area and the rest of the nation. Contributions to NED include increases in the net value of goods and services that are marketed (vendible) and also of those that may not be marketed. Generally, several alternative plans are formulated to address a particular set of water resource problems. These plans are evaluated on four criteria: completeness, effectiveness, efficiency, and acceptability. A NED analysis was used to evaluate navigation improvements to the inlet and harbor.

In a statement dated 25 June 1990, the Assistant Secretary of the Army for Civil Works directed the Corps to use new approaches to implement the President's goal of maintaining and restoring the health of the environment. One of the suggested ways to do this is to use Federal funds to restore environmental values. It was these new approaches that were used to evaluate the Assateague Island restoration and environmental restoration in the coastal bays.

3.3.2 Planning Objectives, Constraints, and Formulation

Planning objectives are expressions of public and professional concerns about the use of water and related land resources in a particular study area. These planning objectives result from the analyses of existing and future conditions within the context of the physical, environmental, economic, and social characteristics of the study area. They are used to guide the formulation of alternative plans and to evaluate the effectiveness of those plans.

3.3.2.a Short-Term Restoration of Assateague Island

Due to the imminent threat of a breach occurring on Assateague Island, the problems of Assateague Island degradation and the need for sediment supply were separated into two components: short-term restoration of Assateague Island and long-term sand management. The short-term restoration study was accelerated to address problem 1a described in Section 3.1.1: *The jetties at the Ocean City inlet have created a disruption in the longshore transport system, thus causing the sediment supply to Assateague Island to be greatly reduced. This has resulted in numerous physical, biological, and economic impacts to the area around Assateague Island, including the loss of a functional barrier island.* The following goals and objectives were established for the short-term restoration of Assateague Island.

Goal: Restore Assateague Island to mitigate for adverse impacts caused by past Corps projects.

Objectives and Constraints:

1. *Restore the northern end of Assateague Island with a volume of sediment that would adequately mitigate for the impacts caused by the Corps' project* - The project should place a sufficient volume of sand to maintain the island until a long-term solution can be implemented.

2. *Reduce the likelihood of a breach that would result in the formation of additional inlets* - Assateague Island is extremely vulnerable to breaching even during a mild storm due to the loss of sediment volume.

3. *Promote natural habitat diversity* -As much as possible, natural forces should be allowed to shape the character of the island and its biota, and the project should not favor or maintain a particular habitat condition over time.

4. *Minimize impacts to the Piping Plovers* - Piping Plover is protected under the Endangered Species Act, and its status in the area is of significant interest to agencies and the public.

5. *Reduce the probability of storm damage/increased erosion in the vicinity of Assateague Island* - The mainland communities behind Assateague Island are more susceptible to damage during storms due to waves overwashing the island.

6. *Protect navigation interests* - Because of shoaling, boaters already experience problems navigating the coastal bays; however, if Assateague Island were to breach, the situation would worsen.

7. *Protect and enhance recreational and economic resources* - Recreation on Assateague Island, in the back bays, and on the mainland is vital to the area's economy and must be protected.

The recommended plan for the short-term restoration of Assateague Island meets all of those objectives. The plan is described in Section 1.5. For more information, see Appendix D.

3.3.1.b Long-Term Sand Management

Sand is a limited resource in the coastal area, and long-term sand management in the area is a complex issue. The Ocean City Inlet jetties have disrupted the longshore transport of sand between Fenwick and Assateague Islands, and have caused sand to become trapped in the ebb shoal, flood shoal, the updrift fillet, and other back bay areas. The following goals and objectives were established for this component of the project:

Goal: To restore sediment transport by supplying an amount of material to Assateague Island that would naturally be transported to the island if the jetties did not exist. To evolve towards the most efficient, sustainable long-term sand management program that over time will follow the natural process and not adversely impact the water system. By preventing the movement of sediment through the inlet, the plan should help reduce the shoaling problems in the coastal bays and on the ebb shoal. The plan should also consider the sediment supply needs of the Ocean City beach.

Objectives:

1. Mitigate for future impacts that the jetties will have on Assateague Island; determine a long-term program for restoring and maintaining the flow of sediment to the island.
2. Create an efficient, sustainable long-term sand management program.
3. Reduce shoaling in the back bays and the ebb shoal to improve navigation.
4. If possible, determine a long-term solution that addresses the sediment supply needs to the regional coastal area either as a routine measure or under emergency conditions.

3.4 FORMULATION OF ALTERNATIVE PLANS

The long-term sand management component of the study involved investigating the sediment budget and sediment pathways throughout the entire study area. For a map of these pathways, see Figure 3-4. As stated previously, after the jetties were built in the mid-1930's, the updrift fillet formed. This fillet consisted of sand that was trapped by the jetties and thus was prevented from continuing down the coast in its natural pattern. Once the updrift fillet could trap no more sand, a point that was probably reached within 5 years of its formation, the sand was further distributed into new patterns. This redistributed sand created the ebb and flood shoals, and began shoaling in additional areas in the back bays.

In determining alternatives for the restoration, it was necessary to also determine how much sand would be necessary to meet the goal of restoration. A sediment budget was developed, representing the timespan from 1980 to 1996, which was considered a present-day sediment budget (see Appendix A2). This budget indicated the following quantities: Q1, the littoral transport rate from Fenwick Island towards Ocean City Inlet, is equal to approximately 115,000 m^3 (150,000 yd^3) per year; Q2, the transport of littoral sediments from the ebb shoal to Assateague Island, is equal to approximately 53,000 m^3 (69,000 yd^3) per year; and Q3, the littoral transport rate from Assateague Island into Ocean City Inlet, is equal to approximately 83,000 m^3 (108,000 yd^3) per year. The volume required to restore natural processes to Assateague Island is defined as Q1-Q2+Q3, which equates to approximately 145,000 m^3 (189,000 yd^3) per year. This volume accounts for the loss of material from Assateague Island into the inlet system (see Appendix A8).

The optimal plan to restore the natural system would be to capture all the sand as it reaches the north jetty and transport it across to Assateague Island. Another option is to transport the sand from the places where it has been trapped, such as the ebb and flood shoals and updrift fillet, to Assateague Island. The term used to describe these actions are bypassing. Supplying sand to Assateague Island, restoring natural transport processes, back-passing sand for Ocean City "hot spot" erosion needs, and reducing shoaling of the bays are all aspects of long-term sand management. We have investigated the availability of sand in the area and have determined long-term plans that can be implemented for the wise use of this resource. The following list includes all the initial alternative plans identified for long-term sand management:

1. **No action**.

2. **Remove the jetties**, thereby allowing sediment to resume its natural transport process. This action would lead to two sub-alternatives:

2a. Continuously dredge the inlet channel to maintain navigation.

2b. Abandon the navigation project entirely and allow the inlet to eventually shoal back in.

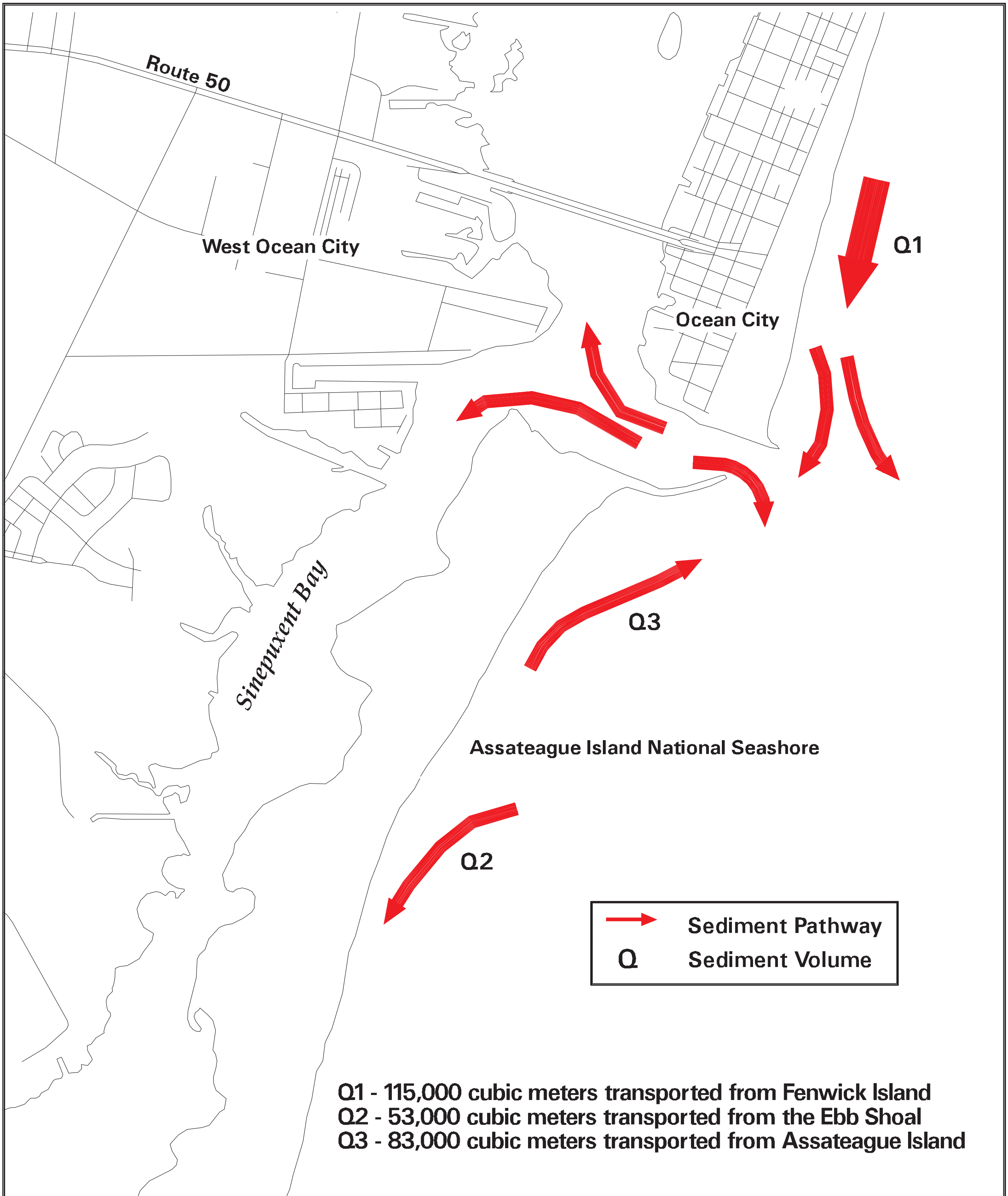
3. **Construct a fixed plant** at the southern tip of Ocean City to transport material to Assateague Island. This plant would include a pump house, a crane that or other means to move sand from the updrift fillet to the pump house, and a pipe under the inlet that would transport the material to Assateague Island. A fixed plant would operate year-round. An illustration of the Indian River, Delaware fixed plant is seen in Figure 3-5. Note that the Indian River Plant pumps the material north across the inlet, whereas at Ocean City, sand would be pumped south to Assateague Island.

This alternative then offers two sub-alternatives:

3a. Use booster pumps on Assateague to pump the material to more than one location on the island.

3b. Pump material to a single site on Assateague Island and then carry it by truck to its desired locations along the island.

4. **Use a Punaise** to dredge material and pump it to Assateague Island. A Punaise is a submersible dredge, shaped like an upside-down thumbtack, that was developed in the Netherlands and has been used there and in some other countries, but not yet in the United States. A Punaise could be either rented or possibly purchased.



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Sediment Pathways

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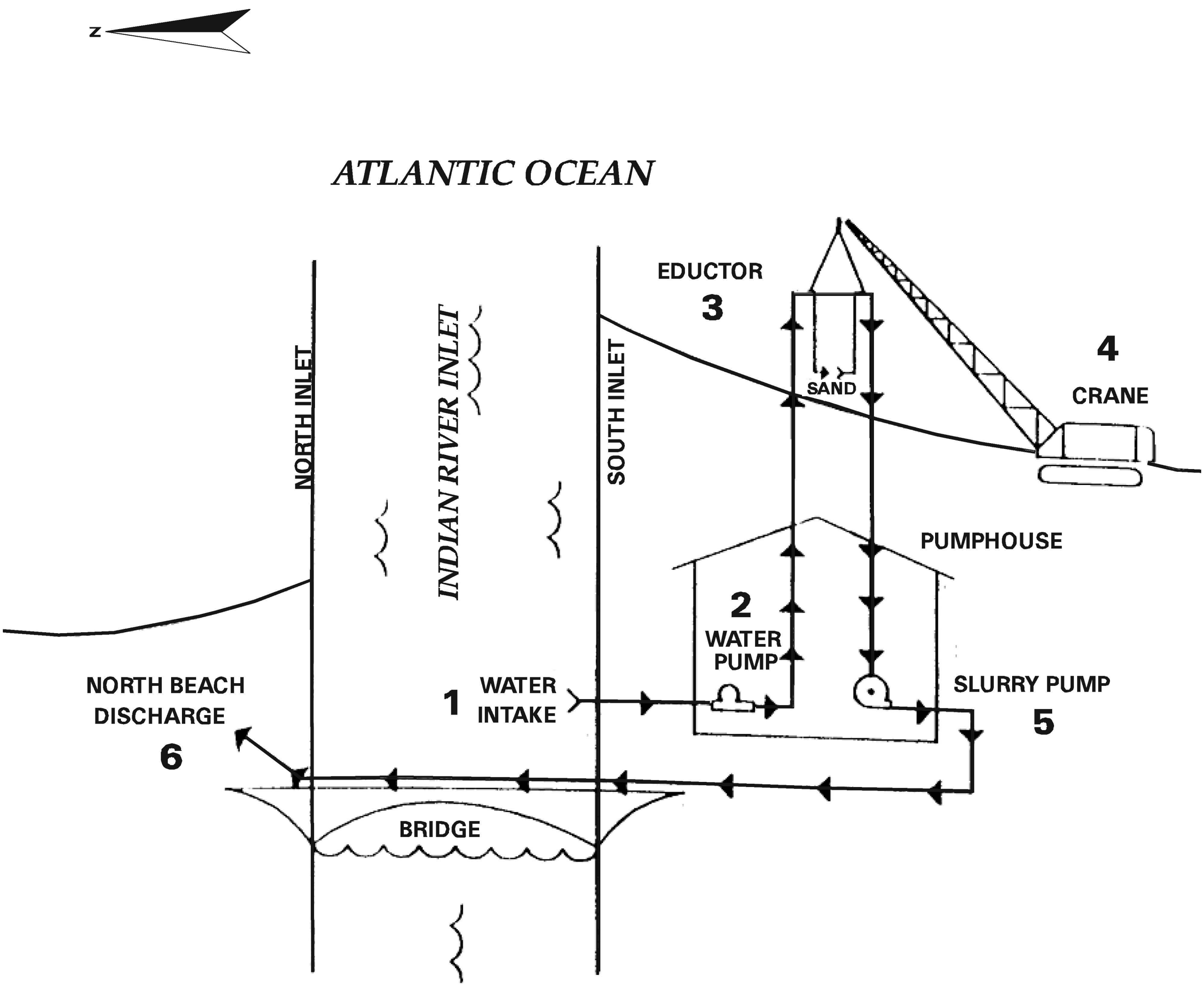
Figure 3-4

1. WATER SUCTIONED FROM INLET
2. WATER PUMPED TO EDUCTOR
3. EDUCTOR EXCAVATES SAND
4. CRANE DEPLOYS EDUCTOR
5. SLURRY RETURNS TO PUMP
6. SLURRY PUMPED AS FILL



US Army Corps of Engineers Baltimore District	Ocean City Water Resources Feasibility Study	Indian River, Delaware Sand Bypassing Plant

Date: 12-SEP-1997
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Figure 3-5

5. **Use a mobile dredge** to remove material from the sources chosen and place it on Assateague Island. This alternative provides a number of sub-alternatives, as there are different types and sizes of mobile dredges, and the equipment could be either purchased or rented. The sub-alternatives are as follows:

5a. Purchase a hopper dredge. Hopper dredges are so named because they contain the hopper on board where the dredged material is placed after it is "vacuumed" from the bottom by a drag head. Next the hopper dredge carries the material to the placement site and deposits it. These dredges are best operated three seasons of the year (spring, summer, and fall) Winter dredging could be dangerous due to the likelihood of severe weather and the limited seaworthiness of the dredge.

5b. Purchase a clamshell dredge. A clamshell dredge is different from a hopper dredge in that it captures material from the bottom using a clamshell-shaped bucket. The material is placed in a hopper located on a barge and then transported by the barge to the placement site where the material is deposited.

5c. Arrange to use a shallow dredge like the *Currituck*, a unique hopper dredge custom built for and , owned, and operated by the Wilmington District, Corps of Engineers.. This dredge is smaller than traditional hopper dredges. Consequently, it is much more versatile and can be used to dredge coastal bay areas in addition to the ebb and flood shoals.

5d. Contract annually for the use of a hopper or other type mobile dredge.

With the exception of Alternative 1, the no-action plan, all the alternatives listed above have similar benefits to Assateague Island, in that they all would provide the material necessary to restore the natural longshore transport process (although Alternatives 3a and 3b would require auxiliary dredging by a mobile dredge to provide the full amount of 145,000 m^3 (189,000 yd^3)). The potential of a breach of the island, caused by its lack of sediment nourishment, would be reduced. A significant portion of Assateague Island National Seashore would not be lost, and the recreational opportunities available there would not be impacted. Further, Sinepuxent Bay would not be filled in and the coastal bays ecosystem would not be impacted. Communities on the mainland would not be threatened by damages to the same degree as they would be without the barrier island to protect them.

Alternatives 3, 4, and 5 involve several types of bypassing and or back-passing scenarios. Back-passing means that sand could be transported back to Ocean City, as opposed to its being bypassed to Assateague Island. These plans were screened for completeness, efficiency, effectiveness and acceptability. Basically, the purpose of most of these systems was to take material from the updrift fillet, before it is transported into the back bays or to the ebb shoal, and pass it across the inlet to Assateague Island. Other options included taking the material directly from the ebb shoal or from the back bays and transporting it further south on Assateague Island. Back-passing the material from the southern tip of Ocean City north to the Ocean City beaches was also an option that could be combined with the bypassing plans. A back-passing capability could benefit Ocean City in emergency situations, when reaches of the beach have excessively eroded after storms.

3.5 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

The evaluation and comparison of long-term sand management is a two part process. The first component evaluates the best method of long-term sand management which leads to the evaluation of the best implementation process.

3.5.1 Evaluation of Initial Alternatives

Alternative 2, the plan to remove the jetties, involved two sub-alternatives: (a) frequent dredging to maintain the navigation channel and (b) abandonment of the navigation project. At present, the actual impacts of either Alternative 2a or Alternative 2b are difficult to fully calculate. It is reasonable to assume that if the jetties were removed, more frequent dredging of the navigation channel would be needed to keep it operable. How frequently this dredging would need to be done cannot be determined, as it is impossible to know exactly how the sand will distribute itself after jetty removal. It is quite possible that such dredging would be needed more than once per year. If Alternative 2b were chosen, the jetties would be removed and the navigation project would be abandoned. The inlet would likely begin to migrate towards the south and shoal in completely in the next few decades. Additional time would be required to navigate from the mainland, as boaters would have to travel down to Chincoteague or up to Delaware to reach the ocean. Additional back bay dredging would be required to a 3-m (10 ft) deep channel. These impacts to commercial fishermen would be significant. It is not unreasonable to assume that, eventually, watermen might relocate from the area because of the delays. Recreational fishing would be negatively impacted also, for the same reason. In addition, water in the back bays would have a longer residence time, resulting in reduced salinity possibly affecting water quality. The ebb shoal could destabilize, and sand would probably be transported south. In summary, the consequences to this action would be significant, but difficult to predict in any detail with a high degree of accuracy.

Alternative 4, purchase or rent a Punaise, presented a number of difficulties. First, only two of these dredges actually exist, making them both difficult and expensive to purchase or rent, and presenting a question as to their availability. Second, a great degree of risk and uncertainty exists, especially related to experience with the technology. Third, a power supply to the Punaise is necessary for operation. Fourth, the Punaise requires a 10 m (33-ft) layer of clean sand for efficient operation, which makes it less flexible. Finally, it was discovered that there may be unresolved legal issues about the use of this technology in the United States. For these reasons, Alternative 4 was eliminated from further consideration.

This elimination left the no-action plan and Alternatives 3a, 3b, and 5a through 5d. Since Alternatives 3a, 3b, and 5a through 5d. provide similar benefits to Assateague Island, they were evaluated using a wide range of criteria, including initial cost, annual operation and maintenance cost, risk and uncertainty related to Baltimore District or others' experience with the technology, risk and uncertainty related to operational reliability, back-pass capability, capability for improving navigation, aesthetics, sand source flexibility, placement/location flexibility, potential for continuous versus periodic use, weather limitations, and sponsor/local citizen acceptability. Number rankings were assigned to each alternative or sub-alternative in the above categories to analyze their feasibility and effectiveness, with a ranking of "5" being the highest score and a ranking of "1" being the lowest. Then the numbers assigned were tallied along with annualized and unit costs to compare the alternatives. The decision matrix used for analyzing these alternatives is included as Table 3-1. It is important to note that the costs given include construction, operation, and maintenance costs only. They do not include costs for pre-engineering design, construction management, escalation, or contingency.

The environmental impact of each alternative was considered, although it is not included in the matrix. This was due to the fact that there are a number of environmental factors - water quality, benthos, birds, etc., and one rating would not accurately depict the environmental impact. However, both fixed plants and dredging are methods utilized around the country and along the east coast, specifically in Maryland and Delaware, and the environmental impacts are known and accepted. At the time this matrix was developed, the specific details associated with how, when, and where exactly the project would be implemented were not known. The environmental impacts of dredging and a fixed plant with booster pumps were considered to be similar enough that one did not appear to be significantly more or less environmentally damaging than the other. They would both involve dredging material from specific areas and placing it in the surf zone along Assateague Island. Further, it was known that when the project was to be designed, it would be such that the impacts would be minimized. The one alternative, construct a fixed plant and truck the material along Assateague Island, was considered to have more of an impact to the piping plovers and other species and habitat on Assateague Island, so this alternative was not aggressively pursued.

Table 3-1. Long-Term Sand Management Screening Matrix

	Screening Criteria															
PLAN	First Cost	Annual Operation & Maintenance	Annualized Cost	Risk & Uncertainty - Experience w/ Technology	Risk & Uncertainty - Operational Reliability	Back-Pass Capability	Improve Navigation	Aesthetics	Sand Source Flexibility	Placement/ Location Flexibility	Periodic=1; Continuous=5	Weather Limitations	Sponsor/Local Acceptability	Sum	Unit Cost (Annualized Cost/145,000 cubic meters)	Relative Ranking(Sum/ Unit Cost)
3. Fixed plant at O.C.																
3a. Boosters on Assateague	$7,000,000	$957,000	$1,488,000	3	2	5	4	1	1	2	5	4	2	29	$10.26	3
3b. Pump across inlet and truck along Assateague	$4,500,000	$1,914,000	$2,256,000	3	3	5	4	1	1	3	5	4	2	31	$15.56	2
5. Use a mobile dredge*																
5a. Purchase a hopper dredge	$15,000,000	$4,818,000	$5,957,000	5	5	5	5	3	4	5	1	2	4	39	$41.08	1
5b. Purchase a clam shell dredge	$5,500,000	$671,000	$1,089,000	5	5	5	5	3	4	5	1	1	4	38	$7.51	5
5c. Shallow dredge (Wilmington Corps Currituck)	$0	$533,000	$533,000	5	5	5	5	3	5	5	1	1	4	39	$3.68	11
5d. Contract small/medium dredge	$0	$865,000	$865,000	5	5	5	5	3	4	5	1	2	4	39	$5.97	7
KEY																
1=negative; 5=positive																

*** Borrow areas include north jetty fillet, ebb shoal, inlet, and flood shoals**
Assumes 145,000 cubic meters of material annually
**** Note: Costs do not include PED, Construction Mgmt, Escalation or Contingency**

Alternative 3a, constructing a fixed plant at Ocean City and using booster pumps on Assateague Island received a final summed score of 29 and would have an annualized cost of $1,256,000 and a unit cost of $11.42 (costs do not include supplemental mobile dredging). This alternative ranked "5" for its back-pass capability, as did every other alternative considered. It also ranked "5" for its ability to operate year-round. It ranked low in operational reliability (due to the potential for booster pipes to clog), placement and location flexibility, and sponsor and local citizen acceptability ("2"), and even lower in aesthetics and sand source flexibility ("1").

Alternative 3b, constructing a fixed plant at Ocean City, then pumping the sand across the inlet and conveying it by truck to sites on Assateague, received similar scores to Alternative 3a. The summed score of this alternative was a little higher, 31, but its annualized cost would be $1,792,000 and its unit cost would be $16.29 (costs do not include supplemental mobile dredging). Most of its individual scores were the same as those for Alternative 3a, with the exception of operational reliability and placement/location flexibility, for which it earned scores of "3."

Furthermore, following the analysis of alternatives, it was determined that a fixed plant alone would not be able to capture the full volume of sand necessary for the restoration of Assateague Island, and would need to be supplemented by a mobile dredge of some type.

Alternative 5a, purchase a hopper dredge, has a sum of 39, an annualized cost of $4,789,000, and a unit cost of $43.46. It is by far the most expensive alternative of the six (3a, 3b, and 5a-5d) alternatives left. Other than this marked difference, it received identical scores to Alternatives 5b, 5c, and 5d in the following categories: risk and uncertainty related to experience with the technology (5; the Corps has extensive experience with mobile dredges), risk and uncertainty related to operational reliability (5; this equipment is highly reliable), back-pass capability (5; again, all alternatives were able to meet this requirement), improve navigation (5), aesthetics (3; not particularly attractive, but not present year-round either), placement/location flexibility (5; mobile dredges can place sand anywhere in the surf zone), potential for continuous versus periodic use (1; none of these four alternatives could be used year-round), and sponsor/local citizen acceptability (4).

Alternative 5b, purchase a clamshell dredge, has a sum of 38, an annualized cost of $926,000, and a unit cost of $8.39.

Alternative 5c, arrange to use a shallow dredge like the Wilmington District's *Currituck* on a regular basis. This alternative has a sum of 39, an annualized cost of $533,000, and a unit cost of $3.68, the lowest of any of the alternatives.

Alternative 5d, contract annually for the use of a shallow hopper dredge, has a sum of 39, an annualized cost of $865,000, and a unit cost of $5.97. In the event that a shallow dredge like the *Currituck* were unavailable for one or both dredging periods of a given year, Alternative 5d, contracting annually for use of a mobile dredge, could be a "back-up" alternative, and is the second least-expensive option.

Alternative 5c, using a shallow hopper dredge, like the Wilmington District's *Currituck*, is the recommended plan. This mobile dredge received a sum equal to the highest score of all alternatives (39) and was the least expensive alternative investigated ($3.30 per unit). It has the ability, unlike any other dredge known to the Baltimore District, of dredging both offshore and in the back bays, due to its especially small size. The current schedule for the *Currituck's* use indicates that it would be available for fall and spring dredging in the project area, and if its capabilities were required elsewhere to assist in an emergency, Alternative 5d, contracting for a small hopper dredge, could be substituted as the recommended plan. Tables 3-2 and 3-3 demonstrate the cost effective analysis for the plan selection.

3.5.2 Evaluation of Mobile Bypassing Alternatives

After analysis determined that mobile bypassing is the best alternative for long-term sand management, it became necessary to evaluate a variety of dredging options, including using different bypassing material sources, different sand quantities, and dredging at various frequencies. As discussed previously, the volumetric sediment transport rate required to restore "natural processes" to Assateague Island is estimated to be 145,000 m^3/yr (189,000 yd^3/yr).

Sand Sources

Also discussed in Section 2, there are five potential sources of sand available for Assateague Island long-term sand management: (1) Ocean City updrift fillet, (2) ebb shoal, (3) flood shoal, (4) navigation channels, and (5) off-shore including Great Gull Bank, see Figure 3-6. To optimize the potential source locations and reduce potential adverse impacts of over using one area, combinations of the five source areas were considered. In addition, evaluations were conducted to determine the volumes of material that could be mined from each potential bypassing material source.

1. Ocean City Updrift Fillet. The present day sediment budget indicates approximately 115,000 m^3/yr (150,000 yd^3/yr) is arriving at the inlet from the north, however, the ebb shoal has developed to the point that approximately 53,000 m^3/yr (69,000 yd^3/yr) is bypassing naturally. It follows that the amount of bypassing material that should be mined from the updrift accretion fillet is the amount supplied to the fillet minus the amount that is naturally bypassing or 83,000 m^3/yr (108,000 yd^3/yr).

TABLE 3-2. COST EFFECTIVENESS ANALYSIS: LONG TERM SAND MANAGEMENT ALTERNATIVES

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5a	39	41.08
5b	38	7.51
5c	39	3.68
5d	39	5.97

Listed in Ascending Order of Outputs then Costs

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5b	38	7.51
5c	39	3.68
5d	39	5.97
5a	39	41.08

Production Inefficient Solutions Struck Through

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5b	38	7.51
5c	39	3.68
~~5d~~	~~39~~	~~5.97~~
~~5a~~	~~39~~	~~41.08~~

Production Inefficient Solutions Removed
Production Ineffective Solutions Struck Through

Plan	Sum	Unit Cost
~~3a~~	~~29~~	~~10.26~~
~~3b~~	~~31~~	~~15.56~~
~~5b~~	~~38~~	~~7.51~~
5c	39	3.68

Production Ineffective Solutions Removed
Cost Effective Solution

Plan	***Sum***	***Unit Cost***
5c	**39**	**3.68**

TABLE 3-3. COST EFFECTIVENESS ANALYSIS: NEXT BEST ALTERNATIVE, IF 5C IS REMOVED

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5a	39	41.08
5b	38	7.51
5d	39	5.97

Listed in Ascending Order of Outputs then Costs

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5b	38	7.51
5d	39	5.97
5a	39	41.08

Production Inefficient Solutions Struck Through

Plan	Sum	Unit Cost
3a	29	10.26
3b	31	15.56
5b	38	7.51
5d	39	5.97
~~5a~~	~~39~~	~~41.08~~

Production Inefficient Solutions
Removed
Production Ineffective Solutions Struck Through

Plan	Sum	Unit Cost
~~3a~~	~~29~~	~~10.26~~
~~3b~~	~~31~~	~~15.56~~
~~5b~~	~~38~~	~~7.51~~
5d	39	5.97

Production Ineffective Solutions
Removed
Cost Effective Solution

Plan	***Sum***	***Unit Cost***
5d	**39**	**5.97**

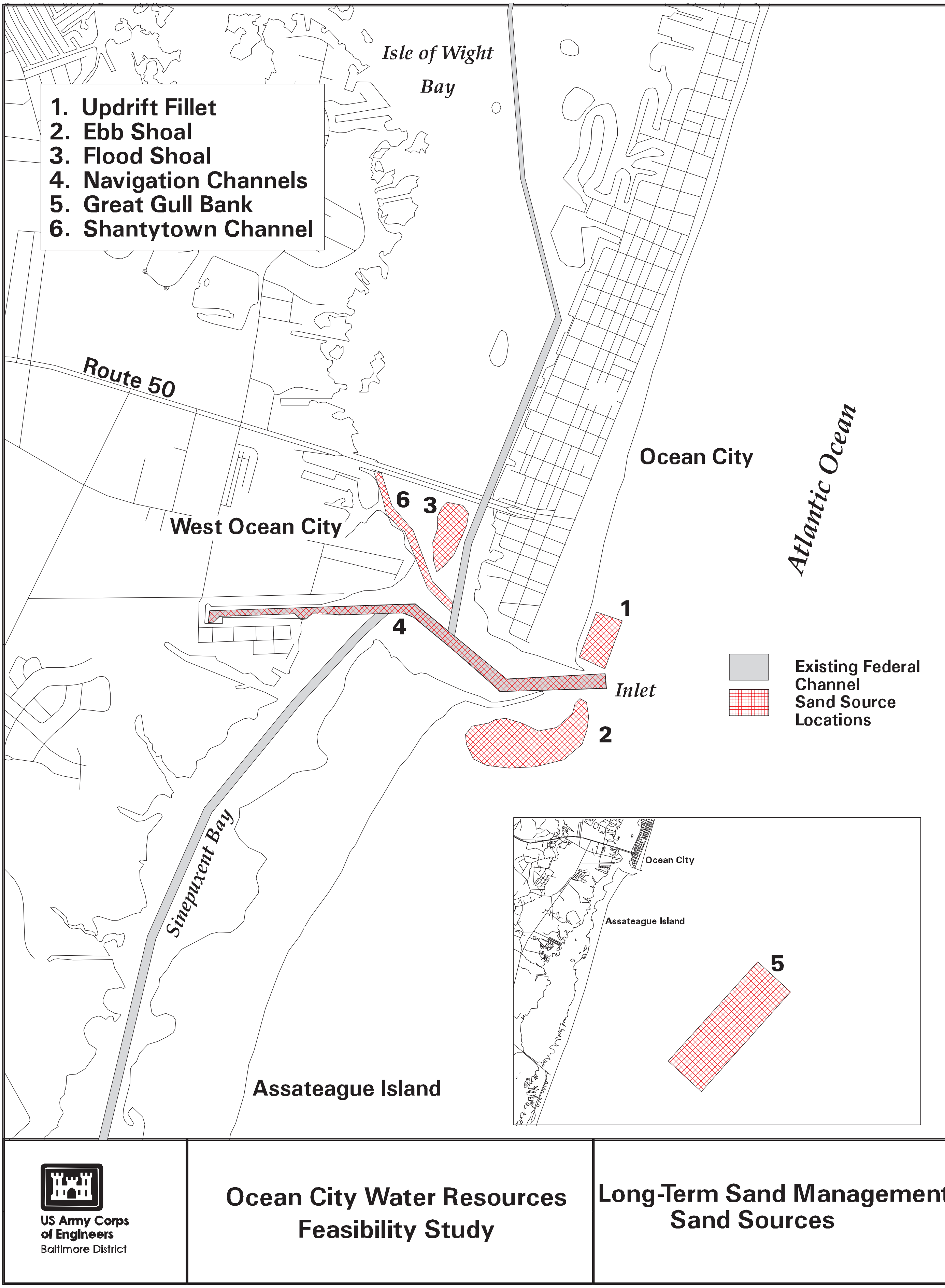

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Figure 3-6

Consideration was given to the effects of mining these amounts of material from the various bypassing material sources. First, the probable response of the beach to the assumed mining of the updrift fillet was examined. A modeling study was conducted by Offshore & Coastal Technologies Inc. (OCTI) under contract to the Baltimore District. Two numerical models were implemented for the study, a cross-shore beach profile storm response model (SBEACH), and a longshore transport model (LONGSHOR). Detailed analyses are provided in Appendix A10. Two potential influences of mining the material from the fillet area were identified: the first is updrift effects, the second is the narrower shoreline in the mining area itself potentially allowing damage to the adjacent parking lot and amusement facility in the event of an extreme storm.

Several scenarios that varied the quantity of material dredged and the length of shoreline over which material is removed were evaluated. In addition, a representative longshore transport rate was selected based on examination of data extracted from the Wave Information Study (WIS) pertinent to the area. The modeling analysis indicated that to minimize updrift impacts on the pier area and the seawall area of the existing Atlantic Coast of Maryland Storm Protection Project, material should be taken from an area as close to the jetty as possible. Results show that when less sand is dredged per foot of shoreline spread over a longer extent of shoreline to the north, significantly greater updrift shoreline recession than when the same amount of material is taken from a more confined area adjacent to the jetty can be expected. Furthermore, it was determined that no more than 57,000 m^3 (74,000 yd^3) of material should be mined in any year to minimize the updrift impacts. Another constraint on the amount of material that should be removed from any given location would be the induced exposure to storm erosion damage. To be conservative, it was assumed that a minimum of a 15 meter (49 ft) buffer should be maintained between the predicted position of the +1.8 meter (+6 ft) (top of berm) National Geodetic Vertical Datum (NGVD) contour location after the design storm event and any landward facilities such as the parking lot. It was determined that a post-dredging shoreline should leave a total beach width of at least 61 meters (200 ft) from the excavated non-storm MHW level to the parking lot.

Based on the results of the modeling analysis, it is recommended that the material be dredged from an area between the north jetty and the fishing pier. The length of the landward side of the proposed bypassing material area is approximately 210 m (689 ft) with a 61 meter buffer on either side of the fishing pier and the north jetty. The length of the seaward side of the bypassing material area is approximately 275 m (84 ft) . The depth of cut would extend from -1.5 m to -5.5 m (-5 to -18 ft) NGVD. Approximately 43,000 m^3 (55,900 yd^3) can be excavated from within the confines of this area. This equates to removal of approximately 200 m^3 (260 yd^3) per meter of shoreline.

To be conservative, it is recommended mining approximately 40,000 m^3 (52,000 yd^3) annually (less than the allowable). In addition, it is recommended mining half that amount at any one time 20,000 m^3 (26,000 yd^3) further minimizing the impacts, and monitoring the response of the area to the excavation. In that manner, adjustments can be made if adverse impacts to the fillet area would occur. Additional conservatism is incorporated in the modeling results because the SBEACH model assumes that no longshore transport takes place during a storm. In fact, at the fillet there may be a strong tendency for the sink created by the dredging to infill during a storm. This will reduce the storm recession distances by providing additional material to the profile.

Further, the model's predicted recession distances are considered worst case (i.e., a storm hits immediately following dredging, or there is no longshore transport). Taking less than the allowable amount, dredging twice each year instead of removing all material at once, and monitoring for impacts will reduce any negative impacts to the updrift fillet. In addition, borrowing the proposed amounts from the fillet is not expected to result in erosion damages to the parking lot or the amusement facility. However, wave action could cause damages to the amusement facility and pier during a design event with or without excavation. If the updrift fillet is used as a potential bypassing source, further investigations into the effects, if any, of the proposed excavation on the stability of the north jetty and fishing pier (i.e., pier piling depths) will be conducted.

2. Ebb Shoal. Approximately 105,000 m^3 (137,000 yd^3) of material is required from the remaining bypassing material sources, to include the ebb shoal, the second source of material considered. Current estimates indicate that approximately 10 million m^3 (13 million yd^3) of material are contained in the main ebb shoal. The use of the ebb shoal as a source of sand for bypassing can be controversial because of the unknowns associated with potential adverse impacts to the inlet system. However, based on best professional judgment, it is expected that since the proposed yearly dredging would remove such a small percentage of the overall volume in the ebb shoal (approximately 0.7 percent), that removing this material will not cause any adverse impacts to the inlet system. It is intended to dredge small volumes of material from the seaward slope over a fairly large area while maintaining the overall shape and configuration of the ebb shoal. This will also serve to minimize impacts.

3. **Flood Shoal.** The third source of material is the north flood shoal. Similar to the ebb shoal, little is known about the consequences of mining flood shoals. To help alleviate these concerns and objections, several modeling evaluations were undertaken. Specifically, mining small portions of the flood shoal and area from the updrift fillet adjacent to the north jetty were evaluated. A detailed description of these analyses are contained in Appendices A9 and A10. The model results indicate the effects of mining small amounts of the flood shoal (10-20,000 m^3 annually) (13-26,000 yd^3) to be negligible. Most likely, the recommended plan would involve dredging material from the perimeter of the northern flood shoal, adjacent to the east and west navigation channels. See Appendix A5 for a complete description of the analysis.

4. Navigation Channels. The fourth source of material is the navigation channels in the vicinity of Ocean City inlet. This includes two Federal Channels; the Ocean City Inlet channel and the Isle of Wight channel that runs along the east side of the bay, adjacent to Ocean City; and the channel that runs along the west side of the bay, adjacent to Shantytown and the mainland. This west channel is sometimes dredged by the State of Maryland. These are the three main channels used by both commercial and recreational boaters in the area and because they are in close proximity to the inlet, they fill in with clean sand suitable for placement on Assateague Island. These three channels, which are easily accessible by a shallow dredge, can provide large volumes of sand, making the project cost-effective. Dredging of the inlet and Shantytown channels has been performed over the past 50 years with the most recent dredging completed in May 1997. Dredged material has been placed in various locations including the surf zones off Assateague Island and Ocean City, and upland on the Ocean City and Assateague beaches. No adverse impacts to the inlet hydrodynamics have occurred as a result of these ongoing operations. Therefore, it is expected that mining these areas as part of the long term sand management plan will have no adverse impacts on the inlet system. Approximately 20,000 m^3 (26,000 yd^3) could be mined annually from the inlet, Isle of Wight, and Shantytown channels. This operation would serve the dual purpose of reducing the impacts of channel shoaling in the area while providing a source of sediment for bypassing operations.

5. Great Gull Bank. Of the 42,800,000 m^3 (56,000,000 yd^3) of volume of sand, approximately 6,890,000 m^3 (9,000,000 yd^3) is suitable for beach fill based on the compatibility of grain size with the sand existing on Assateague's beach. Sand could be dredged from an oblong-shaped area along the eastern margin of the southwestern quadrant of Great Gull Bank. The bypassing material area is approximately 93 ha (230 acres) in size, with maximum dimensions of 3,050 m (10,000 feet) and 500 m (1,500 feet) respectively parallel to the long and short axes of the offshoal source.

Mobile Bypassing Alternatives

Combining these sediment supply needs and the various bypassing material sources, the total amount of material capable of being dredged, a variety of alternatives were analyzed to address the sand deficiency. The alternatives evaluated are described below.

1. Mining the full 145,000 m^3/yr (189,000 yd^3/yr) from the ebb shoal each year. (Assumes a shallow dredge each year.)

2. Mining the full 290,000 m^3/yr (377,000 yd^3/yr) from the ebb shoal every 2 years. (Assumes a shallow dredge.)

3. Mining the full 145,000 m^3/yr (189,000 yd^3/yr) from Great Gull Bank each year. (Assumes a medium dredge.)

4. Mining the full 580,000 m^3/yr (754,000 yd^3/yr) from the Great Gull Bank every 4 years. (Assumes a medium dredge.)

5. Mining 100,000 m^3/yr (130,000 yd^3/yr) from the ebb shoal each year for three years and 280,000 m^3 (364,000 yd^3) from Great Gull Bank every fourth year. (Assumes a medium dredge.)

6. Mining 160,000 m^3/yr from the ebb shoal every 2 years starting the first year and 260,000 m^3 (338,000 yd^3) from Great Gull Bank every fourth year. (Assumes a medium dredge.)

7. Mining 145,000 m^3/yr (189,000 yd^3/yr) from a variety of sand sources each year (40,000 m^3/yr (52,000 yd^3/yr) from updrift fillet, 85,000 m^3/yr (111,000 yd^3/yr) from ebb shoal, and 20,000 m^3/yr (52,000 yd^3/yr) from navigation channels and flood shoal. Assumes a shallow dredge each year.)

8. Mining 290,000 m^3/yr (377,000 yd^3/yr) from a variety of sand sources every 2 years (40,000 m^3/yr (52,000 yd^3/yr) from updrift fillet, 230,000 m^3/yr (299,000 yd^3/yr) from ebb shoal, and 20,000 m^3/yr (52,000 yd^3/yr) from navigation channels and flood shoal. (assumes a shallow dredge.).

It is important to note that there are few, if any, shallow dredges like the *Currituck*. Therefore, the vessel under special circumstances, may not be available. As discussed, a shallow dredge like the *Currituck* can dredge from the ebb shoal, the updrift fillet, and the back bays. In the event a shallow dredge is not available for a dredging cycle there are several options: 1) during the next cycle material quantities will be doubled; 2) the following year 290,000 m3 would be placed on Assateague Island; 3) a small dredge would be contracted that year.. Unlike the *Currituck*, small dredges are not able to maneuver and dredge through the back bays. It was also assumed that during the times when a small dredge would be used, the back bays would not be used as a bypassing material source.

The evaluation process led to defining a screening matrix of these alternatives. The dredge matrix appears in Table 3-4. Screening criteria that were used included placement impacts to Assateague Island, flexibility of bypassing material sources, impacts to the bypassing material sources, mimicking the natural sand transport process, improvements to navigation, and local and sponsor acceptability. Cost savings and efficiency were also factors. A scoring of 5 (positive) to 0 (negative) was given for each category to each alternative. Costs of each alternative were annualized to provide a final rating.

Table 3-4. Long-Te: Sand Management Screening Matrix for Dredging Options

	Long-Term Sand Management	Annualized LTSM Cost	Impacts to Assateague Isl	Sand Source Flexibility	Sand Source Impacts	Mimics Natural Process	Improvements to Navigation	Sponsor/Local Acceptability	Sum	Unit Cost (Annual Cost /145,000 m^3)	Final Rating (Sum/Unit Cost)
1	Full 145,000 m^3 from ebb shoal each year - shallow dredge each year.	$516,400	4	2	4	3	2	3	18	$3.56	5.1
2	Full 290,000 m^3 from ebb shoal every 2 years - shallow dredge	$486,500	2	1	3	2	2	2	12	$3.36	3.6
3	Full 145,000 m^3 from Great Gull each year - use medium hopper dredge	$2,088,400	4	2	4	0	0	1	11	$14.40	0.8
4	Full 580,000 m^3 from Great Gull every 4 years to Assat - use medium hopper dredge	$2,035,800	1	1	4	0	0	0	6	$14.04	0.4
5	100,000 m^3 from ebb shoal each year and 180,000 m^3 from Great Gull every 4 years to Assat - use medium hopper dredge	$762,600	2	4	4	2	1	2	15	$5.26	2.9
6	160,000 m^3 from ebb shoal every 2 years and 260,000 m^3 from Great Gull every 4 years - use medium hopper dredge	$1,028,900	1	3	4	2	1	2	13	$7.10	1.8
7	145,000 m^3 from a variety of sources each year - 40,000 m^3 from inlet fillet, 85,000 m^3 from ebb shoal and 20,000 m^3 from channels and flood shoals - shallow dredge	$563,400	4	5	4	5	4	4	26	$3.89	6.7
8	290,000 m^3 from a variety of sources every 2 years - 40,000 m^3 from inlet fillet, 230,000 m^3 from ebb shoal, and 20,000 m^3 from channels and flood shoal - shallow dredge	$534,800	2	5	3	4	3	3	20	$3.69	5.4
	Key: 5 = positive; 0 = negative										
	Notes:										
	Assateague requirement - 145,000 m^3 each year.										
	Annualized costs do not include escalation, contingency, PED, construction management nor real estate.										
	Only 40,000 m3 of material from the updrift fillet and only 20,000 m3 from flood shoal and navigation channels are available each year.										

The environmental impact of each alternative was considered, although it is not included as a separate column in the matrix. This was due to the fact that there are a number of environmental factors - water quality, benthos, birds, etc., and one rating would not accurately depict the environmental impacts. However, some of the impacts are reflected in the other categories. Also, all of the alternatives involve dredging from specific areas and placing it along the same area of Assateague Island so that the impacts are similar, such as temporary disturbance to nekton, benthos, and plankton. The plans only differ in sand sources and frequency. It was determined that environmentally, one alternative was not substantially better than another. The impacts of the recommended project are discussed in Section 6.

An objective in working with a variety of parties was determining a long-term sand management plan that was acceptable to all. A concern of all sponsors including the District was not to negatively impact any bypassing material sources. Taking too much material could result in affecting the hydrodynamics or material recharge not occurring. The NPS did not favor using the ebb shoal, the Town of Ocean City did not favor using the Ocean City updrift fillet. The study sponsors and public did not want to use Great Gull Bank unless absolutely necessary. There was no opposition to using the material from the navigational channels however, the engineers were hesitant to using the flood shoal for fear the hydrodynamics of the back bays may change. The greater the material from individual sources, the greater the opposition. We needed a plan that took into account these concerns and objections.

Another concern was not taking too much material that would change the hydrodynamics of the water system. Several modeling efforts were undertaken to research this problem. OCTI modeled the flood shoal and navigation channels and the impacts to the Ocean City fillet to determine mining impacts. More detailed analysis of these models is located in Appendices A9 and A10.

Taking these concerns into account, Table 3-5 describes the evaluation process and screening for each alternative, including the environmental impacts and benefits, economic impacts and benefits, and navigational benefits to the coastal bays. Sponsor acceptability is also included. This table helps to explain how the numbers were derived for Table 3-4.

Table 3-5. Evaluation of Mobile Bypassing Alternatives

Alternative	Environmental/Economic Assessment	Navigational Benefits	Acceptability
1. Full 145,000 m^3 from Ebb Shoal to Assateague Island each year	Replaces the annual amount lost. 145,000 m^3 is less than 2% of the ebb shoal total volume. Minimally affects the bypassing material source recharge rates. Partially mimics the natural sand transportation process. Using one bypassing material source limits sand source flexibility.	Creates minimal benefits to navigation (improves navigation at the inlet mouth).	Using ebb shoal as bypassing material source has local and sponsor acceptability. However, National Park Service opposes the sole use of the ebb shoal.
2. Mining 290,000 m^3/yr from the ebb shoal every two years.	Twice the naturally depleted sand quantities every other year. Greater sand volumes can adversely impact Assateague Island. 290,000 m^3 is 3% of the ebb shoal total volume. Minimally affects the bypassing material source recharge rates. Partially mimics the natural sand transportation process. Using one bypassing material source limits sand source flexibility. Environmental impacts to bypassing material and placement sites only every other year.	Creates minimal benefits to navigation (improves navigation at the inlet mouth).	Using ebb shoal as bypassing material source has local and sponsor acceptability. However, the National Park Service opposes the sole use of the ebb shoal.

Table 3-5 Continued. Evaluation of Mobile Bypassing Alternatives

Alternative	Environmental/Economic Assessment	Navigational Benefits	Acceptability
3. Mining 145,000 m^3/yr from Great Gull Bank each year.	Replaces the annual amount lost. Temporary impacts to fishing at Great Gull Less than 1% of material used. Bypassing material source does not affect recharge. Does not mimic the natural sand transportation process. Using one bypassing material source limits sand source flexibility. Cumulative impacts to offshore shoals.	No benefits to navigation.	Using Great Gull Bank as bypassing material source has limited local and sponsor acceptability.
4. Mining 580,000 m^3/yr from the Great Gull Bank every four years.	Placing large material volumes in surf zone can have negative environmental impacts. Larger quantity of material used. Bypassing material source does not recharge. Does not mimic the natural sand transportation process. Using one bypassing material source limits sand source flexibility. Cumulative impacts to offshore shoals.	No benefits to navigation.	Using the ebb shoal Great Gull Bank as bypassing material source has limited local and sponsor acceptability.

Table 3-5 Continued. Evaluation of Mobile Bypassing Alternatives

Alternative	Environmental/Economic Assessment	Navigational Benefits	Acceptability
5. Mining 100,000 m^3/yr from the ebb shoal each year for three years and 280,000 m^3 from Great Gull Bank every fourth year.	Placing larger volumes in surf zone every four years causes greater magnitude of environmental impacts. Less than 1% of total material used. Minimally affects the bypassing material source recharge rates. Partially mimics the natural sand transportation process. Increases sand source flexibility.	Creates minimal benefits to navigation.	Using the ebb shoal Great Gull Bank as bypassing material source has limited local and sponsor acceptability.
6. Mining 160,000 m^3/yr from the ebb shoal every two years starting the first year and 260,000 m^3 from Great Gull Bank every fourth year.	Placing larger volumes in surf zone every four years causes greater environmental impacts at time of placement. Larger amounts of total material used. May affect the bypassing material source recharge rates. Partially mimics the natural sand transportation process.	Creates minimal benefits to navigation.	Using the ebb shoal Great Gull Bank as bypassing material source has limited local and sponsor acceptability.

Table 3-5 Concluded. Evaluation of Mobile Bypassing Alternatives

Alternative	Environmental/Economic Assessment	Navigational Benefits	Acceptability
7. Mining 145,000 m^3/yr from a variety of sand sources each year (40,000 m^3/yr from updrift fillet, 85,000 m^3/yr from ebb shoal, and 20,000 m^3/yr from navigation channels and tidal shoals).	Replaces the annual amount lost. Impacts to sources minimal due to use of multiple sources. Minimally affects the bypassing material source recharge rates. Mimics the natural sand transportation process. Extremely flexible. If source not recharged can use a different source or different quantity.	Improves navigational benefits to the back bays and coastal area.	Has local and sponsor approval due to the fact that no one area is severely impacted.
8. Mining 290,000 m^3/yr from a variety of sand sources every two years (40,000 m^3/yr from updrift fillet, 230,000 m^3/yr from ebb shoal, and 20,000 m^3/yr from navigation channels and tidal shoals).	Twice the amount of material supplied every other year. May impact surf zone environment. Only 40,000 m^3 material available from the updrift fillet each cycle. Need to increase bypassing material volumes of navigation channels or ebb shoal. Increased volumes may cause disturbance in water dynamics in the channel. Bypassing material sources should recharge. Moderately mimics the natural sand transportation process (not continuous). Extremely flexible.	Improves navigational benefits to the back bays and coastal area.	Has local and sponsor approval due to the fact that no one area is severely impacted.

Benefits of Alternative Plans

All eight alternatives provide similar benefits to Assateague Island in that they provide the required volume of material to the island. They vary by frequency and bypassing material source, but by maintaining a sediment supply to Assateague Island, they restore the island to a more natural condition. The benefits include the following:

- ♦ Restoring a unique barrier island of national significance to a more natural state.
- ♦ Reducing likelihood of a minor breach.
- ♦ Promoting habitat diversity.
- ♦ Reducing future downdrift erosion and preventing overwash areas from expanding, which would otherwise cause the loss of hundreds of acres of other habitat types.
- ♦ Promoting potential for development of approximately 247 ha (100 ac) of salt marshes on the back side of the island.
- ♦ Reducing the infilling of Sinepuxent Bay and the Ocean City Inlet.
- ♦ Protecting navigation through Sinepuxent Bay and the Ocean City Inlet.
- ♦ Protecting existing estuarine habitat in Sinepuxent Bay that would be lost to island retreat (from tens to hundreds of acres).
- ♦ Preventing loss of SAV beds in Sinepuxent Bay (tens of acres).
- ♦ Decreasing or maintaining existing erosion rate of mainland.
- ♦ Allowing continued recreation in a unique, natural barrier island setting.
- ♦ Providing some protection to mainland communities.

3.6 SELECTION OF PLAN

The physical, environmental, and economic benefits, impacts, and estimated costs for the 8 alternative plans were evaluated. As Table 3-4 indicates, number rankings were assigned to each to analyze their feasibility and effectiveness. These numbers were then tallied along with annualized and unit costs to determine a relative rating so that the alternatives could be compared. As shown, Alternative 7 produced the highest rating, 6.7 A cost effective analysis was then used to determine the best alternative as shown in Table 3-6.

TABLE 3-6. COST EFFECTIVENESS ANALYSIS: LONG TERM MOBILE BYPASSING ALTERNATIVES

Plan	Sum	Unit Cost
1	18	3.56
2	12	3.36
3	11	14.40
4	6	14.04
5	15	5.26
6	13	7.10
7	26	3.89
8	20	3.69

Listed in Ascending Order of Outputs then Costs

Plan	Sum	Unit Cost
4	6	14.04
3	11	14.40
2	12	3.36
6	13	7.10
5	15	5.26
1	18	3.56
8	20	3.69
7	26	3.89

Production Ineffective Solutions Struck Through

Plan	Sum	Unit Cost
4	~~6~~	~~14.04~~
3	~~11~~	~~14.40~~
2	12	3.36
6	~~13~~	~~7.10~~
5	~~15~~	~~5.26~~
1	18	3.56
8	20	3.69
7	26	3.89

Cost Effective and Least Cost Solutions

Plan	Sum	Unit Cost
2	12	3.36
1	18	3.56
8	20	3.69
7	26	3.89

Average Costs Calculated

Plan	Output (Index Sum)	Unit Cost	Average Unit Cost per Index Unit Output
2	12	3.36	0.28
1	18	3.56	0.20
8	20	3.69	0.18
7	26	3.89	0.15

Plan	*Sum*	*Unit Cost*
7	**26**	**3.89**

The Corps of Engineers Cost-Effectiveness Analysis Procedure (USACE IWR Report 94-PS-2) was utilized for this evaluation. Project alternatives for each objective were analyzed for economic efficiency by first reordering the alternatives so that they are listed in order of ascending outputs. For each level of output the least cost alternative was then identified, and alternatives which produced equivalent output for a greater cost were eliminated from further consideration. Alternatives were then analyzed for economic effectiveness by conducting a pair-wise comparison of outputs and costs to identify and delete those alternatives that will produce less output at equal or greater cost than subsequently ranked alternatives. Average costs were then calculated for the remaining solutions. After the economic efficiency and effectiveness analyses were completed, alternatives that remained for further consideration were cost-effective. To provide further guidance to recommend a plan an incremental analysis was conducted. Incremental analysis reveals and interprets changes in costs for increasing levels of outputs. Based on the results of the cost effectiveness and incremental analyses, recommended plans were selected.

For the proposed long-term restoration of Assateague Island, there are four cost-effective alternatives. A simple trend of decreasing average unit cost as project outputs increase characterizes the relationship among the cost-effective project alternatives. Alternative 7 possesses the lowest average unit cost per output in index units. Because of this trend where the lowest average cost alternative produces the greatest output, an incremental analysis is not possible.

As the cost effective analysis indicates Alternative 7, mining 145,000 m^3/yr (189,000 yd^3/yr) from a variety of sand sources each year: 40,000 m^3/yr (52,000 yd^3/yr) from updrift fillet, 85,000 m^3/yr (111,000 yd^3/yr) from ebb shoal, and 20,000 m^3/yr (26,000 yd^3/yr) from navigation channels and flood shoals produces the greatest level of benefits. This plan replaces the annual amount of sand lost at Assateague Island with minimal impacts to sources due to the use of multiple sources. In addition, this plan approximates the natural longshore sand transport process and is extremely flexible. Specifically, if a bypassing source does not infill at the anticipated rate, then use of an different source or different quantity is possible. This plan in time, will create a sustainable, cyclical, long-term sand bypassing approach. Therefore, based on these criteria, Alternative 7 was selected as the recommended plan.

3.7 DESCRIPTION OF RECOMMENDED PLAN

3.7.1 Physical Description of Plan

To implement this recommended plan, we intend to utilize a shallow dredge like the Wilmington District's dredge *Currituck*. The *Currituck* is a shallow hopper dredge 44 m (144 ft) long and drafts approximately 7 feet fully loaded. The hopper capacity is 240 m^3 (310 yd^3) and it can operate in relatively rough seas. The dredge can discharge directly in the surf zone. Currently, the maximum and minimum dredging depth of the *Currituck* is 5 m (17 ft) and 2 m (5 ft), respectively. However, modifications to the drag arm are being considered which would allow dredging to depths of approximately 6 m (21 ft). The dredge can remove thin layers of sand over large areas, which is desirable for the sand areas being considered. Therefore, it is recommended to bypass approximately 145,000 m^3 (189,000 yd^3) annually by mining approximately 72,500 m^3 (94,000 yd^3/yr) from the designated bypassing material sources twice each year, once in February/March and once in October/November. The long-term recommended plan has a project life of 25 years. This has been coordinated with the Wilmington District and they are available and capable of implementing the project during these months. In the event a shallow dredge is not available, the recommended plan will be to either skip that semi-annual cycle and double the next cycle quantities; skip that year double the next year's quantities; or contract a small dredge using the ebb shoal and updrift fillet as material sources.

To further reduce the potential for adverse impacts to the placement site as well as the sites to be mined, it was decided to bypass two times each year during times of greatest net southerly longshore transport with a 2 to 3 month lag time between bypassing cycles. Dredging twice a year serves to provide sediment to Assateague Island on a more periodic basis which mimics natural processes better than bypassing the entire yearly volume during one cycle. By bypassing smaller volumes over a longer period of time, the inlet area is less susceptible to changes to the hydrodynamic regime including current and shoaling trends. Bypassing twice during the September through April timeframe with the 2 to 3 month lag will allow for the "mined" areas to infill naturally through the southerly longshore transport process prior to both the second bypassing cycle and prior to May, when the net longshore transport becomes predominantly northerly in direction. In addition, this time frame for dredging avoids the peak summer boating season, therefore, minimizing the potential for safety problems between the dredge and boats. This method of bypassing will minimize impacts to the entire inlet system. In addition, dredging between September and mid-March avoids any potential impacts to Piping Plovers on Assateague Island. Further, since material placement is in the surf zone not on the beach, the potential for adversely impacting the plovers is low.

It is proposed to semi-annually mine the maximum from the Ocean City updrift fillet taking approximately 20,000 m^3 (26,000 yd^3) each time for a total of 40,000 m^3 (52,000 yd^3) per year. In addition, it is proposed to mine approximately 43,000 m^3 semi-annually (85,000 m^3 (111,000 yd^3) annually) from the ebb shoal. It is recommended that approximately 5,000 m^3 (7,000 yd^3) be mined semi-annually (10,000 m^3 (13,000 yd^3) annually) from the navigational channels. This operation would serve a dual purpose of reducing the impacts of channel shoaling in the area while providing a source of sediment for bypassing operations. It is also proposed to mine approximately 5,000 m^3 (7,000 yd^3) from the flood shoal semi-annually for a total annual volume of 10,000 m^3 (13,000 yd^3). This constitutes about 3 percent of its volume. However, unlike the updrift fillet and ebb shoal, there is less certainty whether the mined area will infill at comparable rates.

The Baltimore District and the study sponsors agree that mining small amounts of material from various bypassing sources lessens the impact that would be experienced by a single source. Detailed monitoring is necessary to assess the impacts year to year of each bypassing material source. Consequently, if a bypassing material source is being too heavily impacted, the following year material would not be mined from that source. More detailed information on the monitoring plan follows this section in Section 3.7.1. Also, supplying material yearly, rather than every 2 to 4 years, more closely mimics the natural sediment transport process, an objective of the study. In addition, performing the dredging two times a year lessens the environmental impacts to Assateague Island.

Using a conservative approach and using multiple borrow sources, upsetting the inlet hydrodynamics will be avoided. In addition, this approach will allow for evaluation on an annual basis of the efficiency and sustainability of the bypass sources. In the future, the long-term plan will demonstrate a stable, sediment bypassing system whereby materials taken will be perpetually recharged and a cyclical process will occur. This plan provides flexibility so that over time, we can adapt to the best methods and sand sources.

As stated in Section 2.1.1.a, the sediment budget analysis conducted as part of this study indicated the existence of a nodal point located about 6.3 km (3.9 miles) south of the inlet (see Appendix A2). It is suggested that net littoral transport north of the nodal point is to the north and south of the nodal point to the south. To feed the regional littoral transport system and address the erosion problems both north and south of this nodal location, this location is an important consideration for placing the bypassed material. The material would be placed in the surf zone along a reach of shoreline from 2 to 5 m (5 to 15 ft) deep NGVD extending from approximately 6 km (3.75 miles) to 8.4 km (5.25 miles) south of the inlet. To address the major erosion problem south of the nodal point, 80% of the material will be placed in the reach between nodal point and 8.4 km (5.25 miles) south of the inlet while the remaining 20% will be placed in the reach north of the nodal point, as shown on Figure 3-7. A total of 145,000 m^3 (189,000 yd^3) will be bypassed annually by placing 72,500 m^3 (94,000 yd^3) along this stretch of shoreline twice each year. During each placement operation approximately 60,000 m^3 (78,000 yd^3) will be placed south of the nodal point while the remaining 15,000 m^3 (20,000 yd^3) will be placed north of the nodal point.

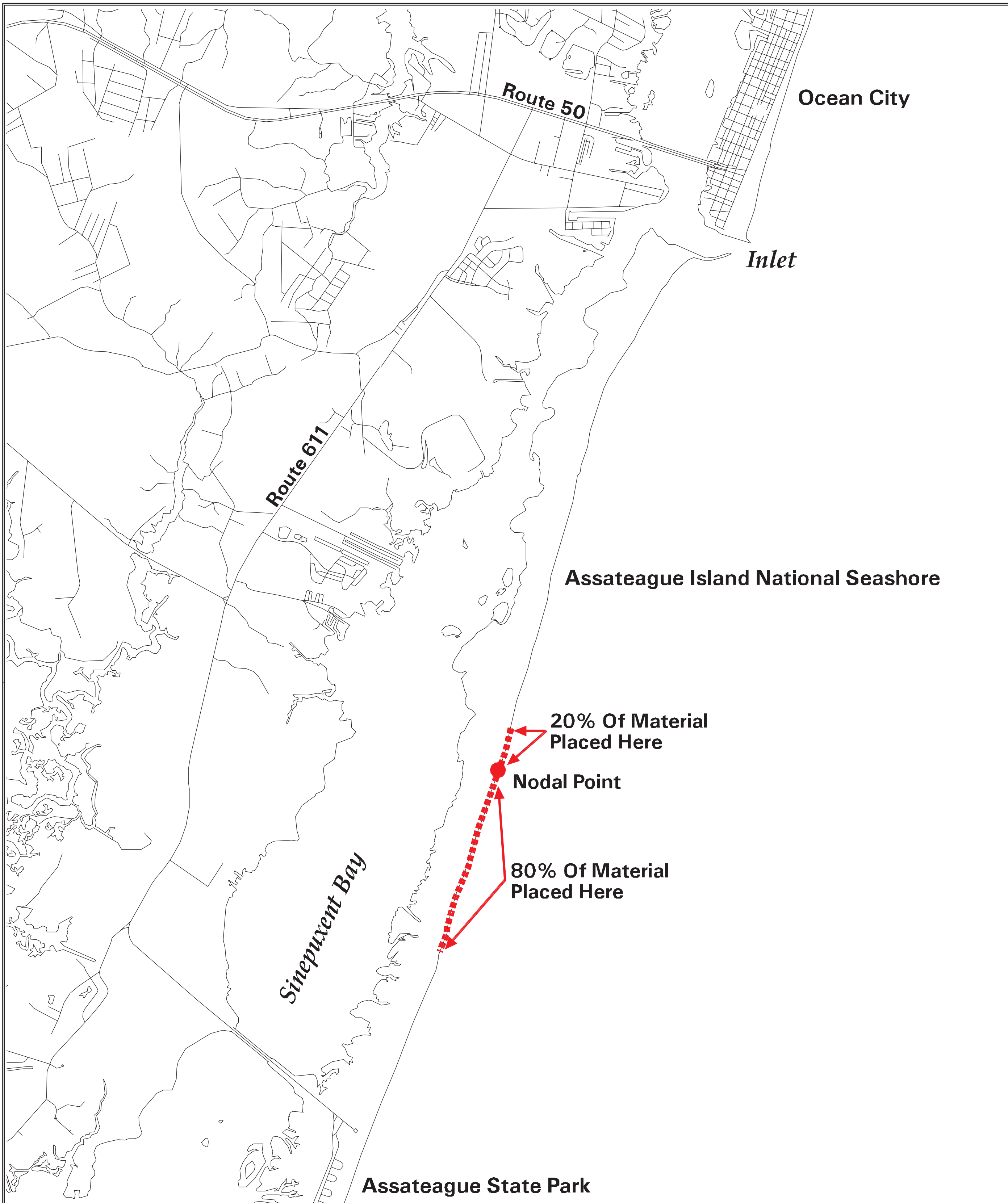
Ocean City Back-Passing

As one of the objectives of the long-term sand management, the sediment needs of the entire coastal area were considered. Specifically, whether or not the long-term project could be combined with the Atlantic Coast Shoreline Protection Project was addressed. The Shoreline Protection Project addresses the sediment needs of the Ocean City beach. Criteria the study evaluated were the quantity of sediment, the potential bypassing material sources, and the types of dredge vessels necessary for both projects. However, analysis indicates the types of dredge vessels required for the periodic nourishment of the Ocean City beach and that required for placement along Assateague Island's surf zone are much different in size, depth and capacity. Therefore, the long-term restoration of Assateague Island can not be combined with the four-year cycle of renourishment of the Atlantic Coast Shoreline Protection Project.

However, we did consider methods of how Ocean City or the Shoreline Protection Project could benefit from the annual dredging operation proposed for the long-term restoration of Assateague Island. For the restoration of Assateague Island it was determined that 145,000 m^3 (189,000 yd^3) per year should be dredged from sources in and around the inlet area, where the sand is currently being captured, and placed in the surf zone along Assateague Island. In evaluating these sand sources, it was determined that an addition 15,000 m^3 (20,000 yd^3) per year could be dredged for use in other locations within the study area, such as Ocean City. This amount is deemed an appropriate quantity as to not adversely impact any of the proposed borrow areas.

It was determined that placing this volume of material annually in areas of increased erosion along Ocean City would provide short-term benefits to that area, would provide longer-term benefits to other project areas as it naturally migrates through the system, and would decrease the cost of the four-year renourishment. Furthermore, if the sand is back-passed in spring or early summer, the wave conditions would tend to be more favorable for onshore transport of sand, where it is most beneficial to the Project.

The estimated cost of the beach sand required for periodic renourishment for the Atlantic Coast Shoreline Protection Project is currently \$6.50 per m^3, excluding mobilization, demobilization and other fixed costs. The renourishment is typically accomplished by dredging a borrow area offshore of Ocean City with a hopper dredge and aided with a booster pump and pipeline. The sand is directly piped onto the Ocean City beach in order to maintain the original design level of shoreline protection. If 15,000 m^3 (20,000 yd^3) of sand each year from the Ocean City inlet area is back-passed, the cumulative effect over four years would be to reduce the renourishment requirement by 60,000 m^3 (78,000 yd^3).



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Long-Term Sand Management Sand Placement Strategy

Date: 16-AUG-1997
/harold2/pmn/ocity/report/ltsm.map

Figure 3-7

The potential cost savings to the Shoreline Protection Project would derive from the lower costs associated with the back-passing of sand from the Ocean City inlet area to an area of the Ocean City beach. The cost of back-passing sand from the Ocean City inlet utilizing the shallow dredge is \$2.75 per m^3 excluding the cost of mobilizing and demobilizing the dredge. This assumes that the haul distance is comparable to the Assateague Island haul distance; this equates to the vicinity of 33rd Street. If the renourishment area is below 33rd street, the cost savings will increase; above 33rd Street, the cost savings will decrease. Therefore the cost of \$2.75 per m^3 for the shallow dredge versus the cost of \$6.50 per m^3 for the normal renourishment cycle every four years translates into a cost savings of \$3.75 per m^3 if the shallow dredge is employed for the Ocean City sand back-passing. The \$3.75 per m^3 times 15,000 m^3 equals a cost savings of \$56,250 each year or equivalently, \$225,000 every four years. Thus there is a potential cost savings of \$225,000 every fourth year when the Atlantic Coast Shoreline Protection renourishment cycle is undertaken.

The Corps of Engineers, Baltimore District, Engineering Division is currently analyzing three reaches of Ocean City beach that experience chronic erosion problems. The analysis will indicate whether any modification to the project is warranted. The study could propose structural modifications or additional renourishment in these areas. The 15,000 m^3 (20,000 yd^3) discussed above is being considered as a potential resource for solutions to these problem areas.

The existing authorities for both projects would be used to budget funds for the Corps of Engineers contribution. The \$41,300 estimated cost for the Atlantic Coast of Maryland shoreline protection project would be shared in accordance with the signed Project Cooperation Agreement - 53% (\$21,900) Federal, 47% (\$19,400). The costs for the Assateague Island would be cost shared in accordance with agreed upon cost sharing. Each year, both projects would be individually identified in the President's budget.

3.7.2 Monitoring Plan

Overview. The purpose of the monitoring plan is to evaluate and document the effectiveness of the Long Term Management Plan by assessing the physical evolution of the inlet system to include both updrift and downdrift beaches. Changes in key physical characteristics of the system will be evaluated in an attempt to identify cause and effect relationships should problems occur. Since the long-term sand management plan is flexible by nature, the information gathered during the course of the monitoring plan will allow for adjustments to correct potential performance problems. Also, adjustments can be made if assumptions made during this study turned out to be incorrect.

The monitoring program will begin before the first placement cycle to accurately characterize the pre-project conditions thereby establishing baseline conditions by which project related changes may be measured and evaluated. Monitoring should continue throughout the life of the project (i.e., 25 years), although the frequency and/or the extent of monitoring may be decreased in the future as the reliability of predicting project performance is enhanced.

1. Monitoring Components. The recommended monitoring plan has six central physical data collection components: (a) surveys of the areas to be mined, (b) bathymetric surveys of the inlet system, (c) shoreline surveys of adjacent beaches, (d) wave and water level measurements, (e) current measurements, (f) aerial photography and (g) sediment sampling. These six components provide the minimum information required to sufficiently document the behavior of the bypassing material areas and related changes to the inlet system and adjacent beaches. The monitoring plan presented focuses on the physical aspects and behavior of the project.

a. Surveys of Areas to be Mined. The areas to be mined identified for the long term project include the updrift fillet, ebb shoal, flood shoal, and the navigation channels. A fathometer type survey of the flood shoal, ebb shoal and navigation channels will be performed before and after each dredging event, while the updrift fillet will be surveyed using a sea sled type system. In addition, the updrift fillet will be surveyed at the mid-point between dredging events for the first 3 years of monitoring, to more closely monitor the infilling rate and profile response in this area. Thereafter, surveying of the areas to be mined will coincide with pre- and post-dredging activities. A pre and post dredging analysis will provide quantities of material mined from each area, and allow for an evaluation of infilling rates and future availability of material.

b. Hydrographic Surveys of the Inlet System. Complete hydrographic survey coverage of the entire inlet system to include the ebb shoal should be performed on an annual basis. The area to be surveyed is comparable to the area analyzed in the development of the sediment budget used in the formulation of the long term project. Initially, this should be accomplished prior to any project construction to establish a baseline condition upon which to measure relative changes to the inlet system. To allow time for the system to adjust to subsequent dredging of the bypassing material areas, the annual survey should be performed in June of each year, at the approximate mid-point of the interval between the semi-annual dredging operations. These data will be collected annually for the first 3 years of monitoring and every other year thereafter. Using these data, difference plots and calculations can be performed which may indicate the existence of shoaling problems, scour problems, channel shifting, shoal migration, etc. In addition, these data can be input into a calibrated numerical hydrodynamic model to assess adverse current patterns which may be attributed to the project. A hydrodynamic modeling system has been previously developed for other study purposes which may be refined and utilized if these assessments become necessary.

c. Shoreline Surveys. To document the effects of mining the updrift fillet on the position of the shoreline landward of the dredged area as well as potential updrift effects, a survey of the position of the mean high water line will be conducted at various times during the year. The survey will be conducted using conventional surveying techniques along the waterfront from the north jetty extending north a distance of approximately 1,524 m (5,000 ft). A rod man will traverse the beach from approximately +2 m (6 ft) and 0 m NGVD in a zigzag fashion to delineate the mean high water line. These surveys should be conducted concurrently with the profile surveys of the updrift fillet in January, March, June, September and November. This frequency of measurement will be performed for the first 3 years of monitoring. Thereafter, shoreline surveys will be conducted in conjunction with Pre- and post-dredging measurements. Plots of shoreline position can then be compared to assess shoreline response to the mining operations and potential adverse impacts can be identified (i.e., unacceptable amounts of shoreline recession). Similarly, the MHW shoreline of Assateague Island is to be systematically surveyed from the south jetty to a point extending south a distance of 12 km (8 miles). For the first three years, the shoreline will be surveyed each year in the spring and fall and once a year in September thereafter. These data will be used to document the readjusted rates of accretion and erosion along the project shoreline.

d. Profile Surveys. Beach profile surveys will be collected at approximately 0.5 km (0.3 mile) intervals from the south jetty to a point approximately 14 km (9 miles) south. The profile surveys are to be collected using a sea-sled type system. The survey shall extend across the entire zone of active profile change. In areas where there is little to no relief the subaerial portion of the profile could extend across the entire island. The profile will extend seaward in a direction normal to the local shoreline orientation to a point seaward of the depth of closure. Depth of closure is defined as the depth beyond which sediment transport of engineering significance does not occur (Stauble et al. 1993, Hallermeirer 1981, Birkemeier 1985). These data will be collected in September of each year for the first three years of the project and every other year thereafter. The frequency and need for continued collection of these data will be assessed at that time. These data will be collected in September, because it is at this time prior to the winter storm season, that the beach is in its most accreted condition. During this time, effects of storms on the observed profile are minimized making it easier to assess the fill condition from year to year and providing a consistent measure of the long term performance. These data will be used to evaluate the percentage of retention of the fill volume in the project area from year to year as well as to help characterize the volume of material remaining on the subaerial beach.

e. Wave, Water, and Current Measurements. Wave and water level data will be collected using a directional wave gage. Two directional wave gages are currently operational offshore of Ocean City. The north wave gage is located approximately 8.8 km (5.5 miles) north of the inlet in offshore in approximately 30 meters (98 ft) of water while the south gage is located approximately 1.9 km (1.2 miles) north of the inlet in the same depth of water. In addition, the south site is operated as a controlled tide station. A controlled tide station is also being operated by the Baltimore District at the Coast Guard Station in Isle of Wight Bay. These collection sites are deemed appropriate to use for the Long Term Restoration Project on Assateague Island. Continued operation of these gages for the Long Term Project will provide a continuous record of information from which values of significant wave height, peak wave period, peak direction, and mean water level can be determined. These data will be used to assess the severity of storms impacting the area as well attempting to establish a cause and effect relationship between actual waves and water levels and measured beach response (i.e., comparison of measured infilling rates of updrift fillet to calculated transport rates, evidence of shoreline erosion along areas of Assateague Island, etc.). These stations will be operated for 3 years after the start of the long term sand placement project. It will be decided at that time whether to continue this level of monitoring.

Additional tide and current meters could be deployed at strategic locations for short durations on an as needed basis. Since it is conceivable that mining the various areas in concert will have an effect on the hydrodynamic regime and local bathymetry of the inlet and adjacent bays, these data will provide a means to assess these relative changes. Tide stations will be deployed in Sinepuxent and Isle of Wight Bays at the location of the boundaries of the bathymetric grid developed for the hydrodynamic model used for the study. These stations will collect data for a period of 30 days to capture the spring and neap tides. Current data would be collected at appropriate locations over at least a tidal cycle. These data along with the most recent bathymetric data of the inlet system would be utilized to calibrate the numerical hydrodynamic model. This calibrated model and the base condition model (previously calibrated model before construction) could then be run with the same boundary conditions and the relative changes in the currents and water levels throughout the model domain could be assessed. This would allow for an “apples to apples” comparison of the hydrodynamic regime on a temporal sense and under differing conditions.

f. Aerial Photography. Aerial photography of the project shoreline and inlet area will be performed in September of each year for the first three years after initiation of the long term plan and once every 2 years thereafter. The frequency and need for continued collection of these data will be assessed at that time The aerial coverage will extend from the inlet to a point approximately 14 km (9 miles) south. Coverage will include a single flightline with 60% overlap stereo coverage of the entire project shoreline. Color infrared film with a 9 x 9 inch film format will be specified. A scale of 1" = 400' is to be used. The photography will be taken around low tide, to provide the maximum area of exposed intertidal beach and inlet shoals.

Higher altitude coverage will also be conduced to cover an area approximately one quarter of a mile on either side of the inlet. The coverage will include the ocean, bay and mainland shorelines in this area. A scale of 1" = 800' will be used. All other requirements are the same as for the shoreline coverage. These data will provide a visual record of shoreline position, variations in beach planform, condition of the beach and berm, and subaerial beach width. The location of coastal bay shoals can also be observed. In the past, Lidar surveys were attempted for this area. However, due to turbidity and the murkiness of the water, measurements could not be taken. Therefore, Lidar surveys are not recommended for the monitoring plan.

g. Sediment Sampling. Sediment sampling will be conducted to document sediment characteristics of the borrow areas and adjacent beaches. Sampling locations will be within the borrow areas (i.e., front face of ebb shoal, accretion fillet, flood shoal, and navigation channels) and both beaches adjacent to the inlet. Submerged samples can be collected by boat using a bucket dredge and surface grab samples can be collected by hand with a core scoop on portions of the exposed beach. Samples will be collected before and after each dredging event for the first three years following construction of the initial project and then every other year through year seven. Analysis of these data should provide insight into the sediment transport pathways and increase the understanding of sediment processes at an engineered inlet.

2. Summary. Tables 3-7 and 3-8 present the recommended data collection schedule for physical monitoring of the project area. The schedule is divided into two phases. The initial phase is a period of more intensive monitoring during the first three years of the project. This phase includes continuous wave and water level data collection and more frequent bathymetric surveys, beach surveys, shoreline surveys, and aerial photography to sufficiently document processes and responses characterizing the project. This phase provides information to gain a good understanding of the project behavior which can be used to enhance the project performance. The final phase focuses on longer term aspects of the project and assuring project functionality is maintained. It is recommended that the second phase of the project continue through at least year 7, at which time a decision will be made whether to continue phase 2 level of monitoring.

TABLE 3-7
DATA COLLECTION SCHEDULE FOR LONG TERM SAND PLACEMENT
PROJECT YEARS 1 THROUGH 3

MONITORING COMPONENT	JAN	FEB	MAR	JUN	SEP	OCT	NOV	DEC
SURVEY EBB SHOAL	**X**	dredge	**X**		**X**	dredge	**X**	
SURVEY UPDRIFT FILLET	**X**	dredge	**X**	**X**	**X**	dredge	**X**	
SURVEY FLOOD SHOAL	**X**	dredge	**X**		**X**	dredge	**X**	
SURVEY NAVIGATION CHANNELS	**X**	dredge	**X**		**X**	dredge	**X**	
SURVEY OF INLET SYSTEM				**X**				
BEACH PROFILES (Assateague Island)					X			
SHORELINE SURVEY (updrift fillet shoreline)	**X**		**X**	**X**	**X**		**X**	
SHORELINE SURVEY (Assateague Island)			**X**		**X**			
SEDIMENT SAMPLING	X		X		**X**		X	
AERIAL PHOTOGRAPHY					**X**			
WAVE & TIDE DATA [1]	◄──	──	──	──	──	──	──	──►

1/ Additional tide and current data to be collected throughout the inlet and back bay areas on an as needed basis.

TABLE 3-8
DATA COLLECTION SCHEDULE FOR LONG TERM SAND PLACEMENT
PROJECT YEARS 4 through 25 (25 Years = Project Life)

	EVEN NUMBER YEARS FOLLOWING CONSTRUCTION				ODD NUMBER YEARS FOLLOWING CONSTRUCTION			
MONITORING COMPONENT	**PRE DREDGE**	**POST DREDGE**	**JUN**	**SEP**	**PRE DREDGE**	**POST DREDGE**	**JUN**	**SEP**
SURVEY EBB SHOAL	**X**	**X**			X	X		
SURVEY UPDRIFT FILLET	X	X		.	X	X		
SURVEY FLOOD SHOAL	X	X			X	X		
SURVEY NAVIGATION CHANNELS	X	X			X	X		
SURVEY OF INLET SYSTEM							X	
BEACH PROFILES (Assateague Island)								X
SHORELINE SURVEY (updrift fillet shoreline)	X	X			X	X		
SHORELINE SURVEY (Assateague Island)				X				X
SEDIMENT SAMPLING					X	X		
AERIAL PHOTOGRAPHY								X
WAVE & TIDE DATA	TO BE DETERMINED							

3.7.3 Operation and Maintenance

We do not anticipate the need for maintenance or corrective action; however, the team realizes the risks being taken in constructing a project in a dynamic area. The performance of the project will be evaluated through the monitoring plan and adjustments in the bypassing can be made each year. If however, ***the project evolves to an unacceptable condition,*** it is envisioned that corrective action may need to be taken. Although it is difficult to predict when, or if, this will occur, we are assuming that every five years, construction equipment may be required to ***reposition*** sand for a period of a week. Table 3-9 presents the O&M first costs and annualized cost of this corrective action. Maintenance of the project will be performed by the project sponsor, the National Park Service.

Table 3-9 Project Operation and Maintenance Costs

O&M First Cost	$60,400
O&M Annualized Cost	$5,200

3.7.4 Risk and Uncertainty

Major risk and uncertainty factors in the analysis of the long term sand management component are the effectiveness of sand placement on Assateague Island, the effects of removing sand from the ebb shoal and fillet, and the availability of a dredge similar to the *Currituck* dredge vessel on an annual basis. Measures were taken to address the uncertainty inherent in a project of this scope. CHL modeled longshore sediment transport, grain size and composition, the geomorphology of Assateague Island, as well as other hydrologic and physical factors that could affect outputs. Although there is risk and uncertainty in these model outputs, they do provide an observed, determinate outcome around which a range of outcomes can be expected to occur. In regard to availability of a dredge similar to the *Currituck*, the cost to use an alternate dredge was included in the analysis to account for this risk factor.

3.7.4 Cost Estimates

The cost for the long-term sand management is estimated to be $25,243,000. The first year cost is estimated to be $1,385,000 (Table 3-10). This cost includes $313,000 (contingency included) for lands and damages. These costs are also included in the $17,200,000 short-term restoration project. If the short-term project is constructed, the long-term project would be reduced by this amount. A copy of the detailed estimate is provided in Appendix C.

Table 3-10. First Year Long Term Sand Management Costs

LTSM	First Costs	Fully Funded Costs
Long-term Sand Replenishment	$665,000	$750,000
PED (including Monitoring Plan)	$297,000	$335,000
Construction Management	$110,000	$124,000
Lands and Damages	$313,000	$353,000
Total	**$1,385,000**	**$1,562,000**

SECTION 4

NAVIGATION

4.0 INTRODUCTION

This chapter contains discussions of the water resource problems in the study area as they relate to navigation. Several problem areas were identified and potential solutions were investigated. This chapter describes the problems, most probable future without-project conditions, alternative solutions, and the recommended plans. Annex B, Economics Evaluation, contains detailed discussions on how costs and benefits were derived.

4.1 PROBLEM, NEEDS AND OPPORTUNITIES

The study team established the following problem statement for the navigation component of the project:

The commercial waterway users are experiencing shoal-induced damages and increased operating costs while navigating the Ocean City harbor and inlet channels and the Shantytown channel.

Commercial waterway users experience shoal-induced navigational difficulties navigating the channels of the Ocean City Inlet, Harbor, and the Shantytown Channel (adjacent to the Ocean City Fishing Center) (Figure 4-1). These are the channels most heavily used by commercial watermen. Most of the local commercial watermen in the area moor their vessels at the federally maintained Harbor (Fisherman's Marina harbor in West Ocean City), and use the harbor and inlet channels regularly. There are 27 year-round commercial watermen operating from the Harbor. In addition, many transient watermen fish the surrounding waters and land their catch in the harbor. The Shantytown channel provides navigational access for boaters using the Ocean City Fishing Center. The center has a 220-slip marina and also houses 4 commercial headboats and 30 charter boats in its facilities.

Shoal formation in the bays in the vicinity of the inlet adversely impacts channel navigability. The inlet and harbor Federal channels are currently maintained to a depth of 3 meters (m) (10 feet [ft]), which is inadequate to accommodate the 8 local commercial vessels that draw up to 13 ft under full load. These vessels experience virtually continuous shoal-related navigational difficulties even with periodic maintenance dredging. The business operating costs of commercial watermen using the existing harbor and inlet channels increase significantly due to channel shoaling. Annual fleet-wide cost increases range from $158,000 in the first year of the 7- year dredge cycle when the channels are deepest, to $227,000 by the last year of the cycle when the effects of shoaling are the worst.

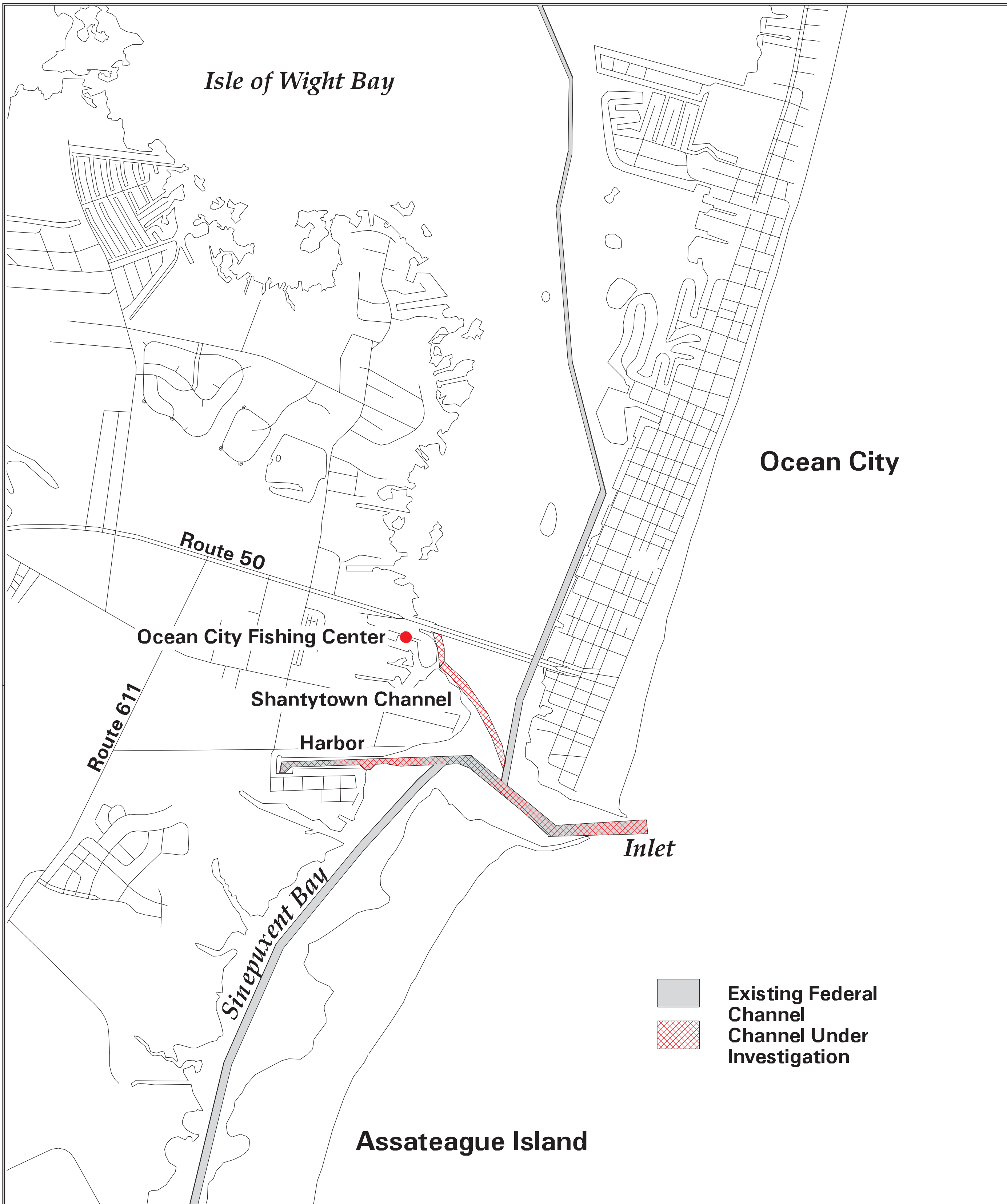
The Shantytown channel is not a federally maintained channel. The State of Maryland and the marina owner dredge the channel on a seasonal basis, but shoaling resumes almost immediately after dredging, and navigational difficulties ensue. As the channel shoals, boat owners are forced to navigate with the tides in order to minimize damage to their vessels while traversing the channel. The boats most significantly impacted by the shoaling pattern in the channel are the 4 commercial headboats, which draw from 6 to 8 ft. However, as the shoal continues to accrete, the 30-vessel charter fleet is impacted as well. Besides requiring almost continuous maintenance dredging, shoaling of the Shantytown channel increases operating costs for users. The overall operating cost increase due to shoaling is estimated to exceed $80,000 annually.

A number of sources contribute sediment to the shoals in the inlet and bays. Aerial photographs taken from 1933 to the present, and in particular from 1971 to 1993, show growth and migration of shoals in and around the coastal bays that are affecting navigability of the waterways. The root of the problem is flood current transport of material through the Ocean City Inlet, carried north and south into the adjacent back bays, coupled with shoreline erosion along the oceanfront and in areas susceptible to scour in the coastal bays.

The ebb shoal (just oceanward of the south jetty) is growing in size, prohibiting vessels from taking the direct approach into and out of the inlet. Boaters will have an even more difficult time navigating in the future if the ebb shoal continues to grow.

4.2 FUTURE WITHOUT-PROJECT PROBLEMS

The most likely future without a project condition defines the condition that will most likely exist if no action is taken to change the existing navigation conditions in the study area. The most likely future without project provides a baseline condition against which alternative future plans are measured. The future without-project condition for the navigation channels reflects the results of engineering modeling studies, economic surveys and forecasts, and environmental baseline studies. The ensuing sections describe the future without project condition for the inlet and harbor (Section 4.2.1) and for Shantytown channel (Section 4.2.2).



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Federal Navigation Channels

Date: 13-AUG-1997
/harold2/pmn/ocity/report/nav.map

Figure 4-1

4.2.1 Inlet and Harbor

Without a project to alter current shoaling patterns in the harbor and inlet, it is expected that the existing 4-7 year maintenance dredging cycle will continue. The inlet and harbor channel will continue to be dredged to the Federally authorized dimensions of 3 m (10 ft) deep and 61 m (200 ft) wide. Shoals will continue to form in established areas in the channel and increase the operating costs of commercial watermen using the harbor and inlet. The current rate of shoaling in these areas is approximately 0.15-0.30 m (0.5-1.0 foot) per year. The effect the channel shoaling process has on boating operations is to gradually increase damages, maintenance costs, tide-waiting delays and fuel costs as controlling depths in the channel become shallower in the years following the maintenance dredging.

It is expected that the current rate of shoaling, vessel damages, and delays will continue in the future. Commercial watermen using the Ocean City harbor and inlet system will operate in the face of economic inefficiencies and increased operating costs that are a direct result of shoaling of the existing Federal channel. The national economic development (NED) costs associated with this condition are expected to continue to impact commercial fishing operations in the future. The annual NED cost attributable to shoal-induced navigational problems amounts to $190,000 (see Annex B).

4.2.2 Shantytown

Without a project to alter the current shoaling frequency and location patterns in the Shantytown channel, the existing condition is expected to continue. Local interests will continue to dredge the channel on an annual basis, and channel users will continue to experience shoal-induced damages and increased operating costs soon after dredging. Implementation of a long-term sand management project may reduce shoaling patterns in the inlet system and the Shantytown channel, but the effects are difficult to predict.

Under current conditions, the channel is usually dredged in April to a depth of 2.4 m (8 ft) by the State of Maryland, the marina owner, and its users. Immediately after the dredge event, the natural process of the flood tide initiates the migration of sand into the channel. During the spring and summer recreation season, channel usage is very heavy and shoal material from the flood tide tends to be disturbed and unsettled, reducing the deposition of material in the channel to some degree. In this season, although adverse effects to users do occur, they are manageable. After the recreational season as boat traffic diminishes, channel controlling depths decrease to about 1.2-1.5 m (4-5 ft), which poses a significant impediment to navigational users. During the 6 month period from October until the following spring channel clearing event, channel shoals induce increased operating costs for users. Shoaling costs include vessel damage repair costs, delays awaiting tide shifts to traverse shoals, and headboat trips lost due to insufficient bottom clearance. The total increase in annual operating costs attributable to channel shoaling in Shantytown is $80,000.

4.3 GOALS AND OBJECTIVES

Due to difficulties commercial waterway users have been experiencing in navigating the Ocean City Inlet, harbor, and Shantytown channel, these shoaling problems are being investigated as part of this study. The following goal and objectives were developed:

Goal: Improve navigation through the inlet, harbor, and Shantytown Channel.

Objectives: The objectives that the study team identified included the following--

1. Establish a safe navigation channel through the inlet, harbor, and Shantytown Channel.
2. Reduce or eliminate the damage being incurred by commercial vessels.
3. Reduce or eliminate the waiting time for vessels to navigate the channels.

4.4 FORMULATION OF ALTERNATIVE PLANS

4.4.1 Inlet and Harbor

Three alternatives to the currently authorized protect were formulated to address the navigation problems being experienced by users of the Ocean City harbor and inlet channels. Each alternative would deepen the authorized channel depth. The three alternatives investigated were:

1. Deepen inlet channel to 4.3 m (14 ft), harbor channel to 3.7 m (12 ft)

2. Deepen inlet channel to 4.9 m (16 ft), harbor channel to 4.3 m (14 ft)

3. Deepen inlet channel to 5.5 m (18 ft), harbor channel to 4.9 m (16 ft)

Though it was considered in the formulation process for each of the three alternatives, no widening of the currently authorized 61 meter (200 ft) wide channel was included in the plans. The existing channel width is sufficient for vessel passage in conjunction with a deeper channel.

4.4.2 Shantytown Channel

Six alternatives to the existing condition in Shantytown channel were considered in the investigation. The six alternatives considered were:

1. West Side Channel Extension
2. Overdredging By Deepening the Channel
3. Overdredging By Widening the Channel
4. Training Wall and Shoreline Hardening
5. Jetty Construction at Site of Old Bridge
6. Channel Fluidizer System

A description and evaluation of these alternatives is included in Section 4.5.2.

4.5 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

4.5.1 Inlet and Harbor

Each of the alternative plans will increase the depth of the existing harbor and inlet navigation channels and reduce the shoal-induced impacts to channel users. It was assumed that with each alternative, the shoaling rate in the channel will remain the same as the existing shoaling rate; therefore, the channel will require maintenance on the same 4-7 year cycle as in the existing conditions. Because the most recent dredging cycle interval for the inlet channel was 7 years, that was the interval cycle used for the analysis of effects. For the harbor the interval used for the analysis was average dredging cycle interval of 10 years.

Alternative 1 consists of deepening the authorized inlet channel to 4.3 m (14 ft) and the harbor to 3.7 m (12 ft). The authorized channel width will remain 61 m (200 ft). For the initial 2 years of the 7-year shoal and dredge cycle, Alternative 1 effectively eliminates costs induced by channel shoaling because channel depths provide sufficient clearance for all vessels navigating the channel. By year 3 of the cycle, as shoaling gradually diminishes controlling depths, costs induced by shoaling will begin to occur. The annual shoal-induced operating cost with this alternative amounts to $85,000. By reducing the shoal-induced operating costs incurred by commercial watermen, Alternative 1 provides a annual savings of $105,000 compared to the without project condition.

Alternative 2 consists of deepening the authorized inlet channel to 4.9 m (16 ft) and the harbor to 4.3 m (14 ft). The authorized channel width will remain 61 m (200 ft). Alternative 2 will significantly reduce the costs to commercial watermen of operating in the inlet channel and harbor. For the initial 6 years of the 7-year shoal and dredge cycle, Alternative 2 effectively eliminates costs induced by channel shoaling because channel depths provide sufficient clearance for all vessels navigating the channels. By year 7 of the cycle, as shoaling diminishes controlling depths to 13 ft, costs induced by shoaling will begin to occur. The annual cost with Alternative 2 amounts to $41,000. By reducing the shoal-induced operating costs incurred by commercial watermen, Alternative 2 provides an annual savings of $149,000 compared to the without project condition.

Alternative 3 consists of deepening the authorized inlet channel depth to 5.5 m (18 ft) and the harbor depth to 4.9 m (16 ft). The authorized channel width will remain 61 m (200 ft). Alternative 3 will virtually eliminate the shoal-induced costs to commercial watermen of operating in the inlet channel. Because controlling depths are not expected to reach the 13 ft start of damage threshold between maintenance dredging events, Alternative 3 effectively eliminates costs induced by channel shoaling. The average annual operating cost for the commercial fleet is reduced to ordinary hull maintenance costs. This cost amounts to $37,000 on an annual basis. By reducing the shoal-induced operating costs incurred by commercial watermen Alternative 3 provides an annual savings of $153,000 compared to the without project condition,

Table 4-1 displays the benefits for each plan.

TABLE 4-1: ALTERNATIVE BENEFIT ANALYSIS

Average Annual	Average Annual Alternative	Shoal-Induced Costs Benefits
Without Project	$190,000	$0
Alternative 1	$85,000	$105,000
Alternative 2	$41,000	$149,000
Alternative 3	$37,000	$153,000

The preliminary project implementation costs for each alternative were evaluated to determine the average annual costs of each alternative. For each alternative, project costs were based on an identical mobilization and demobilization estimate of $260,000 and an estimated cost of $5 per cubic yard to remove the material from the channel to place it on Assateague Island. These estimates were derived from the actual costs of the spring 1997 maintenance dredging of the inlet channel. The average annual costs are based on a 50-year protect life, using the capital recovery factor for the current interest rate for FY 1997 of 7.375 percent. No operation and maintenance costs were included in the analysis because it is assumed that the alternatives will continue to require maintenance dredging equivalent to what is accomplished for the current, authorized project. Because the quantities to be removed during maintenance dredging are expected to be comparable, the costs are not expected to differ significantly. Table 4-2 displays the project costs and the average annual costs for the alternatives.

TABLE 4-2

	Alternative 1	**Alternative 2**	**Alternative** 3
Project First Cost	$680,000	$1,000,000	$1,142,000
Average Annual Cost	$52,000	$76,000	$108,000

4.5.l.a Environmental Considerations with a Project. Increasing channel depth will not induce significant changes in the inlet dynamics and the hydrodynamics of the coastal bays. An enlarged channel may slightly alter the flow and current regime of the inlet, which may in turn affect local current patterns and erosion. However, most of the Ocean City Inlet is already wide and deep and there are only a few isolated shallow areas that would need to be dredged to deepen the channel. CHL ran a hydrodynamic model of the inlet and bays to determine the impact that dredging deeper would have. It showed that deepening would have insignificant changes to the hydrodynamics of the area (see Appendix A4).

Material from past maintenance dredging operations of the inlet channel has been placed on the beach at Ocean City. An analysis of the quality and amount of the material to be removed will be required to make sure that inlet material is still suitable for beach nourishment. Suitable inlet material will likely be used for beach placement in the future and could positively impact the restoration of Assateague Island. In the past, material from dredging of the harbor is not considered suitable for beach placement, and has been placed at an upland site near the Ocean City airport. Although not suitable for beach nourishment, dredged material from the harbor could be utilized for the creation or rehabilitation of islands in the coastal bays.

It is not expected that the deepening of the inlet and harbor channels will increase navigation in the coastal bays. The channels into the bays (lsle of Wight and Sinepuxent) will remain authorized
to 6 ft, only allowing smaller vessels to enter the bays.

4.5.2 Shantytown Channel

To facilitate the evaluation of Shantytown channel alternatives, two numerical models were used to simulate currents in Shantytown Channel. A 1-D model (DYNLET 1), was used as the primary source of current simulations. A second model, A 2-D depth integrated model, was used to investigate the structural solutions to shoaling. The modeling effort yielded the following conclusions for each alternative.

West Side Channel Extension

Model simulations indicate that extension of the Shantytown channel north of Route 50 would establish peak tidal flow velocities sufficient to keep the channel clear. This alternative would require extension of the 2.4 m (8 ft) deep Shantytown channel north from Route 50 with a 12.2 meter (40-foot) wide tie-in to the main channel about 1.6 km (one mile) north of the bridge. It would require an initial dredge volume of 100,000 yd^3, annual maintenance dredging of 30,000 yd^3 per year for the first several years of operation, and close monitoring of its impact on shoal equilibrium. The estimated cost of the initial dredging is $800,000 and for the annual maintenance dredging $300,000,

The major disadvantage is the cost to implement the plan. Because project costs would far exceed potential project benefits (at most $80,000 annually) with the channel extension alternative, it is not a feasible alternative.

Overdredging By Deepening the Channel

This alternative consists of deepening the channel by overdredging by anywhere from 1.2 to 3.0 meters (4 to 10 ft) to extend the non-shoaling navigable period between maintenance events. Model applications indicate that overdredging would not be an effective solution to the shoaling problem because it has a negligible effect on channel velocities and would likely result in an increased shoaling rate from the adjacent flood shoal. In addition, the estimated annual cost with this alternative is $230,000, far in excess of the maximum project benefit amount of $80,000. For these reasons, the alternative is not feasible for implementation.

Overdredging By Widening the Channel

This alternative consists of increasing the channel width to reduce shoaling rates. Modeling indicates that in order to achieve a reduction in channel shoaling, a combination of channel deepening and channel extension would be needed to affect flows appreciably. Widening the channel could also alter the configuration of the flood shoal. The costs of this alternative, because it includes extension and deepening of the channel, are far in excess of the maximum project benefit amount of $80,000. Because of its high implementation cost and uncertainties about its effect on the flood shoal, this alternative was eliminated from consideration.

Training Wall and Shoreline Hardening

This alternative would consist of the construction of solid walls along both sides of the channel to prevent sediment incursion from the adjacent flood shoal and the eroding shoreline. This would potentially block sediment from entering the channel from these adjacent sources. Modeling shows that these structures would be ineffective because they have minimal impact on velocities due to the large tidal prism and the relatively small structure. Shoaling will continue from sediment entering from the inlet. The approximate first cost is $550,000 and the annual maintenance dredging cost is $15,0,000. The annual cost of $192,000 is more than double the maximum annual benefits with the project. Based on the alternative's excessive implementation cost and uncertainty about its effectiveness, it was eliminated from consideration.

Jetty Construction at Site of Old Bridge

This alternative would consist of construction of a timber jetty at the site of the old bridge ruins just south of the Shantytown channel, to reestablish previous, non-shoaling tidal flow patterns in the channel. In concept, this alternative would retrain flows to effectively reduce shoaling in the Shantytown Channel. However, modeling studies indicate that substantial dredging to reconfigure the flood shoal to its previous proportions would be necessary. This dredging would result in a disequilibrium in the flood shoal and probable adverse impacts on navigation in the Isle of Wight channel and under the Route 50 bridge. The approximate first cost of this alternative is $700,000 and additional dredging costs would be significant. This alternative is not feasible because of its impacts on the flood shoal and uncertainties about its effectiveness.

Channel Fluidizer System

This alternative would require installation of a piping system to fluidize and transport bottom material out of the channel. Theoretically, the material could be directed to areas where tidal currents would be sufficient to carry it away. Modeling showed that ebb currents are insufficient to mobilize fluidized material from the seafloor, a necessary part of the system. The estimated first cost is $310,00 and could be much greater. Annual operating cost estimates are $135,000. Total estimated annual costs are $159,000, far in excess of the maximum amount of benefits with the project. This alternative is an unproved technology with uncertainties in terms of cost and function. For these reasons, the fluidizer alternative is considered not feasible.

4.6 SELECTION OF RECOMMENDED PLAN

4.6.1 Inlet and Harbor

As a step in the process of comparison of alternatives and to assist in the selection of a recommended alternative, a comparison of alternative benefits and costs was done. The benefit cost ratio (BCR) is the ratio of average annual benefits to average annual costs. Economic feasibility of an alternative requires that the BCR be equal to or greater than one. Table 4-3 summarizes the benefit cost ratios and net benefit analysis for the 3 alternatives. The BCRs were calculated based on preliminary cost estimates for each alternative. Each alternative has a BCR greater than one.

The recommended plan is the plan that maximizes the difference between annual benefits and annual costs. This plan is identified as the national economic development (NED) plan. For the harbor and inlet navigation evaluation, Alternative 2, deepening the inlet to 4.9 m (16 ft) and the harbor to 4.3 m (14 ft) is the NED alternative and the recommended plan.

Table 4-3. Benefit-Cost Ratios and Net Benefits Harbor and Inlet Navigation Alternatives

Alternative	Average Annual Benefits	Average Annual Costs	Benefit to Cost Ratio	Net Benefits
Alternative 1	$105,000	$52,000	2.02	$53,000
Alternative 2	$149,000	$76,000	1.96	$73,000
Alternative 3	$153,000	$108,000	1.41	$45,000

4.6.2 Shantytown

Based on the formulation of alternatives in Section 4.5.2, it was determined that there is not a economically feasible solution to the shoaling problem and therefore, there is not a Federal interest to implement a navigation project for Shantytown Channel. However, because of its proximity to the inlet, and the renewable volume of sand, this area has been identified as a potential bypassing source area for the long-term sand management project. Although the main purpose of dredging this area would be to support the long-term sand management, an incidental benefit would be to reduce the impacts of channel shoaling.

4.7 DESCRIPTION OF RECOMMENDED PLAN - INLET AND HARBOR

4.7.1 Physical Description of Plan

The recommended plan consists of dredging the Ocean City harbor to a depth of 4.3 m (14 ft) and dredging the inlet to a depth of 4.9 m (16 ft). To dredge the harbor to 4.3 m (14 ft) including a 2-foot overdepth will require removal of 68,000 m^3 (88,000 yd^3) of material. Forty six thousand (46,000) m^3 (60,000 yd^3) will be removed from the inlet channel to provide an authorized depth of 4.9 m (16 ft) from the entrance to the harbor to deep water outside the inlet including a 2-foot overdepth. Overdepth is standard operating procedure to account for the inaccuracies of dredging and assure the authorized depth is obtained. This additional depth also increases the time between maintenance dredging. The alignment of the channel will follow the alignment of the existing channel.

Material dredged from the harbor and inlet will be used to create island and wetland habitat, as part of the environmental restoration component of the project, as described in Section 5 of this report. Any remaining material from the inlet (clean sand) will be placed on Assateague Island as part of the long-term management plan or on the Ocean City beach. The remaining material in the harbor will be placed upland at a site near the Ocean City airport.

4.7.2 Operation and Maintenance

The Federal government is responsible for operation and maintenance of Federally authorized navigation channels. The currently authorized 3 meter (10 ft) deep channel in the Ocean City harbor and inlet is maintained by the Federal government. The inlet is maintained every 4-7 years. The harbor is maintained every 10 years. Because shoaling rates are not expected to change with implementation of the 4.9 meter (16 ft) inlet, 4.3 meter (14 ft) harbor alternative, the frequency and cost of maintenance dredging is not expected to differ from the existing condition. The inlet was dredged most recently in spring 1997 at a cost of $344,000 for removal of 14,000 m^3 (18,000 yd^3) of material. The harbor was most recently dredged at cost of $337,000 in 1990.

The project non-Federal sponsor will bear the responsibility of providing a dredged material placement site for maintenance dredging. The Corps will determine the suitability of the dredged material site. It is anticipated that material from dredging of the inlet will be placed on the beaches at Ocean City or Assateague Island. Some of the material dredged from the harbor will be used for the environmental restoration projects in the coastal bays. Material not needed for environmental restoration will be will be placed at an upland site near the Ocean City airport. Because it is not certain that both the environmental restoration projects and the navigation channel project will be constructed, the project cost estimate is based on the assumption that the entire volume of harbor material will be placed at the upland site. The actual project implementation cost for the navigation channels is expected to decrease if a portion of the material can be used for environmental restoration.

4.7.3 Risk and Uncertainty

Major risk and uncertainty factors in the evaluation of navigation alternatives involve the accuracy of information gathered and used in the evaluation, the annual shoaling rate used in the evaluation, and the inherent unpredictability of future demographic, economic, hydrologic, and meterological events.

In order to reduce the potential impacts of risk and uncertainty in the economic evaluation, a number of measures were taken. The hydrologic and sediment transport effects of channel deepening were modeled and found to be insignificant. This information reduces uncertainty regarding the effectiveness of future outputs from a physical perspective and validates the assumption that shoaling rates will not change with a deeper channel in place. In order to crosscheck the accuracy of information gathered regarding shoaling and its effect on channel navigation and on commercial users' operating costs, a variety of data sources were consulted. These sources included public meeting forums, focus groups, interviews with channel users and government officials. Another risk management measure used was to assume a shoaling rate of 0.5 foot per year. This rate is on the low end of the estimated annual rate of shoaling and thus minimizes the risk of overstating benefits. Also, the number and size of commercial vessels used in the channel was kept constant in the evaluation for the life of the project, thus minimizing the risk of over estimating future benefits.

4.7.4 Construction Method

The harbor will likely be dredged using a hydraulic cutterhead dredge. The material will be pumped via a pipeline to be placed upland at the airport. The inlet portion of the project would be dredged using a hopper dredge. The inlet material would be placed in the surf zone on Assateague Island.

4.7.5 Project Cost Estimate

The cost for the recommended plan is $1,672,200. The fully funded cost for the recommended plan is $1,776,800. Table 4-4 provides the total breakdown of costs for implementation of the harbor and inlet deepening alternative. The project will be implemented under Section 107 of the Continuing Authorities Program. In accordance with Section 101 of WRDA 86, Table 4-5 provides the non-Federal contribution during construction. Table 4-6 presents the non-Federal contribution over 30 years.

Table 4-4. Total Project Costs for Inlet Deepening to 16 feet and Harbor Deepening to 14 feet.

Construction Activity	First Costs	Fully Funded Cost
Lands and Damages	$38,600	$42,100
Mobilization & Demobilization	$455,100	$481,200
Dredging	$853,100	$8904,700
Engineering & Design	$66,000	$71,800
Construction Management	$110,000	$119,700
Disposal Area	$149,400	$157,300
TOTAL PROJECT COST	**$1,672,200**	**$1,776,800**

Table 4-5: Non-Federal Contribution during Construction.

Construction Activity	
a. Construction	
Mobilization & Demobilization	$45,500
Dredging	$85,300
Engineering & Design	$6,600
Construction Management	$11,000
Disposal Area	$15,000
b. Lands and Damages	$38,600
SUBTOTAL	**$202,000**

Table 4-6: Non-Federal Contribution Over 30 Years

a. Additional 10% of Construction less credit for LERRD	$124,800

SECTION 5

ENVIRONMENTAL RESTORATION

5.0 INTRODUCTION

This chapter focuses on the water resources problems of the coastal bays environment. Several problems which merit active environmental restoration actions were identified. This chapter discusses these problems, future conditions without any action, alternative plans to address these problems, and recommended solutions.

5.1 PROBLEM IDENTIFICATION

The reconnaissance study identified a number of environmental water resources problems that were carried into the feasibility study. An interagency meeting was held in February 1996 to reconsider the problems identified in reconnaissance and to identify additional problems. This list of problems was presented for consideration at a public meeting in May 1996 and the list was further defined and explored through coordination with resource agency representatives and academic scientists. The following environmental water resources problems were identified as important for consideration in this study:

1. Water quality in the St. Martins River, Newport Bay, Taylorsville Creek, Turville Creek, and Herring Creek is degraded by pollutants from surface water runoff and groundwater seepage.
2. Water quality in manmade canals and lagoons is degraded because of pollutant inputs and poor circulation.
3. More than ***700*** hectares (ha) (***1,750*** acres[ac]) of salt marsh in the coastal bays watershed have been destroyed for development. These losses have occurred primarily in the northern coastal bays.
4. More than 8,500 ha (21,000 ac) of forested wetlands in the coastal bays watershed have been drained for agriculture. An additional 1,600 ha (4,000 ac) have been destroyed for development. These losses have occurred primarily in the watersheds of the St. Martin River, Isle of Wight Bay, Manklin Creek, and Newport Bay.
5. Beach-nesting bird species have lost more than 80 percent of historical nesting habitat because of development on Fenwick Island and recreational use and dune construction on Assateague Island.
6. Waterbird colonies on dredged material islands in Sinepuxent and Chincoteague Bays are threatened by severe erosion.
7. Submerged aquatic vegetation is largely absent from the mainland shore of the coastal bays, presumably because of water quality problems.
8. Oyster beds in the coastal bays have been destroyed by disease and predators.

Given the list of problems, the study team established the following problem statement:

The Maryland coastal bays watershed has lost many thousands of acres of fish and wildlife habitat to agriculture, development, and erosion. Ecosystem functions that maintain environmental quality have also been lost.

5.2 GOALS AND OBJECTIVES

Based on the problems identified, the following goal and preliminary list of objectives were developed for this study:

Goal: *Restore fish and wildlife habitat and ecosystem functions in the coastal bay watershed.*

Preliminary List of Objectives

1. Improve water quality in polluted tidal tributaries.
2. Improve water quality in manmade dead-end canals.
3. Replace lost salt marsh habitat and ecosystem functions.
4. Replace lost forested wetland habitat and ecosystem functions.
5. Provide/maintain nesting habitat for colonial waterbirds.
6. Restore/create submerged aquatic vegetation beds.
7. Restore/create oyster beds.
8. Enhance fish habitat to compensate for lack of SAV and loss of oyster beds.

These preliminary objectives were screened for practicability and need with input from resource agency representatives. As an additional part of the screening process, these objectives were evaluated to determine whether they fit the Maryland Coastal Bays National Estuary Program criteria that were established to identify significant habitat losses. These criteria are:

1) The loss occurred and/or is occurring at a high rate.
2) The loss is substantially permanent or recovery will occur slowly.
3) The loss is likely to produce significant secondary effects.

Improving water quality in the tidal tributaries (Objective 1) and manmade canals and lagoons (Objective 2) was determined to be outside of the purview of the Corps environmental restoration mission. However, some improvement in water quality could be gained through restoration/creation of wetland habitat and functions (Objectives 3 and 5), which is a primary mission of the Corps. Water quality is being addressed comprehensively for the region through the National Estuaries Program.

Restoration/creation of salt marsh and forested wetlands (Objectives 3 and 4) was determined to be of critical importance since both of these habitats have been lost at a high rate, and these losses are essentially permanent unless restoration action is taken. In addition, loss of these ecosystems likely incurred substantial detrimental secondary environmental impacts to the watershed, such as decreased water quality, and when combined with wetlands losses throughout the Delmarva region, likely produced regional detrimental cumulative impacts.

Restoration/creation of colonial waterbird nesting habitat (Objective 5) was determined to be of importance since nesting habitat has been lost at a high rate, and these losses are essentially permanent unless restoration action is taken. It is unclear whether loss of colonial waterbird nesting habitat has caused detrimental secondary impacts to the ecosystem. However, loss of nesting habitat on a regional scale is substantial, and likely produced cumulative detrimental impacts to colonial waterbird populations. Furthermore, the Corps of Engineers is among the few Federal and state agencies which have the demonstrated capability to pursue this objective.

Restoration/creation of SAV beds (Objective 6) was not pursued as a primary objective for several reasons. SAV beds have been naturally increasing in area in the coastal bays (see Section 2.4.1); they have doubled in size over the last 10 years, and there is no reason to expect that this trend will not continue. Therefore, it is not clear that there is a need to actively restore SAV. In addition, SAV bed restoration/creation efforts have a limited success rate, and water quality conditions that cannot be controlled could induce failure of this initiative. However, in recognition of the importance of SAV to the aquatic ecosystem, it was determined that SAV bed restoration/creation would be incorporated as a subcomponent of restoration and creation of salt marsh and colonial waterbird nesting habitat (Objectives 3 and 5).

Restoration/creation of oyster beds (Objective 7) would, in the absence of limiting factors, readily qualify for active environmental restoration measures because nearly complete loss of historic coastal bay beds has occurred, it is likely that this loss produced substantial secondary effects to the aquatic ecosystem. Unfortunately, this objective was dropped from consideration because high salinity conditions support the presence of oyster diseases and parasites that would likely cause failure of restored/created beds. It is not expected that salinity conditions in the coastal bays will be reduced in the future; thus, the long-term outlook for oysters in the coastal bays looks bleak.

Enhancing fish habitat (Objective 8), by such means as creating artificial reefs, was dropped as a primary objective because of lack of perceived need. It was determined that fish habitat could effectively be enhanced through the restoration/creation of salt marsh and habitat islands for waterbirds (Objectives 3 and 5).

From this screening, it was determined that to meet the project goal of restoring fish and wildlife habitat and ecosystem functions in the coastal bay watershed the two following objectives should be the focus of study efforts:

Objectives:

1. Replace lost salt marsh and forested wetlands habitat and ecosystem functions.
2. Provide nesting habitat for colonial waterbirds.

5.3 FUTURE WITHOUT PROJECT PROBLEMS

5.3.1 Nesting Habitat for Beach-Nesting Colonial Waterbirds

No additional habitat on Fenwick Island is expected to become available since future land use is expected to remain consistent with current use. The natural process of inlet formation, migration, and closure that is primarily responsible for creating nesting habitat has been effectively stopped on Fenwick Island as a result of island stabilization. Small parcels of bare-substrate nesting habitat may be available sporadically on Fenwick Island as sites are disturbed for construction and other purposes, but these sites will be temporary, very limited in size, and will have minimal beneficial impacts to beach-nesting colonial waterbird populations.

Some new barren sand nesting habitat would continue to be created at a slow rate in the vicinity of the Route 50 bridge in the northern coastal bays, provided that sand management practices for Ocean City continue as per current conditions. However, the rate of creation of new habitat may only be equal to the rate of loss of this habitat on Skimmer Isle as natural vegetative succession occurs.

Barring a breach, it is expected that a balanced approach to the management of Assateague Island, providing for recreation and protection of natural resources, will be maintained. The overwash-prone zone at the north end of the island will continue to expand southward because of continued sediment starvation. If beach-nesting colonial waterbirds nest there, then additional area would be closed to public use by the Park Service to protect the waterbirds. However, the northernmost end of the island adjacent to the jetty is becoming increasingly stable and vegetation development would be expected there, effectively causing some loss of nesting habitat on the northernmost end of Assateague Island. And it is expected that dunes and recreation facilities within the state park will be maintained, and that bare-substrate nesting habitat will not become available within state lands. In the southern portion of Assateague Island National Seashore, dunes that were constructed prior to the 1970's are no longer being maintained (except in developed areas). This should increase potential nesting habitat for beach-nesting waterbirds as storms destroy the constructed dunes and destroy vegetation that developed in the lee of these dunes. Overall, it is expected that the area on Assateague Island available for nesting purposes for beach-nesting colonial waterbirds will remain constant or increase somewhat, barring a breach.

If the northern end of Assateague Island, which is considered most vulnerable to breaching, were to breach, then no additional bare-substrate nesting habitat would be created. The northern end of the island is already in a bare-substrate condition, and the narrowness of Sinepuxent Bay limits the potential for creation of additional barren sand islands on the bayside of northern Assateague. It is anticipated that a breach would be filled in shortly after its formation to protect mainland properties and maintain navigation through Sinepuxent Bay, as was done in the early 1960's.

If a breach in the southern portion of Assateague Island National Seashore were to occur, new barren sand island habitat would be created naturally on Assateague Island adjacent to the breach. Barren sand habitat would also be created on new flood-tidal shoal islands within Chincoteague Bay.

Nesting habitat for beach-nesting colonial waterbird species such as terns and skimmers will continue to remain in critically short supply. Continuing loss of nesting habitat to development and shoreline stabilization elsewhere along the U.S. coastline may cause further cumulative detrimental impacts to these bird species, and increases the relative importance and value of creating barren sand nesting habitat in the coastal bays watershed. These species will continue to be listed on the state rare species list.

5.3.2 Nesting Habitat for Vegetation-Nesting Colonial Waterbirds

It is expected that existing colony sites for egrets and herons, which are concentrated on islands within the coastal bays, will continue to erode, causing a gradual loss of nesting habitat. Some new habitat is expected to become available on Skimmer Isle as a result of natural vegetative succession. No other new nesting habitat is expected to become established on any other natural or created islands. Since these species have not established colonies on the mainland of the coastal bays in recent years, in spite of potentially available habitat, no new colonies are expected to become established on the mainland.

The coastal bays are thought to be the most important nesting area for colonial waterbirds in the state of Maryland, and any changes in nesting habitat availability that occur within the coastal bays take on a much greater significance as a consequence. Continuing regional loss of potential nesting habitat on the mainland to development and disturbance impacts, and interruption of the natural and human processes that form islands may cause further cumulative detrimental impacts to these bird species, and increases the relative importance and value of nesting habitat that remains in the coastal bays watershed. Since colonial waterbirds concentrate their reproductive energies in colonies at just a few locations, preserving the long-term viability of colony sites is of great importance to the survival of these species. If nothing is done to maintain island habitat for colonial waterbirds in the coastal bays, populations of a number of species may in the future decrease to the point where they become threatened or endangered.

5.3.3 Salt Marsh

Continued sea level rise is expected to result in the future loss of salt marsh in the northern coastal bays. Loss is predicted because suitable habitat on the mainland shoreline upon which these ecosystems would naturally migrate as sea level rises has been developed. Impacts of rising sea level are of less concern in Chincoteague Bay because much of the mainland is rural in character, and migration space is available.

If nothing is done to restore the more than ***600*** ha (***1,500*** ac) of salt marsh habitat lost in the northern coastal bays, then the northern coastal bays will continue to be impaired by the loss of the important functions and habitat formerly provided by these ecosystems. If nothing is done to compensate for continuing losses from sea level rise, then the quality and quantity of the habitat and functions that salt marshes currently provide will diminish even further.

5.3.4 Forested Wetlands

Even if no action is taken by the Corps of Engineers to restore forested wetlands, then forested wetlands acreage may increase somewhat. Voluntary wetlands restoration projects, which concentrate largely on providing wildlife habitat, are being conducted and will continue to be conducted by the Natural Resource Conservation Service and other resource agencies. At this time approximately 200 ha (500 ac) of ***forested*** wetlands are being restored/created within the coastal bays watershed under these programs. These programs don't target areas in which historic losses have occurred and where water quality is impaired. Available land within the northern coastal bays on which to restore historic forested wetlands will diminish in supply as population growth and development consume additional farmland. It is expected that small-scale drainage and loss of existing forested wetlands will continue under regulatory exemptions provided for forestry and agriculture, but large-scale losses will be minimized by existing Federal and state laws. Forested wetlands destroyed for development will be mitigated for by creation of new forested wetlands as required under Federal and state regulations.

The northern coastal bays ecosystem will continue to be impaired by the loss of the important functions formerly provided by the extensive forested wetlands that once existed there. A number of the functions performed by forested wetlands are critical to maintenance of environmental quality. Good environmental quality, in turn, is critical to maintaining the character of the area as a desirable tourist destination. Because some of the forested wetlands that occurred in the coastal bays watershed have the ability to store carbon in their soils, their loss may also contribute to global warming that may result from human-induced increasing levels of carbon dioxide in the atmosphere.

5.4 FORMULATION OF ALTERNATIVE PLANS

A number of alternatives were proposed to meet the two objectives. These included the following:

1. No action.
2. Restore or create shoreline salt marshes.
3. Create salt marsh on newly-built dredged material islands.
4. Restore or create forested wetlands.
5. Restore/maintain existing colonial waterbird nesting habitat by restoring/protecting islands that are eroding.
6. Create habitat for beach-nesting colonial waterbirds by building new barren substrate dredged material islands.

5.4.1 Environmental Restoration Prioritization

After determining that restoring or creating salt marsh, forested wetlands, and colonial waterbird nesting habitat should be the focus of this study, it was necessary to consider how much habitat of each type should be restored. This is identified as "restoration need" in Table 5-1, and is based on a consideration of losses of the habitat type. In addition, it was necessary to consider the relative scarcity and significance of these habitat types in the event that a situation arose in which prioritization of one habitat over another must be considered in selecting restoration projects.

Table 5-1: Restoration needs and relative significance and scarcity of habitats proposed for restoration efforts.

Objective	Restoration Need	Habitat Scarcity	Habitat Significance
Create bare-substrate islands for beach-nesting colonial waterbirds	10's to 100's of acres	Rare	Very Great
Maintain island habitat for vegetation-nesting colonial waterbirds	<10 acres	Uncommon	High
Restore/create salt marsh	100's to 1000's of acres	Common	High
Restore/create forested wetlands	100's to 1000's of acres	Common	High

5.4.2 Coastal Bays Environmental Restoration Site Selection Process

Once the acreage limits for the environmental restoration objectives were set and the significance and scarcity of habitat types prioritized, it was necessary to identify potential sites to pursue these efforts. Processes to select sites were developed specifically for each objective. Each site selection process was developed to meet habitat and function restoration needs, to minimize possible detrimental environmental and societal impacts, and to engender sponsor support.

Because of the potential trade-offs that can result when an existing habitat is restored or converted to another habitat type, it was considered generally desirable to first look for restoration sites for salt marsh, forested wetlands, and colonial waterbird nesting habitat. Once restoration opportunities were given full consideration, creation sites were considered.

An important practical consideration in locating potential sites was land ownership. Potential restoration sites were sought in coordination with Federal and state resource agencies, local environmental consultants, and local government personnel, as well as by reviewing maps and other existing information. Site-location efforts focused on publicly-owned land and land owned by interested conservation organizations, although privately-owned property was also considered. A summary of coordination efforts undertaken to locate potential wetland restoration/creation sites is included in Annex A, Part 7. Because of land ownership patterns in the watershed, it was recognized that publicly owned land suitable for salt marsh and forested wetland restoration was limited. For Corps environmental restoration projects, privately-owned land must be acquired by a local government in-fee. In order to determine how to approach private landowners, discussions were held with representatives of the Maryland Department of Natural Resources (MD DNR), Natural Resources Conservation Service (NRCS), and the Corps of Engineers, Regulatory Branch. These agency representatives unanimously recommended that the financial resources available for purchase of land for restoration purposes should be determined prior to inquiring as to whether a landowner was interested in participating in environmental restoration. This opinion was based on experience with ongoing restoration programs in which landowners typically want to know in advance that the restoration project will be funded, prior to the private property owner becoming involved in a program. Since in the context of this study it would not be possible to determine until the study was completed how much money was available to purchase land, nor how many acres would be purchased, nor which projects would be approved and funded, no effort was made to solicit sites on private land. However, contacts at other resource agencies knew of private land that might be available even with the limitations inherent to this study, and brought this to the attention of the study team. All candidate sites identified were considered and are listed in the following tables.

When creating island habitat, it was necessary to determine potential sites of borrow material. Currently, there is an intense local concern over loss of navigable waters in the coastal bays. Therefore it was determined that for island habitat creation, some materials may be used from privately dredged sources. This could improve navigation and increase local sponsorship for the project.

5.4.2.a Salt Marsh Restoration/Creation Site Selection Process. It was determined that salt marsh restoration efforts should focus on the area of the coastal bays where these losses occurred (see Annex A, Part 5). Salt marsh losses to development are concentrated within the northern coastal bays; only a minor proportion of the losses to development have occurred in the southern bays. In the context of this study, salt marsh restoration/creation is not needed within the southern coastal bays since these bays are largely surrounded by salt marsh where natural conditions permit, and minimal shoreline development has occurred. Therefore, efforts to locate restoration sites focused on the northern bays and their tidal tributaries. Several reconnaissance trips to locate and examine potential sites were conducted. Unfortunately, restoration opportunities were extremely limited because salt marshes that were destroyed generally have been developed. Privately-owned potential salt marsh restoration sites are typically small tracts of land within shoreline developments. Only four potential sites were identified, as shown in Table 5-2.

Of these potential restoration sites, only Ocean Pines Parcel 17 and Isle of Wight Wildlife Management Area were considered practical for further consideration. Wood Duck Park and the St. Martins River Islands were rejected because of site-specific drawbacks listed in Table 5-2.

5.4.2.b Salt Marsh Creation Site Selection Process. Because few candidate restoration sites were identified, sites where salt marsh could be created were then sought and considered. The process to identify salt marsh creation sites in the northern coastal bays considered avoidance of detrimental environmental and societal impacts, as well as availability of dredged material for marsh creation. Tables 5-3 and 5-4 present factors considered in determining areas where salt marsh habitat should not be created. For each factor, an information layer was created in the Geographic Information System (GIS). All the layers were then displayed simultaneously. This overlay analysis served to indicate regions where salt marsh creation was and was not potentially feasible.

Table 5-2: Potential salt marsh restoration sites considered.

Site	Potential Size hectares (acres)	Attributes	Drawbacks
Ocean Pines Parcel 17	3.4 (8.5)	Restoration simple: ~0.6 m (2 ft) of fill (dredged material) will need to be excavated, then site planted. No competing use for site possible because of its location within jurisdictional wetlands delineation.	Private ownership. Site will need to be purchased or donated.
Ocean Pines Wood Duck Park	0.8 (2)	Restoration simple: ~0.6 m (2 ft) of fill (dredged material) will need to be excavated, then site planted.	Private ownership. Competing use: site is lawn and actively used as open space park by local residents.
Isle of Wight W.M.A.	4.4 (11)	Public ownership, MD DNR interested in restoring marsh and improving site.	Fill several feet thick will need to be excavated. Fill consists of construction debris and dredged material.
St. Martins River Islands	0.4 (1)	Salt marsh still exists at site.	Private ownership. Small size - effectively "island creation". [Site doesn't pass salt marsh creation site-screening criteria; see 5.4.2.b for criteria.]

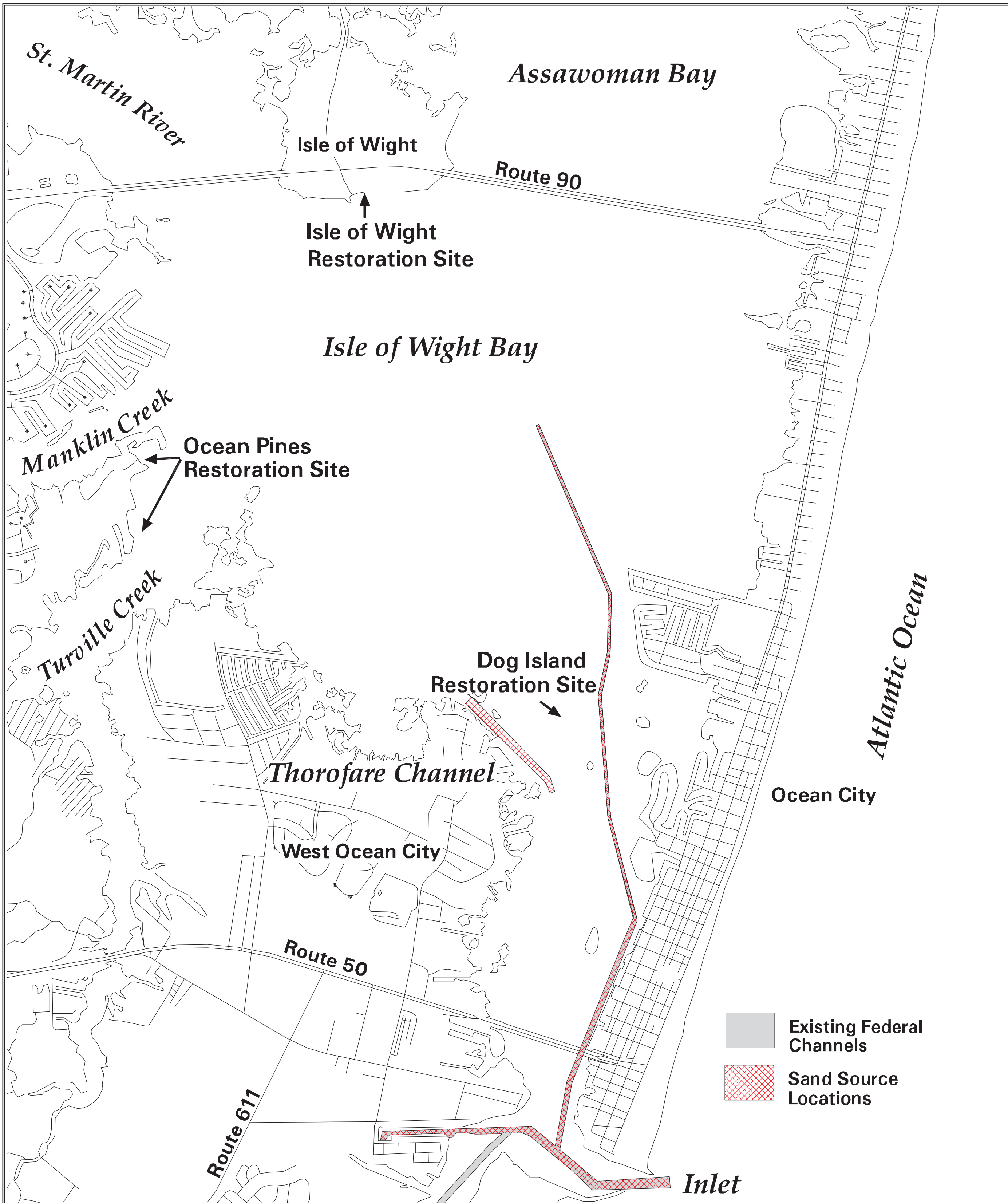
Table 5-3: Environmental constraints for selection of *habitat creation* sites.

Potential Environmental Constraints	Potential Measures to Avoid and/or Minimize Impacts and/or Consider Constraint	Information Sources/ Comments
BIOLOGICAL RESOURCES		
Finfish	Avoid prime commercial and recreational fishing areas.	Coordination with MD DNR
	Avoid detrimental impacts to ecologically important habitat: SAV beds, marsh edges, active oyster beds, and historic oyster beds (in west Assawoman and Chincoteague Bays).	SAV maps (VIMS), Maryland Natural Oyster Bed Map, NWI maps, site visits
Shellfish	Avoid active oyster beds.	No extant beds identified. Determined to not be a constraint
	Avoid prime commercial and recreational shellfish grounds.	Coordination with MD DNR
	Avoid areas of high ecological significance.	None located independent of prime commercial and recreational finfish and shellfish sites
Submerged aquatic vegetation (SAV) beds	Avoid existing beds.	SAV maps (VIMS), site visits
	Avoid likely SAV recovery areas: waters less than 1 m deep on bayside of Assateague and central and northern Fenwick.	Bathymetric data, SAV maps (VIMS), coordination with VIMS
Wetlands (emergent)	Avoid detrimental impacts to existing emergent wetlands.	NWI Maps, site surveys
PHYSICAL ENVIRONMENT		
Natural shorelines	Avoid stabilization of existing natural shorelines.	Site surveys and aerial photos.
Vulnerability to destruction if Assateague Island breached	Avoid areas behind northern Assateague Island with high breach potential.	CERC research included in Appendices of Assateague Report
Water quality impacts	Avoid placing islands in areas of poor water quality where island could reduce circulation.	MDE and EMAP Reports

Table 5-4: Societal constraints for selection of *habitat creation* sites.

Potential Constraints	Potential Measures to Avoid and/or Minimize Impacts and/or Consider Constraint	Information Sources/ Comments
Airport and flyway	Avoid placement in a 1- mile radius from the airport boundary to minimize bird-airplane strike hazard	Ocean City Airport, FAA
Assateague Island National Seashore	Avoid areas within the National Seashore boundary	National Park Service
Material availability for creating habitat substrate	Identified region between the Ocean City Inlet and Route 90 as area with greatest potential as source of dredged material	MD DNR, USACE Operations, Local Government, Private Dredgers
Navigation channels	Avoid navigation channels and a 50 foot buffer around the channels	USACE Operations
Utility lines	Avoid utility line areas and a 500 foot buffer around the area	U.S. National Ocean Service Charts
Water recreation areas	Avoid navigable waters greater than 3 feet deep, avoid jet ski use areas	MD DNR, Baywatch

Coordination with resource agencies and private organizations served to identify preferred potential sites within the acceptable region in the northern coastal bays identified through the GIS analysis (see Annex A, Part 7 for records of correspondence). Two potential sites for salt marsh creation were selected: a site south of Isle of Wight (Figure 5-1); and another in Dog Island Shoals (Figure 5-1).



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Restoration Sites: Dog Island, Isle of Wight, and Ocean Pines

Date: 12-SEP-1997
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Figure 5-1

5.4.2.c Colonial Waterbird Colony Island Restoration Site Selection Process. Potential candidate islands for restoration were natural and dredged material islands that support or once supported significant populations of colonial waterbirds. The habitat value of these candidate islands is at risk either because of erosion or natural vegetative succession. Unfortunately, many other islands that formerly provided significant nesting habitat for colonial waterbirds have been lost to erosion. Candidate islands were identified through consultation with the MD DNR and National Biological Service (Table 5-5).

Table 5-5: Sites considered for island restoration.

Island Name and Location	Significance as Nesting Habitat to Waterbirds in Current Condition	Site Concerns/ Potential Reason(s) for Rejection
South Point Spoils in Chincoteague Bay	Very High, possesses substantial numbers of nesting Double-crested Cormorant, herons, egrets, Glossy Ibis, and Herring Gull. Brown Pelican roost on island in large numbers, and until recently site was northernmost colony of Brown Pelican.	Island is eroding. Restoring island would directly impact SAV.
Heron Island in Isle of Wight Bay	Moderate, possesses egrets, herons, and Glossy Ibis.	Island is eroding. Site vulnerable to predation and disturbance because of close proximity to Fenwick Island.
Bridge Island in Sinepuxent Bay	Low, only Herring Gull nest on site, and island is very small (<0.2 ha (0.5 ac)).	Island is eroding. Small size and low existing value, restoring island would directly impact SAV.
Skimmer Isle in Isle of Wight Bay	Very High, provides nesting habitat for substantial number of beach-nesting colonial waterbirds.	Island is undergoing natural vegetative succession and coastal plant communities are developing. Would require destruction of native plants.
Spoil Buoy 11 in Sinepuxent Bay	None, site is now just an intertidal shoal.	Island has eroded to the point where it is mostly a shoal; to restore this site would effectively be "island creation." Site fails to pass several island creation screening criteria: proximity to navigation channel; vulnerable to breach impact; and high use for clamming.

Bridge Island, Heron Island, Skimmer Isle, and Spoil Buoy 11 were rejected because of reasons listed in the appropriate rows of Table 5-5. South Point Spoils could perhaps be rejected from consideration because of the presence of SAV; however, because the site is a well-established colony supporting substantial numbers of vegetation-nesting colonial waterbirds, the site has very high significance. In addition, until recently the island possessed the northernmost colony of Brown Pelicans. Given this consideration, it was considered important to retain South Point Spoils as an alternative.

5.4.2.d Colonial Waterbird Habitat Island Creation Site Selection Process. Because there were so few islands that could be restored, sites for creation of new nesting habitat islands for bare-substrate nesting waterbirds were sought. The site selection process included consideration of bird habitat needs, availability of dredged material, and avoidance of detrimental environmental and societal impacts as shown in Tables 5-5 and 5-6.

Within the large region determined to be potentially suitable, coordination with resource agencies and local interests served to identify one preferred site for habitat island creation: Dog Island Shoals (Figure 5-1). This specific site was selected within the potential region because it appears to pose minimal risk of detrimental environmental impacts, will not usurp recreational boating space, and is within the area identified as a likely source of dredged material for island construction. Coordination is included in Annex A, Part 7.

5.4.2.e Forested Wetlands Restoration Site Selection Process. It was decided that forested wetlands restoration/creation efforts should focus on subwatersheds of the coastal bays watershed where these losses have occurred. An analysis of potential forested wetlands losses in the coastal bays watershed was conducted to determine where these losses have occurred since the early 20th century, and provide guidance on where restoration should take place. This analysis is contained in Annex A, Part 5. Subwatersheds in which the greatest potential loss of forested wetlands have occurred are listed in Table 5-7. Forested wetland losses have occurred primarily on interstream divide and depression landscape positions; relatively minimal loss has occurred along stream systems. Interstream divide landscape positions include the broad flat areas between streams as well as depressions that occur within these flat areas that aren't connected to stream systems. For meeting the objective of restoring lost habitat, forested wetlands should be restored/created within the subwatersheds in these landscape positions where losses have occurred.

It was also desired that forested wetland restoration/creation should improve water quality problems, particularly those caused by pollutants in groundwater and surface water runoff that exist in several of the tidal tributaries of the coastal bays. The objectives of restoring both habitat and improving water quality could potentially be compatible, particularly with regard to nitrogen nutrient-loading. Boynton and others (1993) provide a priority ranking for subwatershed nutrient-loading management efforts based on total nutrient loading contributed by nitrogen and phosphorus. The subwatersheds identified as priorities for nutrient-loading management are nearly identical to the subwatersheds identified in this study as possessing the greatest potential losses of forested wetlands as illustrated in Table 5-7.

Table 5-6: Beach-nesting waterbird habitat needs considered to determine optimal location of *created islands*.

Nesting Habitat Needs	Considerations to Meet Needs
Create islands in areas where natural processes will not be likely to do so.	Natural island creation is most likely to occur in conjunction with a breach on Assateague Island, or on northern flood-tidal shoal in vicinity of existing Skimmer Isle if Ocean City beach nourishment continues and no long-term sand management project is implemented. The northern end of Assateague is breach-prone; however, the narrowness of Sinepuxent Bay and likely breach repair by man will probably prevent natural island creation in this area. Breach of Fenwick Island is considered unlikely because of shoreline protection project and extensive developments. Expected long-term restoration of Assateague and regional sand management may cause reduction of sediment input to coastal bays, and may induce loss of flood-tidal shoal islands in vicinity of Route 50, rather than creation of new islands. Thus, need to create islands is greatest in northern bays and least in lower Sinepuxent and Chincoteague Bays.
Minimize vulnerability to human disturbance.	Because of demonstrated success of Skimmer Isle in high human use area, location is being determined by other factors. Measures to minimize vulnerability will instead include other protective measures such as posted signs, patrols, and education.
Optimize proximity to food source.	Identify potential foraging areas for target species and place created islands within suitable distance. Common Terns prefer to forage near the inlet. Therefore, it was decided that island should optimally be within 8 km (5 miles) of inlet.
Restrict predator access.	(1) Place new island a minimum distance of 500 m (1,640 ft) from the shoreline to reduce the likelihood of predators reaching the island; (2) Island size should be smaller than 10.1 ha (25 ac) so as not to provide permanent habitat for predators.
Water quality.	Unclear about the water quality requirement for the target species but decided to stay in areas of good water quality.

Table 5-7: Subwatersheds with greatest potential loss of forested wetlands and priority subwatersheds for management of pollutant loads[1].

Subwatershed	Total Potential Loss of Forested Wetlands ha (ac)	% Loss of Potential Forested Wetlands	Groundwater (Nutrients)	Surface Runoff (Nutrients and Total Suspended Solids)
St. Martin River - South	1990 (4910)	53	St. Martins River South	St. Martins River South
St. Martin River - North	1520 (3760)	60	St. Martins River North	St. Martins River North
Turville Creek/Isle of Wight	920 (2270)	41	Newport Bay (Out Pt. to Wallops Neck)	Newport Bay (Out Pt. to Wallops Neck)
Ayers Is. to Golden Quarter Neck - West	750 (1850)	58	Turville Creek/Isle of Wight	Turville Creek/Isle of Wight
Virginia	690 (1700)	40	Ayers Island to Golden Quarter Neck West	Assawoman Bay

Within these subwatersheds, identified both as areas that have suffered substantial loss of forested wetlands and as priority areas for water quality management, it is then necessary to determine where forested wetlands should be restored or created. At this time no studies have yet attempted to identify which areas of the coastal bays landscape (e.g., uplands, wetlands, shallow water areas) are most critical to maintenance of water quality (lack of this identified by Boynton and others, [1993]). As noted previously, from a habitat restoration perspective, efforts should focus on restoring forested wetlands that historically occurred in interstream flat and depression landscape positions, since relatively minor losses have occurred along floodplains. However, if water quality improvements are to be obtained, then consideration of surface and ground water flow is required and forested wetlands restoration or creation sites should instead be sought down-gradient of nonpoint nutrient-loading sources. This suggests that water quality improvements could best be obtained by siting created forested wetlands along drainage ditches, the margins of the bays, floodplains, and perhaps interstream depressions. Since the sites most suited to create forested wetlands to restore water quality are generally not on the interstream

[1] The table presents potential losses of forested wetlands ranked by total acres rather than proportional loss, since certain watersheds historically supported minimal amounts of forested wetlands, and the loss of small areas is presumed to have had less relative impact on the water quality of the coastal bays ecosystem than larger acreage losses.

flats where losses have been concentrated, it is possible in only a limited portion of the coastal bays watershed to restore/create forested wetlands to improve water quality in areas of historic habitat loss.

Restoration sites in the target subwatersheds were sought in coordination with Federal and state resource agencies, local environmental consultants, local government personnel, private conservation organizations, and land trusts, as well as through reviewing maps and other existing information (see Annex A, Part 7). Several reconnaissance trips to locate and examine potential sites were conducted. Unfortunately, restoration opportunities on public land within the target subwatersheds were non-existent, although an abundance of potential sites occur on private property. Therefore, work to restore forested wetlands habitat and functions would need to take place on private land. Potential forested wetland restoration sites on private land are typically in agriculture. Resource agency contacts with the NRCS indicated that purchase of properties for the purpose of restoring forested wetlands within the target subwatersheds is feasible. However, acquiring land within the constraints of the Ocean City Water Resources Study schedule and Corps of Engineers policies is problematic, as discussed previously in Section 5.4.2. Because of these constraints, it was determined that this forested wetlands restoration could not be effectively pursued within the Ocean City Water Resources Study. Instead, it is hoped that this initial work which identified areas of losses by subwatershed and landscape position can provide a framework for forested wetlands restoration/creation efforts that might be undertaken by another agency, perhaps as part of the ongoing National Estuary Program Study being conducted by the Environmental Protection Agency. Collaborative work on projects underway as mitigation measures to meet permit requirements with MD DNR or the Corps of Engineers, Regulatory Branch was also considered, but no suitable sites were identified.

During efforts to locate restoration sites a number of significant natural areas worthy of consideration for protection or restoration by other agencies were identified. A list of these sites is included in Annex A, Part 4.

5.4.3 Habitat Restoration Guidelines

General guidelines for creation/restoration of salt marsh and colonial waterbird nesting habitat were established in consultation with scientists, resource agency representatives, and through a review of existing literature. Sites selected for salt marsh creation/restoration were Ocean Pines, Isle of Wight, and Dog Island Shoals. Sites selected for colonial waterbird habitat creation/restoration were Dog Island Shoals and South Point Spoils. A comprehensive list of species expected to utilize each habitat type can be found in Annex A, Part 4.

<u>5.4.3.a Salt Marsh Restoration/Creation Habitat Project Guidelines</u>. The salt marsh should be designed to enhance and maintain the value of the coastal bays as a nursery area for juvenile fish species and blue crab, as well as to provide support for the estuarine food web. The projects

should also be designed to enhance existing open water habitat in the vicinity of the created or restored marsh to the degree possible. Table 5-8 presents guidance developed to aid in site-specific design.

Table 5-8: Salt marsh restoration/creation guidelines.

Factor	Guidance	Rationale
Size	>0.4 ha (1 ac)	If not in close proximity to existing marsh, created/restored marshes smaller than this size probably provide habitat of lesser value for fish and wildlife.
Configuration	Maximize shallow water ecotone on non- or soft-stabilized shoreline while maintaining a minimum width of 15 m (50 feet).	Edge habitat is recognized to be of high value for aquatic life. Minimum width is required to ensure that refuge habitat within marsh for aquatic life is available even at high tides, and to provide effective cover for wildlife.
	Maximize created/preserved quiescent shallow water habitat.	Protected shallow water habitat provides refuge habitat for juvenile fish and crabs to escape predators, and can harbor or promote SAV.
Elevation	Maximize low marsh (elevation MW to MHW).	Low marsh provides habitat that can be utilized by aquatic life during a large portion of the tidal cycle. High marsh is less frequently accessible to aquatic life. It is assumed that the restored low marsh will also produce and export organic matter to support the estuarine food web in greater quantity than would an equal area of high marsh.
Tidal creeks	Create if practicable	Practicable in graded-down upland sites; impracticable in placed dredged material where slumping is a problem.
Shoreline stabilization	Stabilization structures required if fetch is greater than 1.6 km (1 mile).	In sites with high wave energy, project will be vulnerable to erosion, and created salt marsh habitat will be lost if erosion protection is not provided.

5.4.3.b Colonial Waterbird Nesting Habitat Restoration/Creation Design Guidelines. Colonial waterbird nesting habitat should be designed to optimize conditions that allow successful reproduction of these species. Tables 5-9 and 5-10 present guidance developed by natural resource management agency technical experts to aid in project selection and aid site-specific design for beach-nesting and vegetation-nesting colonial waterbirds, respectively. Note that in the case of total island size recommended for beach-nesting species, this guidance departs substantially from the "restoration needs" identified in Table 5-1.

Table 5-9: Design guidelines for created islands for beach-nesting colonial waterbirds (at Dog Island Shoals).

Factor	***Design Guidelines***	***Rationale***
Configuration	Single island (multiple islands acceptable if closer than 250 m (820 ft)).	Single island will provide greatest acreage for least perimeter stabilization cost.
Shape	Kidney-bean (horseshoe, or with multiple arms also acceptable).	Kidney-bean shape is cost-effective means of creating stable island with minimal perimeter while providing protected cove areas. Cove area is desired to enhance value of island to aquatic habitat. Cove shoreline will be planted with salt marsh, and SAV can be established in protected shallow water. These conditions will provide foraging areas for young birds and enhance aquatic habitat for finfish and shellfish. Cove shorelines will not require structural stabilization and will ensure that island possesses natural shoreline areas with gentle slope for access to water for birds.
Size	0.4 to 1.2 ha (1 to 3 ac) optimal.	The island will need to be actively managed to preclude vegetation development, and large islands are difficult to manage. If vegetation development is not successfully managed, the bare-substrate nesting habitat will be lost, and the project would be unsuccessful. Smaller islands are more amenable to long-term vegetative management than larger islands. 1.2 ha (3 ac) is considered to be the maximum size that might be effectively managed, given personnel and financial constraints. Nesting habitat is in dire shortage locally, and minimum size of 0.4 ha (1 ac) is probably acceptable. If vegetation was completely controlled, 2.0 to 10.1 ha (5 to 25 ac) would be optimum size to both provide space necessary for social interaction among members of bird colony, act as magnet to attract more species of birds, and limit ability of island to support predators.
Substrate	Coarse crushed shell or gravel at surface. Dredged material may be used to construct island but must be capped with a layer of coarser materials.	Will maintain xeric conditions which restrict plant growth to mimic barren substrate conditions of natural beach nesting habitat. Waterbirds scrape out nests in substrate, thus compromise is required between extremely coarse materials which would create optimally xeric conditions, but would prevent birds from forming nests, and sand which would allow ready nest creation, but would also favor rapid vegetative growth.

Table 5-9 (Concluded): Design guidelines for created islands for beach-nesting colonial waterbirds (at Dog Island Shoals).

Factor	*Design Guidelines*	*Rationale*
Vegetation	Interior of island devoid of vegetation. Plant salt marsh within cove area shoreline and on exposed shoreline where fetch is less than 1 mile. Plant SAV within shallow waters of coves.	Will mimic barren substrate conditions of natural beach nesting habitat. Long-term management objective is to maintain island in unvegetated condition. Use of coarse substrate will minimize vegetation establishment. Salt marsh will provide foraging area for young birds and enhance aquatic habitat. SAV will enhance aquatic habitat.
Topography	Gentle slopes with no greater than 1 m rise per 30 linear m. Exposed shorelines will require stabilization structure. Gentle slope along stabilized shoreline will be created through overfill on exterior of structure. Slope on cove perimeter will be very gentle. Access travel lanes over or through any dikes should be provided. Microtopographic features (e.g., ridges or lumps) with maximum relief of 1/2 to 1 m are desirable.	Flats and gently sloped areas will provide preferred nesting conditions and allow birds easy access by walking to all parts of island, except for the shoreline along the stabilization structures. Even if steep shorelines exist along stabilization structures this is not expected to be detrimental to colonial waterbirds. Microtopographic features will increase diversity of surfaces available for nesting and increase the number of species that will nest on the island. Gently sloped access to water in cove will provide foraging habitat for young birds.
Elevation	Island emergent during high water. Generally optimal elevation range is from 30 cm to 1 m above MHW.	Island elevation should be sufficient to prevent flooding of colony during storm events. High elevations may expose island to wind erosion, but coarse substrate materials will minimize this risk. Higher elevations are desirable to slow rate of vegetative succession and minimize long-term vegetative development.
Shoreline Stabilization	Stabilize shorelines of island where fetch is greater than 1.6 km (1 mile) with geotextile tube. Shorelines in protected coves or where fetch is less than 1.6 km (1 mile) will be unstabilized beach or will be stabilized with salt marsh vegetation.	Stabilization is necessary to ensure long-term survival of site, and to minimize concerns of off-site transport of island material by erosion into navigation channels and navigable waters. Geotextile tubes pose less risk of injury to young birds than rock, rock is particularly inappropriate for dividing cells internal to the island perimeter. Shoreline in protected cove will allow easy ingress/egress between island and water for wildlife.

Table 5-10: Design guidelines for created vegetated bird habitat islands (at South Point Spoils).

Factor	*Design Guidelines*	*Rationale*
Substrate	Fine to coarse grained dredged material or other materials may be used to construct island but must be capped with a layer of sediment or soil suitable for vegetation establishment.	Will provide conditions which promote plant growth to establish woody vegetation (shrubs and trees).
Vegetation	Plant high tide bush (*Baccharis halimifolia*), marsh elder (*Iva frutescens*), and bayberry (*Myrica pennsylvanica*) on island margin. Plant winged sumac (*Rhus copallina*), black cherry (*Prunus serotina*), and eastern red cedar (*Juniperus virginiana*) in interior. Plant salt marsh in cove and SAV within shallow protected waters <0.9 m (3 ft) deep.	Will establish desired vegetated conditions of natural nesting habitat. Long-term management objective is to maintain island in vegetated condition. Salt marsh and SAV will enhance aquatic habitat and mitigate for loss of potential SAV habitat.
Shape of additional island	Kidney-bean (other more complex shapes acceptable).	Kidney-bean shape is cost effective means of providing island habitat and protected cove area. This shape will provide foraging areas for young birds and enhance aquatic habitat for finfish and shellfish. SAV can be readily established in protected shallow water. (If necessary to minimize risk to SAV beds and navigation channels island shapes other than kidney-bean can be utilized.)
Topography	Gentle slopes with no greater than 1 m rise per 30 linear m. Overfill on exterior of shoreline stabilization structures to create gentler slope where wave erosion will allow overfill to remain in place. Create very gentle slope on cove perimeter. Microtopographic features (e.g., ridges or lumps) with maximum relief of 1/2 to 1 m are desirable. Provide pedestrian bird access travel lanes over or through any dikes if island is constructed in more than one phase and dikes are required.	Flats and gently sloped areas will provide preferred nesting conditions and allow birds easy access by walking to all parts of island, except for the shoreline along the stabilization structures. Even if steep geotextile tube shorelines exist along stabilization structures this is not expected to be detrimental to colonial waterbirds. Microtopographic features will increase diversity of surfaces available for nesting and increase the number of species that will nest on the island. Gentle slope in cove and overfill areas will provide pedestrian access to water for birds.
Elevation	Island emergent during high water. Generally optimal elevation range is from 1 m to 3 m above MHW.	Island elevation should be sufficient to prevent flooding of colony during storm events. If the elevation is too high it may expose island to wind erosion and impair desired vegetation development.
Shoreline Stabilization	Stabilize shoreline with geotextile tube where fetch is greater than 1.6 km (1 mile). Shorelines in protected cove or where fetch is less than 1.6 km (1 mile) can be unstabilized beach or will be stabilized with salt marsh vegetation.	Stabilization is necessary to ensure long-term survival of site, and to minimize concerns of off-site transport of island material by erosion into surrounding aquatic habitat, navigation channels, and navigable waters. Geotextile tubes are preferable to rock since young birds can fall into crevices between rocks and perish.

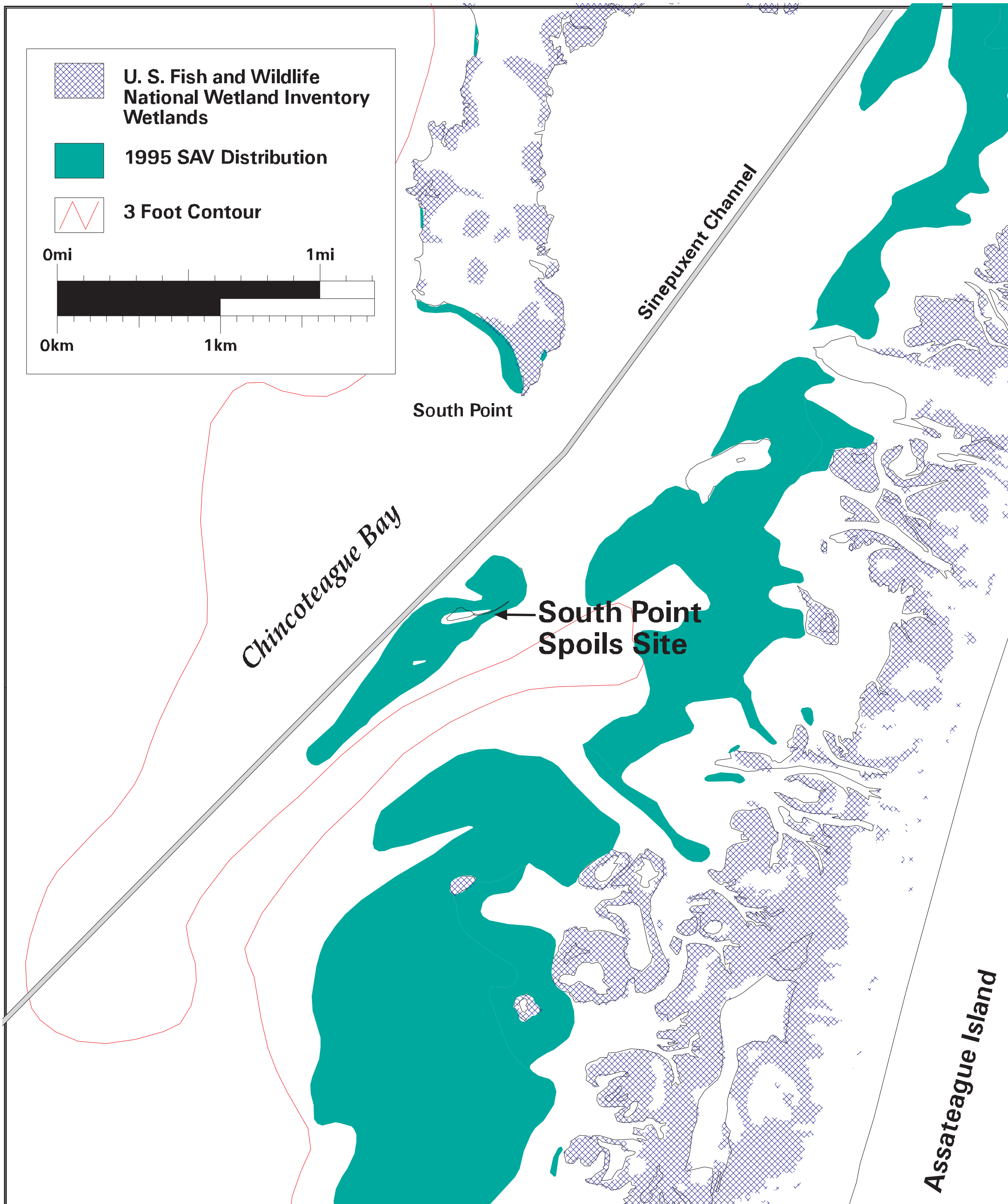
5.5 FORMULATION OF ALTERNATIVE PLANS FOR EACH SITE

For each identified potential project site a number of alternative plans were developed utilizing the habitat guidelines, and site-specific engineering, environmental, and societal constraints. The following discussion provides background information that focused and constrained alternative projects proposed for each identified site.

5.5.1 South Point Spoils: Formulation of Potential Alternative Plans

Given the presence of the significant SAV bed surrounding the existing 0.9 ha (2.3 acre) island and bird colony, it was determined that restoration alternatives, such as stabilizing or enlarging the island, should seek to minimize impacts to SAV (Figure 5-2). Restoring the existing island to a size up to its historic 2 ha (5-ac) size by enlarging it (and destroying SAV) did not present an acceptable resource trade-off if there was another practicable alternative that could provide equivalent benefits to colonial waterbirds. In consultation with colonial waterbird experts, it was determined that the interacting group of breeding birds that constitute a colony need not occur on one single physical island. Given that birds will readily fly short distances between islands, it was determined that islands within 250 m (820 ft) could be considered to be interconnected from a bird perspective, and could be considered to provide almost the same benefit as a contiguous land mass of equivalent size. This consideration served to shift the emphasis in formulating alternatives from restoring the existing island to restoring the colony. Restoration of the colony could be accomplished by increasing the total acreage of island habitat available within a 250 m (820 ft) radius, whether on one or several islands.

The existing island is considered to be of very high value to colonial waterbirds, and it was recognized in the formulation of alternatives that there would be a significant lag-time between the creation of any new vegetated island and its full performance as a functioning nesting island site. Several stabilization options for the existing island were considered. These are presented in Table 5-11. Based on the results of the analysis within Table 5-11 and coordination with agencies and technical experts, it was decided that stabilizing the remaining island at its 1997 shoreline was the most favorable alternative. This configuration would incur minimal displacement of SAV since SAV is generally absent in water depths less than 0.15 m (0.5 feet), however, it is expected that SAV disturbance will occur during construction. SAV Surveys of the site are contained in Annex A, Part 4.



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Location Map South Point Spoils

Date: 15-AUG-1997
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Figure 5-2

Table 5-11: Alternatives considered for the stabilization of the existing island at South Point Spoils

Alternative	SAV Impacts	Colonial Waterbird Impacts	Results of Evaluation
No action	SAV impacts avoided	Loss of nesting habitat for colonial waterbirds	Rejected
Stabilize only the most vulnerable sections of existing island	SAV disturbance during construction. Recovery period following construction could be several years.	Island is potentially vulnerable to erosion from all directions; island size is suboptimum for colonial waterbirds and could continue to decrease even after project construction. Island size would continue to decrease prior to project implementation.	Rejected
Stabilize entire perimeter of existing island that is vulnerable to erosion	SAV disturbance during construction. Recovery period following construction could be several years.	Island size is suboptimum for colonial waterbirds, and island size will continue to decrease until project is implemented, however would maintain habitat value as it exists at time of project implementation several years from now.	Rejected
Restore island to 1997 shoreline and stabilize entire perimeter that is vulnerable to erosion	Loss of SAV beds that develop on eroded island footprint in water depths greater than 0.15 m (0.5 feet) between 1997 and time of project implementation. SAV disturbance during construction. Recovery period following construction could be several years.	Island size is suboptimum for colonial waterbirds; however, preserving existing 1997 island would maintain existing habitat value, which is significant.	Accepted

The optimum island size for many species of colonial waterbirds is between 2.0 and 10.1 ha (5 and 25 ac). However, it was determined that because of the potential risk to the existing SAV, and because of loss of potential SAV recovery habitat, a new island constructed in close proximity to the existing island, but outside of the SAV beds, should be no larger than the minimum necessary to bring the total colony size up to 2.0 ha (5 ac). Therefore, alternatives that provided for the construction of up to 1.2 ha (3 ac) of new island(s) within 250 m (820 ft) of the existing island were considered. Shallow water outside of the mapped SAV beds occurs both to the southeast and northwest of the existing island. The waters to the southeast of the existing island lie within the Assateague National Seashore Boundary. Creating a new island to the southeast of the existing island would require greater disturbance to existing SAV than if a new island was constructed between the existing island and the Sinepuxent Channel. Therefore, island creation was considered as an alternative only to the northwest of the existing island. Although this location would place a new island in close proximity to the navigation channel, relatively few boaters use the channel, and potential disturbance from boaters was determined to be manageable by the MD DNR. The location of the new island - close to the existing island, outside of the mapped SAV beds, and between the navigation channel and the existing island - would provide easy access between the islands for birds, minimize impacts to SAV, facilitate placement of material dredged from the channel, and protect the existing island from waves from the west/northwest. Records of meetings and coordination that were critical in formulating alternative plans for this site are included in Annex A, Part 7.

Of critical importance in planning the restoration of the colony is the source of material to be used. Two basic alternatives existed: material could be dredged from a nearby source; or material could be imported by barge at far greater expense from another source. Because of a need to minimize disturbance to aquatic habitat, it was decided that the only acceptable nearby source of material was the Sinepuxent Federal Channel. A hydrographic survey of the channel was completed in February 1997 to determine potential volumes of material available (for more details, see Appendix A5). The survey indicated that if the entire channel were to be maintenance-dredged to its authorized depths, then approximately 83,400 m^3 (109,000 yd^3) of material would need to be removed. Of this total volume, 72,100 m^3 (94,200 yd^3) was within the reach of the channel between the northern end of South Point Spoils and the terminus of the channel in Chincoteague Bay. Thus, it was proposed to consider dredging a portion of the Sinepuxent Channel to obtain the volume of material necessary to construct up to 1.2 ha (3-ac) of additional island nesting habitat within 250 m (820 ft) of the existing island.

Comparative benefits of shoreline stabilization using rock, geotextile tube, and bulkhead for the existing and created island were then considered. Bulkheading the shoreline was rejected because of a lack of environmental benefits and possible detrimental impacts to the aquatic ecosystem that could occur because of scouring adjacent to the structure. Rock is generally believed to provide the greatest aquatic habitat benefits of these three methods; however, rock is substantially more expensive than geotextile tube. Aquatic environment benefits of rock are greater where water depths are greater. Intertidal waters around the existing island would limit any potential aquatic habitat benefits there since the rocks would be primarily exposed above the water surface. From a bird habitat needs perspective, geotextile tubes are preferred over rock as a means of shoreline stabilization, since young birds can get caught in the crevices between rocks. Therefore, given that potential detrimental impacts to young birds from the use of rock would be in conflict with the island's purpose, only islands stabilized with geotextile tube were compared. Because material in the channel is too fine to adequately fill the tubes, sandy fill material will be barged from the inlet/harbor area.

In summary, for the South Point Spoils site the following site-specific constraints were developed in the formulation of alternative plans: stabilize the existing island at its 1997 shoreline; use geotextile tubes to stabilize erosion-vulnerable shorelines; create up to 1.2 ha (3 ac) of new island(s) within 250 m (820 ft) to the northwest of the existing island; create new islands no closer than 15 m (50 ft) from the navigation channel and SAV bed boundary.

5.5.2 Ocean Pines: Formulation of Potential Alternative Plans

A maximum of 3.4 ha (8.5 ac) of land in two separate parcels had been identified as unbuildable and were potentially available for salt marsh restoration by removal of fill material at the site (Figure 5-1). Although it would have been possible to purchase and restore only a portion of one of the parcels, considerations such as the costs of mobilizing and de-mobilizing for a partial restoration made purchasing and restoring either whole parcel separately or both parcels together the preferred option. The material that was to be excavated from the parcels was initially considered as a potential source of material for marsh creation elsewhere. However, the material from Ocean Pines was determined to be unsuitable from a geotechnical perspective because of unknown compaction and subsidence that would occur as belowground plant parts decayed and collapsed during and following transport, placement, and grading. In addition, this material was rejected for use elsewhere because of transportation concerns. If removed by land, heavy trucks would be required to travel through residential areas of Ocean Pines with resultant impacts to roads and residents. Water removal was considered infeasible because of the lack of ready barge accessibility to the site. Because the site is relatively protected from wave action, no shoreline stabilization was proposed. This lack of stabilization also offers the benefit of preserving natural marsh shoreline. Because of the presumed stability of the former dredged material and native soils upon which the marsh would be built, it was assumed to be engineeringly practicable to enhance the habitat quality of the site for aquatic life by creating tidal creeks.

In summary, for the Ocean Pines salt marsh restoration site the following site-specific guidelines were utilized in formulating alternative plans: either one or both whole parcels would be restored; material would be excavated and disposed of in an upland area in close proximity to the restoration site; no shoreline stabilization would be required; and tidal creeks would be created.

5.5.3 Isle of Wight Wildlife Management Area: Formulation of Potential Alternative Plans

The Isle of Wight site presented a complex array of potential alternatives focused on restoring filled marsh, creating shoreline marsh, and creating island marsh. A variety of potential sources of material to create marsh substrate were considered: upland; locally excavated; locally dredged; and beneficially used dredged material. Shoreline stabilization could be accomplished using geotextile tubes or rocks to create a revetment, sill, or offshore breakwater. This section discusses how these potential factors were combined in formulating potential alternative plans for the site.

To minimize impacts to the natural vegetated shoreline along the southwestern side of the island which is valuable both as a natural shoreline and as a public beach accessible by car or boat, all salt marsh restoration work would take place along the disturbed and degraded southeastern shoreline. The length of potential shoreline along which work could take place in this area is approximately 590 m (1,900 ft). In order to minimize impacts to recreational boating, no marsh or structures (such as breakwaters) would be constructed in water deeper than 0.9 m (3 ft) MLLW.

As discussed in Section 2, the MD DNR has plans to improve the southeastern shoreline for increased public access and safety. To ensure compatibility with these future efforts, discussions with the MD DNR were held to determine where salt marsh restoration work could potentially be done. Much of the southeastern corner of the island where salt marsh historically occurred will be utilized for these improvements. However, a 1.1 ha (2.8 acre) parcel within which restoration work could be undertaken was identified. The easternmost portion of this parcel contains the remains of the concrete slab production facility mentioned in Section 2.

On the southeastern shoreline along which salt marsh creation is proposed, the 0.9 m (3 ft) contour lies approximately 275 m (900 ft) offshore to the south of the county boat ramp and gradually approaches closer to the island such that it lies approximately 250 m (800 ft) offshore of the southeastern corner of the island. Approximately 22.3 ha (55 ac) of water less than 0.9 m (3 ft) deep lie between a line drawn perpendicular to the shoreline at the boat ramp and the Route 90 bridge on the east side of the island. During agency coordination meetings, it was determined that no more than half of the area should be developed as salt marsh so that the project would also provide protected shallow water habitat to enhance aquatic habitat. Records of meetings held with resource agencies are included in Annex A, Part 7.

Coordination with resource agencies determined that natural shoreline edge should be maximized for any marsh constructed. If islands were to be constructed, smaller islands were preferable to large islands in order to (1) allow for exchange of water to maintain good water quality, (2) allow for movement of aquatic life around/between the created marsh island, and (3) increase marsh/shallow water edge. It was determined that no marsh island constructed at the site should be greater than a maximum size of 2 ha (5 ac) to meet the objectives. If offshore breakwaters were to be constructed, they should be sited and spaced to meet the water quality and passageway objectives. The salt marsh design guidelines (Table 5-9 in Section 4.5.3) set a minimum created marsh size of 0.4 ha (1 ac) to meet minimum salt marsh/habitat requirements. This size could be met by any combination of created island or shoreline marsh, or marshes restored in excavated fill, as long as the marshes are in close proximity.

The distinction between created shoreline marsh and created marsh islands was determined to be somewhat academic once the shoreline marsh reaches a substantial size if dredged material is used. Both shoreline salt marsh and island salt marsh would require wave protection on the bayside. The design guidelines in Table 5-8 specify that soft or natural shorelines should be maximized. This could be accomplished through several potential combinable configurations: shoreline marsh with detached offshore breakwaters; marsh islands with revetment on the bayside and unprotected lee side; or a peninsula protected by a revetment. Resource agencies expressed concerns that a peninsula could restrict flushing in the protected waters behind it, and that its mouth could be readily shoaled in. Therefore, it was decided that a peninsula would not be constructed. This left shoreline and marsh islands for further consideration.

Because of concern over vandalism and long-term stability of geotextile tubes in this popular recreation site, it was decided that rock structural protection is optimal for this site. Rock also offers greater aquatic habitat benefits, since it can provide cover and living space for a multitude of aquatic organisms. Ambient water depths in excess of 0.5 m (1.5 feet) MLLW would allow some of the aquatic habitat enhancement of rock to be realized. In addition, the MD DNR plans to install a stone revetment along the shoreline, and using rock for stabilization of new marsh would blend with the MD DNR shoreline improvements. However, in order to provide for determination of the most cost-effective project, both geotextile tubes and rock were considered as shoreline stabilization options.

Sources of material for salt marsh creation along the shoreline or as islands at Isle of Wight could include sand taken from upland sources; material excavated while restoring the filled marshes on the southeastern shoreline; dredged material from Federal or state channels, or private sources; or dredged material from the vicinity of the proposed island creation or salt marsh restoration areas.

Material that could be excavated from the filled marshes along the southeastern shoreline was determined to be unsuitable for creation of shoreline marsh because of its high content of concrete and asphalt which would not support plant growth, and because of the heterogeneous nature of the material which would make placement and accurate grading of the material problematic. Material excavated from the fill site was determined to be unsuitable for creation of the foundation of marsh islands because the heterogeneous nature of the material would make transport, placement, and grading of the material problematic. As a consequence, for any marshes to be restored by excavation of fill, only upland disposal of the excavated material was considered.

The possibility of dredging to create a protected water lagoon between created marsh islands or offshore breakwaters and the shoreline to enhance habitat and simultaneously obtain additional material was considered. Based on discussions with the MD DNR, dredging a protected water lagoon in the lee of created islands to a depth of 0.6 to 0.9 m (2 to 3 ft) (approximate maximum expected depth of SAV bed occurrence) could potentially enhance aquatic habitat in the area. For habitat enhancement purposes, this deeper water area must be linked to water of equivalent depth in Isle of Wight Bay by a channel or series of channels, whether natural or constructed. However, it was determined to be engineeringly impracticable to dredge a created lagoon because of high expense and unknown ability/availability of a dredge to work in the very shallow waters at the site. Channels that would be created to maintain water exchange between the created lagoon and the bay would be difficult to keep open, and both the created lagoon and access channels would be likely to rapidly shoal in. As a consequence, any habitat enhancement would be temporary. Thus, dredging to obtain material and perhaps enhance the aquatic environment was rejected.

Sand taken from upland sources was determined to be acceptable for creating/restoring shoreline marsh, but not for creating marsh islands because of public concerns and high costs. Public concerns focus on loss of navigable waters that have occurred as the bays have shoaled in, and their expressed desire is to have material removed from the bays, rather than added. Material from dredging of Federal and state channels was determined to be potentially available. However, because of sponsor concern over total project costs and unknown future dredging schedules and proportioning of material between Assateague Island, Ocean City, and Isle of Wight, an estimate was made for planning purposes that up to 34,000 m^3 (45,000 yd^3) of dredged material might be available for work at Isle of Wight. Of this volume, 31,000 m^3 (45,000 yd^3) was utilized as the maximum available to create islands at the site. The Isle of Wight site was determined to be of limited potential suitability for the placement of privately dredged material as compared to Dog Island Shoals because of its relatively greater distance from known regularly-dredged sites on southern Ocean City. Therefore, creation of a site for placement of privately-dredged material was not further considered at Isle of Wight.

In summary, for the Isle of Wight salt marsh restoration/creation site the following site-specific guidelines were utilized in formulating alternative plans: up to 1.1 ha (2.8 ac) of marsh could be restored by excavating fill in the parcel identified by the MD DNR; excavated fill material would be disposed of offsite; up to 590 m (1,900 ft) of the southeastern shoreline was available for creation of new shoreline marsh; any created shoreline marsh must be at least 15 m (50 ft) in width; the bay shoreline of restored or created marsh would require wave protection because of the significant wave energy in the area; up to 34,000 m^3 (45,000 yd^3) of dredged material could be used for construction; any created islands must be no larger than 2 ha (5 ac) in size; and no tidal creeks would be created in placed dredged material (see Table 5-8). Materials used for island creation would come from Federal or state maintained channels in Isle of Wight Bay.

5.5.4 Dog Island Shoals: Formulation of Potential Alternative Plans

As discussed previously, this site was identified for creation of both bird habitat islands and salt marsh. Institutional constraints discussed in Table 5-9 limited alternative proposals for bare-substrate islands to no more than 1.2 ha (3 ac). Larger sizes were considered to be unmanageable in a bare substrate condition by the MD DNR over the long term. Given the dual purpose of creating salt marsh and bird habitat, a maximum island or archipelago size was set at 10.1 ha (25 ac) to restrict the ability of predators to become established at the site. This 10.1 ha (25 ac) limit includes all island(s) and habitat that could be created at the site. Salt marshes can support predators as well as upland habitat, and if multiple islands were created, there would not be space available at the site to leave a gap of 500 m (1,640 ft) between islands, which is the minimum distance required to inhibit predators from moving between islands.

Because of its proximity to Ocean City, this site was recognized to be a prime potential site to beneficially use dredged material to create the salt marsh components of the project. This will reduce project costs for the Corps and project sponsors, and will assist local residents and businesses in disposing of their clean dredged material. It is anticipated that the material sources for local use of the site would be privately dredged marinas, canals, and other small projects in the developed areas behind Ocean City. Material could include maintenance or new dredging. Based on preliminary estimates that 4,600 m^3 (6,000 yd^3) of material would be generated annually by private sources (see Annex A, Part 4 for additional information), it was decided that the initial project construction would be relatively small and would include a 1.2 ha (3-ac) island constructed by the Corps and three 0.4 ha (1-ac) dredged material placement cells for future use by local dredgers. This would provide an estimated 3-year capacity for local use to create habitat. Local dredgers' future placement needs (beyond 3 years), in excess of the initial 2.4 ha (6 ac) project, may warrant the containment area to be made larger by adding cells. If this is the case, the local governments could construct additional cells for new dredged material and saltmarsh creation, or the Corps may be able to cost-share as part of the Section 1135 environmental restoration program, both subject to receipt of Federal and state authorizations.

In order to minimize impacts to recreational boating it was originally considered desirable to build the island(s) in the shallowest water available at the furthest distances from the Federal and state navigation channels. However, this constraint is directly contradictory to the need to make the site amenable for the placement of mechanically dredged material. Barges that will transport material to the site will require water depths of at least 0.9 m (3 ft). It would also be possible to dredge a channel to the site for barges to load/unload. However, this channel would tend to shoal in over time, and responsibility for re-dredging access to the site is not desired by sponsoring parties. Therefore, it was decided that the island must be accessible from natural waters that are at least 0.9 m (3 ft) deep. (This need for access from deeper water does not preclude the design guidelines from Tables 5-9 and 5-10. Guidelines require that the created island also provide protected cove habitat and a soft or natural shoreline for easy access between the terrestrial and aquatic environments for wildlife.)

After completion of the initial 2.4 ha (6 ac) island by the Corps and local dredgers, additional containment structures may be constructed subject to Federal and state permits. The added containment structures might be connected to the existing island mass or built separately, provided that the 10.1 ha (25 ac) limit is maintained to discourage predators. It is not considered advisable to construct the containment structure(s) too far in advance because of uncertainty over when and how much material will be added in the future. In addition, if constructed in advance, a containment structure could create quiescent habitat within which SAV might establish. Filling a site vegetated by SAV with dredged material may be contradictory to Federal and state regulatory policies.

In coordination with resource agencies, it was determined that only clean material will be allowed to be placed behind the geotextile tubes for the three 0.4 ha (1-ac) sites. Material containing at least 75 percent sand will be assumed to be clean and will be accepted without prior chemical testing because there is no heavy industry in the project area, and contaminants that do occur in the coastal bays will not adhere to sand. Material containing less than 75 percent sand must be tested for the presence of contaminants in order to prove that it is clean, prior to its being considered for acceptance at the 2.4 ha (6 acre) island site. After appropriate permits are obtained, persons desiring to place material at the sites must receive final approval from the Town of Ocean City indicating that the material is acceptable, and placement capacity is available. If in the future non-Federal interests desire to construct additional placement sites in excess of the initial 2.4 ha (6 acre) Federal project site for placement of dredged material then Federal and state regulatory permits will be required. In addition, these parties must receive approval from the town of Ocean City.

5.6 EVALUATION AND COMPARISON OF ALTERNATIVE PLANS

5.6.1 Methods Used to Quantify Environmental Outputs

In order to evaluate how well each alternative plan met the objectives it was necessary to quantify or rank the value of the environmental outputs that each would produce. Distinct evaluation criteria were selected for each environmental restoration objective to allow for an objective comparison of the benefits expected to be produced by each alternative (Table 5-12). No single approach was deemed adequate to simultaneously quantify outputs of colonial waterbird nesting habitat and salt marsh restoration.

Measures that can be used to quantify outputs of environmental restoration projects include analysis of impact to energy flow, populations, and habitat quality. Habitat-based evaluation techniques were chosen for this study since they offer a sound ecological basis for impact assessments without the constraints inherent in energy flow and population analyses. A variety of desktop Habitat Evaluation Procedures (HEP) have been utilized to quantify and evaluate the environmental impacts produced by water resources projects. HEP can be either species or community-focused. Species-oriented Habitat Suitability Index (HSI) models produced by the FWS were utilized in a desktop exercise to quantify the environmental outputs of the alternatives for the colonial waterbird-oriented project plans at South Point Spoils and Dog Island Shoals. For the restoration objectives focused on colonial waterbirds (Table 5-12) a representative species from each guild was first selected for analysis. For the restoration objective focused on salt marsh, ac produced by each alternative were determined to be the most appropriate measure of quantifying environmental output. Since each salt marsh project would conform to the guidelines established in Section 5.4, differences in environmental functions of any alternative would be largely dependent upon size.

Table 5-12: Coastal Bays Environmental Restoration Objectives and Measurement Units

Environmental Restoration Objectives	Measurement Unit
Create bare substrate islands to provide nesting habitat for beach-nesting colonial waterbirds such as terns	Units of nesting habitat produced for Common Tern
Restore/maintain island habitat to increase/maintain nesting habitat for vegetation-nesting colonial waterbirds such as brown pelicans, egrets, and herons	Units of nesting habitat produced for Brown Pelican
Restore/create tidal wetlands to provide food web support for Coastal Bays ecosystem and habitat for fish and wildlife	Acres of salt marsh habitat produced

The HSI models utilize an equation to quantify habitat suitability for a particular species or community. Each equation incorporates a series of variables representing environmental attributes known to be critical for the success of a particular species or community. The number of variables differs from model to model. Each variable is used to determine a suitability index (SI) of the habitat for that variable. The value for each SI variable ranges from 0 to 1. Zero represents no habitat suitability; 1.0 represents optimum habitat suitability. Each SI value is determined independently. The model utilizes an equation incorporating the individual SIs to calculate a HSI which ranges from 0 to 1. The HSIs are then used to calculate habitat units (HU) for each alternative. HUs are defined as the area of a particular habitat type created multiplied by the HSI for that alternative.

Results from application of HEP for different species cannot be added directly. One unit of habitat for one species or community does not equal one unit of habitat for another. Each model incorporates variables specific to the focus of the model, and the models do not consider the same factors. In the case where different units of output are produced but a single quantity is desired to compare alternative plans, the analysis may proceed by either creating an index which ranks the relative value of the habitats created (e.g., according to the relative scarcity/significance of the resource); or each output can be considered separately. Given the disparate nature of the two objectives, it is considered important to retain the outputs for each objective for independent consideration. A discussion of the models used to quantify environmental outputs is included in Annex A, Part 6.

Although the shoreline stabilization structures used to create the islands are arguably of some value to nekton and benthos, no value is given to these structures in this analysis since there is no shortage of stabilized shorelines in the region. SAV habitat that is expected to be produced by plantings and promotion of natural colonization through creation of protected water conditions is not quantified as a benefit due to uncertainties over likely success of planting efforts, and over uncertainties of natural colonization of quiescent shallow water created by the projects.

5.6.2 Cost Effectiveness Analysis

In order to select the most cost-effective plans from the array of alternatives it was necessary to weigh the benefits to be derived versus the costs. The Corps performs analyses to ensure that the most cost-effective project(s) are selected. Traditional benefit-cost analysis cannot be performed for environmental restoration projects because the benefits are not measured monetarily. Instead of measuring outputs of environmental restoration projects in dollars, benefits are determined based on an appropriate measure of environmental output. The Corps of Engineers *Evaluation of Environmental Investments Procedures Manual* (IWR Report #95-R-1) was utilized. In this case, acres of salt marsh, and Common Tern and Brown Pelican nesting Habitat Units were selected, as discussed previously in Section 5.6.1. Considerations of scarcity and significance of the restored/created habitat locally and regionally can provide additional justification for selection of a project(s).

A project lifespan of 25 years was selected as a reasonable period of time over which to evaluate alternatives outputs. However, given the dynamic nature of the coastal environment and the presumed finite lifespan of potential building materials such as geotextile tubes, the project outputs are not considered permanent features. All benefits and costs are calculated assuming that all projects are completed at the same time, however, it is anticipated that construction initiation of the projects will actually occur over about a two year period. For example, habitat creation at Isle of Wight and Dog Island Shoals using both Federal and privately dredged material would require starting times that are dependent on initiation and completion of the dredging projects. In any case, it is anticipated that all the salt marsh and upland cells would be filled and planted to design specifications within 5 years after completion of the initial cell.

There are differences in the development time of salt marsh, bare-substrate nesting habitat, and vegetation-nesting habitat. Habitat development should be complete with regard to salt marsh vegetation establishment within several years after all cells are filled and planted. However, full ecological functioning of the created/restored salt marsh may take 15 to 20 years (for example, complete colonization of the site by all the benthic organisms which inhabit natural salt marshes). Full habitat functioning of habitat created for vegetation-nesting colonial waterbirds is expected within several years of island creation since vegetation planting is incorporated into proposed projects. In contrast, habitat functioning of the islands created for beach-nesting birds will begin in the spring of the year following placement of material. The outputs calculated for the bare-substrate island assumes that these created islands will be maintained in an unvegetated condition. Maintenance of the bare-substrate surface will be the responsibility of the MD DNR; the island will be incorporated into the Sinepuxent Bay Wildlife Management Area. If vegetation is allowed to develop on the Dog Island Shoal bare-substrate island, the habitat value of the site for beach-nesting colonial waterbirds will be severely compromised.

Costs for planting SAV were included on island creation projects at Isle of Wight and Dog Island Shoals as a means to enhance aquatic habitat at the site. No costs for planting SAV were included for the South Point Spoils alternatives since from the site survey and coordination with experts (Annex A, Part 7), it was determined that there is a great abundance of natural propagule material and natural recolonization of the site would be expected in a relatively short period of time. However, should recolonization not occur, SAV planting will need to be undertaken and additional costs will be incurred.

5.6.3 Preliminary Evaluation

The infinite potential number of alternatives required that logic be applied to limit the number of salt marsh and colonial waterbird habitat creation/restoration alternatives for analysis. The Corps of Engineers *Evaluation of Environmental Investments Procedures Manual* (IWR Report #95-R-1) provides for this situation and suggests that sub-routine cost effectiveness analyses can be performed to eliminate certain alternatives from consideration prior to combining all measures.

Habitat creation at Dog Island Shoals would require island creation because the site currently consists of shallow open water. Island creation is an option at the Isle of Wight and South Point Spoils sites. The shape for any island of a given size could be modified into an infinite number of possible configurations. However, for the purposes of this analysis the kidney-bean shape was determined to be a reasonable compromise between cost-effectiveness and the need to provide an area of protected water in the lee of the island for aquatic habitat enhancement. Therefore, all new islands were presumed to be built in a kidney-bean shape for comparison purposes. However, it is recognized that the constructed island shape would be modified somewhat during design to suit site-specific conditions.

Islands could be built in an infinite number of sizes, as well as in combinations of islands of different sizes. For the purposes of this preliminary analysis, it was necessary to determine whether a trend existed between costs versus outputs of various combinations of island sizes. Costs and outputs of generic 5, 4, 3, 2, and 1 acre habitat islands which could be combined to yield from 1 to 25 acres were compared to determine the most cost-effective combination of island sizes. Only whole-acre created islands were evaluated since it was believed that this would adequately characterize any trend in the relationship between costs and outputs. It was determined that for any island construction project, it is more cost-effective per salt marsh acre or bird habitat unit to build the maximum size individual island possible, rather than build two or more small islands that add up to the same size as the large island. However, coordination with resource agencies (see Annex A, Part 7), determined that in certain cases smaller islands offer greater aquatic habitat benefits and fewer detrimental impacts. Based on this concern for Isle of Wight, it was determined that no island created would be larger than a maximum size of 2 ha (5 ac). Consequently, if islands are constructed at the Isle of Wight site it is most cost-effective to build combinations of islands such that the largest possible number of 2 ha (5 ac) size islands are constructed. Any remaining acreage after multiples of 2 ha (5 ac) islands are constructed would be constructed as a single island that would be as large as possible (for example, one 2-ac island rather than two 1-ac islands).

Preliminary analyses were run for shoreline salt marsh restoration/creation alternatives less than 0.6 ha (2 ac) in size at Isle of Wight which compared the costs of a free-standing breakwater versus a revetment. Costs for constructing these stabilization features from rock and geotextile tube were compared. Geotextile tubes were determined to be less expensive than rock if a dredge would already be in use. In the case of restoring filled salt marsh and or constructing a shoreline marsh when a dredge was not already in use, then geotextile tubes could still potentially be utilized, however they would have to be filled from a land-based unit. In this case, the costs of rock were cheaper because of the substantial cost of filling geotextile tubes from a land-based unit. The costs of a rock revetment versus a free-standing rock breakwater were also compared. Because of the substantially less rock required, revetments are less costly than breakwaters. However, they fail to provide a natural or soft shoreline which is a desired feature. Details of these preliminary costs are presented in Annex A, Part 6.

5.6.4 Evaluation of Individual Alternatives

A preliminary compilation of costs and outputs for each individual alternative was prepared which included the various sources of material, shoreline stabilization methods, and numbers of islands and size of habitats as discussed previously in the site-specific plan formulation of this document. These alternatives are listed in Annex A, Part 6.This first cost estimate did not include combinations of alternatives.

There were three alternative projects considered for the Dog Island Shoals island creation site. For shoreline stabilization of the bare-substrate island, all alternatives employ geotextile tubes rather than rock for shoreline stabilization because of potential increased mortality risk to young birds caused by rock as discussed previously. Given the optimum habitat conditions that will be produced by created bare substrate island, 1 nesting HU for Common/Least Tern will be produced for every 1 acre of bare substrate island that is created. The alternatives evaluated produced from 1 to 3 nesting HUs for Common Tern, and range in total cost from $484,000 to $984,000. Project costs are greatly increased by shell costs. Crushed shell, or some other similar material, is required to maintain dry conditions that will restrict vegetation establishment, while still allowing beach-nesting birds to scrape out nests in the island surface.

There were four potential individual projects for the restoration of the South Point Spoils colony. Geotextile tubes rather than rock are used for shoreline stabilization because of potential increased mortality risk to young birds caused by rock as discussed previously. Environmental output for individual projects ranged from 1 to 3 Brown Pelican Habitat Units for creation of new islands. Total costs for creation of new islands ranged from $334,000 to $533,000. Stabilization of the existing island at the 1997 shoreline alone would produce 2.3 HUs and would cost $318,000.

There was a multitude of individual salt marsh projects considered for the Ocean Pines, Isle of Wight, and Dog Island sites. These initial estimates were prepared with the knowledge that it was not possible to realistically distinguish between the costs of rock versus geotextile tube at Isle of Wight because many design-specific factors would come into play which would be important to computing costs. Later in the study during site-specific design, it became apparent that the costs of rock had been greatly overestimated at Isle of Wight in this analysis. The cost-effectiveness analysis was not rerun, however, because it was believed that the general guidance provided by the analysis had not been compromised.

Results of this initial analysis of individual salt marsh project alternatives indicated several trends. Outputs and total costs for restoration projects at Ocean Pines ranged from 2.5 to 8.5 acres and $201,000 to $574,000 respectively. These are the lowest average costs per acre for salt marsh of the three sites. Marsh islands constructed at Dog Island Shoals using dredged material ranged from 1 to 3 acres in output, costs ranged from $249,000 to $341,000. At Isle of Wight, marsh islands that were stabilized by rock were found to be substantially more expensive than islands stabilized by geotextile tubes. Costs for single islands constructed at Isle of Wight ranging from 1 to 5 acres in size stabilized by geotextile tubes ranged in cost from $269,000 to $516,000 respectively. The same cost range for islands stabilized by rock was $523,000 to $1,068,000. Costs for restoration of shoreline marsh by excavation were found to be extremely expensive. Total costs for producing from 0.8 to 2.8 acres of salt by excavating fill ranged from $432,000 to $1,219,000. Costs and outputs for creating new marsh along the Isle of Wight shoreline ranged from $463,000 to $869,000 for 1.1 to 2.3 acres of marsh if upland fill was used.

5.6.5 Evaluation of Combinations of Alternatives

Combinations of alternatives for cost-effectiveness analysis were then prepared. The infinite number of potential alternatives was constrained by the results of the subroutine cost-effectiveness analyses applied above. Combinations of alternatives were also constrained by site specific limitations discussed previously. The outputs and costs of these combinations are presented in Annex A, Part 6.

No additional combinations were generated for construction of bare substrate islands at the Dog Island Shoals site. As discussed in Table 5-9, total island size was limited to 1.2 ha (3 ac) because of the need for vegetation management and institutional constraints of the MD DNR. The preliminary evaluation served to exclude consideration of constructing more than one island at the site to reach the maximum 1.2 ha (3 ac) size.

There were seven potential combinations of projects for the restoration of the South Point Spoils colony. Environmental output for this objective ranged from 0.9 to 5.3 Brown Pelican Habitat Units among the seven combinations. Costs ranged from $318,000 to $679,919.

Preparing combinations of salt marsh alternatives at Ocean Pines, Isle of Wight, and Dog Island Shoals for evaluation and comparison was more problematic. The results of the individual alternatives evaluation served to provide guidance on restricting the number of potential alternatives for inclusion in this effort. As a result of the trend identified in Section 5.6.4, it was determined that all solutions that fail to include Ocean Pines will not be cost-effective. Therefore, no combinations which failed to include Ocean Pines were considered. Alternatives that involved restoration of marsh along the Isle of Wight shoreline by excavation were dropped from consideration because of their prohibitively high estimated cost. For created salt marsh islands at Isle of Wight and Dog Island Shoals, only combinations that would use geotextile tubes to stabilize the shoreline (as opposed to rock) were included (as discussed previously though, this later proved to be in error since rock costs had been overestimated). After these exclusions were made, there were 280 combinations of potential salt marsh projects at Dog Island Shoals, Isle of Wight, and Ocean Pines that remained for consideration. These combinations are presented in Annex A, Part 6. Salt marsh output in acres produced ranged from 2.5 (one parcel at Ocean Pines) to 23.5 (maximum of all projects at Ocean Pines, Isle of Wight, and Dog Island Shoals). Total costs ranged from $210,000 to $1,202,000 for the range of combinations considered.

5.6.6 Comparison of Alternatives and Selection of Recommended Plan

Modeled project habitat outputs in acres of salt marsh or Habitat Units for the colonial waterbirds were compared to total project costs in three separate cost effectiveness analyses to provide guidance for the selection of the best project alternatives for each of the three objectives. The Corps of Engineers Cost-Effectiveness Analysis procedure (USACE IWR Report 94-PS-2) was utilized for this evaluation. Project alternatives for each objective were analyzed for economic efficiency by first reordering the alternatives so that they are listed in order of ascending outputs. For each level of output (acres or HUs) the least cost alternative was then identified, and alternatives which produced equivalent output for a greater cost were eliminated from further consideration. Alternatives were then analyzed for economic effectiveness by conducting a pair-wise comparison of outputs and costs to identify and delete those alternatives that will produce less output at equal or greater cost than subsequently ranked alternatives. Average costs were then calculated for the remaining solutions. After the economic efficiency and effectiveness analyses were completed, alternatives that remained for further consideration were cost-effective. To provide further guidance to recommend a plan an incremental analysis was conducted. Incremental analysis reveals and interprets changes in costs for increasing levels of outputs. Based on the results of the cost effectiveness and incremental analyses, recommended plans were selected. Results and iterative steps of these analyses are provided in Annex A6.

Dog Island Shoals

All alternatives for the creation of bare-substrate nesting habitat at Dog Island Shoals were cost effective. The lowest average cost per habitat unit project is the largest alternative. This occurs because costs for alternatives at Dog Island Shoals are largely driven by the fixed cost of dredged mobilization, and an efficiency of scale factor comes into play which causes lower average costs to be associated with larger project sizes. To complete an incremental analysis, alternatives with less output than the alternative with the lowest average cost must then be removed from further consideration. Application of this step serves to eliminate all but the largest project from consideration, and no alternatives remained to complete a proper Incremental Analysis. However, based on the results of the cost-effectiveness analysis which demonstrate that the lowest average cost project is the largest alternative, and because of the documented regional scarcity of bare-substrate nesting habitat, the largest alternative (3 ac) bare substrate island at Dog Island Shoals was selected. This maximum sized alternative is cost effective, readily meets the specific objectives and constraints established in the Design Rationale section, and the value of the nesting habitat it will create is of great significance to the coastal bays and the state of Maryland.

South Point Spoils

Of the seven potential alternatives for the restoration of the South Point Spoils waterbird colony, five cost-effective solutions were identified. These cost effective solutions are presented in Table 5-13. The lowest average cost per habitat unit solution is the alternative that produces the largest colony size. This occurs because of an economy of scale factor driven by the fixed cost of the dredge, and because of the pronounced increase in habitat value that occurs once the colony size reaches 2.0 ha (5 ac). To complete an incremental analysis, alternatives with less output than the alternative with the lowest average cost must then be removed from further consideration. Application of this step served to eliminate all but the largest project from consideration, and no alternatives remained to complete a proper Incremental Analysis. Based on the results of the cost effectiveness analysis which demonstrate that the lowest average cost solution is the largest alternative, and because of the noted significance of this colony to the coastal bays region, the alternative which includes stabilization of the existing island plus construction of a new 3 acre island was selected.

Table 5-13: Cost Effective Solutions for the Restoration of South Point Spoils Colony

Alternative	No.	Combined HUs	Combined Costs ($)	Average Costs ($/HU)
No Action		0.0	0	0
Stabilize Existing Island	A	0.9	314,000	341,000
Stabilize Existing Island and Construct New 1 Acre Island	C1	1.3	474,000	359,000
Stabilize Existing Island and Construct New 2 Acre Island	C2	1.7	578,000	336,000
Stabilize Existing Island and Construct New 3 Acre Island	C3	5.3	672,000	127,000

<u>Salt Marsh at Ocean Pines, Isle of Wight, and Dog Island Shoals</u>
Of the 280 alternative salt marsh combination projects at Ocean Pines, Isle of Wight, and Dog Island Shoals, fifteen cost-effective solutions were identified. These are presented in Table 5-14. A complex interplay between fixed costs (dredge and equipment mobilization) versus outputs caused this result. The lowest average cost per acre solution (no. 4 c 30) would produce 11.5 acres of salt marsh by restoring all 8.5 acres at Ocean Pines and by creating a total of 3 acres at Isle of Wight.

Because of the number of remaining cost-effective solutions and the spread of costs versus outputs, it was possible to conduct an incremental analysis to provide guidance on which of these solutions should be selected. The incremental analysis is presented in Annex A6. Among the 15 potential cost-effective salt marsh solutions, only two were incrementally justified: 1) construction of a total of 4.7 ha (11.5 ac) of salt marsh comprised of 3.4 ha (8.5 ac) at Ocean Pines, 0.8 ha (2 ac) of created shoreline marsh at Isle of Wight, and 0.4 ha (1 ac) of island at Isle of Wight; and 2) construction of a total of 9.5 ha (23.5 ac) of salt marsh comprised of 3.4 ha (8.5 ac) at Ocean Pines, 0.8 ha (2 ac) of created shoreline marsh at Isle of Wight, 4 ha (10 ac) of island at Isle of Wight, and 1.2 ha (3 ac) of islands at Dog Island Shoals. Of the two incrementally justified salt marsh combinations, the largest was selected for recommendation since it would best rectify the substantial salt marsh losses that have occurred in the coastal bays and it is supported by the project sponsors.

Table 5-14: Cost Effective Solutions for the Creation of Salt Marsh at Ocean Pines, Isle of Wight, and Dog Island Shoals

No.			Combined Cost ($)	Combined Acres	Average Cost ($/acre)	Ocean Pines (acres)	Isle of Wight: Shore-line (acres)	Isle of Wight: Islands (acres)	Dog Island Shoals (acres)
1			0	0		0	0	0	0
2	a	1	201000	2.5	80400	2.5	0	0	0
2	a	2	418000	6	69667	6	0	0	0
4	a	30	464000	9.5	48842	8.5	0	1	0
4	c	30	491000	11.5	42696	8.5	2	1	0
4	c	28	610000	13.5	45185	8.5	2	3	0
4	d	90	661000	14.5	45586	8.5	2	1	3
4	c	26	716000	15.5	46194	8.5	2	5	0
4	d	88	780000	16.5	47273	8.5	2	3	3
4	d	87	833000	17.5	47600	8.5	2	4	3
4	d	86	886000	18.5	47892	8.5	2	5	3
4	d	85	978000	19.5	50154	8.5	2	6	3
4	c	21	1032000	20.5	50341	8.5	2	10	0
4	d	83	1096000	21.5	50977	8.5	2	8	3
4	d	81	1202000	23.5	51149	8.5	2	10	3

For the Isle of Wight site it was later determined during site-specific design that rock costs had been overestimated, and rock stabilization was substituted for geotextile tubes. Because of consequent cost factors which favor low rather than high breakwaters, shoreline marsh protected by offshore breakwaters was substituted for island marsh since island stability during storm wave overwash would be uncertain. These substitutions were considered to be fully in spirit with the results of the cost-effectiveness analysis which served to provide guidance that as much as possible of the potentially available 34,000 m3 (45,000 yd3) of dredged material should be utilized to create/restore salt marsh at Isle of Wight. These substitutions were approved by the project sponsors. These changes are also consistent with the guidelines set forth in Table 5-8, and are expected to produce equivalent enhancement to the local aquatic environment since the distinction between shoreline marsh protected by offshore breakwaters and island marsh in the relatively uniform water depths of the site is somewhat academic anyway.

5.7 DESCRIPTION OF RECOMMENDED PLANS

Recommended plans for the following four environmental restoration or creation sites were developed as part of this study: South Point Island Colony Restoration, Dog Island Shoals Waterbird Habitat Creation, Isle of Wight Saltmarsh Habitat Creation, and Ocean Pines Saltmarsh Restoration. Detailed cost estimates were prepared for each of the four sites and were further broken out for separable components of each site, such as costs for stabilizing the existing South Point Island and for construction of a new island at the site. The costs as shown are conservative and do not reflect the potential savings of constructing several of the projects at one time, thereby reducing the costs of such items as mobilization and de-mobilization of a dredge. For example, it is anticipated that if South Point Island and Dog Island were constructed together at the time of the harbor and inlet channels deepening, the costs for mobilization and de-mobilization could be reduced. Because the volume of material required to be dredged from the inlet and harbor for deepening is adequate to construct the projects, this savings is very possible.

5.7.1. South Point Spoils Island Colony Restoration

5.7.1.a Physical Description of Project. The recommended plan focuses on creating and stabilizing habitat to augment the existing waterbird colony to restore it to its historic size. The project will consist of stabilizing the existing island and creating a new 3-ac island (see Figure 5-3). Both the stabilization and the new construction will be accomplished using sand-filled geotextile tubes to protect the island perimeters. It is expected that the new island will be located between the existing island and the navigation channel, outside the mapped SAV beds that surround the existing island. The precise location of the new island will be determined closer to construction so that the location of SAV beds can be accurately mapped and negative impacts avoided. The other primary consideration in locating the new island is maintaining the unity of the waterbird colony by constructing the new island in close proximity to the existing island as discussed in Section 5.5.1. Hydraulic equipment will be used to dredge material from the Sinepuxent Channel for filling the created island interior. Sand from the harbor and inlet area, rather than the higher silt and clay content Sinepuxent channel material, will be used to fill the geotextile tubes. Time of year restrictions on construction activities to minimize impacts to colonial waterbirds and SAV will require that work be done between September and March.

Guidelines for design and construction of the existing island stabilization include the following (Figure 5-4):

1. Stabilize the existing island to its size in 1997: 0.9 ha (2.3 ac).
2. Place sand-filled variable height, 0.5 m (1.5 ft.) to 1 m (3 ft.), geotextile tubes outside the perimeter of most of the island, leaving the accreting spit at the northeast end of the island as an unprotected, natural beach. Fill the area between the geotextile tubes with 6,500 yd^3 from the Ocean City harbor. The island itself will be filled with materials from Sinepuxent Channel

(Figure 5-5). Dredged material will be placed to match or slightly exceed existing top of bank elevation, +.5 m to +1 m MHW.

3. The stabilized island will be planted with appropriate species for erosion protection and to provide cover and nesting habitat, such as trees, shrubs, and grasses. Planting of SAV is not included in the plans because of the abundance of SAV propagules in the area and the likelihood of natural recolonization in the newly protected areas.

4. A monitoring program is being developed by the Corps and project sponsors. Monitoring by the Corps will include inspections by an engineer and a biologist on a regular 5-year cycle to determine construction integrity and biological functioning of the project. If SAV beds that are disturbed during construction don't recover within two years following completion of construction then SAV will be planted in all disturbed areas to facilitate SAV recovery.

Guidelines for design and construction of the new island include the following:

1. Construct the island in close proximity 250 m (820 feet) to the existing island and the Sinepuxent Channel, but at least 15 m (50 ft) away from perennial SAV beds and the navigation channel.

2. Place sand-filled geotextile tubes on 0.45 m (1.5 ft) thick platform layer of fill to form a 1.2 ha (3-ac) kidney bean-shaped island, with the outside arc of the island facing the navigation channel and the smaller, inside arc oriented toward the existing stabilized island. Larger 1.5 m (5-foot) diameter geotextile tubes forming the outside arc of the new island would protect both the cove formed by the island, as well as the existing island from the erosive action of waves from the west/northwest. Design elevation of island at highest areas would be +1.5 m (5 ft) MHW to place it above stormtide. Smaller 0.9 m (3-ft) diameter geotextile tubes placed to form the inside arc of the island would provide a +0.6 m (+2 ft) elevation. This will create a gently-sloped soft shoreline which will allow some movement of dredged material, water, and animals between the new island and the protected area between the new and existing islands.

3. The new island would be planted with appropriate nesting and cover species, including trees and shrubs on the higher elevations and marshgrass at lower elevations. Planting of SAV is not included in the plans because of the abundance of SAV propagules in the area and the likelihood of natural recolonization in the newly protected areas.

4. A monitoring program is being developed by the Corps and project sponsors. Monitoring by the Corps will include inspections by an engineer and a biologist on a regular 5-year cycle to determine construction integrity and biological functioning of the project.

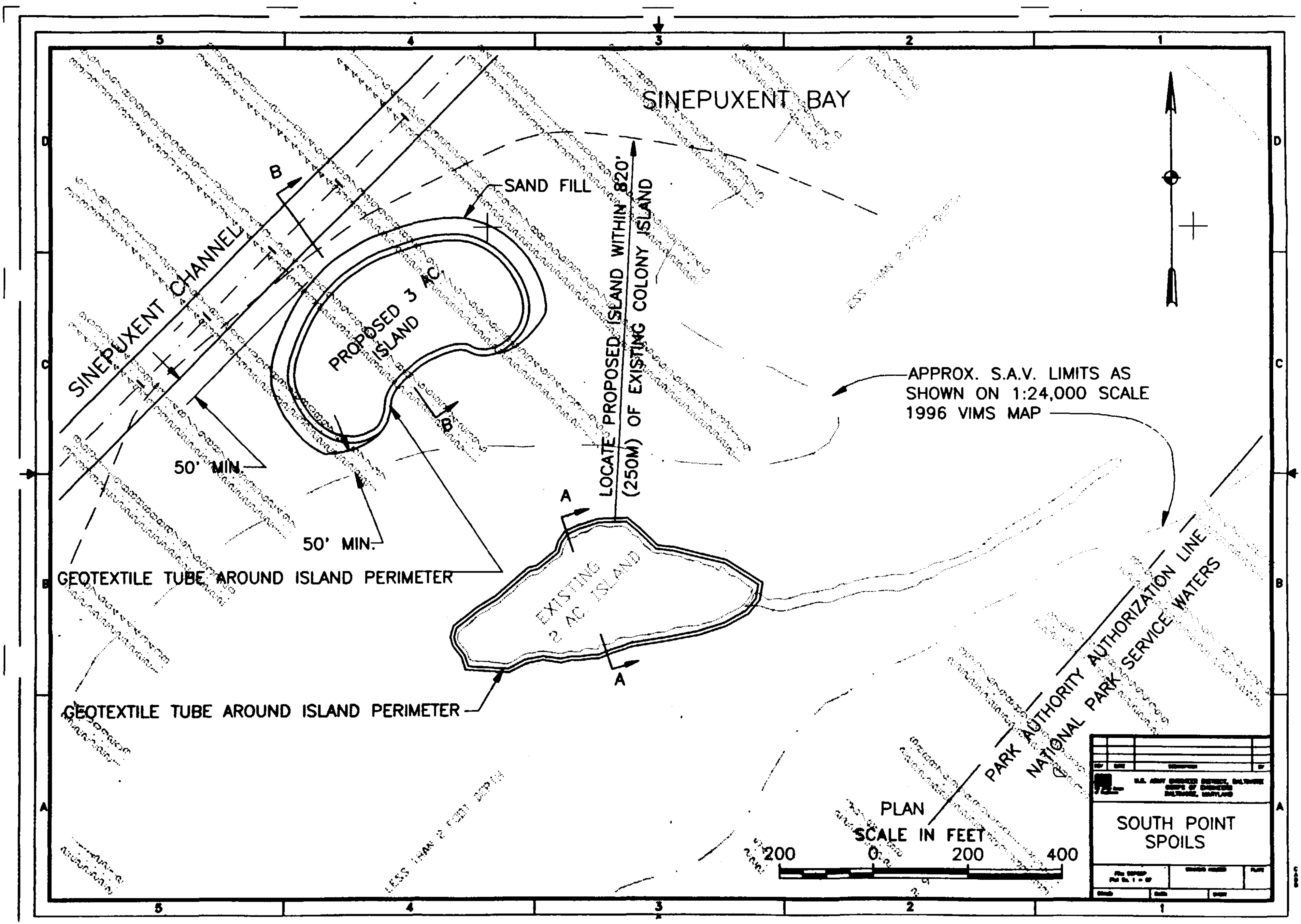
<u>5.7.1.b Operation and Maintenance</u>. Maintenance of this project will be the responsibility of the non-Federal sponsor. It is expected that minimal maintenance will be required. The geotextile tubes are expected to last 15 to 25 years. Because these islands are for waterbird habitat, the MD DNR will restrict public access to these islands from mid-March to the end of August. This closure should also reduce wear and tear on the geotextile tubes from humans. It is possible,

though, that a few patches will be needed to repair holes in the geotextile tubes in the future. For cost estimating purposes, it is assumed that some patching will be required every 3 years for the 25 year life of the project. If the plants die during the project life, the non-Federal sponsor will be responsible for replanting the islands. This could be done fairly inexpensively using volunteer groups. Total project operations and maintenance costs for the stabilized island are expected to be $5,800.

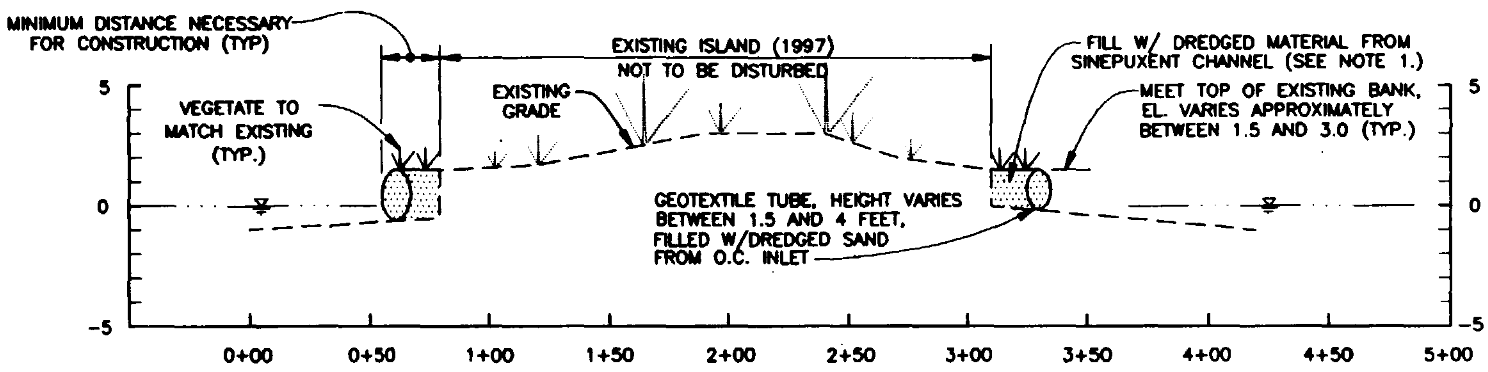
5.7.1.c Project Cost Estimate. The project cost is estimated to be $1,174,500 (Table 5-15). The project will be implemented under Section 206 of WRDA, as amended Under the CAP authority, cost sharing would be 65 percent Federal and 35 percent non-Federal. The detailed cost estimate is provided in Appendix C.

Table 5-15. Construction Costs for South Point Spoils.

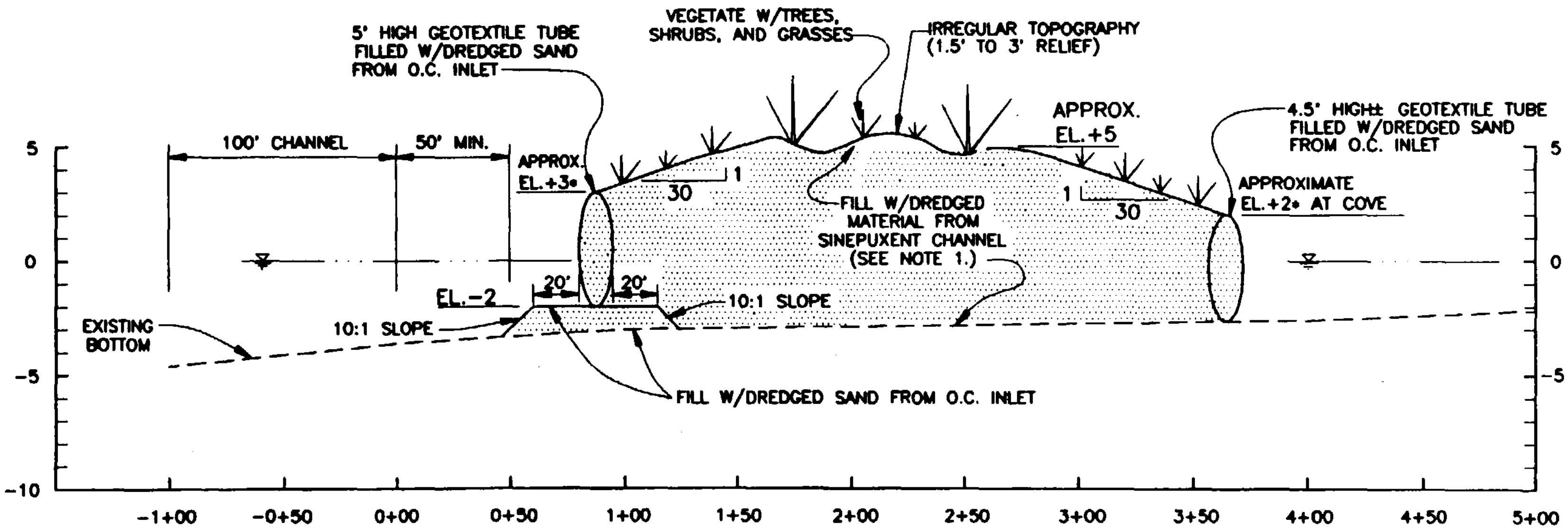
Construction Activity	First Cost	Fully Funded Cost
Lands and Damages	$10,900	$11,800
Fish and Wildlife Facilities	$989,800	$1,042,300
Planning, Engineering & Design	$107,800	$117,300
Construction Management	$66,000	$71,800
TOTAL PROJECT COST	**$1,174,500**	**$1,243,000**
Total Operation and Maintenance	$5,800	



SINEPUXENT BAY
SINEPUXENT CHANNEL
SAND FILL
B
PROPOSED 3 AC. ISLAND
LOCATE PROPOSED ISLAND WITHIN 820' (250M) OF EXISTING COLONY ISLAND
APPROX. S.A.V. LIMITS AS SHOWN ON 1:24,000 SCALE 1996 VIMS MAP
50' MIN.
50' MIN.
GEOTEXTILE TUBE AROUND ISLAND PERIMETER
A
EXISTING 2 AC. ISLAND
GEOTEXTILE TUBE AROUND ISLAND PERIMETER
PARK AUTHORITY AUTHORIZATION LINE
NATIONAL PARK SERVICE WATERS
PLAN
SCALE IN FEET
200 0 200 400
SOUTH POINT SPOILS



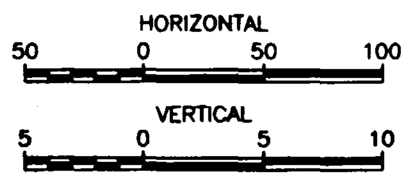
SECTION A–A



SECTION B–B

ELEVATIONS OF MW AND MHW TO BE DETERMINED

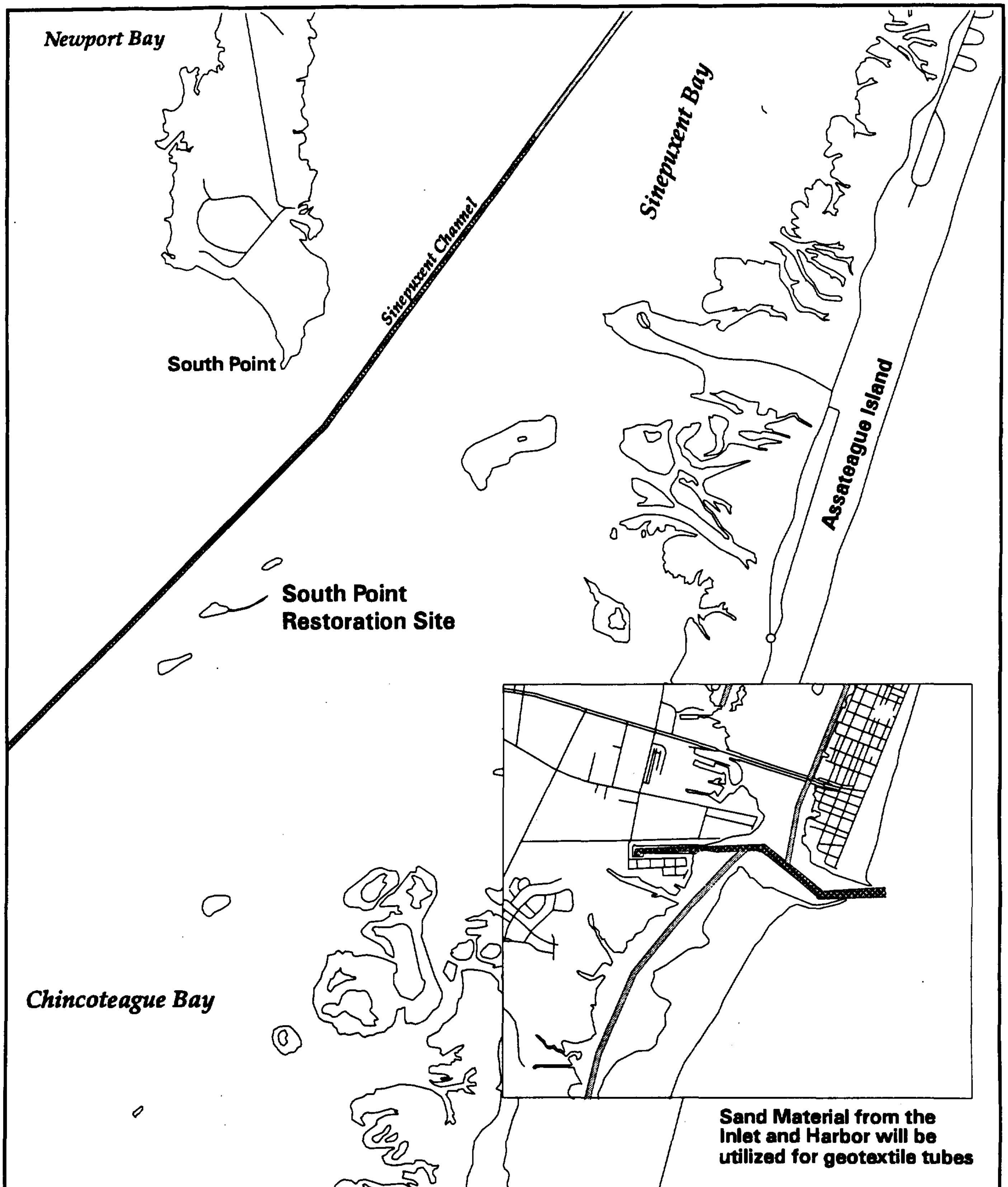
• EXACT ELEVATIONS RELATIVE TO STORM TIDE TO BE DETERMINED.



NOTE 1. DREDGED MATERIAL FROM SINEPUXENT CHANNEL IS EXPECTED TO HAVE A HIGH PROPORTION OF SILTS AND CLAYS. ADDITIONAL STUDY IS RECOMMENDED.

2. SPECIAL MEASURES MAY BE NECESSARY TO MINIMIZE TURBIDITY AND ITS EFFECT ON NEARBY S.A.V.

SOUTH POINT SPOILS



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Ocean City Water Resources Feasibility Study

South Point Spoil Restoration Sand Sources

Figure 5-5

5.7.2 Dog Island Shoal Waterbird Habitat Island Creation

5.7.2.a Physical Description of Project. The recommended plan combines the creation of 1.2 ha (3 ac) of upland island bird habitat and the creation of a minimum of 3 additional acres of salt marsh habitat within one 2.4 ha (6 ac) geotextile tube-protected island (Figure 5-6). Initial project construction would include placing sand-filled geotextile tubes to enclose a 2.4 ha (6 ac) site located on the Dog and Bitch Shoal. As part of this initial project construction, three acres of the island would be filled to provide upland nesting habitat. The remaining portion of the 2.4 ha (6-ac) site would be divided into 0.4 ha (1-ac) cells, using smaller diameter geotextile tubes; the 3 cells created would be filled and planted by local non-Federal interests. It is anticipated that approximately 0.4 ha (1 acre) could be filled in a year, taking 3 years for local interests to fill and plant the remaining 1.2 ha (3 ac). If these initial cells are not filled within several years from private dredged material sources, material from Federal or state maintained channels will be used to fill the cells. Site selection for the island was based on environmental, recreational, and technical factors, such as maintaining distance from the mainland to discourage predator access, staying within a shallow area that is not attractive to boaters, and providing access for dredgers using the site. At its maximum size the island can be no larger than 10.1 ha (25 ac) because of the nesting habitat needs of the need to minimize the island's attractiveness for predators of beach-nesting colonial waterbirds for whom the initial 1.2 ha (3 acre) upland island would be constructed. Because of the size constraint, and depending on the need for dredged material placement capacity by local interests, a maximum of an additional 7.6 ha (19-ac), adjacent to the initial 2.4 ha (6.0 ac), may be considered for filling by local dredging interests and developed as salt marsh habitat in the future. Approval of this expansion will be subject to outcome of Federal and state regulatory processes. Additional cell creation can be performed by local interests or perhaps by the Corps under the Section 1135 program.

Guidelines for design and construction of the upland and saltmarsh bird habitat island at Dog Shoals (Figure 5-7):

1. Initial construction would include placing sand-filled geotextile tubes to enclose a 2.4 ha (6 ac), kidney bean-shaped area. Portions of the geotextile tube perimeter subject to erosion would be protected by stone armor. The site would be located at the north end of the shoals, adjacent to the -0.9 m (-3 ft) contour to provide access for dredging equipment. The 2.4 ha (6 ac) area enclosed by the geotextile tubes would include one 1.2 ha (3 ac) cell that would be filled by the Corps with material dredged from the harbor and navigation channels and adjacent shoals (Figure 5-8). The elevation of the upland cell would be approximately 0.6 m (2 ft) above stormtide. The bare surface would be covered with crushed oyster or hard clam shells in a layer approximately 0.3 m (1 ft) thick to provide upland bird nesting habitat and to discourage vegetation.

2. The remaining 1.2 ha (3 ac) enclosed by the geotextile tubes would be subdivided into three 0.4 ha (1 ac) cells by placing additional, smaller diameter geotextile tubes within the enclosed 2.4 ha (6-ac). Each of the 0.4 ha (1 ac) cells would be filled by local dredgers during the following 3 years, using material dredged from the coastal bays.

3. Material placed at the site would be subject to a testing protocol to be finalized by the Corps, the project sponsors, and other natural resource management agencies. Only acceptable material will be allowed to be placed in the three 0.4 ha (1 ac) cells. Without prior chemical testing only material containing at least 75 percent sand will be allowed to be placed within the site. The 75 percent sand requirement is based on the lack of heavy industry in the project area, and the fact that contaminants tend to not adhere to large grained material such as sand. Prior to its consideration for acceptance at the site, dredged material containing less than 75 percent sand must be tested to determine whether it is clean. If placement capacity is available, appropriate Federal and state permits as well as final approval from the town of Ocean City indicating that the material is acceptable will be obtained prior to placing material at the 2.4 ha (6 acre) Federal project site.

4. After filling each of the three 0.4 ha (1-ac) cells to an elevation suitable for saltmarsh development, the cells will be planted with appropriate saltmarsh grasses by the non-Federal sponsors.

5. Construction of the initial 2.4 ha (6-ac) Federal project island would require approximately 23,000 m^3 (30,000 yd^3) of dredged material: 15,000 m^3 (20,000 yd^3) for the upland cell; and 8,000 m^3 (10,000 yd^3) for the saltmarsh cells. Development of the island to the maximum 10 ha (25-ac) size by building an additional 7.7 ha (19 ac) of salt marsh would accommodate up to 50,000 m^3 (65,000 yd^3) of material. Initial construction by the Corps would serve two functions. It would benefit colonial waterbirds by providing nesting habitat and potentially demonstrate the utility of island creation as a means of disposing of dredged material in the northern coastal bays. Material dredged from the harbor and inlet, or other channels could be used for establishment of the initial island. Following creation of the initial prototype Federal project island, material could be added incrementally to the existing island as available and as approved by Federal and state regulatory processes. In the future, incrementally added material could bring the island to its maximum design area of 10 ha (25-ac), subject to receipt of Federal and state permits.

6. If the 3 created 0.4 ha (1-ac) cells have not been filled with dredged material from local sources within 5 years of project construction, then the site will be used for the placement of material from the Federal or state channels. In addition, if SAV should develop within the placement cells prior to their being filled (effectively creating habitat), it will not deter use of the cell for its intended island creation purpose.

7. A post-construction monitoring program is being developed by the Corps and project sponsors. Monitoring by the Corps will include inspections by an engineer and a biologist on a regular 5-year cycle to determine construction integrity and biological functioning of the project.

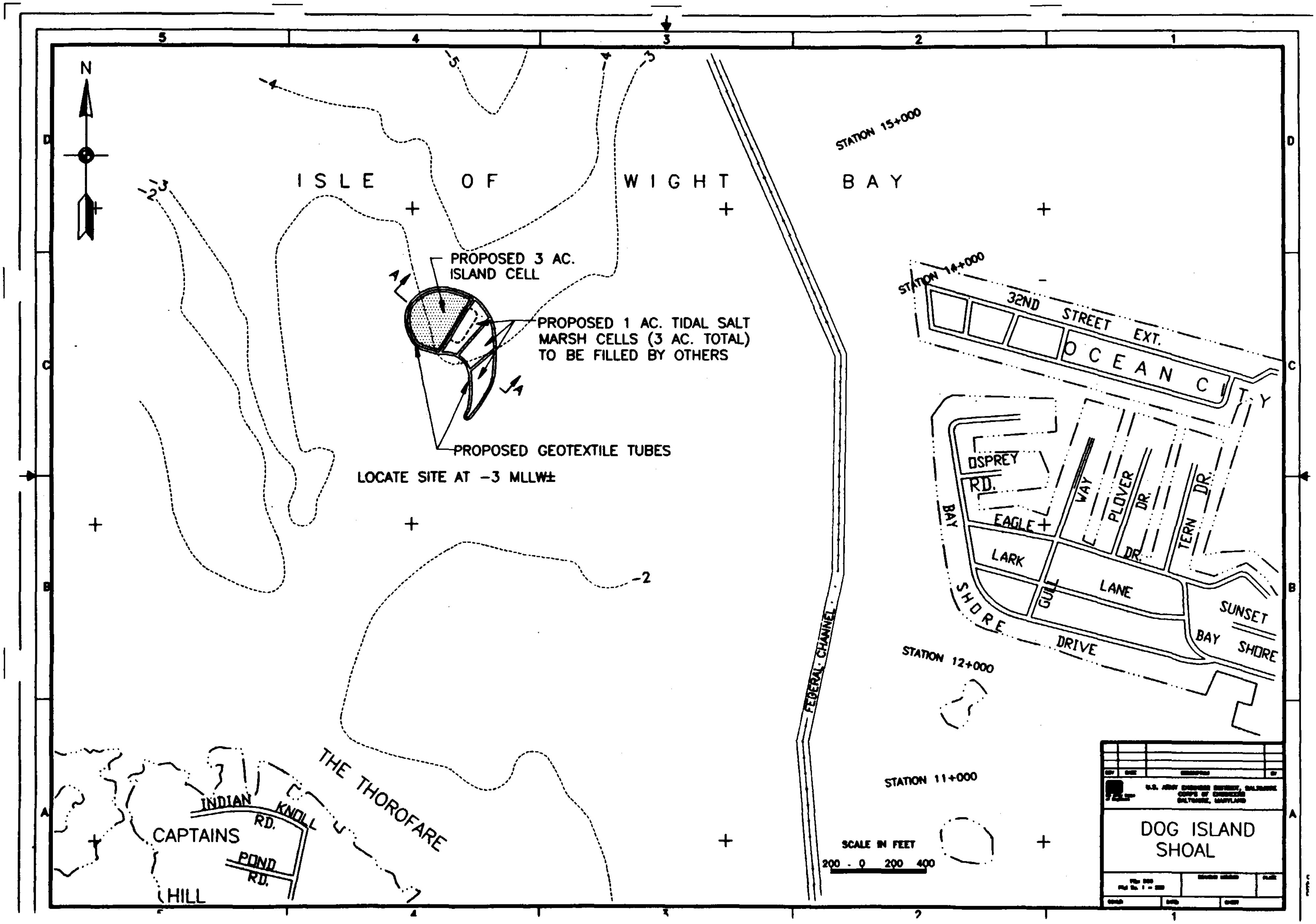
5.7.2.b Operation and Maintenance. Maintenance of this project will be the responsibility of the non-Federal sponsor. The geotextile tubes are expected to last 15 to 25 years. Because the initial 1.2 ha (3 acre) island is proposed for waterbird nesting habitat, all the constructed islands will be closed to the public by the MD DNR during the period of mid-March through August. Closure to protect beach-nesting waterbirds should also reduce wear and tear on the geotextile tubes. It is possible, though, that a few patches will be needed to repair holes in the geotextile tubes in the future. The 1.2 ha (3 ac) island is being topped with crushed shells to discourage vegetation growth. It will be the non-Federal sponsors responsibility to keep the island clear of vegetation. It is expected that semi-annual application of pre- and post-emergent herbicides will be required for this purpose. Herbicide application or mechanical removal of vegetation that becomes established will be required for the entire life of the project. Herbicide application will be thoughtfully conducted to minimize detrimental impacts to the surrounding aquatic habitat. Herbicide application is used on similar islands elsewhere for the purpose as proposed herein.

After local dredgers have filled each cell, the non-Federal sponsors will plant them with saltmarsh grasses. Vegetation management on the created 1.2 ha (3 acre) waterbird nesting habitat island will be conducted by the MD DNR in a manner compatible with the nesting needs of the species which are expected to utilize the site. For the 1.2 ha (3 ac) of saltmarsh creation, if the plants die during the project life, the non-Federal sponsor will be responsible for replanting the islands. This could be done fairly inexpensively using volunteer groups. The total operation and maintenance cost is expected to be $15,500.

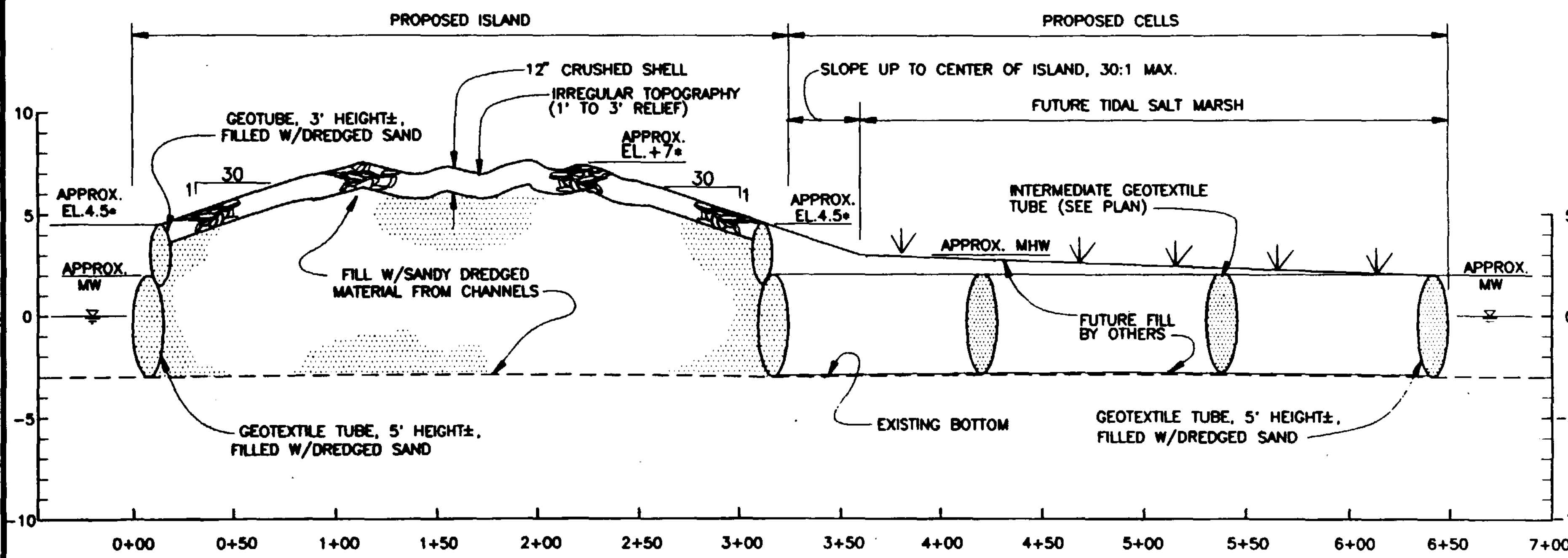
5.7.2.c Project Cost Estimate. The project cost is estimated to be $1,354,600 (Table 5-16). The project will be implemented under Section 206 of WRDA 96. The cost sharing ratio will be 65 percent Federal and 35 percent non-Federal. A copy of the detailed estimate is provided in Appendix C.

Table 5-16. Construction Costs for Dog Island Shoals.

Construction Activity	**First Cost**	**Fully Funded Cost**
Lands and Damages	$10,900	$11,900
Fish and Wildlife Facilities	$1,169,900	$1,432,900
Planning, Engineering & Design	$107,800	$117,300
Construction Management	66,000	$71,800
TOTAL PROJECT COST	**$1,354,600**	**$1,432,900**
Total Operation and Maintenance	$15,500	



ISLE OF WIGHT BAY
PROPOSED 3 AC. ISLAND CELL
PROPOSED 1 AC. TIDAL SALT MARSH CELLS (3 AC. TOTAL) TO BE FILLED BY OTHERS
PROPOSED GEOTEXTILE TUBES
LOCATE SITE AT −3 MLLW±
STATION 15+000
STATION 14+000
STATION 12+000
STATION 11+000
32ND STREET EXT.
OCEAN CITY
OSPREY RD.
WAY
PLOVER DR.
TERN DR.
EAGLE
LARK
DR.
GULL
LANE
BAY SHORE DRIVE
SUNSET
BAY SHORE
FEDERAL CHANNEL
THE THOROFARE
INDIAN KNOLL RD.
POND RD.
CAPTAINS HILL
SCALE IN FEET
200 0 200 400
U.S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
BALTIMORE, MARYLAND
DOG ISLAND SHOAL



SECTION A-A

* EXACT ELEVATION ABOVE STORM TIDE TO BE DETERMINED.

ELEVATIONS OF MW AND MHW TO BE DETERMINED

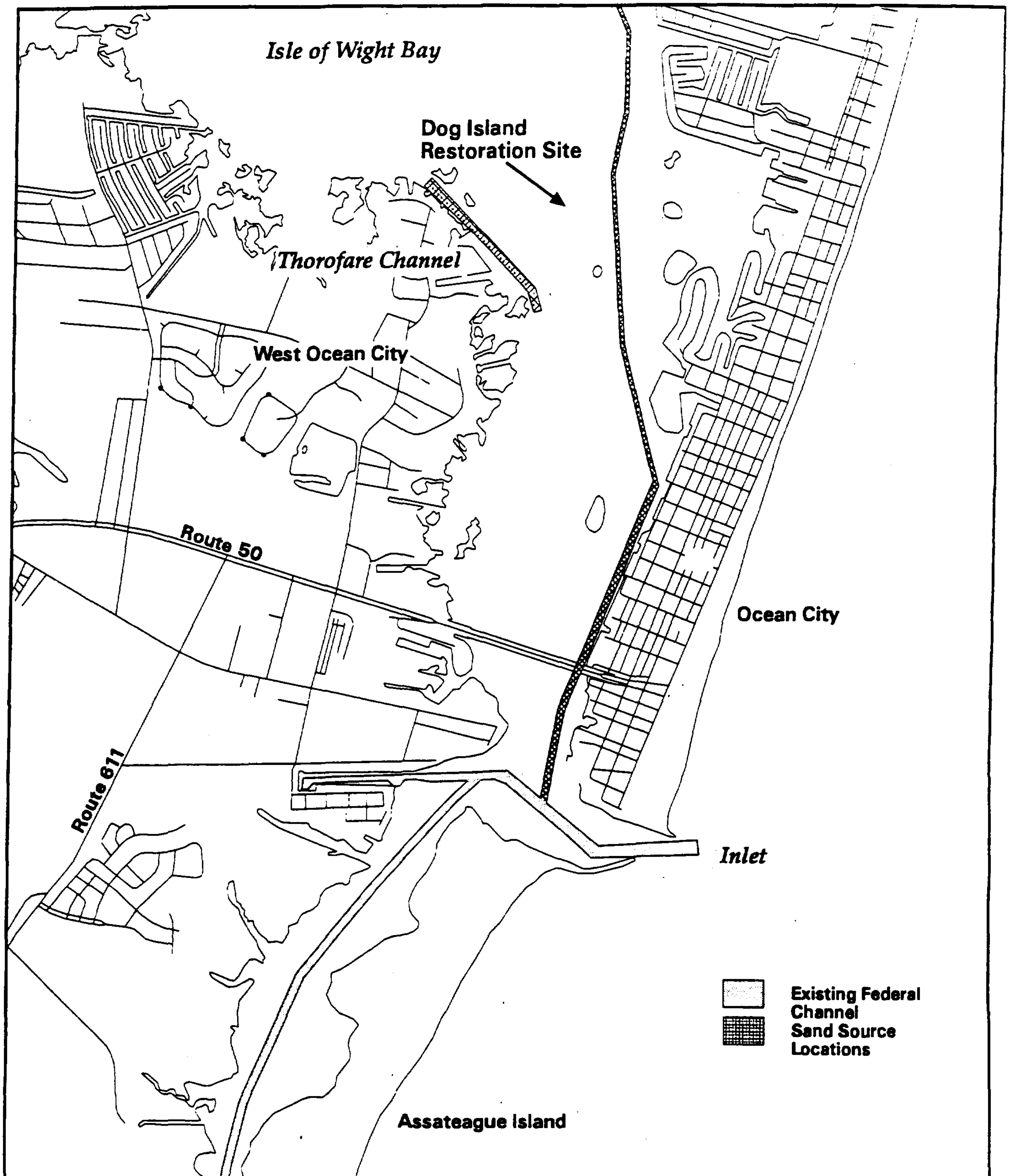
HORIZONTAL

50 0 50 100

VERTICAL

5 0 5 10

DOG ISLAND SHOAL



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Dog Island Sand Sources

Figure 5-8

5.7.3 Isle of Wight Management Area Saltmarsh Habitat Restoration

5.7.3.a Physical Description of Project. The recommended plan for environmental restoration at Isle of Wight includes the construction of saltmarsh areas along a shoreline that is currently protected by concrete rubble, and the construction of offshore breakwaters to protect the shoreline saltmarsh and to create protected aquatic habitat. The proposed environmental restoration project is located on MD DNR-owned land that is scheduled to be developed as a passive recreation area. The project location is along the southeast edge of the Isle of Wight Management area. The project will extend from the former boat ramp at the end of St. Martins Neck Road and continue east to the shoreline. The site is accessible from Route 90 and provides fishing and crabbing opportunities, as well as trails and interpretive facilities, at an important gateway into Ocean City.

Guidelines for the design and construction of the saltmarsh shoreline includes the following (Figures 5-9 and ***5-10***):

1. Up to approximately ***10*** acres (***4.0*** ha) of ***low*** shoreline saltmarsh would be constructed and restored along ***600 m (2000 ft)*** of shoreline. The offshore area in the vicinity of the proposed tidal marsh and breakwater varies from 1 to ***1.7*** feet below MLLW. The top of the existing slope is approximately 5 feet above MLLW, and the bottom is 1 foot below MLLW. The elevation of the created shoreline saltmarsh will slope from the existing grade at the top of the stone fill to match the existing shoreline grade. Areas at elevations between MW and MHW will be maximized to provide low saltmarsh habitat. East of the project area the shoreline orientation changes to north/south. This area consists of a deteriorated metal sheet pile wall approximately 135 m (450 feet) in length which will be replaced by a stone revetment.

2. Stone breakwaters will be constructed offshore of the shoreline saltmarsh. The breakwaters will form an arc offshore of the length of the shoreline saltmarsh. The western end of the breakwater will tie-in to the ***proposed access road embankment***; the eastern end will tie-in to the proposed stone revetment. The breakwaters will be positioned between the ***2.0*** foot and ***1.0*** foot MLLW bathymetric contours. The breakwaters will be constructed with gaps of a sufficient size to allow ready water exchange and movement of aquatic life. Size of the gaps and precise breakwater locations will be determined in part by engineering considerations of wave transmission and refraction through the gaps. The breakwater marsh will maximize areas at MW to MHW elevations to provide low saltmarsh habitat and slope from high elevation at the outside edges to meet the existing grade in the interior coves between the breakwaters and the shoreline. The existing deteriorated sheet pile wall will be replaced with a stone revetment to prevent erosion.

3. The material used for the shoreline saltmarsh areas will be clean sand with some fines. The source of the material will be from maintenance dredging of the nearby Federal navigation channels (Figure 5-***11***). If non-Federal channels will be utilized then state and Federal permits must be obtained. The material used will be deposited along the shoreline and then graded to slope from MHW at the shoreline to MW at a distance of 100 feet from shore. Additional material will be placed further offshore to create a few tombolos within the protected area. The existing concrete rubble revetment along the shoreline is proposed to remain. The voids in the rubble are proposed to be filled with sandy dredged material, and repositioning of a portion of the rubble is recommended to provide a smoother grade.

4. The saltmarsh areas may be vegetated with *Spartina. alterniflora,* ***Spartina patens, Distichlis spicata and Panicum virgatum*** on MW to MHW areas.

5. Additional construction is proposed for recreation purposes. ***Parking for 16 cars is proposed along the end of St. Martins Neck Road. To minimize disturbance to the existing salt marsh, parallel parking is proposed. To accommodate the parking, fill will be required to widen the road embankment. The remainder of St. Martins Neck Road is proposed to be reconstructed south of Route 90.*** In addition, a ***paved*** walking/maintenance trail, a ***timber*** picnic pavilion, ***two timber*** crabbing/fishing piers, and ***a small restroom facility is proposed at the end of St. Martins Neck Road.***

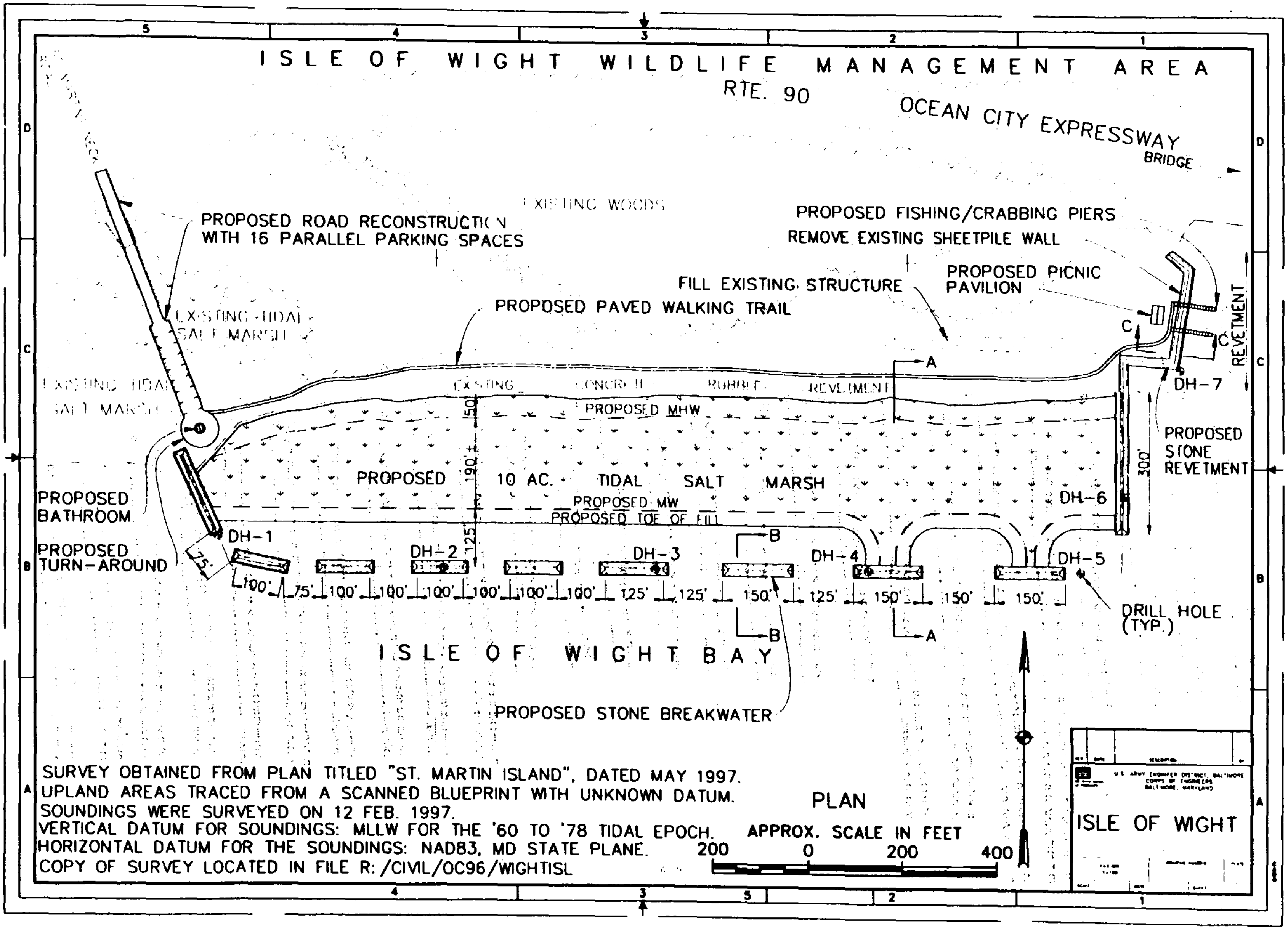
6. A monitoring program is being developed by the Corps and project sponsors. Monitoring by the Corps will include inspections by an engineer and a biologist on a regular 5-year cycle to determine construction integrity and biological functioning of the project.

5.7.3.b Operation and Maintenance. Maintenance of this project will be the responsibility of the non-Federal sponsor. For the saltmarsh creation, if the plants die during the project life, the non-Federal sponsor will be responsible for replanting the islands. This could be done fairly inexpensively using volunteer groups. The total project operation and maintenance costs are expected to be $15,300.

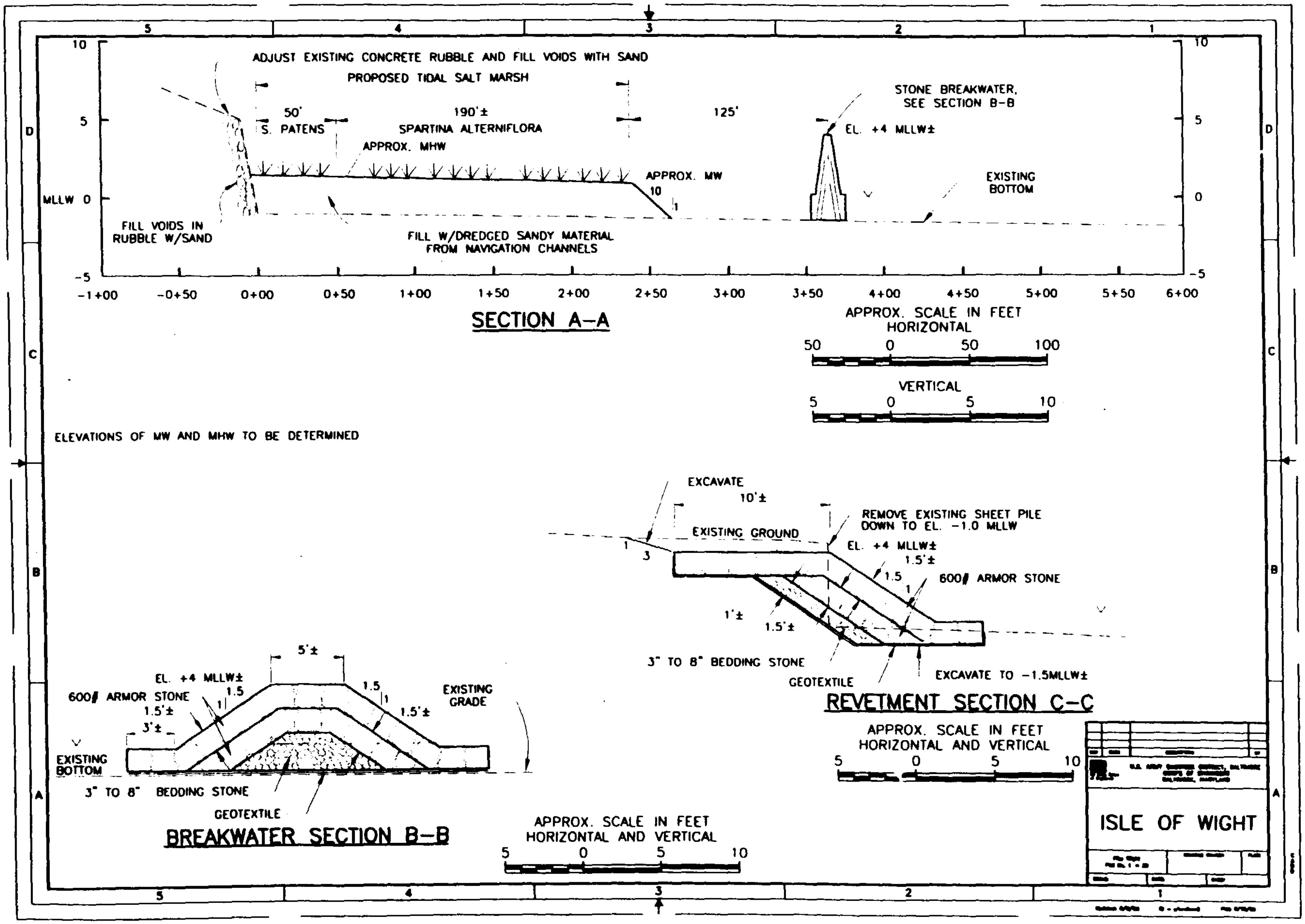
5.7.3.c Project Cost Estimate. The project cost is estimated to be $***2,444,400*** (Table 5-17.) These costs are based on a preliminary 4-acre area of protected tidal salt marsh. The project will be implemented under Section 206 of WRDA 96, as amended. Project cost sharing ratio under Section 206 is 65 percent Federal and 35 percent non-Federal. However, exact cost sharing will be determined once the project betterments are designed in the PED phase. Project betterments are a 100% non-Federal responsibility.

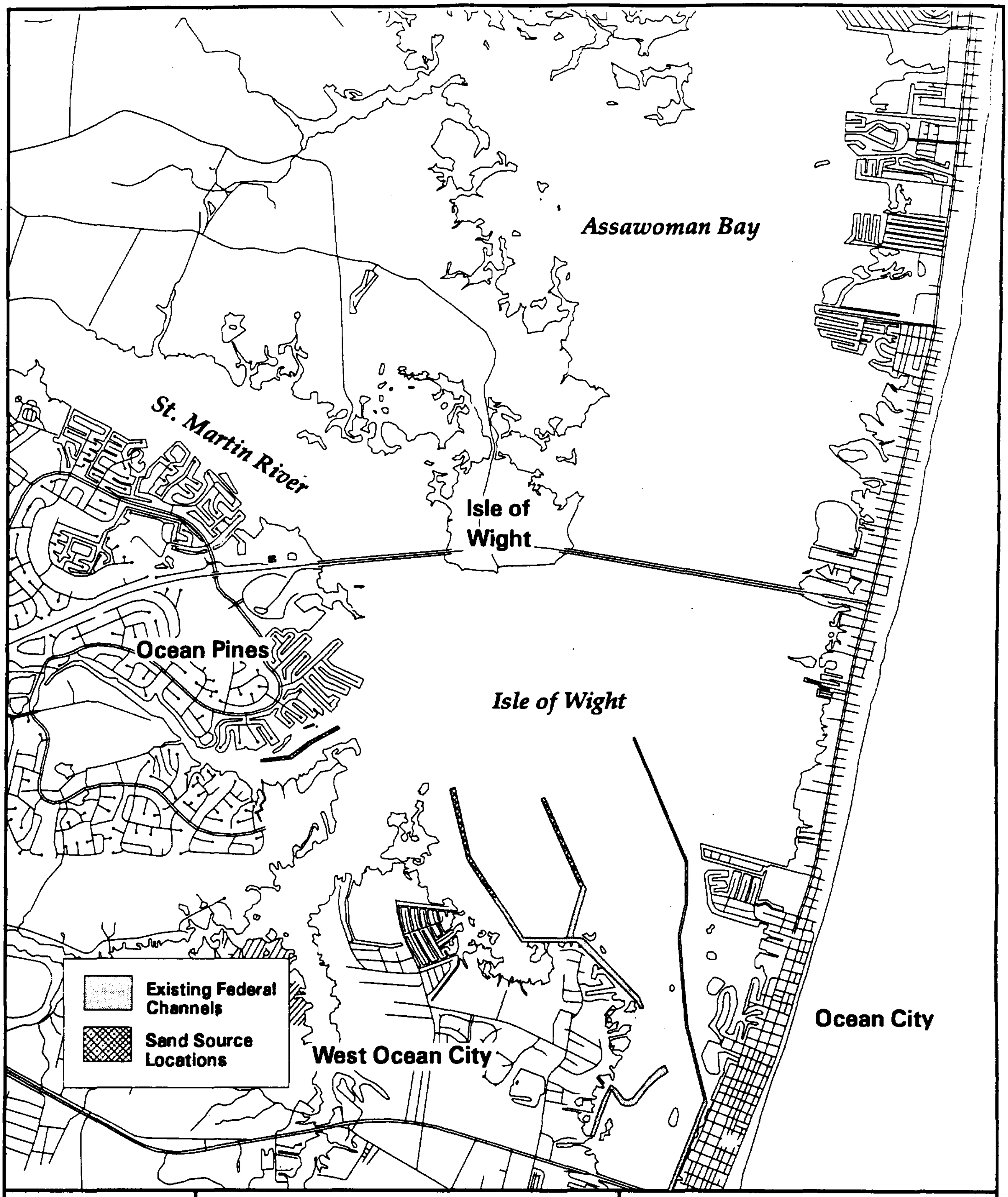
Table 5-17. Construction Costs for Isle of Wight.

Construction Activity	First Cost	Fully Funded Cost
Lands and Damages	***$41,900***	***$45,500***
Fish and Wildlife Facilities	***$942,900***	***$992,900***
Breakwaters and Seawalls	***$651,100***	***$685,700***
Recreation Facilities	***$408,100***	***$429,700***
Bank Stabilization	***$160,600***	***$169,100***
Planning, Engineering & Design	***$107,800***	***$117,300***
Construction Management	***$132,000***	***$143,600***
TOTAL PROJECT COST**	***$2,444,400***	***$2,583,800***
Total Operation and Maintenance	$15,300	



ISLE OF WIGHT WILDLIFE MANAGEMENT AREA
RTE. 90
OCEAN CITY EXPRESSWAY
BRIDGE
EXISTING WOODS
PROPOSED ROAD RECONSTRUCTION
WITH 16 PARALLEL PARKING SPACES
PROPOSED FISHING/CRABBING PIERS
REMOVE EXISTING SHEETPILE WALL
PROPOSED PICNIC
PAVILION
FILL EXISTING STRUCTURE
PROPOSED PAVED WALKING TRAIL
EXISTING TIDAL
SALT MARSH
EXISTING CONCRETE RUBBLE REVETMENT
PROPOSED MHW
REVETMENT
DH-7
PROPOSED
STONE
REVETMENT
300'
PROPOSED 10 AC. TIDAL SALT MARSH
PROPOSED MW
PROPOSED TOE OF FILL
PROPOSED
BATHROOM
PROPOSED
TURN-AROUND
DH-1
DH-2
DH-3
DH-4
DH-5
DH-6
50'
190'
125'
75'
100'
75'
100'
100'
100'
100'
100'
100'
125'
125'
150'
125'
150'
150'
150'
DRILL HOLE
(TYP.)
ISLE OF WIGHT BAY
PROPOSED STONE BREAKWATER
SURVEY OBTAINED FROM PLAN TITLED "ST. MARTIN ISLAND", DATED MAY 1997.
UPLAND AREAS TRACED FROM A SCANNED BLUEPRINT WITH UNKNOWN DATUM.
SOUNDINGS WERE SURVEYED ON 12 FEB. 1997.
VERTICAL DATUM FOR SOUNDINGS: MLLW FOR THE '60 TO '78 TIDAL EPOCH.
HORIZONTAL DATUM FOR THE SOUNDINGS: NAD83, MD STATE PLANE.
COPY OF SURVEY LOCATED IN FILE R:/CIVIL/OC96/WIGHTISL
PLAN
APPROX. SCALE IN FEET
200 0 200 400
ISLE OF WIGHT


ADJUST EXISTING CONCRETE RUBBLE AND FILL VOIDS WITH SAND
PROPOSED TIDAL SALT MARSH
50'
S. PATENS
190'±
SPARTINA ALTERNIFLORA
125'
APPROX. MHW
STONE BREAKWATER, SEE SECTION B-B
EL. +4 MLLW±
APPROX. MW
EXISTING BOTTOM
FILL VOIDS IN RUBBLE W/SAND
FILL W/DREDGED SANDY MATERIAL FROM NAVIGATION CHANNELS
MLLW 0
SECTION A-A
APPROX. SCALE IN FEET
HORIZONTAL
VERTICAL
ELEVATIONS OF MW AND MHW TO BE DETERMINED
EXCAVATE
10'±
EXISTING GROUND
REMOVE EXISTING SHEET PILE DOWN TO EL. -1.0 MLLW
EL. +4 MLLW±
1.5'±
600# ARMOR STONE
1'±
1.5'±
3" TO 8" BEDDING STONE
GEOTEXTILE
EXCAVATE TO -1.5MLLW±
REVETMENT SECTION C-C
APPROX. SCALE IN FEET
HORIZONTAL AND VERTICAL
5'±
EL. +4 MLLW±
600# ARMOR STONE
1.5'±
3'±
EXISTING GRADE
EXISTING BOTTOM
3" TO 8" BEDDING STONE
GEOTEXTILE
BREAKWATER SECTION B-B
APPROX. SCALE IN FEET
HORIZONTAL AND VERTICAL
ISLE OF WIGHT



US Army Corps of Engineers
Baltimore District

Ocean City Water Resources Feasibility Study

Isle of Wight Sand Sources

Date: 17-FEB-199[illegible]
[illegible]/fig5-11.map

Figure 5-11

5.7.4 Ocean Pines Saltmarsh Restoration

5.7.4.a Physical Description of Project. The recommended plan for restoring saltmarsh on two parcels of filled land at Ocean Pines includes removing approximately 0.6 to 0.9 m (2 to 3 feet) of fill material, creating tidal creeks, grading to intertidal elevations to allow tidal flow, and revegetating the sites with saltmarsh plants. The project area is located in Section 17 adjacent to a proposed residential development. The 2.4 ha (6-ac) site is located at the north side of a loop road; the 1 ha (2.5-ac) parcel is located on the south side of the loop road (Figure 5-***12***). (A 0.6 ha (1.5 ac) parcel located adjacent to the 2.4 ha (6 ac) site was also filled and will require similar restoration efforts, however, that site is the responsibility of the developer.)

Guidelines for the design and construction of saltmarsh areas at Ocean Pines include the following (Figure 5-***13***):

1. Restoration of both the 2.4 ha (6 ac) and 1 ha (2.5-ac) sites will require the excavation of existing fill to bring 90 percent of each site to an intertidal elevation (between MW and MHW) to create low marsh. The remaining 10 percent of the land will be high marsh areas where low marsh ties into the existing elevations of surrounding land. Information on local saltmarsh elevations indicates that an elevation range for created low marsh from less than 0.4 to 0.5 m (1.3 to 1.6 ft) will be appropriate. This elevation range is based on information from an adjacent site and will be field checked using the upper boundary of tall-form *Spartina alterniflora* as MHW if the shoreline is gradually sloped (short-form *S. alterniflora* is not a good indicator of the MHW line.)

2. Tidal creeks will be constructed to enhance the value of the sites to tidal organisms and the sites will be graded to flow into the created tidal creeks. The creek bottoms will be level and the creeks will be oversized to ensure the presence of salt water at low tide, to minimize the future impacts of stormwater runoff, and to decrease maintenance requirements. In order to minimize the impacts of wave action, the creeks will be designed so that the mouths are in protected coves.

3. Each of the sites will be planted with *Spartina alterniflora* over the entire created low marsh area and with *Spartina patens*, *Distichlis spicata*, and *Panicum virgatum* in created high marsh fringe where the marsh project ties in to adjacent uplands. Vegetation will be fertilized if determined to be necessary.

4. Material excavated from each of the parcels will be placed at a material staging area as part of the project.

5. A monitoring program is being developed by the Corps and project sponsors. Monitoring by the Corps will include inspections by an engineer and a biologist on a regular 5-year cycle to determine construction integrity and biological functioning of the project.

5.7.4.b Operation and Maintenance. Maintenance of this project will be the responsibility of the non-Federal sponsor. It is expected that minimal maintenance will be required. An annual inspection of the site will be performed for the first 5 years following project construction. If a portion of the plants die during the project life, the non-Federal sponsor will be responsible for replanting them. This could be done fairly inexpensively using volunteer groups. The total operation and maintenance costs are expected to be $3,400.

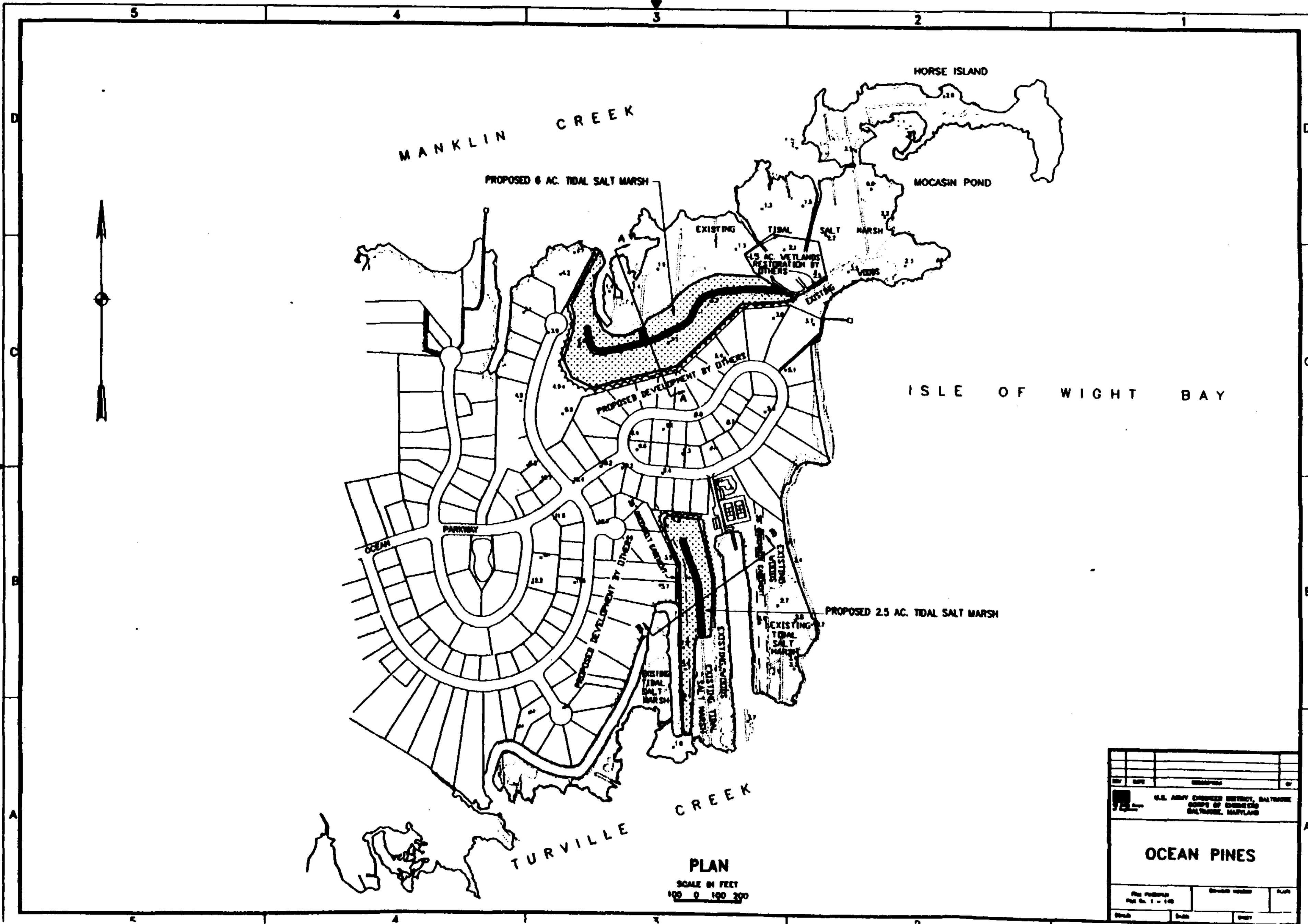
5.7.4.c Project Cost Estimate. The project cost is estimated to be $773,100 (Table 5-18). The project will be implemented under Section 206 of WRDA 96. Cost sharing will be 65 percent Federal and 35 percent non-Federal. A copy of the detailed cost estimate is provided in Appendix C.

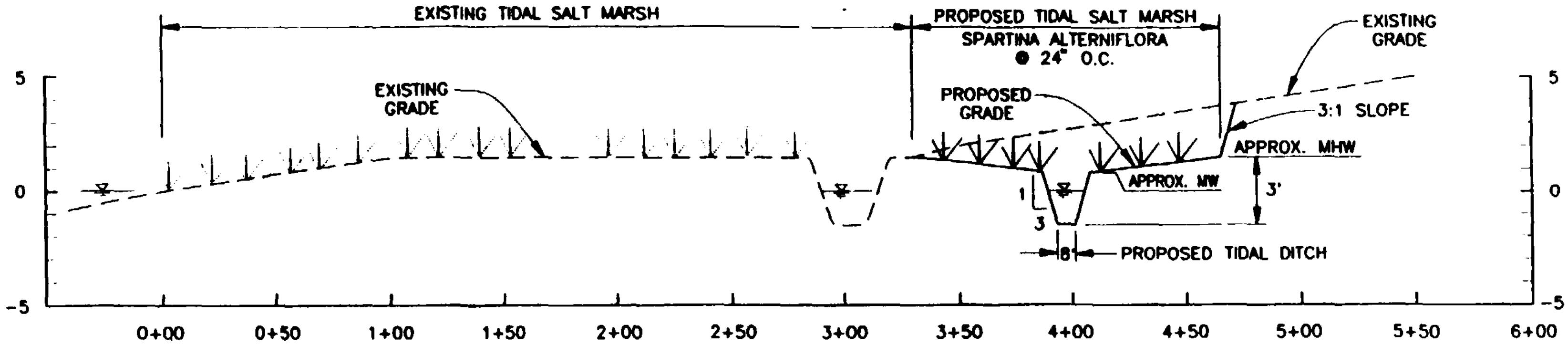
Table 5-18. Construction Costs for Ocean Pines.

Construction Activity	**First Cost**	**Fully Funded Cost**
Lands and Damages	$50,000	$54,400
Fish and Wildlife Facilities	$607,600	$639,700
Planning, Engineering & Design	$66,000	$71,800
Construction Management	$49,500	$53,900
TOTAL PROJECT COST	**$773,100**	**$819,800**
Total Operation and Maintenance	$3,400	

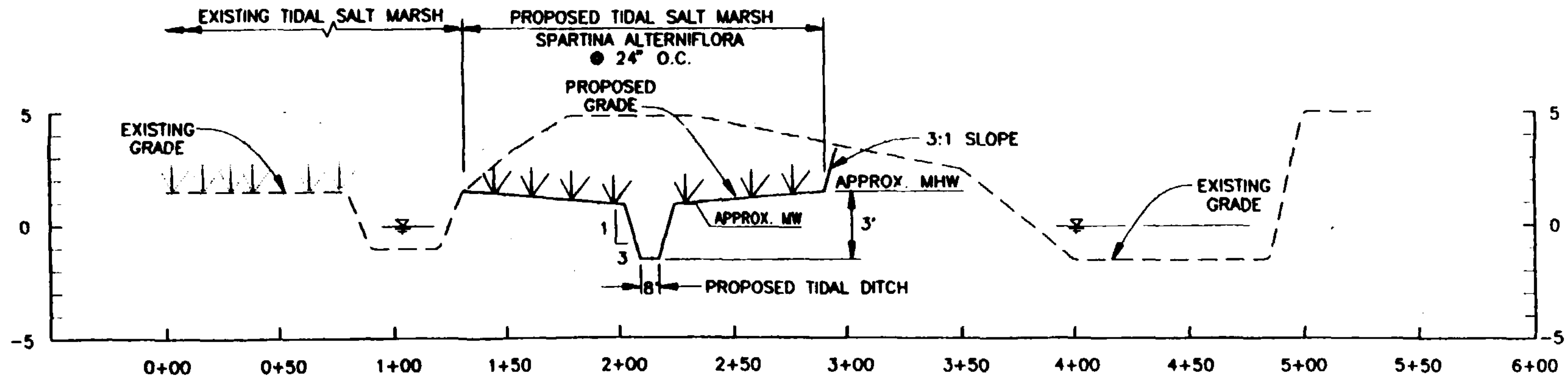
5.7.5 Risk and Uncertainty

Risk and uncertainty arise from the underlying variability of complex natural and biological dynamics of the coastal ecosystem in the evaluation of these environmental restoration projects. It is recognized that the cost effectiveness evaluation of environmental outputs implies a degree of certainty in the economic costs and biological effectiveness of alternatives. The range of outputs and costs could be greater or lesser than the levels estimated in the evaluation. In order to reduce risk and uncertainty, the planning process was designed to narrow the range of uncertainty in the identification of needs, formulation of objectives, screening of sites, and sizing of alternative solutions. Physical, biological, geographical and institutional constraints were taken into consideration in the site selection and site evaluation process. The scarcity and significance of resources guided the evaluation of habitat needs. The sites selected and the sizing of those sites represent the outcome of this process.


MANKLIN CREEK
HORSE ISLAND
MOCASIN POND
PROPOSED 6 AC. TIDAL SALT MARSH
EXISTING TIDAL SALT MARSH
1.5 AC. WETLANDS RESTORATION BY OTHERS
WOODS
EXISTING
ISLE OF WIGHT BAY
PROPOSED DEVELOPMENT BY OTHERS
OCEAN
PARKWAY
PROPOSED 2.5 AC. TIDAL SALT MARSH
EXISTING WOODS
EXISTING TIDAL SALT MARSH
EXISTING TIDAL SALT MARSH
EXISTING WOODS
TURVILLE CREEK
PLAN
SCALE IN FEET
100 0 100 200
OCEAN PINES

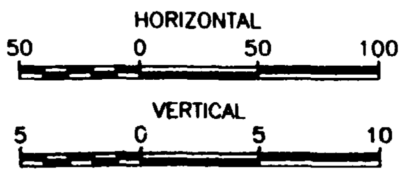


SECTION A–A



SECTION B–B

ELEVATIONS OF MW AND MHW TO BE DETERMINED



OCEAN PINES

SECTION 6

IMPACTS TO PROJECT AREAS

6.0 INTRODUCTION

During the process of selecting the preferred alternatives for the long-term sand management, navigation, and coastal bays environmental restoration projects, the Baltimore District and the project sponsors evaluated impacts to the physical environment, to biological resources, to society, and to the economy from the alternative plans under consideration. The Baltimore District has prepared several reports that provide additional information on the project area. These reports may be obtained upon request from the District. Recent reports include the Ocean City, Maryland, and Vicinity Water Resources Draft Integrated Interim Report and Environmental Impact Statement Restoration of Assateague Island (May 1997), and the Ocean City, Maryland, and Vicinity Water Resources Study Reconnaissance Report (May 1994). The discussions therein are incorporated by reference.

This section focuses on impacts of the selected alternatives, which are summarized in Table 6-1. Impacts that are likely to be substantial and issues of particular concern to society are addressed at length, while impacts that are likely to be negligible or minimal are addressed briefly to limit the length of this document. This section includes a consideration not only of direct impacts, but also of indirect and cumulative impacts of the proposed actions.

Direct impacts occur at the project sites at the time of construction. For the long-term sand management program, direct impacts will occur annually or semi-annually as a result of (1) dredging sand from the ebb- and flood-tidal shoals, the navigation channels, and the Ocean City updrift fillet; (2) transporting this sand to Assateague Island; and (3) placing this sand in the surf zone of Assateague Island. Backpassing and placing material on the Ocean City beach is covered under the Atlantic Coast of Maryland Shoreline Protection Project EIS. For the navigation projects, direct impacts will occur during (1) dredging, (2) transporting dredged material, and (3) placing dredged material. For the coastal bays environmental restoration projects, direct impacts will occur during (1) site preparation, which may include excavation and use of herbicides; (2) construction of shoreline stabilization features; (3) dredging and transport of the dredged material used to form the substrates for the projects; and (4) project construction, which may include placement of dredged and excavated material and shell, grading of material, planting of vegetation, and application of fertilizer.

Table 6-1 Summary of Project Impacts

	Long Term Sand Management						Navigation Improvements						Coastal Bays Environmental Restoration					
	Direct			Indirect			Direct			Indirect			Direct			Indirect		
	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)	Type of Impact (1)	Range of Impact (2)	Duration of Impact (3)
Physical Environment																		
Surficial Geology, Soils, and Sedimentary Processes	C	WS	M	B	WS	M	*	L	M	C	L	Y	C	L	Y	*	L	Y
Physiography and Topography	N/A	N/A	N/A	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	C	L	Y	*	L	Y
Soils	N/A	N/A	N/A	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	*	L	Y	B	L	Y
Bathymetry	C	WS	M	C	WS	M	C	L	M	C	L	Y	C	L	Y	*	L	Y
Hydrodynamics	*	WS	N/A	*	WS	M	*	L	N/A	*	L	N/A	*	L	N/A	*	L	N/A
Air Quality	*	WS	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A
Water Quality	*	WS	M	N/A	N/A	N/A	*	L	D	N/A	N/A	N/A	*	L	M	* (DI)	L	Y
Biological Resources																		
Wetlands	N/A	N/A	N/A	B	WS	Y	N/A	N/A	N/A	B	L	Y	*	L	M	B	L	Y
Submerged Aquatic Vegetation	N/A	N/A	N/A	B	WS	Y	N/A	N/A	N/A	B	L	Y	A	L	M	B	L	Y
Upland Vegetation	N/A	N/A	N/A	B	WS	Y	N/A	N/A	N/A	B	L	Y	*	L	M	B	L	Y
Benthos	A	WS	Y	A	L	Y	A	L	M	*	L	M	A	L	M	B	L	Y
Nekton	*	WS	M	*	WS	Y	*	L	M	N/A	N/A	N/A	*	L	M	B	L	Y
Plankton	*	WS	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A
Birds (4)	*	N/A	N/A	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	*	L	M	B	L	Y
Mammals (4)	*	N/A	N/A	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	*	L	M	B	L	Y
Reptiles and Amphibians (4)	*	N/A	N/A	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	*	L	M	B	L	Y
Rare, Threatened, and Endangered Species	*	N/A	N/A	*	WS	Y	*	L	M	N/A	N/A	N/A	*	L	M	B	L	Y
Community and Socioeconomic Setting																		
Recreation	A	L	M	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	A	L	M	B	L	Y
Cultural and Historical Resources	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	C	L (OP)	N/A	N/A	N/A	N/A
Hazardous, Toxic, and Radioactive Waste	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Land Use	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Visual and Aesthetic Value	A	L	M	B	WS	Y	N/A	N/A	N/A	N/A	N/A	N/A	A	L	M	B	L	Y
Prime and Unique Farmland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wild and Scenic Rivers	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Noise	*	L	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A	*	L	M	N/A	N/A	N/A
Navigation	B	L	Y	B	L	Y	B	L	Y	B	L	Y	N/A	N/A	N/A	B	L	Y
Demographics	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Economics	C	L	Y	B	WS	Y	C	L	M	N/A	N/A	N/A	C	L	M	N/A	N/A	N/A
Environmental Justice	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1 A = Adverse
B = Beneficial
* = Negligible
C = Change that is neither + or -
N/A = Not Applicable

2 L = Local
WS = Wide Spread
N/A = Not Applicable

3 D = Days
M = Months
Y = Years

4 Does not include endangered/threatened species

OP Ocean Pines
DI Dog Island Shoals

Indirect impacts occur after project construction or may be removed in distance from the direct impact locations. For the long-term sand management program, indirect impacts will occur as hydrodynamics of the inlet and its tidal shoals are altered and as natural processes modify the dredged area of the ebb and tidal shoals, navigation channels, and Ocean City fillet. Indirect impacts will also occur as these same processes redistribute the sand placed on Assateague Island. For the navigation improvement projects, indirect impacts will occur as waves and currents redistribute sediment in and adjacent to the dredged channels, and as bathymetric bedforms and currents adjust to the changes that accompany shoaling of the channels. Predictions of indirect environmental impacts from the long-term sand management and navigation components of the study rely on output from computer models. The models provide an objective means of predicting the consequences of various alternative plans. (This discussion assumes that the models provide an accurate representation of the actual end result.) All other predictions of impacts rely on best professional judgment (for additional information regarding modeling see Appendix A). For the coastal bays environmental restoration projects, indirect impacts will occur as sedimentation patterns and currents alter, forming new patterns to accommodate the presence of the new land masses. Indirect impacts, such as the alteration of the food web will occur as salt marsh and terrestrial islands replace open water habitat and as populations of colonial waterbirds increase.

Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts are an important consideration for the area, since the coastline is already intensively managed for shoreline stabilization and navigation purposes.

6.1.1 Surficial Geology and Sedimentary Processes

6.1.1.a Long-term Sand Management

Assateague Island

Direct Impacts

Up to 160,000 cubic meters (208,000 yd^3) will be used for long-term sand management. Approximately 145,000 cubic meters (189,000 yd^3) will be placed annually in the nearshore of Assateague Island. This 145,000 cubic meters (189,000 yd^3) of material will be placed annually, or semi-annually in volumes of 72,500 cubic meters (94,300 yd^3) each placement cycle. A shallow split-hull hopper dredge will be used to transport material to Assateague Island. Material will be placed in the surf zone in water depths of less than 1 meter (3 ft) to as deep as 4.6 meters (15 ft), from the shoreline to about 150 meters (500 ft) offshore. The dredge will place volumes of up to 237 cubic meters (310 yd^3) of sand at each placement site, although it may travel with lesser volumes as wave conditions dictate. The vessel will be stationary or nearly stationary during discharge of sand. Since the material will drop directly from the split-hull vessel into shallow water, it is assumed that minimal spreading of material will occur in the water column. Therefore, for the purposes of this impact analysis, it is assumed that each placement site will, at a maximum, be twice the approximate dimensions of the vessel: 18 meters (60 ft) by 90 meters (300 ft), or 0.16 hectares (0.4 ac). For each semi-annual phase of the project, it is expected that a minimum of 275 placement events will occur. If each placement site is separate spatially and if minimal dispersion occurs in the water column, then 44 hectares (110 ac) of nearshore bottom will be directly impacted. If a placement site is used more than once, the area that is directly impacted will be reduced. At each placement site, sand deposited by the hopper dredge will cover the bottom up to a maximum of 1 meter (1 yd) deep. The placed material will be thickest in the center of the placement area and will thin towards the outer edges. This will alter surficial sediment character to that of the material placed at the sites. The grain size of placed material will be within the range of natural sediments that occur in the nearshore and on the island.

Indirect Impacts

The long-term sand management program will largely restore the geological integrity of Assateague Island. The program will differ from natural delivery in that material will be placed on the island in large volumes in concentrated areas, over short periods of time, rather than in small, more widely dispersed volumes over longer periods of time. Of the potential plans considered in Section 3.5 that rely on dredging, the semiannual placement of material best approximates the natural process. The increased volume of sand contained within the island will reduce the probability that a breach will occur on northern Assateague Island. Placed material will effectively persist within the subtidal portion of the project area only until the next renourishment action.

Immediately following placement in the waters of Assateague, the sand will be transported in currents generated by waves and tides. Sand will be introduced into the longshore transport system and will begin moving subtidally in the nearshore. The movement of sand is difficult to predict with certainty, direction and rate of movement will depend upon weather conditions in the weeks and months following placement. Sand placed north of the nodal point from 5.0 kilometer (3.1 mi) to 6.3 kilometer (3.9 mi) south of the inlet would generally travel in a northerly direction and would be effectively trapped at the northernmost end of the island by the jetty and local hydrodynamic conditions. A minor portion of this material is expected to be deposited within the ebb shoal. The monitoring program will adjust the amount of material dredged from the ebb shoal to account for accretion in that area. Sand placed in the nearshore south of the nodal point from 6.3 kilometers (3.9 mi) to 8.4 kilometers (5.3 mi) south of the inlet would travel generally in a southerly direction. If a strong northeaster storm occurs shortly following placement, then southward sand movement will likely occur along the entire project area.

Following placement in autumn or winter, material redistributed in the nearshore by waves and currents may form a sand bar parallel to the shoreline. During summer months, sand will migrate on-shore and merge with the existing island, increasing island width. This increase in width will not be detectable beyond several kilometers south of the placement area. The average shoreline retreat rate of the northern end of the island is expected to be reduced from in excess of 5 meters (16 ft) per year (current condition) to a retreat rate comparable with the pre-jetty historic condition of the island which averaged approximately 1.5 meters (5 ft) per year.

During storm events, overwash will move some of the sand that has been added to the system and deposit it on the island interior. Some of the material will be transported seaward during storm events, from the placement area to deeper waters beyond the depth of closure. Nearshore and offshore sediments in the vicinity of Assateague Island are sandy, so no significant change in surficial sediment character is expected.

Ocean City Updrift Fillet and Tidal Shoal Areas

Direct Impacts

Dredging will remove up to 160,000 cubic meters of sediment annually from the bypassing areas. Assateague Island long-term restoration will require 145,000 cubic meters (189,000 yd^3) and Ocean City requires up to 15,000 cubic meters (20,000 yd^3). It is anticipated in the first year that sand management will remove approximately 40,000 cubic meters (52,000 yd^3) from the Ocean City fillet; 100,000 cubic meters (130,000 yd^3) from the ebb shoal; and 20,000 cubic meters (26,000 yd^3) from the navigation channels and flood shoal. Impacts of dredging will be monitored, and the removal of sand will be conducted at a rate comparable to the shoaling rate that characterizes these areas. A detailed dredging plan will be developed during the Plans and Specifications Phase in collaboration with local, state, and Federal agencies. The removal of sand from each of these features can be considered a minor temporary loss, since it is expected that the excavated volume will be replaced in the foreseeable future by natural processes. Sand underlying the material to be removed at each site is similar in grain size to that which will be removed, so the borrow area surface sand is expected to remain similar in character.

Indirect Impacts

Dredging will cause minor and localized indirect impacts by altering tidal and wave hydrodynamics at each borrow site. These changes will in turn induce minor alterations to shoaling and erosion patterns throughout the area of the ebb and flood-tidal shoals and inlet. However, impacts to borrow areas and the system will be minimized through strategic removal of only a small portion of the available volume from any given site. Impacts will be monitored to manage the dredging rate in subsequent years. It is anticipated that the profile will quickly grade itself to a 1:15 slope below the MWL line and then eventually conform to the original predredging shape (Appendix A10). Currents and waves will modify the excavated area after dredging and, over time, depressions created by dredging are likely to be filled in and modified by material transported from adjacent areas.

The long-term sand management program is expected to reduce the shoaling rate in the vicinity of the flood tidal shoals in the coastal bays. Reduced influx of sediment to the coastal bays is likely to slow the growth of, or perhaps even cause the erosion of, flood-tidal shoals in the coastal bays (including Skimmer Isle), which are formed and maintained by inflow of sand from the inlet. However, changes made to the yearly dredging plan in accordance with results of monitoring will minimize impacts to Skimmer Isle.

6.1.1.b Navigation

Direct Impacts
Dredging will remove approximately 68,000 cubic meters (88,000 yd^3) of sediment from the Ocean City harbor and 46,000 cubic meters (60,000 yd^3) from the inlet. The alignment of the channel will follow the alignment of the existing channel. Sediment underlying the material to be dredged in the harbor will be sand. This will be exposed at the surface following dredging.

Indirect Impacts
Potential impacts to surficial geology and sedimentary processes could best be predicted by considering likely alterations to hydrodynamics. Deepening the harbor and inlet are not expected to significantly alter the hydrodynamic conditions, shoaling rates, nor patterns (Appendix A5). Only negligible changes to surficial sediment or patterns of erosion and deposition are expected. Over time, the dredged sites would be expected to reshoal with sediments comparable to those currently shoaling the channel. Implementation of the long-term sand management program will likely reduce the shoaling rate in the harbor. The LTSM will dredge sand from a large area around the Ocean City inlet, including the navigation channels south of route 50. Consequently, the frequency at which the harbor and inlet will be dredged in the future will be reduced.

6.1.1.c Coastal Bays Environmental Restoration Projects

Dog Island Shoals

Direct Impacts
Surface sediments will be buried and will conform to the character of the constructed islands.

Indirect Impacts
The island will cause alterations in sediment deposition and erosion patterns, and is expected to ultimately evolve to a shape resembling Skimmer Island. Because of the action of tidal currents carrying sediment and the protection that the created island would offer on its south side to wave action from the north, the water to the immediate south of the island is expected to shallow. Tidal currents will cause sediment to accumulate as a V-shaped shoal with the point of the V pointing southwards. In contrast, on the north side of the island, any sand that accumulates as shoals is expected to be subtidal and to occur as finger shoals, oriented roughly north to south off

the east and west ends of the island. These shoals may ultimately hook and join together, creating a protected shallow water area. Because of the presence of approximately a 1 meter (3 ft) thick layer of non-dewatered clays that lies buried below the sand underlying the area, some minor post-construction subsidence of the created island is expected.

Isle of Wight

Direct Impacts
Surface sediments will be buried and will conform to the character of the constructed islands.

Indirect Impacts
The presence of the ***breakwaters*** will alter wave patterns as well as patterns of sediment deposition and erosion. Tidal currents in the area are very weak, and no significant change in currents is expected. Fine-grained sediments will accumulate in the protected waters between the created islands and the created shoreline marsh. Some bottom scour on the southern bayside of the created island may occur due to refraction of waves from the stabilization structure.

Ocean Pines

Direct Impacts
Excavation of fill material will expose portions of the previous tidal marsh sediments at the surface. A portion of the new surface will consist of compacted fill and reed grass remains. Excavated fill material will temporarily cover the upland disposal site within close proximity of the restoration site. These materials will be subsequently used by the developer.

Indirect Impacts
Following its conversion to intertidal elevations, the marsh is expected to accrete sediment and keep pace with rising sea level.

South Point Spoils

Direct Impacts
Surface sediments will be buried and will conform to the character of the constructed islands. The shoreline of the existing island will be stabilized, and the shoreline sediments of the island will be protected from direct physical environment exposure by geotextile fabric.

Indirect Impacts
The shoreline of the stabilized existing island will effectively cease to erode, and sediments from the eroding island will not be transported into Chincoteague Bay. Construction of the new 1.2 ha (3 ac) island will create a partially protected waterway between the created island and existing island. This will induce some accumulation of fine-grained sediments between the islands. This area is not expected to shoal in significantly because the created island and the existing island

may funnel wind-driven currents and cause scour locally to greater than current water depths, exposing subsurface sediments at the surface. Bottom scour on the south and west sides of the created island may occur due to refraction of energy from the stabilization structure.

6.1.2 Physiography and Topography

6.1.2.a Long-term Sand Management

Assateague Island

Direct Impacts
No direct physiographic or topographic impacts are expected, since the material will be placed in the nearshore rather than on the island. No restoration activities will take place on the island.

Indirect Impacts
Sand added to the nearshore during the autumn and winter placements will likely accrete to the island shoreline during summer months, increasing island width by up to several meters (feet) in the project and immediately downdrift areas. It is possible that some of this may make its way onto the terrestrial portion of the island. If so, some of this material will be transported by wind and may locally increase island elevation. Over time, it is possible that small dunes may form, with local relief exceeding 1.5 meters (5 ft). Increased elevation is expected to reduce the frequency of cross-island overwash. The impacts of any dunes that form to rare species are addressed in section 6.5.

Coastal Bays Mainland

Direct Impacts
Because no long-term sand management restoration activities are planned for the coastal mainland, no direct impacts are expected.

Indirect Impacts
If a breach occurred, it would produce substantial impacts to the mainland, including increased wave erosion and currents near the shoreline which could damage dwellings and property. The project will reduce the likelihood of the island breaching. Restoration of the sediment supply in conjunction with the short-term restoration project, may potentially promote local growth of dunes and an increase in height of Assateague Island and may reduce the frequency at which the island is completely submerged during severe storms. This may reduce cross-island transmission of storm waves that can erode the mainland shoreline.

6.1.2.b Navigation Improvements

Direct Impacts and Indirect Impacts

There are no direct or indirect physiographic or topographic impacts that will result from the navigation improvements since neither the mainland nor any islands will be affected.

6.1.2.c Coastal Bays Environmental Restoration Projects

Direct Impacts

Islands will be created where no natural islands have previously existed at Isle of Wight, Dog Island Shoals, and South Point Spoils. The Ocean Pines salt marsh restoration project will lower the site to intertidal elevations. The significance of this change in topography is that it will allow salt marshes to grow in these area.

Indirect Impacts

No significant indirect physiographic or topographic impacts will result from the island construction projects at Isle of Wight, Dog Island Shoals, or South Point Spoils. At Ocean Pines, the restored marsh surface is expected to accrete sediment as sea level rises.

6.1.3 Soils

Direct Impacts

Because long-term sand placement will occur within the surf zone of Assateague Island and navigational improvements will occur within the harbor and inlet waterways, no direct impacts to soils are expected from the proposed long-term placement project or navigation projects. Island creation at Dog Island, Isle of Wight and South Point Spoils will create new soils in the associated terrestrial and aquatic habitats. Clean dredged material, as determined by appropriate testing, will be used to create soil at these sites. No impacts to existing soils are expected at Isle of Wight as a result of salt marsh construction along the existing shoreline. Terrestrial portions of the proposed project area consist of concrete rubble that covers existing soil and sediment. At Ocean Pines, the removal of fill material will make restore/create tidal soils.

Indirect Impacts

With long-term sand placement within the surf zone of Assateague Island, the terrestrial acreage of the island is expected to increase somewhat and terrestrial soil area will increase. No indirect impacts to soils are expected from the navigational improvements within the harbor and inlet waterways. No indirect impacts are anticipated at Dog Island, Isle of Wight and South Point Spoils. At Ocean Pines, the removal of fill material will restore wetland soil functions. Since the original tidal soils will be compacted under the fill, some fill will remain following excavations in order to achieve intertidal elevations.

6.1.4 Bathymetry

6.1.4.a Long-term Sand Management

Assateague Island

Direct Impacts
Placement of sand in the nearshore of Assateague Island will cause local shallowing of the nearshore at placement sites during and immediately following placement. As discussed in Section 6.1.1 (surficial geology and sedimentary processes), it is expected that approximately 44 ha (110 ac) of nearshore bottom will be shallowed by the placement of several feet of material. At each placement site, sand dumped from the hopper dredge will cover the bottom with sand a maximum of up to 1 m (1 yd) deep in an area approximately 91 meters (300 ft) by 18 meters (60 ft).

Indirect Impacts
Waves and currents will rapidly redistribute material following placement. As a consequence of autumn and winter weather conditions, the placed material may form a sandbar offshore causing a shore-parallel zone of shallower water. During summer, the sand bar may weld to the island and water depths will then return to pre-project depths. Restoration of the sediment supply in conjunction with the short-term restoration project, may potentially promote local growth of dunes and an increase in height of Assateague Island. This may reduce the frequency of cross-island overwash, decrease the retreat rate of the island, and reduce the infilling rate of Sinepuxent Bay. Water depths in Sinepuxent Bay will stay more stable on the lee of Assateague Island, rather than shallowing over time.

Flood Tidal Shoal Areas

Direct Impacts
Dredging of sand from the flood-tidal shoal will alter bathymetry by locally increasing depths on the flanks of the shoal rather than the crest (for more detailed discussion, see Appendix A5).

Indirect Impacts
Following dredging, waves and currents will redistribute surficial sediments, mollifying the bathymetric alterations of dredging. Deeper areas created during dredging are expected to infill. Dredging will induce minor alterations to shoaling and erosion patterns causing minor alterations in bathymetry throughout the area of the ebb and flood shoals and the inlet. Impacts will be monitored to manage the dredging plan in subsequent years.

6.1.4.b Navigation Improvements

Harbor and Inlet

Direct Impacts
Dredging will increase depths in the harbor to 4.3 meters (14 ft) MLLW and in the inlet, to 4.9 meters (16 ft). The inlet and channel will gently slope into existing bathymetries.

Indirect Impacts
Dredging the harbor will increase the capacity of the site to accumulate sediments. The harbor will infill with sediments over time, but presumably at a reduced shoaling rate due to long-term sand management. Intense natural tidal currents in the inlet will rapidly redistribute material in the vicinity of the dredged area and blend it with the existing bathymetry.

6.1.4.c Coastal Bays Environmental Restoration Projects

Direct Impacts
Creation of up to 5 hectares (12 ac) of salt marsh at the Isle of Wight will cause the loss of 0.3 percent of the open water and bottom habitat of Isle of Wight Bay. Isle of Wight Bay is 1,900 hectares (4,695 ac) in size. Construction of up to 10 hectares (25 ac) of salt marsh and bird habitat islands at Dog Island Shoals will cause the loss of an additional 0.5 percent of the open water and bottom habitat of Isle of Wight Bay by converting it to salt marsh and upland habitat. Six acres of the potential 25 are part of this project. Creation of a 1.2 hectares (3 ac) island at South Point Spoils will cause the loss of 0.006 percent of the bay bottom and open water habitat in Chincoteague Bay (Chincoteague Bay is 18,900 hectares (46,700 ac) in size). The above percentages are localized to the bays within which the projects would occur.

Indirect Impacts
Altered hydrodynamics in the vicinity of the islands will alter sediment transport patterns, locally altering patterns of sediment erosion and deposition, and locally altering the bathymetry. These changes are not expected to be substantial. Protected waters created by the islands may shallow (compared to existing conditions) if sediments accumulate. Waterways between and adjacent to islands, the mainland, and or breakwaters may increase in depth over existing conditions due to funneling effects of wind-driven and tidal currents. Ocean Pines projects will take place on sites that are currently upland, therefore, no impacts to bathymetry are anticipated.

6.1.5 Hydrodynamics

6.1.5.a Long-term Sand Management

Direct Impacts

The placement of sand and the equipment used to implement the project will not directly alter tidal flows, water surface elevations, nor wave energies; therefore, no direct impacts are expected.

Indirect Impacts

It is anticipated that dredging of the Ocean City fillet and tidal shoals will cause local and minor short-term alterations in wave climate and tidal current velocities in the inlet, ocean, and most substantially in the coastal bays. Waves may be bigger or smaller and currents may be faster or slower than they are now depending on the location. Impacts are considered short-term because the system is continually adjusting. No significant impacts to property or navigation are expected. No change in water surface elevations is expected in either the coastal bays or the Atlantic Ocean. Hydrodynamic impacts will be minimized by removing only a small percentage of the flood or ebb shoal volume during any one dredging operation (see Appendix A8 for additional information). The impacts to hydrodynamics will be managed through the long-term monitoring program, whereby any disturbances to the system will be determined and analyzed prior to resumption of dredging the following dredging cycle. The monitoring program will analyze surveys of the borrow areas, bathymetric surveys of the inlet, tidal currents, grain size, aerial photography and shoreline surveys of adjacent beaches. For more information on the Monitoring Plan, see Section 3.7.2

6.1.5.b Navigation Improvements

Direct Impacts

Dredging operations will not directly alter tidal flows, water surface elevations, nor wave energies; therefore, no direct impacts are expected.

Indirect Impacts

The changes to wave climate and tidal current velocities that will result from deepening the harbor and inlet are minor in scale when compared to the existing intense inlet system; therefore, they are not expected to have a significant impact to hydrodynamic conditions. Impacts of these proposed actions were modeled; the results of this modeling are contained in Appendix A5. Indirect impacts will include localized increased or decreases in wave energy and tidal current velocities.

6.1.5.c Coastal Bays Environmental Restoration Projects

Ocean Pines

Direct Impacts
Implementation of the project will not directly alter tidal flows, water surface elevations, nor wave energies; therefore, no direct impacts are expected.

Indirect Impacts
None are expected, since the project will not alter existing bathymetries outside of the minor creeks created within the restored salt marsh.

Dog Island Shoals

Direct Impacts
Equipment used to implement the project and placement of material will not directly alter tidal flows, water surface elevations, nor wave energies; therefore, no direct impacts are expected.

Indirect Impacts
Creation of the island will cause a minor alteration in tidal current flows because of funneling effects within this area of relatively strong tidal flows. Impacts to currents will be minimized through careful siting of the island at the northernmost edge of the flood-tidal shoal where currents are relatively weak. Impacts cause by alteration in current flow are discussed in Section 6.1.1.c. In addition, the island will be placed as far as possible from existing minor tidal channels so as to not cause scour within these channels. Current patterns and hydrographic data will be studied carefully during detailed design to minimize the risk of causing alterations to the existing channels. The island will create a protected lee with reduced wave energy on its south side as it blocks waves from the north.

Isle of Wight and South Point Spoils

Direct Impacts
Equipment used to implement the project and placement of material will not directly alter tidal flows, water surface elevations, nor wave energies; therefore, no direct impacts are expected.

Indirect Impacts
Creation of islands and shoreline salt marsh will have only very minor impacts on tidal and wind-driven currents since currents are very weak in the vicinity of the proposed salt marsh. The breakwaters will create a protected lee area with reduced wave energy to the bottom and shoreline.

6.1.6 Climate

No impacts will occur as a result of this project.

6.2 AIR QUALITY

Direct Impacts
Emissions during dredging and sand placement will be produced by dredges and work boats. Emissions during habitat construction will be produced by dredges, bulldozers, trucks, small construction vehicles, and work boats. Coordination with the Maryland Department of the Environment (MDE) has indicated that air quality impacts for each action are very minor and expected to be localized. Emissions are expected to be far below 100 tons/year of oxides of nitrogen (NO_X) or volatile organic compounds (VOC), and will thus be in compliance with the ozone and NO_X limits. The MDE has concurred with these findings and has indicated that a conformity determination will not be necessary and the project is expected to be in conformity with the State of Maryland implementation plan.

Indirect Impacts
The proposed actions are not expected to increase boating in the region, additional development, or industrial activity. Therefore, no indirect impacts are expected.

6.3 WATER QUALITY

6.3.a Long-term Sand Management

Assateague Islands

Direct Impacts
Placement of sand in the nearshore of Assateague will briefly increase turbidity during and following placement of material. Because minimal fine-grained material is contained within the sediment to be placed in the nearshore and because coarse-grained sediments will rapidly settle out of suspension, turbidity conditions and water quality are expected to be no more severe than those generated during storm events in the surf zone. Strong wave action in the nearshore zone creates a naturally dynamic environment where bottom sediments are frequently stirred up. The added sand will rapidly settle out of the water column.

Indirect Impacts
Because minimal fine-grained material is contained within the sediment to be placed in the nearshore and because coarse-grained sediments will rapidly settle out of suspension, no significant change in turbidity or water quality from natural background conditions over the long-term following placement of material is expected in the surf zone of Assateague Island.

Ocean City Fillet and Tidal Shoal Areas

Direct Impacts
There will be short-term turbidity impacts to the areas of the borrow sites being dredged during each semi-annual dredging cycle. The coarse grain size of the sand being dredged would allow any sand that is stirred up to rapidly resettle on the bottom. All work will be performed in accordance with the State of Maryland Water Quality Certificate to minimize detrimental impacts. Impacts to biological resources are discussed in Section 6.4 and 6.5.

Indirect Impacts
No indirect impacts are expected, since any impacts to water quality will occur only during project construction in close proximity to the dredging sites.

<u>6.3.b Navigation Improvements</u>

Direct Impacts
Dredging the harbor to a depth of 4.2 meters (14 ft) and the inlet to a depth of 4.9 meters (16 ft) will temporarily increase turbidity during and following dredging. Impacts to water quality will be minimized through a time-of-year restriction against dredging during the period of mid-March to October.

Indirect Impacts
Currently, harbor waters depths in the channel are greater than surrounding waters and the harbor is relatively well-flushed. With navigation improvements of deepening the inlet, the system will remain the same. Therefore, no indirect impacts are expected.

<u>6.3.c Coastal Bays Environmental Restoration Projects</u>

Dog Island Shoals

Direct Impacts
A temporary increase in turbidity will occur during construction and during each placement of dredged material in the vicinity of the island site. This increased turbidity will be contained within the placement cell. Material will be placed by the Corps of Engineers for the initial 1.2 hectares (3 ac) island construction. In the future, material will be placed in three newly created one-acre cells by private dredgers. During construction (e.g., grading the dredged material after

placement), the release of materials contained within the sediments, or runoff of fertilizer and herbicides could cause minor short-term detrimental impacts to water quality. If a geotextile tube ruptures during filling, additional bottom could be buried and disturbed. All proposed future dredging will be reviewed through the permit process for both dredging and disposal or as a Federal project. This review will ensure that impacts to the environment are evaluated and minimized.

Indirect Impacts
The created island will form a protected lee with reduced wave energies. This lee will create a small area in which resuspension of bottom sediments is reduced. There could be a local minor increase in water clarity in the lee areas. The 1.2 hectares (3 ac) created salt marsh at Dog Island shoals is expected to cause local improvement in water quality by filtering nutrients and pollutants. As a consequence of the establishment of this 1.2 hectares (3 ac) placement facility for privately dredged material, local dredging may increase and will be subject to the Federal and state regulatory process. It is expected that future dredging will cause short-term minor detrimental localized impacts to water quality at the dredging sites.

Isle of Wight

Direct Impacts
A temporary increase in turbidity will occur during placement of dredged material for salt marsh construction. Turbidity will be produced by bottom disturbance and escape of suspended sediment from the placement site. This material has a small concentration of hydrocarbons but is considered clean enough by the Baltimore District to place at this site. The small concentrations may be enough to produce a surface film. This is not expected to cause any significant water quality impacts. Any dredging will be in compliance with the MDE water quality certificate. Runoff of fertilizer and herbicide during marsh establishment may also cause insignificant short-term detrimental water quality impacts.

Indirect Impacts
The offshore breakwaters will create a protected lee of open water with reduced wave energies. Within this quiescent area, resuspension of bottom sediments is expected to be reduced. SAV plantings will also inhibit bottom sediment resuspension. As a consequence, there could be a local minor increase in water clarity in the lee areas. The created salt marsh at Isle of Wight is expected to cause local improvement in water quality by removing some pollutants from the water column.

Ocean Pines

Direct Impacts
Construction activities for salt marsh restoration may include excavation, transport, placement, and grading of fill; filling or alteration of existing drainage ditches; cutting new ditches; removal

of undesirable vegetation mechanically or with herbicide; application of fertilizer; and planting of vegetation. These actions may cause minor short-term detrimental impacts to water quality because of increased turbidity, release of materials contained in soils, or runoff of fertilizer and herbicides. These impacts will be minimized by construction sequencing and best management practices.

Indirect Impacts
Minor localized improvements in water quality are expected due to the removal of nutrients and pollutants by the marsh system.

South Point Spoils

Direct Impacts
Dredging sediment from the Sinepuxent Channel to obtain borrow material would create a temporary turbidity plume since this material contains a high proportion of fine-grained material. These impacts would be minimized with a time-of-year restriction (dredging and construction only during the period of October to mid-March). In addition, island creation with fine-grained sediments will cause temporary local water quality impacts, as some turbid water may escape from the island site to the aquatic environment. These impacts will also be minimized by the time-of-year restriction. The impacts that may results from this dredging are expected to be localized, temporary, and insignificant.

Indirect Impacts
The newly created 1.2 hectares (3 ac) island will form a somewhat protected lee with reduced wave energies that, in turn, will cause a minor improvement in water clarity locally by reducing resuspension of bottom sediments in the protected area. It is believed that dredging in the lowermost Sinepuxent Channel will increase neither recreational boating in the area nor development along Chincoteague Bay, therefore no detrimental impacts to water quality from these activities are expected. This shoaled section of the channel from which material is proposed to be removed does not constitute a significant impediment to boaters.

6.4 BIOLOGICAL RESOURCES

6.4.1 Submerged Aquatic Vegetation

<u>6.4.1.a Long-term Sand Management</u>

Direct Impacts
Because SAV is not present in, nor in close proximity to, waters where sand will be dredged nor placed, no impacts are anticipated.

Indirect Impacts
The reduced retreat rate of Assateague Island and the reduced rate of overwash will reduce the severity and frequency of physical disturbances that may currently limit the ability of SAV to colonize the northern Sinepuxent Bay side of Assateague Island. Reductions of the frequency of disturbance will likely allow tens of acres of new SAV to become established within northernmost Sinepuxent Bay where relatively minimal SAV now occurs. Minor alterations in local hydrodynamics and deposition/erosion rates and patterns will be concentrated in close proximity to the inlet where minimal SAV now occurs. Therefore, no indirect impacts to SAV from hydrodynamic alteration are expected.

6.4.1.b Navigation Projects

Direct Impacts
Because SAV is not present within or in close proximity to the harbor and inlet, deepening of these areas will have no direct SAV impacts.

Indirect Impacts
Because SAV is not present within or in close proximity to the harbor and inlet, the navigation projects are expected to have no indirect impacts to SAV.

6.4.1.c Coastal Bays Environmental Restoration Projects

Dog Island Shoals

Direct Impacts
Future dredging in existing or proposed channels which provide material for the future island creation may cause loss of SAV within the established waterways. Because SAV is not present in or in close proximity to the island creation site, no impacts are anticipated. Any SAV that colonizes the island creation site subsequent to erecting geotextile tubes, but prior to filling the cell will be destroyed when dredged material is placed to create salt marsh. Up to 1.2 hectares (3 acres) of SAV could potentially develop which would be destroyed. No establishment of new channels within SAV beds is expected because permits are not typically issued for new areas in which SAV is established.

Indirect Impacts
Creation of protected water habitat in conjunction with the project are expected to promote establishment of SAV beds in the project waters.

Isle of Wight

Direct Impacts
Because SAV is not present in nor in close proximity to the site, nor at any of the sites from which dredged material will come, no impacts are anticipated.

Indirect Impacts
Creation of protected water habitat in conjunction with the project are expected to promote establishment of habitat suitable for SAV to establish in the project waters. SAV plantings will encourage SAV establishment.

South Point Spoils

Direct Impacts
Preliminary analyses indicate that up to 2.2 hectares (5.5 ac) of SAV could be impacted, at least temporarily. Direct impacts to SAV will be minimized by employing an April 15th through October 15th time-of-year restriction on construction activity. For a more detailed consideration of SAV at the site see Section 2.4.1.d and Annex A, Part 4.

In stabilizing and restoring the existing island, direct disturbance to SAV beds will occur as dredging equipment is deployed across the bed to fill geotextile tubes that will surround the existing island. The geotextile tubes will destroy any SAV that develops within the 1997 island footprint as the island erodes. This area may be as great as approximately 0.2 hectare (one-half ac). This is a locally significant impact, but is insignificant from a regional perspective. During filling of the tubes, additional disturbance may occur. Up to 0.8 hectares (2 ac) will be temporarily impacted during construction. Disturbances such as temporarily increased turbidity are expected locally in work areas surrounding the islands and where equipment crosses the beds. If a geotextile tube ruptures during filling, additional acreage of SAV beds could be buried and disturbed. Equipment operating within the SAV beds will include hydraulic pipes, geotextile tubes, and occasionally small work boats. SAV beds in disturbed areas are expected to recover beginning the fall following construction when eel grass seeds that are abundant in the area germinate.

The created 1.2 ha (3 ac) island to the west of the existing island will displace bottom with low percent cover (10% and less) SAV beds. Dredging of the Sinepuxent Channel in the vicinity of South Point Spoils to obtain borrow material will destroy SAV that occurs within the channel. It is unclear whether SAV is persistent or ephemeral within the channel. Any SAV that occurs there is at low percent cover (10% or less) or is ephemeral. Dredging will also produce a short-term period of increased turbidity during and immediately following dredging. However, since construction will occur during the non-growing season only minimal detrimental turbidity impacts are expected. No SAV plantings are proposed because of the abundance of SAV propagules in the vicinity and the demonstrated ready ability of SAV to colonize suitable bottom in the area. The Corps will monitor SAV recolonization in the area of impact and if natural recolonization does not occur the Corps will replant the area.

Indirect Impacts
Because wave energy will rework any sediment deposited in the SAV beds as a consequence of this project over the dormant season in the months following construction, the excess sediment that may be deposited in beds during construction from turbidity is not expected to have a major impact to SAV during the subsequent growing season. The created island will alter distribution of waves and wind-driven current patterns in the vicinity of the newly created island. Local increase in sedimentation as well as bottom scour may occur between the existing and newly created island. Perennial SAV beds in the area will readily adjust to the changes in the physical environment, and no significant detrimental impacts are expected. The newly created island may provide additional protection to beds from disturbance by boaters.

6.4.2 Wetlands

<u>6.4.2.a Long-term Sand Management</u>

Assateague Island

Direct Impacts
Because no material will be placed on wetlands, no impacts are expected.

Indirect Impacts
The potential reduction in frequency of overwash and increased island stability may increase vegetation development on the northern end of the island. An expected outcome is an increase in the proportion of the bayside of the northern end of the island that has salt marsh (see Section 2.4.2 for discussion of vegetation occurring on the island). Up to several tens of hectares of salt marsh may develop.

<u>6.4.2.b Navigation Improvements</u>

Direct Impacts
There are no direct impacts to wetlands because the proposed dredging would occur in the harbor and inlet waterways which lack wetlands.

Indirect Impacts
After the determination is made that the material is clean enough for placement, the dredged materials from the proposed harbor and inlet deepening will provide the materials for creating salt marshes at Isle of Wight and Dog Island Shoals.

6.4.2.c Coastal Bays Environmental Restoration Projects

Dog Island Shoals

Direct Impacts
No impacts to existing wetlands will occur since no wetlands occur at the site. The project will create up to 1.2 ha (3 ac) of salt marsh as part of this project. This represents up to a 0.9% increase in salt marsh acreage in the northern coastal bays.

Indirect Impacts
No indirect impacts to wetlands are anticipated.

Isle of Wight

Direct Impacts
No impacts to existing wetlands will occur since no wetlands occur at the site. The project will create up to 5 hectares (12 ac) of salt marsh. This will increase salt marsh acreage in the northern coastal bays by up to 0.5 percent.

Indirect Impacts
No indirect impacts to wetlands are anticipated.

Ocean Pines

Direct Impacts
The preparation of the site for salt marsh restoration will cause minor disturbance such as increased turbidity to adjacent existing salt marshes. The marshes are expected to recover within several growing seasons following project construction. A large portion of the monotypic stand of reed grass occurring at the site is in a nontidal wetlands area. Grading down the site to intertidal elevations will cause the loss of this habitat. Although reed grass may provide some water quality benefits and stabilizes disturbed shorelines it is invasive and will eliminate more desirable natural wetlands vegetation. Consequently Reed grass stands are considered to be of low value by many resource agencies, some of which have eradication programs because of reed grasses lack of vegetative diversity, invasive habits and limited provision of wildlife habitat. The sites were formerly tidal, and the project will serve to restore 3.4 hectares (8.5 ac) of tidal marsh. The restored marsh will represent a 0.3 percent increase in salt marsh acreage in the northern coastal bays.

Indirect Impacts
No indirect impacts are expected.

South Point Spoils

Direct Impacts

No direct impacts are expected since geotextile tubes and fill will be placed along or seaward of the shoreline at the time of project implementation. Construction will cause a minor disturbance to the edge of the marsh adjacent to the geotextile tube.

Indirect Impacts
Ringing of the island with geotextile tubes will alter the hydrology of the marsh by preventing or restricting flooding of the site during high water events. These changes are expected to have minimal impact to the reed grass marsh since it is a resilient species. The tubes will provide shoreline protection and reduce erosion of the marsh.

6.4.3 Upland Vegetation

6.4.3 a Long-term Sand Management

Assateague Island

Direct Impacts
Because no material will be placed on the emergent portion of the island, no direct impacts are expected.

Indirect Impacts
Restoration of the sediment supply in conjunction with the short-term restoration of Assateague Island project, may potentially promote local growth of dunes and an increase in height of Assateague Island. This may reduce the frequency of cross-island overwash and increase island stability and may increase vegetation development on the northern end of the island. Over time there may be an increase in the proportion of the northern end of the island that possesses dune grassland vegetation (see the Assateague report EIS for discussion of vegetation occurring on the island). Development of minor areas of shrub thicket is also possible in the island interior.

6.4.3.b Navigation Improvements

Direct and Indirect Impacts
Dredging of the harbor and inlet will have no direct effects on upland vegetation. However, material from the harbor and inlet will be used to create upland habitat at Dog Island Shoals and South Point Spoils.

6.4.3.c Coastal Bays Environmental Restoration Projects

Isle of Wight

Direct Impacts
At Isle of Wight, equipment staging and use will destroy upland old field vegetation in the vicinity of the created marsh shoreline. The State of Maryland is planning substantial improvements to the wildlife management area adjacent to the salt marsh creation project, and the old field vegetation will be substantially altered by these actions as well. The State of Maryland will subsequently re-landscape the site.

Indirect Impacts
The project will facilitate future improvements at the site by the State.

Dog Island Shoals

Direct Impacts
Creation of a bird nesting habitat island at Dog Island Shoals will create 1.2 hectares (3 ac of non-vegetated upland.

Indirect Impacts
None.

South Point Spoils

Direct Impacts
Activities will create 1.2 hectares (3 acres) of vegetated upland habitat and maintain existing 2.3 vegetated island habitat comparable to the existing island. A species list of existing vegetation is given in Section 2.

Indirect Impacts
No direct impacts are expected.

Ocean Pines

Direct Impacts
Upland vegetation including reed grass and Loblolly pine at the site will be destroyed and then excavated. This vegetation is considered to be of low value, and no significant detrimental environmental impacts are expected. Other upland vegetation will be destroyed mechanically in the process of re-grading the site to intertidal elevations. No new upland vegetation will be planted.

Indirect Impacts
None are expected.

6.4.4 Benthos

<u>6.4.4.a Long-term Sand Management</u>

Placement on Assateague Island

Direct Impacts
There will be no direct impacts to beach fauna since material will not be placed on the beach. Direct impacts to nearshore benthos will occur as a result of deposition of up to 1 m (3 ft) thick of material at each placement site. This burial depth will cause the mortality of the majority of infauna at each placement site. However, this benthos is particularly resilient and adapted to a high-energy environment and some organisms will survive. Of the benthos that will be impacted at the placement site, clams are more vulnerable to decimation than are polychaetes or amphipods. No commercial clam fisheries impact is expected because commercial clamming is offshore and does not occur at the proposed placement site. Motile surface benthos may be able to relocate in some cases; however, it is expected that the majority of motile benthos at each placement site will also be destroyed. The total area impacted during each semi-annual placement will be approximately 44 hectares (110 ac). The impact will be locally significant for a short period of time following each placement cycle. The creation of the sandbar is not expected to create an adverse impact to biological resources. Placement of the material at water depths less than 5 meters (15 ft) will minimize impacts to the aquatic ecosystem, since the nearshore waters are a harsh environment characterized by frequent bottom scour and deposition. Seasonal recruitment peaks for benthos typically occur in the spring and fall; however, the recovery period of benthos following the spring dredging cycle will be different from that of the fall dredging. The spring dredging cycle will precede the spring recruitment peak. Repopulation of the benthos is expected to proceed rapidly after the spring placement operation, as the natural cycle of recruitment and growth is high during this period. In contrast, following fall dredging, it is expected that repopulation will be slower due to the lower rate of recruitment at this time of year. Destruction and loss of benthos will temporarily disturb the food web and lower the habitat value of the borrow sites.

Indirect Impacts
Beach fauna are not expected to be detrimentally impacted by the increased volume of sand carried onto the island beach since beach fauna are nondiverse and highly resilient. The consistency in grain-size of added sand to native beach and nearshore sediments will minimize future impacts.

Material transported via the littoral transport system southward beyond the placement area on Assateague will have minimal impacts to benthos since benthos of the nearshore are adapted to the shifting substrates of this high energy environment. The volume of sand transported through the nearshore will remain at historic rates. Nearshore bottom sediments are predominantly sandy along the Assateague shoreline. The sand that will be added to the system contains minimal fine-grain sediments and is highly compatible with existing beach and nearshore sand; therefore, impacts that could occur from alterations in sediment character are expected to be minimal. Downdrift impacts to benthos are not expected to be significant. Areas of finer-grained bottom sediment do occur offshore and south of the placement area. Displacement of existing benthos by benthos adapted to the grain size of the placed materials may occur if storm events transport placed sand into these areas.

Flood and Ebb Tidal Shoals and Ocean City Updrift Fillet

Direct Impacts
Dredging will destroy relatively non-motile benthic organisms. Underlying sediments lacking benthos will be exposed and will become the new seafloor. Destruction and loss of benthos will temporarily disturb the food web and lower the habitat value of the borrow sites. However, no important commercial or recreational benthic species are present at these sites (see U.S. Fish and Wildlife Service Planning Aid Report in Annex A, Part 3), and these impacts are expected to be minimal from a regional scale. These impacts will be locally significant for a short period of time following each dredging cycle. Since dredging will occur immediately before a seasonal recruitment peak in the spring, repopulation is expected to be rapid following the late winter semi-annual dredge cycle. Habitat value of the nearshore should rapidly approach pre-project levels during the growing season. Repopulation following late fall dredging will be slower due to the lower rate of recruitment at that time. The benthic communities that inhabit these shoals are primarily composed of common infaunal species that are relatively tolerant of physical disturbance. Recolonization to pre-project levels is expected within several months after dredging (for additional information see Planning Aid Report II in Annex A, Part 3).

Indirect Impacts
Altered current patterns and spatial changes in erosion and deposition patterns of sediments will cause minor and nonsignificant impacts to benthic habitat. It is expected that benthic organisms will readily colonize new areas suited to their life history requirements. New substrate will be similar in grain size to pre-dredge substrates, which will favor recolonization by the same benthic community. As the area shoals in benthos are expected to rapidly recolonize.

6.4.4.b Navigation Improvements

Direct Impacts
Sessile and relatively nonmotile benthic life occupying areas to be dredged will be destroyed but are expected to soon recolonize the area. Direct impacts are expected to be insignificant.

Indirect Impacts
An indirect localized impact to the food web is expected. A recovery period of several months will follow any dredging that causes localized impacts to the food web.

6.4.4.c Coastal Bays Environmental Restoration Projects

Direct Impacts
Construction of up to 2.4 hectares (6 ac) of salt marsh and bird habitat islands at Dog Island Shoals and up to 4.9 hectares (12 ac) of salt marsh at Isle of Wight will cause the permanent loss of 0.4 percent of the open water and bottom habitat available to benthos in Isle of Wight Bay. Isle of Wight Bay is 1,900 hectares (4,695 ac) in size. Creation of a 1.2 hectares (3 ac) island at South Point Spoils will cause the loss of 0.006 percent of the bay bottom and open water habitat available to benthos in Chincoteague Bay (which is 18,900 hectares [46,700 ac] in size).

All sessile and relatively nonmotile benthos will be destroyed at sites filled to create islands or shoreline salt marsh, but this is a very small percentage of benthic habitat in the project area, and this will cause only locally significant but regionally insignificant detrimental benthic impacts. This impact will be minimized through the site selection process that identified and avoided environmentally significant areas for benthos, such as SAV beds and historic oyster beds, as sites for island creation (see Section 5.4, Site Selection Process). Salt marsh benthos are expected to colonize the created wetlands.

Indirect Impacts
Constructed salt marsh will provide detritus for the food web. The island construction projects at Isle of Wight and Dog Island Shoals will create protected shallow water habitat where currently none exists. The projects at Isle of Wight and Dog Island Shoals will create habitat suitable for SAV establishment. These changes are expected to be generally beneficial to benthic organisms.

6.4.5 Plankton

Direct Impacts
During dredging, plankton will be entrained and destroyed at all of the proposed sites. No significant detrimental impacts are expected to any particular species, however, because of the high degree of dispersal (low concentration) of planktonic organisms in the water column. This topic is also covered in the Planning Aid Report located in Annex A, Part 3. No significant impacts are expected during placement

Indirect Impacts
None are expected because of the abundance of plankton in the water column and the high natural mortality of these organisms.

6.4.6 Nekton

This section only includes nekton not recognized to be endangered, threatened, or rare by the Federal government or the State of Maryland. Potential impacts to these special status species are included in Section 6.5 "Rare, Threatened, and Endangered Species."

<u>6.4.6.a Long-term Sand Management</u>

Placement on Assateague Island

Direct Impacts

Because of the volume to be placed and the size of the area to be impacted in each placement event, it is expected that any nekton that remain in an area at the time of placement will be destroyed during placement. Impacts will not be significant because of the few individuals expected to be destroyed relative to the large local populations, the high mobility of nekton, and because of the relatively minimal area of impact compared to the great expanse of coastline on Assateague Island and the eastern seaboard.

Indirect Impacts

It is expected that water quality and benthic impacts will be nonsignificant, and as minimal impacts are anticipated to the food web, impacts to nekton are expected to be minor. No significant detrimental impact is expected from the repeated operations. No significant alterations are expected to the location and strength of tidal current flows that could impair the ability of larval, juvenile, and adult finfish and shellfish to navigate into and out of the coastal bays. Strategic dredging done under the direction of the monitoring program is expected to prevent substantial hydrodynamic change that could cause future detrimental impacts to nekton. Since benthos are expected to recover quickly during the growing season, no significant detrimental impacts are expected to the food web upon which many nekton depend.

Flood and Ebb Tidal Shoals and Ocean City Fillet

Direct Impacts

There will be a short-term increase in turbidity during dredging and a resulting disturbance to nekton, some of which are expected to temporarily relocate. Because of their high mobility, few nekton will be entrained by the dredge. These impacts are not expected to be locally or regionally significant .

Indirect Impacts
It is expected that water quality and benthic impacts will be nonsignificant, and as a consequence of minimal food-web impacts, impacts to nekton are expected to be minor. No significant detrimental impact is expected from the repeated operations. No significant alterations that could impair the ability of larval, juvenile, and adult finfish and shellfish to navigate into and out of the coastal bays are expected to occur to the location or strength of tidal current flows. Strategic dredging done under the direction of the monitoring program is expected to prevent substantial hydrodynamic change that could cause future detrimental impacts to nekton.

6.4.6.b Navigation Improvements

Direct Impacts
During dredging, disturbance may cause nekton to relocate from the project area. Some nekton will be attracted to sediment stirred up from the bottom. Because of their high mobility, few if any nekton will be entrained in the dredge.

Indirect Impacts
The local food web will take several months to recover following this and future maintenance dredgings. Impacts to nekton are not considered significant because of the relatively small area to be dredged as compared to the total food web of the bays and ocean. In addition, the harbor and inlet areas are not of notable significance ***as feeding grounds for fishes that feed on benthic invertebrates, therefore,*** local impacts will be non-significant (See USFWS PAR).

6.4.6.c Coastal Bays Environmental Restoration Projects

Direct Impacts
The high mobility of most fishes, including juveniles, suggests that nekton should be able to avoid any negative conditions associated with point source deposition of sediments that will occur during placement of dredged material and stabilization structures during island construction. Construction of the islands will displace and cause the loss of a very small proportion of the 21,500 ha (53,000 ac) open water and benthic habitat that nekton utilize in the coastal bays. Shallow waters will be impacted; however, shallow water is abundant in the context of the coastal bays, and there is plenty of other habitat for finfish relocation. These losses are not expected to have a significant impact to nekton, including summer flounder, because of the small size of the area to be impacted relative to the size of abundant habitat available elsewhere in the bays. Turbidity is expected during construction, and nekton may temporarily leave the project area. However, impacts will be minimized through time-of-year restrictions on construction activity. Island construction will take place in cold weather when nekton activity is reduced. This time-of-year restriction will minimize direct impacts to summer flounder, since they typically are concentrated in the bays during the warmer weather months. On a local scale, impacts will be non-significant because finfish will easily relocate to adjacent habitats. Any nekton remaining at the sites will readily relocate to adjacent open-water habitat

during island construction. No detrimental indirect impacts are expected from the relatively insignificant loss of open water and bottom habitat and no degradation of the coastal bays as habitat for finfish is expected. Dredging of the Sinepuxent Channel is expected to have minimal impact to juvenile finfish since this channel has been identified as an area inhabited by few juveniles. There could be some temporary impacts to recreational finfish species due to disruption of benthos within the channel, which will take several months to recover to pre-project levels.

Indirect Impacts
The coastal bays salt marsh and bird habitat island creation projects are expected to benefit nekton by providing food web support, and by providing in-water cover and structure in areas that otherwise have a flat and featureless bottom. These changes will beneficially impact the food web. Juveniles are highly vulnerable to predation in featureless flats. The added structure associated with rock stabilization along Isle of Wight and Dog Island will favor structure-oriented fish. Increased bird populations will cause increased predation of nekton, however this impact is expected to be non-significant.

6.4.7 Birds

This section only includes birds not recognized to be endangered, threatened, or rare by the Federal government or the State of Maryland. Potential impacts to these special status species are included in Section 6.5, "Rare, Threatened and Endangered Species."

<u>6.4.7.a Long-term Sand Management</u>

Direct Impacts
During dredging and sand placement, disturbances to birds are expected to be negligible, as birds are expected to temporarily relocate elsewhere during the several months of the year during which dredging and placement of material occurs. No permanent displacement of bird populations is expected. Construction will also not take place during breeding season. Time-of-year restrictions that limit dredging to the time period between September and early March will protect birds during sensitive times of the year.

Indirect Impacts
Salt marsh and dune grassland may form due to the long-term sand placement and the short-term restoration. If it does, it will likely increase local bird species diversity and populations. Bird species expected to utilize newly-developed habitat on the northern end include American Black Duck, several species of sparrows, and Mourning Dove.

6.4.7.b Navigation Improvements

Direct and Indirect Impacts
During dredging and sand placement, disturbances to birds are expected to be negligible, as they will relocate elsewhere. No permanent displacement of bird populations is expected. Increased turbidity during dredging and placement may attract gulls and other scavengers.

6.4.7.c Coastal Bays Environmental Restoration Projects

Direct Impacts
All project construction activities will occur at times of year when birds are expected to be less vulnerable to human disturbance (not during the nesting season). At Dog Island Shoals, it is assumed that any future additional cells will be constructed during periods of the year when birds are less vulnerable to disturbance. Birds may temporarily relocate from the construction area to adjacent habitats during construction, but are expected to return upon completion of the projects. No permanent displacement of bird populations is expected. Restoration of the South Point Spoils colony to a 2 ha (5 acre) size will increase the availability of breeding sites for vegetation-nesting colonial waterbirds. Utilization of created islands as nesting habitat for colonial waterbirds is well demonstrated throughout the mid-Atlantic states and elsewhere along the U.S. coast.

Indirect Impacts
Nesting habitat is the most critical of the life requirements limiting colonial waterbird populations. The proposed island habitat at South Point Spoils is expected to increase the populations of vegetation-nesting colonial waterbirds in the coastal bays watershed. This is a significant positive impact.

6.4.8 Mammals
Impacts to whales are covered in Section 6.5.

6.4.8.a Long-term Sand Management

Assateague Island

Direct Impacts
Mammal species at Assateague Island are described in Section 2. Habitat quality for mammals in the portions of Assateague Island adjacent to the placement zones is generally low due to the frequently overwashed condition of the area. Wildlife may temporarily relocate from the area to adjacent habitats during placement of material in the nearshore, but are expected to return upon completion of the projects. No significant disturbance is expected.

Indirect Impacts
Habitat quality for mammals on the northern end of Assateague Island may improve as vegetative cover increases and small dunes form. Minor positive increases to populations of fox and pony are expected.

Tidal Shoals, Assateague Island Nearshore, and Ocean City Fillet

Direct Impacts
Any harbor seals or dolphins that are in the project area during the dredging and placement of material should be able to readily avoid dredging equipment. These animals may temporarily relocate to other areas during dredging, but this is expected to be only a minor inconvenience to these marine mammals.

Indirect Impacts
None are expected because of the high mobility of marine mammals and the great availability of nekton and plankton outside of the construction areas.

6.4.8.b Navigation Improvements

Direct Impacts
Any harbor seals or dolphins that are in the project area during the dredging of the harbor and inlet should be able to readily avoid dredging equipment. These animals may temporarily relocate to other areas during dredging, but this is expected to be only a minor inconvenience to these marine mammals.

Indirect Impacts
None are expected because of the high mobility of marine mammals and the great availability of nekton and plankton outside of the construction areas.

6.4.8.c Coastal Bays Environmental Restoration Projects

Direct Impacts
Mammals (see Section 2 for information on mammals) may temporarily relocate from areas of Ocean Pines and Isle of Wight to adjacent habitats during project construction, but are expected to return upon completion of the projects. Any harbor seals or dolphins that are in the project areas during placement of material should be able to readily avoid dredging equipment. These animals may temporarily relocate to other areas during dredging, but this is expected to be only a minor inconvenience to these animals. The Dog Island Shoals project will provide additional resting habitat for harbor seals who frequent the existing Dog Island. Harbor seals do not presently utilize the South Point site

Indirect Impacts
Habitat quality for mammals at Ocean Pines and Isle of Wight will improve as highly productive salt marsh vegetation develops and as the habitat quality increases. Habitat accessible to mammals at Isle of Wight will increase, as the constructed island will increase total island size. No significant impacts to benthos, plankton or nekton are expected. No indirect impacts to dolphins or harbor seals are expected.

6.4.9 Reptiles and Amphibians

Sea turtles are discussed in Section 6.5.

Direct Impacts
No direct impacts to reptiles or amphibians are expected to occur as a result of any of the projects. Diamondback terrapin are the species that could most likely be impacted. Construction activities will generally occur during cooler weather months of the year when diamondback terrapins are less active. The area is not now a nesting area for terrapins, and the proposed action will create potential terrapin turtle habitat,

Indirect Impacts
Information on Diamond back terrapin is located in section 2. Diamondback terrapin will lose access to nesting habitat at South Point Spoils as a result of stabilization of the shoreline and the slope being too steep for them to climb. It is not anticipated that the terrapins will be able to transverse the tubes at low tides .However, the soft shorelines within the coves of the created islands at Isle of Wight, Dog Island Shoals, and South Point Spoils are expected to provide access to the interior of these islands and create nesting habitat for diamondback terrapin. Other than for diamondback terrapin, no reptiles or amphibians are expected to be indirectly impacted by the proposed projects.

6.5 RARE, THREATENED AND ENDANGERED SPECIES

A list of rare, threatened or endangered species is given in Section 2. Rare species within the study area that can potentially be impacted by project actions include (1) Piping Plover and other beach-nesting birds, (2) sea turtles, (3) whales, and, (4) white tiger beetles,

6.5.1 Piping Plover and Other Rare Beach-Nesting Bird Species

6.5.1.a Long-term Sand Management

Assateague Island

Direct Impacts

No direct impacts are expected to beach-nesting bird species. No placement of sand will occur on the terrestrial portion of the island. Construction activities will be restricted in the National Seashore where Piping Plover and other rare beach-nesting bird species nest and forage during the period from mid-March until about September 1st. This restriction will prevent detrimental impacts to Piping Plover and other beach-nesting bird species during courtship, nesting, and brood-rearing seasons when they are sensitive to disturbance. Initial coordination with the U.S. Fish and Wildlife Service indicates that no adverse direct impacts are expected.

Indirect Impacts

If vegetation increases and dunes develop on Assateague Island, due to the long-term sand management in conjunction with the short-term restoration, it may cause minor losses of nesting and feeding habitat to Piping Plover, Least Tern, and American Oystercatcher (which thrive under current conditions). Minor impacts to reproductive success for Piping Plover may occur as a result of the obstruction of chick walkways, increased predation, and the loss of moist interior foraging areas that accompany increased island elevation and vegetation development. It is expected, however, that a substantial portion of the northern end of Assateague Island will remain suitable as nesting habitat for these species. In addition, since constructed dunes on the southern end of the island are no longer being maintained, additional nesting habitat there is expected to become available in the future. Initial coordination with the U.S. Fish and Wildlife Service indicates that no significant adverse indirect impacts are expected. Impacts to Piping Plover will be evaluated in a Biological Assessment which is expected to be completed by early March, 1997.

The beach-nesting waterbird colony at Skimmer Isle will probably be detrimentally impacted by the long-term sand placement process. Long-term sand management will probably reduce the rate at which sand is deposited into the flood tidal shoals. Sand deposition has served to create and maintain bare-substrate nesting habitat at Skimmer Island. The growth rate of Skimmer Island will presumably be reduced. In combination with ongoing natural vegetative succession on Skimmer Island which is expected to continue, there will probably be a net loss of bare substrate nesting habitat on the island. However, changes made to the yearly dredging plan in accordance with results of monitoring will minimize impacts to Skimmer Isle.

6.5.1.b Navigation Improvements

Direct and Indirect Impacts
Initial coordination with the U.S. Fish and Wildlife Service indicates that no significant adverse indirect impacts are expected. Operations will take place at times of the year when beach-nesting waterbirds are relatively insensitive to disturbance. Therefore, no direct impacts are expected as a result of dredging operations. The improvements are not expected to cause any changes in environmental character which could significantly impact these species. Therefore, no indirect impacts are expected.

6.5.1.c Coastal Bays Environmental Restoration Projects

Direct Impacts
Island creation at Dog Island Shoals will increase the area available as nesting habitat for beach-nesting birds. Nesting habitat reduction is a major problem limiting populations of these bird species, and this is a substantial positive contribution. Dredging and placement operations for all proposed projects will take place at a time of year (approximately September 1st through mid-March depending upon resource agency restrictions) when these species are relatively insensitive to disturbance. It is anticipated that local actions will follow the same resource agency requirements as the federal project and will be conducted during times of low sensitivity. Therefore, the species will not be sensitive to the presence of dredges and construction equipment required for island creation. Informal coordination with the USFWS has indicated that the navigation improvements are not likely to be a problem.

Indirect Impacts
The island creation projects at Dog Island Shoals are expected to increase the numbers of beach-nesting colonial waterbirds nesting in the coastal bays. However, this positive impact may potentially be somewhat lessened by losses of habitat at Skimmer Isle.

6.5.2 Sea Turtles

A Biological Assessment was submitted to the National Marine Fisheries Service (NMFS) in July 1997 to cover any potential impacts to threatened and endangered sea turtles and whales in all of the project areas. A Biological Opinion from NMFS is expected by November 1997 (see Annex A, Part 4). No significant impacts to sea turtles are expected and the District expects to receive a non-jeopardy opinion from NMFS based on biological opinions written for similar project in nearby states. A summary of potential impacts is as follows:

Direct Impacts
A shallow hopper dredge like the *Currituck,* is expected to be used as the primary dredge. The *Currituck* is not required by NMFS to be equipped with deflectors because of its small draghead size. The NMFS Southeast Region has determined that dredging by the *Currituck* will not have a

significant impact on sea turtles. If another dredge is used, dredging will be coordinated with NMFS to determine whether deflectors or observers will be required. Dredging-vessel strikes of sea turtles are uncommon. It is unlikely that dredge transits in the coastal areas are likely to have impacts to sea turtles in the offshore areas, and sea turtles are seldom found in the Ocean City inlet or the portion of the coastal bays that are within the project area.

Indirect Impacts
No indirect impacts are expected.

6.5.3 Whales

Direct Impacts
Whales, including the very endangered Right Whale, may occasionally transit the project area. However, the project area is not a breeding ground or a major feeding ground, but is used as a migration path along the coast. The most common whale in the project area is the Humpback, which is most often observed in the early part of the year, with February being the month of peak occurrence. Consequently there is a small risk of vessel strikes during that time that may result in injuries or fatalities. Whale spotters will be stationed during daylight hours to minimize or avoid impacts to whales. Daylight dredging only will minimize the risk of whale strikes. Whales are not expected to travel in the harbor and inlet nor the coastal bays.

As stated above, a Biological Assessment was submitted to NMFS in July 1997 to cover any potential impacts to threatened and endangered sea turtles and whales in the project area (see Annex A, Part 4). A Biological Opinion from NMFS is expected in November 1997. No significant impacts to whales are expected and the District expects to receive a non-jeopardy opinion from NMFS based on biological opinions written for similar project in nearby states.

Indirect Impacts
No indirect impacts are expected.

6.5.4 White Tiger Beetles
This species only occurs on Assateague Island of the sites being discussed herein.

6.5.4.a Long-term Sand Management

Direct Impacts
No direct impacts are expected, since no activities will take place on the beach.

Indirect Impacts
No indirect impacts are expected. It is expected that accretion of material to the shoreline will serve to maintain suitable habitat for the white tiger beetle; therefore, populations will neither increase nor decrease.

6.5.4.b Navigation Improvements

Direct and Indirect Impacts
No direct or indirect impacts are expected since dredging activities will occur in the waterways.

6.5.4.c Coastal Bays Environmental Restoration Projects

Direct and Indirect Impacts
Island creation at Dog Island Shoals, South Point Spoils and Isle of Wight will not impact tiger beetle populations since the proposed projects will occur in the aquatic environment. Tiger beetles are also not present at the Isle of Wight mainland due to the rock lined shoreline, nor at Ocean Pines: therefore, no impacts are expected.

6.6 RESERVES, PRESERVES, AND PARKS

Assateague Island State Park

Direct Impacts
The District has coordinated extensively with the MD DNR and impacts to the State Park have been considered throughout the planning process. The project will benefit the State Park by increasing its beach. The additional material will also help to reduce detrimental impacts to park facilities and to existing constructed dunes, which are occurring as a result of sediment starvation.

Isle of Wight

Direct Impacts
We have coordinated extensively with the MD DNR and impacts to the Management Area have been considered throughout the planning process. This project is working in conjunction with the current restoration plans of MD DNR and will benefit the area by increasing its recreational value.

6.6.1 Recreation

6.6.1.a Long-term Sand Management

Assateague Island

Direct and Indirect Impacts
Implementation of the beach replenishment proposed for Assateague Island is expected to maintain the geological integrity of the island and therefore maintain it as a recreation area and

have a positive impact on recreational opportunities and the quality of recreational experience in the localized area of project impact. The project is expected to reduce the incidence of shoaling and sand migration in Sinepuxent Bay behind Assateague Island. This will prevent the navigation channel in the bay from more severe shoaling. These recreational boaters will most likely not lose access to the channel, an impact that could occur if the island were to breach and cause the migration of large volumes of sand. The probability of shoal-induced groundings of recreational boaters will also be reduced. Also, project implementation is not likely to impact access to channels north of Sinepuxent Bay.

Fenwick Island

Direct and Indirect Impacts
Dredging of the Ocean City updrift fillet will have minimal impacts to recreational bathers because of the time of year dredging will take place. Dredging may temporarily impact (1 - 2 weeks) recreational surfers who use the inlet wave system year round.

6.6.1.b Navigation Improvements

Direct Impacts
A time-of-year restriction of mid-March through September will be in effect to minimize detrimental impacts to recreational boaters. Relatively few recreational boaters are on the water during the cooler months, and no inconvenience or detrimental impacts are expected.

Indirect Impacts
Navigation improvements will make navigation easier but are not expected to induce an increase in boat traffic nor provide additional recreational opportunities for boaters.

6.6.1.c Coastal Bays Environmental Restoration Projects

Direct Impacts
Island creation will reduce navigable waters by the amount of the island footprint. Construction will occur in colder weather when little recreational use of the coastal bays occurs. The temporary presence of construction and dredging equipment is anticipated to be a short-term obstacle to waterfowl hunters and fishermen at Isle of Wight and Sinepuxent Bay Wildlife Management areas.

Indirect Impacts
Fishing and crabbing opportunities at Isle of Wight will be improved as the constructed salt marshes increase the habitat value of the area for fish and crabs. The Dog Island Shoals and South Point spoils project sites will be closed during bird nesting season, otherwise they will be open. for recreational use. The islands will be sited to avoid or minimize impacts to commercial and recreational uses of the coastal bays.

6.7 CULTURAL AND HISTORICAL IMPACTS

6.7.1.a Long-term Sand Management

Cultural Investigations by the Baltimore District have indicated that there are no significant cultural resources in the offshore shoal area or in most of the area on Assateague Island. Investigations indicated that historical site WO154, "Dune Wreck," was located adjacent to the southern terminus of the Assateague Island restoration project. However, further analysis revealed that the location of the wreck site, between the two dune lines, was located to the west of the Corps project area. The Corps work will be contained eastward of the eastern dune. Therefore, Dune Wreck is outside the area of potential effect, and no investigation of the site is warranted for this project. Consultation with the Maryland Historic Trust is ongoing, and will be completed prior to the finalization the Feasibility Phase of this project, thereby fulfilling the requirements of Section 106 of the National Historic Preservation Act.

6.7.1.b Navigation Improvements

The navigation improvements component of the project is not expected to have any impacts on cultural resources because dredging will take place within the existing harbor and inlet waterways.

6.7.1.c Coastal Bays Environmental Restoration Projects

The Corps has selected locations for environmental restoration that have been degraded. Therefore, the sites selected have little to no opportunity for containing National Register eligible cultural resources. In fact, the severe disturbance noted at most of these sites suggests that no cultural resources exist. Therefore, no significant impacts to cultural or historic resources are expected in these areas.

The study area has a long history of use by humans from the Paleolithic Period to the present, but most of the known inhabitation sites are located within well-drained, upland portions of the county. Although the salt marshes and fringe wetlands would have been utilized for the collections of floral and faunal resources, these activities leave little in the archeological record, with the exception of shell mounds. Therefore, the majority of the project locations under study by this project have little potential for encountering significant cultural resources.

The only exception to the above statement was noted at the Ocean Pines salt marsh restoration sites, which, in fact, did retain both well-drained soils and an adjacent salt marsh. Phase I shovel testing, however, failed to identify the presence of any cultural resources at this location, nor were any shell mounds encountered in the vicinity. Therefore, the Corps determined that the proposed environmental restoration of the Ocean City area will have no affect on cultural resources, and no further cultural resource investigations are justified for this project.

Consultation with the Maryland Historic Trust is ongoing, but will be completed prior to the completion of the Feasibility Phase of this project, thereby fulfilling the requirements of Section 106 of the National Historic Preservation Act.

6.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTES (HTRW)

There are no known CERCLA or RCRA. sites in the study area; therefore, no HTRW impacts are expected.

6.9 COMMUNITY SETTING

6.9.1 Land Use

The proposed restoration at Assateague Island would occur in the surf zone and would not change land use in the area. Other than Ocean Pines, all proposed projects would occur in the waterways. At Ocean Pines, a zoned residential development is planned for this area in the future. Currently, there is no development near the project sites.

6.9.2 Visual and Aesthetics Values

Direct Impacts

Because there will be a short-term presence of construction and dredging equipment during off-season, minimal and temporary impacts to aesthetics are anticipated.

Indirect Impacts

The proposed restoration of Assateague Island, creation of marshes and islands will positively impact the aesthetics of the areas. These areas could attract various bird populations and wildlife, thereby increasing viewing pleasure.

6.9.3 Prime and Unique Farmland

No projects will take place on Prime and Unique Farmland; therefore, no impacts are expected. The limited acreage of former farmland that occurs in the vicinity of the proposed Ocean Pines project is slated for development in the near future anyway.

6.9.4 Wild and Scenic Rivers

There are no federally designated wild or scenic rivers within the project area. Consequently, no impacts are expected.

6.9.5 Noise Impacts

Direct Impacts
Noise during construction for long-term sand management, navigation improvements, and coastal bays, and environmental restoration projects will be produced by dredges, work boats and land-based construction equipment. Construction will not occur during the times beach-nesting waterbirds are sensitive to disturbance, and noise is not expected to significantly impact other wildlife. Construction will not occur during the period when the project area is most frequented by tourists. Therefore, noise impacts are expected to be minimal for all projects.

Indirect Impacts
Since the projects are not expected to cause additional use of nor economic development of the region, no increase in noise is expected.

6.9.6 Navigation

Direct Impacts
The direct impacts are the removal of up to 68,000 m^3 from the ocean city harbor and 46,000m^3 from the inlet.

Indirect Impacts
Indirect impacts are easier navigation in the project area. The proposed navigation improvements are not expected to significantly increase vessel traffic in the project area or significantly increase the need for additional dredging.

6.10 SOCIOECONOMIC CONDITIONS

6.10.1 Demographics

Implementation of the proposed actions will not significantly impact key macroeconomic elements of the local or regional economy. The project's scope is such that it will not affect the long-term population, employment, or income trends in the study area. It is possible that implementation of the proposed action will, by stabilizing the northern section of Assateague Island, reduce negative impacts to property values on the mainland behind the island, and reduce costs incurred by boaters from increased channel shoaling in Sinepuxent Bay. The extent and magnitude of such effects are not, however, expected to alter economic activity in the study area.

Population trends are not expected to be impacted by project implementation. Physical changes are localized, and no relocation of existing households are required. No existing population centers will be affected. It is not expected that residents will be inclined to relocate because of the project.

6.10.2 Economic

The impact of the proposed project on local or regional employment distribution is not expected to be significant. The project will not, in and of itself, spur growth in the major industries in the study area, nor will it stimulate significant growth in other, less dominant industries. Tourism and agriculture will continue to thrive with or without the project. No significant impacts to commercial fisheries or fishermen are expected.

The impact of the proposed project on income in the study area will not be significant. The project will not change the median household income, which currently lags significantly behind the statewide figure.

The proposed actions may produce a minor and temporary increase in employment during construction and perhaps a slight increase in use of temporary lodging. Any lodging requirements are likely to be met by existing facilities because construction will not occur during periods of peak lodging usage by tourists. The proposed dredging and placement will be accomplished by a small construction crew operating dredges, bulldozers, and trucks. These workers, if they do not live locally, will likely spend money in the area for food and lodging. Therefore, socioeconomic impacts are expected to be slightly positive.

6.10.3 Environmental Justice

No significant adverse impacts under Executive Order 12989, dated February 11, 1994 (*Environmental Justice in Minority Populations*), are expected because there are no minority or low income communities located near the beach replenishment area nor the environmental restoration sites.

6.11 IRRETRIEVABLE USES OF RESOURCES

The projects will redistribute sand within the coastal bay system and nearshore waters of the Atlantic Ocean. The sand will leave the study area on its southern end and serve to maintain the integrity of southern Assateague Island, perhaps inducing additional accretion at Toms Hook. If it is found that the ebb shoal could be mined with an increased frequency beyond that proposed, then a reduction in the rate of consumption of the offshore borrow areas used to maintain Ocean City could be affected. This could serve to prolong the life of the offshore shoals that are more valuable as commercial and recreational fisheries and that are otherwise being irretrievably consumed for beach replenishment.

Irretrievable use of the offshore shoals of the project area can be reduced if the ebb shoal is not managed as a static system. If material is drawn off the ebb shoal at a rate greater than the rate at which it accumulates, then it will remove the need to extract material from the offshore shoals.

Consideration of cumulative impacts to the habitat value of the offshore shoals, as well as to the irretrievable consumption of the mineral resources they contain, will require greater scrutiny in the near future by the State of Maryland. Offshore shoals within Maryland waters north of the Ocean City Inlet are already being heavily utilized as sources of sand for the nourishment of the Ocean City beach. Sand resources within Maryland state waters available for use by Ocean City could conceivably be depleted between the years 2010 and 2025. The increasing use of offshore shoals along the Atlantic coastline as sand sources for beach nourishment, as well as for sources of sand and gravel for construction, necessitates comprehensive consideration of long-term management of these non-renewable features in the near future.

6.12 CUMULATIVE IMPACTS

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. This section discusses potential impacts resulting from other facilities, operations and activities that in combination with potential impacts from this project may contribute to cumulative impacts. Future actions, proposals, or plans are discussed where implementation appears to be possible within a 5 year time frame. Cumulative impact assessment requires consideration of impacts beyond the site-specific direct and indirect impacts evaluated previously in this section. Such assessment should expand the geographic boundaries to consider the effects over an area that extends beyond the immediate site of the proposed action. It is in this context that this section is written.

The natural ecosystems and coastal geological processes of the coastal bays were and will continue to be altered by such human activities as development, shoreline stabilization both along Fenwick Island and the mainland shoreline, the fixed inlet at Ocean City, dredging of navigation channels, and prevention and closure of breaches on Assateague and Fenwick Islands.

6.12.a Long-term Sand Management

The proposed long-term sand management program will prevent future damage to Assateague Island that would otherwise be caused by the jetties which are part of a Corps of Engineers project built in 1933. Restoration of the island's geological integrity will facilitate maintenance of Assateague as an undeveloped barrier island by the National Park Service; this is of particular importance given the relative scarcity of undeveloped barriers along the Atlantic coast and the increasing development expected in the project area, and the loss of natural seashore to development along coastal regions of the U.S.

In combination with the proposed short-term restoration, it is possible that the long-term sand management program could alter island character by promoting dune growth and increased vegetative cover. These changes could be detrimental to Piping plover. However, any changes in island character induced by the short-term restoration action are expected to become

apparent within the period of time covered by that project's Monitoring and Action Plan. The monitoring plan will run for at least 5 years following implementation of the short-term restoration, and contains mitigation options which could lessen cumulative impacts of these projects on Piping plover. In addition, it is important to note that the National Park Service is no longer maintaining the constructed dunes in the majority of the national seashore. This change in management is expected to improve nesting habitat conditions for plovers in other areas of the national seashore.

The proposed project will not eliminate the tidal shoals but will reduce their rate of formation, and perhaps cause them to become reduced in size. The project will reduce the volume of sand flowing into coastal bays and will slow shoaling of the coastal bays in the vicinity of the inlet. Consequently the LTSM is expected to reduce some of the cumulative effects of the beach nourishment of Ocean City.

Infrastructure such as roads, schools, health care facilities, and housing is increasing in the project area. No additional infrastructure such as roads or lodging will be required at Assateague as a result of the proposed project. The project is not expected to change the number of people using the greater project area. However, from an economic perspective, eco-tourism is becoming more important in parts of the country and interest in and visitation at Assateague is likely to increase as the population of the eastern United States increases and finds that there are fewer undeveloped areas like Assateague to enjoy.

6.12 b Navigation Improvements

Cumulative impacts relating to the deepening of the harbor and inlet may lead to a minor increase in boating activities. However, most areas within the channel are already a sizable depth, therefore, no increased congestion on the water is anticipated. Cumulative impacts relating to navigation are not expected to (1) greatly increase the human use of the project area, (2) increase the need for infrastructure such as roads or lodging, or (3) increase congestion on land or on the water or (4) significantly increase the demand for dredging. Beneficially, the materials dredged from the Federal project channel will be used to create bird habitat and salt marsh islands that are expected to increase habitat for fish and wildlife and to provide support to the coastal bays ecosystem.

No new large scale Federal navigation projects are expected to occur in the project area. No new small non-Federal navigation projects are planned that are expected to have a significant cumulative adverse impact to the project area. It is anticipated that as the area is developed there will be more demand for navigable channels or access to existing deep channels. In the short term this is expected to cause only minor impacts to biological resources or water quality. However, uncontrolled growth or dense populations can place increased stress on natural systems particularly in a rapidly developing resort area that is attractive because of the recreational use of navigable waters.

6.12 c Coastal Bays Environmental Restoration Projects

The loss of island habitat, particularly bare-substrate nesting habitat, is a direct result of human activities in the coastal bays. Through the development of Fenwick Island and dune construction and recreation on Assateague Island, barrier island nesting habitat was lost. By preventing a sizable breach from occurring on Fenwick or Assateague Islands, the natural process that would form open sand habitat adjacent to an inlet and islands on the bay side of the barrier islands is stopped. By stabilizing the mainland shoreline, formation of islands along the mainland is stopped. Even though human activities created island habitat by the creation of dredged material islands, these islands are no longer being created in the coastal bays, and the remaining dredged material islands are eroding away.

The coastal bays projects are expected to positively benefit the ecosystem by increasing the acreage of salt marsh and habitat suitable for SAV establishment in the northern coastal bays, and by increasing nesting habitat for colonial waterbirds. As stated in this report the project area has lost much of its salt marsh. The proposed project will restore some of this loss. Although a small amount of SAV and summer flounder habitat will be lost, some resource agencies consider the creation of scarce bird habitat to be more important. Based on information gathered thus far, the impact of the loss of benthic and open water habitat will be locally significant but regionally insignificant for the proposed project because of the relative abundance of benthic and open water habitat in the coastal bays.

The Dog Island Shoals project could induce dredging since the site will provide an inexpensive disposal site. This in turn could have additional impacts on water quality, biological resources, land use and recreation. Potential impacts that could occur to the environment because of increased dredging will be reviewed as part of the existing permitting process. The project proposed in this report is 2.4 ha (6 acres). This report anticipates complete use of the 10 ha (25 ac) island as a reasonable foreseeable project. The additional 7.7 ha (19 acres) will require Federal and non-Federal approvals and must consider alternative placement sites including upland sites. If there is a need to construct additional island acreage in the future at other sites in the coastal bays then this would be evaluated by the appropriate Baltimore District entities depending on whether a permit is required.

6.12.d Potential Future Actions

1. Assateague Island Short Term Restoration

A draft feasibility report and an EIS were prepared by the Baltimore District, Corps of Engineers in 1997. The proposed project if approved and funded will stabilize the shoreline by dredging approximately 1.4 million m^3 (1.8 million cy) from the offshore shoals in the project area.

2. Ocean Pines Development

The Ocean Pines housing development is planned to increase in size by approximately 2,000 units within 7-10 years. This construction will add to the population in the project area and will increase groundwater withdrawal, and nutrient releases into the watershed. A small amount of wetlands were lost, but the developer has mitigated for this loss. The Corps of Engineers project will compensate for loss of wetlands in the project area.

3. Route 113 Dualization

The Department of Transportation has recently released a draft EIS for the dualization of Route 113 which runs from the Maryland/Delaware state line to Snow Hill, MD. This project is under public review. It is not known if it will significantly increase travel to or development in the project area. Approximately 13 acres of palustrine forested wetlands will be impacted by the project. Mitigation sites are being sought for this project by the State Highway Administration.

4. Isle of Wight Wildlife Management Area.

The MDDNR is planning to improve bulkheading at the site and make improvements that provide water access to the area to approximately 50-100 visitors each day. Construction to stabilize the shoreline is expected to have temporary minor impacts.

5. The Atlantic Coast of Maryland Shoreline Protection Project

Approximately 850,000 cubic yards of material will be placed on the Ocean City beach during 1998. Dredging is expected in May or June. This project will use borrow area 9 which will not be used for the project proposed in the LTSM report.

6. Potential Future Expansion of Dog Shoal Islands From 6 To 25 Acres

In addition to the 2.4 ha (6 acres) created as part of this Federal project, 7.7 ha (19 acres) of island habitat using dredged material from the coastal bays may be created in the Dog Shoal area. Dredged material from non-Federal sources will be used. This will result in the loss of benthos in this area and open unvegetated shallow water habitat that will be converted to island salt marsh habitat. This material will come from the northern coastal bays and will be evaluated for suitability. The loss of bottom and shallow water habitat is considered locally significant because of the total size (up to 10.1 ha [25 acres]) of the project. However, the creation of wetlands is considered to be of benefit to the coastal bays ecosystem. Approximately 76,500 cubic meters (100,000 cy) of dredged material could be placed at this site to create the 7.7 ha (19 acres). Any dredging would have to be evaluated by the appropriate Federal and non-Federal regulatory agencies. It is expected that the majority of dredging will occur in previously dredged areas and dead end canals, and therefore, cumulative impacts of dredging are not viewed as significant. It is anticipated that no special aquatic sites such as SAV or historic oyster beds will be disturbed by this dredging, and that dredging will be in compliance with a State of Maryland water quality certificate.

6.13 ENVIRONMENTAL COMPLIANCE

For an activity or site to be environmentally acceptable, the location, design, and operation must be in compliance with a number of environmental protection statutes and executive orders. Table 6-2 outlines the statutes and executive orders that are potentially applicable to the project, including the level of compliance. The multiple organizations involved in the project and the ongoing and open communication surrounding decisions have helped ensure complete compliance with potentially applicable statutes and regulations.

The proposed action complies with applicable cultural resources statutes, including the state Archaeological and Historic Preservation Act and the National Historic Preservation Act. The assessment included evaluation of archaeological and historic resources, economic and social impacts, and interaction with coastal planning regulations. The Maryland State Historic Preservation office has been consulted, and coordination is ongoing. No significant impacts to cultural resources are expected.

The technical impact assessment documented in this report demonstrates that the project complies with applicable components of the Anadromous Fish Conservation Act; Clean Air Act; Coastal Barrier Resources Act; Coastal Zone Management Act; Estuary Protection Act; Magnuson Fishery Conservation and Management Act; National Fishing Enhancement Act; Outer Continental Shelf Lands Act; Marine Protection, Research, and Sanctuaries Act; and the Rivers and Harbors Act. The proposed action will be in full compliance with the Clean Water Act when the State of Maryland issues a water quality certificate or if Congress authorizes the project and the EIS. At the present time, the Corps intends to apply for a water quality certificate. The project also complies with all components of NEPA.

No significant impacts are expected to any rare, threatened, or endangered species; the project will comply with the Endangered Species Act and the Marine Mammal Protection Act. Through the intensive coordination process, the project complies with the Fish and Wildlife Coordination Act in respect to the Piping Plover. In compliance with the Endangered Species Act, a Biological Assessment for the sea turtles and whales has been prepared by the Baltimore District. The Baltimore District, FWS, and NMFS, are engaged in the consultation process required under the Endangered Species Act. Preparation of a biological assessment for the Piping Plover will begin in the winter of 1997. No significant impacts to listed threatened or endangered species are expected.

A number of executive orders are applicable to the project. The impact evaluation process demonstrates that the project complies with Executive Orders number 11593, Protection and Enhancement of the Cultural Environment; number 11514, Protection and Enhancement of Environmental Quality; and number 12088, Pollution Control Standard, as well as with the Prime and Unique Farmlands CEQ Memorandum.

The nature and design of the project explicitly incorporate compliance with Executive Orders number 11988, Floodplain Management, and number 11990, Protecting Wetlands.

This project will comply with Executive Order number 12898, Environmental Justice in Minority Populations and Low-Income Populations. A Public Notice was sent out as part of the 1994 reconnaissance study prepared by the Baltimore District, and two newsletters have been distributed during the preparation of this feasibility study. An additional newsletter will be distributed at the end of the study to inform citizens of the results and recommendations of the study. The Public Notice stated that any person who has an interest may request a public hearing. No significant impacts are expected to occur to any minority or low income communities in the project area. Furthermore, the study team has involved the residents of Worcester County in the decision-making process via a series of public meetings.

Through coordination with the applicable state and Federal agencies, it was determined that no National Point Discharge Elimination System permit or Federal wetlands permit will be required for this Federal project. however, permitting will be required for non-Federal dredging. The project will be in compliance with the Coastal Zone Consistency Act and the Clean Air Act Amendments.

Table 6-2: Compliance of the Proposed Action With Environmental Protection Statutes and Other Environmental Requirements.

Federal Statutes	Expected Level of Compliance[1]
Anadromous Fish Conservation Act	N/A
Archeological and Historic Preservation Act	Full
Clean Air Act	Full
Clean Water Act	Full (2)
Coastal Barrier Resources Act	N/A
Coastal Zone Management Act	Full
Comprehensive Environmental Response, Compensation and Liability Act	N/A
Endangered Species Act	Full (3)
Estuary Protection Act	Full
Farmland Protection Policy Act	N/A
Federal Water Project Recreation Act	Full
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act	Full
Magnuson Fishery Conservation and Management Act	Full
Marine Mammal Protection Act	Full
Marine Protection, Research, and Sanctuaries Act	Full
National Historic Preservation Act	Full
National Environmental Policy Act	Full
Outer Continental Shelf Lands Act (OCSLA)	Full
Resource Conservation and Recovery Act	N/A
Rivers and Harbors Act	Full
Submerged Land Act	Full
Water Resources Planning Act	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act	N/A
Executive Orders (EO), Memoranda, etc.	
Protection and Enhancement of Environmental Quality (E.O. 11514,1977)	Full
Environmental Justice (E.O. 12898)	Full
Protection and Enhancement of Cultural Environment (E.O. 11593)	Full
Floodplain Management (E.O. 11988)	Full
Protection of Wetlands (E.O. 11990)	Full
Recreational Fisheries (E.O. 12962)	Full
40 CFR 122.26 (B)(14), 19 Nov 1990	N/A

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. Partial Compliance: not having met some of the requirements that normally are met in the current stage of planning.
- c. Non-Compliance: violation of a requirement of the Statute, E.O., or other environmental requirement.
- d. Not-Applicable: no requirements for the statute, E.O., or other environmental requirement for the current stage of planning.

2 Compliance will be complete after the State of Maryland issues water quality certificate.

3 Compliance will be complete after written concurrence is received from the U.S. FWS and NMFS.

SECTION 7

PROJECT IMPLEMENTATION

7.0 INTRODUCTION

The recommended plans will require a number of commitments on the part of the U.S. Army Corps of Engineers and the project sponsors in order to realize the benefits of the plans. This chapter describes the major requirements of plan implementation. A Project Management Plan (PMP), which describes the tasks, funding, and schedule through the preconstruction, engineering and design (PED), and construction phases, will be prepared for all three of the project components.

7.1 LONG-TERM SAND MANAGEMENT

7.1.1 Assateague Island

In accordance with Section 534 of the Water Resources Development Act of 1996, the U.S. Army Corps of Engineers is authorized to carry out the restoration of Assateague Island pursuant to Section 111 of the River and Harbor Act of 1968, as amended. The Corps shall coordinate with the affected Federal and State agencies and shall enter into an agreement with the Federal property owner to determine the allocation of the project costs. This Act covers both the short and long term restoration of Assateague Island. The sharing of project responsibilities for both components is currently being coordinated and will be defined in a Memorandum of Agreement (MOA) to be signed by the Assistant Secretary of the Army for Civil Works and the National Park Service.

The PED phase will consist of preparation of the plans and specifications for the first cycle of bypassing, preparation of a more detailed monitoring program, and a project report. No Design Memorandums are required. Funding for the PED phase will be fully Federal. Following the PED phase, the project will proceed to construction. Based on the availability of funding, construction could begin in FY2001. This project is considered continued construction, and will be funded annually through Construction General funds.

In accordance with Section 201, of WRDA 1996, a long-term management plan will be development for long-term dredging. The Baltimore District, Operations Division will maintain the lead in the creation of a Long-term Management Dredging Plan. After dredged materials from the harbor and inlet are used for island creation and Assateague Island nourishment, maintenance dredging of these areas will be used in the following manner: 1) materials dredged from the inlet will be used to periodically nourish Assateague Island, and 2) materials dredged from the harbor will be disposed at the upland Ocean City Airport site.

Implementation of the long-term sand management of Assateague Island could provide a cost-savings to the navigation improvement component of the study. The long-term project proposes to dredge up to 10,000 m^3 (13,000 yd^3) of material each year from the navigation channels. Dredging materials from the federally maintained navigation channels could lessen, or perhaps eliminate, the Corps' O&M dredging cycles of the channels. In 1997, the inlet was dredged at a cost of $344,000 for removal of 14,000 m^3 (18,000 yd^3) of material. The harbor was dredged in 1990 at a cost of $337,000. However, it is difficult to determine the exact cost savings due to possible changes in channel shoaling rates after project construction.

7.1.1.a <u>Local Cooperation</u>

The National Park Service, the Federal property owner of most of the project area, has agreed to enter into an MOA with the Department of the Army prior to construction. The MOA will include the following items of local cooperation and participation by the National Park Service:

a. Provide all lands, easements, rights-of-way, and relocations, as determined by the Corps to be necessary for the construction of the project, including any necessary monitoring and corrective actions.

b. Assure maintenance and repair during the useful life of the project as required to serve the project's intended purpose.

c. Ensure continued public ownership or continued public use of the shoreline upon which the amount of Federal participation is based, and ensure its administration for public use during the economic life of the project.

d. Provide and maintain necessary roads, parking, and other public-use facilities open and available to all on equal terms.

e.. Enter into a memorandum of agreement to provide ***[percentage to be determined]*** *percent of total project costs as provided in Section 534 of the Water Resources Development Act of 1996 and Section 111 of the River and Harbor Act of 1968, as amended by Section 904 of the Water Resources Development Act of 1986.*

7.1.2 Ocean City

The objectives of long-term sand management are to address the sand resources in the littoral drift system and to develop a plan for their management. Two long term needs have been identified - the maintenance of littoral sand flows to Assateague Island and the periodic renourishment of the U.S. Army Corps of Engineers' Atlantic Coast of Maryland Shoreline Protection project at Ocean City, Maryland.

The eight-mile long shoreline protection project at Ocean City requires renourishment about every four years with an estimated 850,000 m^3 of sand, based on the planned Fiscal Year 1998 renourishment. The source of the sand is a bar three miles offshore of Ocean City. In addition to the renourishment of the project every four years, the State has identified a need for 15,000 m^3 of sand to be placed along selected areas of the beach to address areas of extra heavy erosion.

The Ocean City inlet interrupts the littoral flow of sand to Assateague Island as described earlier in this report. An estimated 145,000 m^3 per year is needed each year to continue the natural littoral flow of sand from the north to the south.

These two needs can be accommodated by the sand sources identified in this study - the inlet sand fillet adjacent to the north jetty, the ebb shoal offshore of the inlet, the navigation channels in the inlet and back bay, and the shoals building near the inlet. Economies of scale can be realized by combining the needs of Assateague Island with the needs of the Atlantic Coast Shoreline Protection project at Ocean City. Considered individually, the Assateague Island needs can be accomplished efficiently by an annual dredging contract. However, a separate dredging contract for the back-passing of 15,000 m^3 sand to the Atlantic Coast of Maryland Shoreline Protection project at Ocean City from these sand sources would be cost prohibitive due to the high cost of mobilizing and demobilizing a dredge for this small amount of sand. By combining these needs into one dredging contract, both can be met at a reasonable cost.

The existing authorities for both projects would be used to budget funds for the U.S. Army Corps of Engineers contribution. The $41,300 estimated cost for the Atlantic Coast of Maryland shoreline protection project would be shared in accordance with the signed Project Cooperation Agreement - 53% ($21,900) Federal, 47% ($19,400). The costs for the Assateague Island would be cost shared in accordance with agreed upon cost sharing. Each year, both projects would be individually identified in the President's budget.

7.2 NAVIGATION

The deepening of the channels through the inlet and harbor will be implemented under the authority of Section 107 of the River and Harbor Act of 1960, as amended. The Maryland Department of Natural Resources (MD DNR), Worcester County and the Town of Ocean City support the project. MD DNR will act as the official non-Federal sponsor, but will have separate agreements with the County and Town to share the cost. In accordance with Section 201 of the Water Resources Development Act of 1986, as amended, during construction, the non-Federal sponsor will pay 10 percent of the costs of construction of the general navigation improvement when the project depth does not exceed 20 feet. The non-Federal sponsor will repay with interest, over a period not to exceed 30 years, an additional 0 to 10 percent of the total cost of depending upon the amount of credit given for the value lands, easements, rights of way and relocations (LERRDs) following project completion.

The non-Federal sponsor is to provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project. The non-Federal sponsor for so long as the project remains authorized, is responsible for the operation, maintenance, repair, replacement, and rehabilitation of the completed project, or the functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

The Federal share of the cost will be paid through the Continuing Authorities Program. Under Section 107, no PED agreement is needed. The plans and specifications cost will be paid for up front by the U.S. Army Corps of Engineers and reimbursed by the non-Federal sponsors at the time of construction. In addition, the Project Cooperation Agreement (PCA) will be developed with the non-Federal sponsor through the CAP program.

7.3 ENVIRONMENTAL RESTORATION

MD DNR, Worcester County and the Town of Ocean City are all interested in cost-sharing the four recommended environmental restoration projects. This component of the project will be implemented under the authority of Section 206 of the Water Resources Development Act of 1996, as amended. The projects will be cost-shared 65/35 with the non-Federal sponsors. Approximately 150,000 cubic yards of material must be dredged from the harbor and inlet in order to deepen it to the proposed depth, and approximately 40,000 cubic yards of material is needed to construct the Dog Island and South Point Spoils islands and wetland sites. If these projects are constructed simultaneously, a construction cost savings can be realized in dredging mobilization and demobilization and disposal costs. The Isle of Wight wetland construction will use materials from nearby channels. It will be coordinated with any MD DNR's restoration plans for the area. The Ocean Pines saltmarsh restoration can be constructed under a separate contract since it is on land and will not require dredging.

The non-Federal sponsor is to provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project. The non-Federal sponsor for so long as the project remains authorized, is responsible for the operation, maintenance, repair, replacement, and rehabilitation of the completed project, or the functional portion of the project, at no cost to the Government, in accordance with applicable Federal and State laws and any specific directions prescribed by the Government.

Under the authority of Section 206 to implement project construction, a PED agreement is not needed. The plans and specifications cost will be paid for up front by the U.S. Army Corps of Engineers and reimbursed by the non-Federal sponsors at the time of construction. In addition, the Project Cooperation Agreement (PCA) will be developed with the non-Federal sponsor through the CAP program.

7.4 FINANCING PLAN

The National Park Service, Maryland Department of Natural Resources, Worcester County and the Town of Ocean City are willing to cost-share the long-term sand management. Information on their capabilities to fund the project will be included after cost-sharing arrangements have been made.

SECTION 8

PUBLIC INVOLVEMENT AND AGENCY COORDINATION

Public involvement and agency coordination for the Ocean City Water Resources Study was designed to be an integral part of the planning process. The purposes of the public involvement program included informing the public and decision makers as required by NEPA; gathering useful information; coordinating with citizens, interest groups, and agencies; assessing support for the project; providing a mechanism for citizen input to the planning process; and explaining the use of tax dollars to the taxpaying public. Public involvement participants included the project partners; natural resource management, regulatory, and planning agencies; citizen and interest groups; and the general public. Project cost-sharing sponsors are the Town of Ocean City, Maryland Department of Natural Resources (MD DNR), National Park Service (NPS), and Worcester County.

The intent of the public involvement program was (1) to identify the several publics with an interest in the project or that might be impacted by the project, (2) to encourage constructive interaction between the study team and the public, (3) to elicit the ideas, issues, and concerns important to each group; and (4) to incorporate those ideas, issues, and concerns into the planning process. Strong and consistent agency coordination was critical throughout the study, and included formal written communication, spirited interaction at study team meetings, assistance with presentations, and participation at public meetings and workshops. Extensive informal communication among agencies also took place as questions were raised and answered during phone conversations and in impromptu discussions. Each interaction, meeting, and conversation was important to the plan formulation process. A summary and a copy of the letters, comments, and records of other communications are included in Annex A.

The public involvement program developed for the feasibility study was a continuation of a comprehensive program completed during the reconnaissance phase of the project. Reconnaissance phase activities included a broad scoping process to identify potential water resource problems and solutions. The reconnaissance public involvement program included a series of public meetings and workshops, as well as meetings with interest groups, focus groups, and agency representatives.

The product of the scoping efforts was a list of approximately 30 problems relating to water resources in the Ocean City area. Potential corrective plans were developed and evaluated for the problems identified, a determination was made about Federal interest in correcting the problems, and a cost estimation for a feasibility level study was prepared. Four of the 30 water resource problems were characterized as being in the Federal interest and are addressed in the feasibility study. The problems selected as Federal-interest projects include the short-term restoration of Assateague Island, long-term sand management, navigation improvements to the harbor and inlet, and environmental restoration in the coastal bays.

Public involvement activities at the feasibility level were organized into several stages, corresponding with the stages and tasks of other study activities. Each stage provided different opportunities for public participation and resulted in specific products. Members of the study team were committed to an extensive public involvement program that included a range of activities throughout the study including formal and informal meetings, correspondence, and conversations with agency representatives, citizen interest groups, and individuals.

The four stages of the public involvement program included project initiation, development of preliminary plans, preparation of detailed plans, and completion of the planning process. The stages were modified during the feasibility study to provide the flexibility needed in a project with four separate components. Because of the accelerated schedule for the short-term restoration project, meetings and other public involvement activities often included both preliminary discussions on issues involving the three normally scheduled projects and decision-making discussions on the short-term restoration project.

The complexity of the project, with its four major components and many sub-parts, required a variety of communication techniques during the public involvement process. Public involvement activities at the initiation of the feasibility phase included a newsletter, a public information workshop, and publication of the Notice of Intent in the Federal Register. The newsletter reviewed the reconnaissance study accomplishments and provided information on the feasibility phase. The public workshop on May 9, 1996, was attended by approximately 100 people and provided information on the status of each of the study components. A second newsletter was prepared to provide information on the status of the project as well as to address concerns and specific questions raised at the meeting. Issues and concerns identified by the meeting attendees, especially sedimentation in the back bays, were subsequently incorporated into the project planning process.

Since the first public workshop, efforts have concentrated on smaller, more focused group activities. In addition to the regular monthly study team meetings, which include representatives from five Federal, state, and local agencies, focus group meetings have been convened as necessary to discuss issues or questions identified, such as how to add material to the northern end of Assateague Island without negatively impacting Piping Plover habitat, and whether removing sedimentary material from offshore shoals would harm the off-shore fishery or change the wave action along the beach.

The Corps continued to meet with many agencies, interest groups, and members of the public as the recommended alternative for the short-term restoration of Assateague Island and preliminary plans for the remaining three components of the feasibility study were developed. Following development of these plans, a public information meeting was held on June 4, 1997 and the one final and three preliminary plans were again presented to the public for review and comment. Presentations on each of the project components was made by the Corps and the project sponsors. The final short-term Assateague Island restoration information was presented and the preliminary plans for navigation improvements, environmental restoration, and long-term sand management component were also presented. The expertise and familiarity with the project components of each of the sponsor/participants and was reflected in their presentations. The result was a successful public meeting.

A number of small group meetings with special interest and technical groups, such as the Scientific and Technical Advisory Committee (STAC) of the National Estuary Program (NEP), followed the June 1997 public meeting. The purposes of these meetings were to gather additional comments, suggestions, and technical information as preliminary plans were refined for the long-term sand management, navigation improvements, and environmental restoration components of the study. All questions, comments, and suggestions made throughout the study have been considered and incorporated into the project plans or addressed in the study report. Following the review and approval of the report by the project sponsors, agencies, and higher authorities, a final public meeting will be held to present the recommended plan and to invite comments from the public on the recommended project plans. In addition to the public meeting, a final newsletter will be distributed presenting information on the recommended plans and copies of the final study report will be made available in local libraries and by mail upon request.

SECTION 9

SUMMARY AND CONCLUSIONS

The watershed area of Ocean City, Assateague Island, and the Maryland coastal bays offers many attractions that draw millions of seasonal visitors and part-time residents, as well as growing numbers of new permanent residents. The area offers a wide variety of recreation opportunities and activities, and the wide open bays are home to many birds, fish, and other wildlife. In addition to tourism, the region and the State of Maryland benefit economically from a substantial fishing industry that is based in Ocean City.

The National Seashore and State Park, on nearby Assateague Island, is a unique feature of the study area and a national treasure, one of the few natural barrier islands remaining in the nation. It was the intent of Congress in establishing Assateague Island National Seashore that the park (1) provide a protected enclave for the complex plant and animal communities, both terrestrial and aquatic, that characterize the Mid-Atlantic Coast, and (2) fully illustrate the natural processes of change that shape the coastal environment. Located within a 3-hour drive of nearly 45 million people, the National Seashore offers an unspoiled setting and a unique opportunity for visitors to enjoy and be educated about the nature of barrier islands as well as about Assateague's unique and, in some cases, endangered wildlife. The island has gained world renown for its population of feral horses popularized by the publication of *Misty of Chincoteague*, a book about the island's wild ponies, and by the book's many sequels. Assateague Island also serves as a unique "natural laboratory" for the scientific community to conduct investigations relating to barrier island flora, fauna, ecology, and island geomorphology and coastal processes. The mission of Assateague Island National Seashore is to preserve these unique coastal resources and the natural ecosystem conditions and processes upon which they depend, provide appropriate resource-based recreational opportunities compatible with resource protection, and educate the public as to the value and significance of the area. Since 1965, the National Park Service (NPS) has succeeded in this endeavor, maintaining the island in close to its natural state while providing access to millions of visitors attracted to the island's natural setting and wildlife. This access to the public has allowed unique educational opportunities, both formal and informal, to visitors of all ages, that will cease to exist if the island continues to degrade.

Extensive population, development, large-scale agricultural operations, and other factors are jeopardizing the quality of water resources in the coastal bay watershed. Problems include degrading water quality, loss of wetlands, loss of nesting habitat for waterbirds, increasing sediment in the coastal bays, excessive erosion of the Assateague Island National Seashore, navigation difficulties, and increased storm damage. During this study, a comprehensive investigation of various water resource problems has been performed, and solutions to improve the ecosystem as a whole have been developed. The four components of the project investigated are (1) short-term restoration of Assateague Island, (2) long-term sand management of Assateague Island and Ocean City, (3) navigation improvements, and (4) environmental restoration in the coastal bays.

One cause of some of the water resource problems is the disruption of sediment movement caused by the jetties that stabilize the Ocean City Inlet. The jetties were constructed by the Corps of Engineers in 1934, after the inlet formed during a major storm in 1933. Since its formation more than 60 years ago, the inlet has functioned as a thoroughfare for boating traffic between the ocean and the coastal bays. In addition to providing access to the coastal bays, the jetties have disrupted the sediment supply between Ocean City and Assateague Island. Prior to the formation and stabilization of the inlet, the sand generally traveled from Ocean City south to Assateague Island. Since their construction, the jetties have rerouted a large portion of the sand that would have otherwise reached Assateague. Consequently, the northern 11 km (6.8 miles) of the island shoreline have been seriously affected. The disruption in the natural longshore transport of sediment between Ocean City and Assateague Island has resulted in adverse physical, biological, and economic impacts to the area. The result is an island that is not being maintained in a natural condition, and that lacks the geologic integrity of a healthy barrier island. The island overwashes frequently, and the shoreline has eroded back towards the mainland at an accelerated rate. This has caused the loss of salt marshes and subtidal habitat on the bay side of the island, the infilling and reduction in size of Sinepuxent Bay, and a decrease of habitat diversity on the island. It has contributed to navigation difficulties through the inlet and back bays and has increased the vulnerability of mainland communities to storm damage.

Navigation problems in the back bays and the Ocean City inlet are the result of channel shoaling and the need for deeper channels for larger drafting vessels. This shoaling results in delays for commercial fishermen and recreational boaters attempting to navigate the channels of the Ocean City harbor and inlet and the Shantytown Channel. Watermen whose boats have a draft too great to navigate the shoaled channels are forced to navigate with the tides in order to minimize damage to their vessels. Damages they are unable to avoid result in financial impacts to the fishermen.

The environmental degradation of the area, due to agriculture, development, and erosion, has resulted in the loss of many thousands of acres of fish and wildlife habitat in the Maryland coastal bays watershed. These losses include more than ***700*** ha (***1,750*** ac) of salt marsh in the coastal bays watershed and more than 10,100 ha (25,000 ac) of forested wetlands. Ecosystem functions that maintain environmental quality have also been lost. Beach-nesting bird species have lost more than 80 percent of their historical nesting habitat to development on Fenwick Island and the recreational use of Assateague Island, and waterbird colonies on dredged material islands in Sinepuxent and Chincoteague Bays are threatened by severe erosion. This study has included extensive analysis of these and other environmental problems and possible solutions to them.

These many problems--the sediment supply shortage to Assateague Island, the environmental degradation, and the navigation problems--are interrelated. Therefore, in conducting this study, the study team looked at multi-purpose solutions that would address all the problems described above. Since the degradation of Assateague Island was determined to be an urgent problem, an interim study was accelerated and a draft report completed in May 1997, so that a project to address the island's immediate needs could be implemented expeditiously. The short-term restoration of Assateague Island recommends the placement of 1.4 million m^3 (1.8 million yd^3) of sand which serves to partially mitigate for past sediment starvation that began with construction of the jetties in the mid-1930's. This project, a one-time renourishment of the island, is described in depth in the draft interim report described above and issued in May 1997.

Solutions were also investigated to address the continuing sediment deprivation of Assateague Island, navigation needs, and environmental degradation. In investigating these problems and evaluating solutions, we studied the overall sediment needs of Ocean City and Assateague Island. Analysis of the sediment budget indicated an annual sediment shortfall of approximately 145,000 m^3 (189,000 yd^3) of material to Assateague Island due to the presence of the jetties. Also, the eight-mile long shoreline protection project at Ocean City requires renourishment about every four years with an estimated 850,000 m^3 (1.1 million yd^3) of sand, based on the planned Fiscal Year 1998 renourishment. The source of the sand is a bar three miles offshore of Ocean City. In addition to the renourishment of the project every four years, the State has identified a need for 15,000 m^3 (20,000 yd^3) of sand to be placed along selected areas along the Atlantic Coast of Maryland Shoreline Protection Project at Ocean City to address areas of high erosion.

These needs will be addressed through long-term sand management. The recommended plan for Assateague Island is for the "mobile bypassing" of sand that would naturally have reached the island had the jetties never been built. Mobile bypassing will involve using a shallow mobile hopper dredge to remove sand that has been redirected to a number of sites, and then bypassing it to Assateague Island. The recommended plan for the Atlantic Coast Shoreline Protection Project is to combine its needs with the annual bypassing to Assateague Island. This dredging will take place annually or semi-annually during the spring and fall, using a shallow dredge like the *Currituck*, a shallow split-hull dredge built, owned, and operated by the Wilmington District, Corps of Engineers. This schedule will provide sediment to the island on a periodic basis that will more closely mimic natural processes; the use of the exceptionally shallow and adaptable *Currituck* will allow dredging to include the ebb shoal, updrift fillet, navigation channels and flood shoals. In order to avoid the creation of new problems by taking too much sand from any one source or too frequently from the same source, thus further disturbing the balance of the area, the project will be monitored annually. A team of decision makers, led by the Corps and consisting at a minimum of all the project sponsors (the National Park Service (NPS), the State of Maryland, Worcester County, and the Town of Ocean City), will determine each year how much material will be taken from each of the available sources, based on the monitoring results that will indicate the rate at which the sources are being naturally replenished after dredging.

To address the navigational problems, the recommended plan is to deepen the harbor channel from an authorized depth of 3.07 m (10 feet) to a depth of 4.3 m (14 feet), and deepen the inlet channel from an authorized depth of 3.07 m (10 feet) to a depth of 4.9 m (16 feet). This dredging will remove approximately 68,000 m^3 (88,000 yd^3) of material from the harbor and 46,000 m^3 (60,000 yd^3) from the inlet. Material dredged from the harbor and inlet will be used in the environmental restoration project and, potentially, in the long-term sand management project. It is expected that the shoaling rates in the proposed deeper channels will be similar to the existing shoaling rates and no additional maintenance dredging will be required. In addition, with the implementation of the long-term sand management component, maintenance dredging of the inlet should decrease significantly. Although there is no Federal interest in implementing a navigation project for Shantytown Channel, since the high maintenance cost outweighs the benefits, due to its proximity to the inlet, and the renewable volume of sand, this area has been identified as a potential bypassing source area for the long-term sand management project. Although the main purpose of dredging this area would be to support the long-term sand management, an incidental benefit would be to reduce the impacts of channel shoaling. This action will not only benefit Assateague Island, but will also improve navigation conditions in the Shantytown channel, which is used by many commercial and recreational boaters.

The recommended environmental restoration plan includes restoring a total of ***4*** ha (***10***ac) of salt marsh at the Isle of Wight Wildlife Management Area and 3.4 ha (8.5 ac) of salt marsh at Ocean Pines, stabilizing the eroding South Point Island to its 1997 size of approximately 0.9 ha (2.3 ac), constructing a new 1.2 ha (3 ac) island in proximity to South Point to create vegetated habitat for colonial waterbirds, and creating a 1.2 ha (3 ac) island near Dog Island that will be bare substrate with a shell surface for colonial waterbird nesting. The island created near Dog Island will also include additional cells that will be available to local citizens, businesses, and government for the placement of material dredged locally. Thus, 1.2 ha (3 ac) additional acres of salt marsh will be added in the near future, and up to 19 additional acres could eventually be created, increasing the size of this island to as much as 10 ha (25 ac). The areas of restored salt marsh will receive tidal inflow and will provide nursery habitat for a variety of aquatic creatures. Stabilizing South Point Island will protect existing habitat for the Brown Pelican colony currently nesting there, and the additional areas will create and stabilize habitat for colonial waterbirds such as the Least Tern.

The long-term sand management and environmental restoration projects were evaluated as having economic project lives of 25 years; the navigation project was evaluated as having an economic life of 50 years. The estimated cost for the long-term sand management, in support of the restoration of Assateague Island is $25,243,000. The first year cost is estimated to be $1,385,000. It is assumed that the first year will be constructed in year 2001. The cost includes $313,000 (contingency included) for lands and damages. These costs are also included in the $17,200,000 short-term restoration project. If the short-term project is constructed, the long-term project would be reduced by this amount. The estimated total cost of the long-term sand management in support of the Atlantic Coast of Maryland Shoreline Protection Project is $41,000 annually. The estimated cost for navigation improvements is $1,672,200. The estimated amount for environmental restoration projects is ***$5,746,600***.

The authority to implement the Assateague Island components of the project, both short-term and long-term sand management, were provided by Section 534 of the Water Resources Development Act of 1996. This Act directed the Corps to implement the restoration of Assateague Island pursuant to Section 111 of the River and Harbor Act of 1968. In addition, the Act authorized the expenditure of $35 million dollars for both the short- and long-term restoration of Assateague Island. As stated, the short-term restoration project is estimated at $17.2 million. At an annual cost of more than $1.1 million for long-term sand management, the project as authorized will carry us through to fiscal year 2011, assuming the project is fully Federally funded. For the 25 economic year project duration, the estimated fully funded long-term sand management cost is $43,773,000. As such, there is a need for additional authorization to raise the current Federal appropriations limit of $35 million. It stated that the Secretary shall coordinate with affected Federal and State agencies and shall enter into an agreement with the Federal property owner to determine the allocation of the project costs. The Corps is currently coordinating with NPS, the State of Maryland, Worcester County, and the Town of Ocean City to define project implementation responsibilities for both the short-term restoration of Assateague Island and the long-term sand management. All of the project sponsors support the recommended project. The NPS, who administers the Assateague Island National Seashore, has agreed to enter into a Memorandum of Agreement with the Department of the Army.

The authority to implement the back-passing of material to the Atlantic Coast of Maryland Shoreline Protection Project is the Water Resources Development Act of 1986.

The deepening of the inlet and harbor channels will be implemented through navigation provisions of the Corps' Continuing Authorities Program, as authorized by Section 107 of the River and Harbor Act of 1960, as amended. The Maryland Department of Natural Resources (MD DNR), Worcester County and the Town of Ocean City support the project. As directed by Section 201 of the Water Resources Development Act of 1986, as amended, during construction, the non-Federal sponsor will pay 10 percent of the costs of construction of the general navigation improvement when the project depth does not exceed 20 feet. The non-Federal sponsor will repay with interest, over a period not to exceed 30 years, an additional 0 to 10 percent of the total cost of depending upon the amount of credit given for the value lands, easements, rights of way and relocations (LERRDs) following project completion.

The environmental restoration projects will be implemented under the general authorities of Section 206. MD DNR, Worcester County and the Town of Ocean City support the four restoration projects. The projects will be cost-shared 65/35 with the non-Federal sponsors.

Public involvement and agency coordination for the Ocean City Water Resources Study was designed to be an integral part of the planning process. The purposes of the public involvement program included informing the public and decision makers as required by NEPA; gathering useful information; coordinating with citizens, interest groups, and agencies; assessing support for the project; providing a mechanism for citizen input to the planning process; and explaining the use of tax dollars to the taxpaying public. Public involvement participants included the project partners; natural resource management, regulatory, and planning agencies; citizen and interest groups; and the general public.

Currently, there are a number of ongoing studies and projects in the study area. The action that is relevant to this Corps study is the acceptance of the Maryland coastal bays into the U.S. Environmental Protection Agency's National Estuary Program (NEP) in 1995. Under the NEP, the MD DNR has organized the Maryland Coastal Bays Program (MCBP). This program is charged with protecting and preserving the coastal bays to ensure ecological and economic prosperity in the region. Over a 3-year period, the MCBP will develop a Comprehensive Conservation Management Plan. The plan will include an in-depth examination of the problems besetting the coastal bays and a set of agreed-upon solutions. Participants in the MCBP include numerous Federal, state, and local agencies; special interest groups; and private citizens. The Corps of Engineers is an active participant in the program and the recommended solutions described in the report support the goals and objectives of this program.

This project will stabilize one of the few remaining functioning barrier islands on the Atlantic coast; restore a unique national treasure, the Assateague Island National Seashore; protect the habitat of the famed wild ponies of Assateague; restore lost salt marsh habitat for aquatic creatures; restore lost island habitat for colonial waterbirds; and protect habitat for Brown Pelicans. It will also improve navigation through the Ocean City harbor and inlet and will help alleviate the shoaling problems in the coastal bays. In all these efforts, the project addresses multiple and interrelated water resource problems in a way that (1) optimizes benefits by linking dredging with restoration and (2) saves money. The project fulfills Congress' intention to mitigate for impacts caused by past Corps construction and has the support of all its sponsors as well as the public. In the thorough investigation, analysis, and plan development undertaken during the course of this study, the Baltimore District has attempted and succeeded in balancing environmental and economic concerns in formulating solutions to the multiple water resource problems of the area.

SECTION 10

RECOMMENDATIONS

In conducting this study, the Baltimore District took a regional approach to addressing the water resource needs of the Ocean City, and Vicinity study area. The District investigated the feasibility of (1) restoring Assateague Island to mitigate for the adverse impacts caused by the construction of the Ocean City Inlet jetties, (2) addressing the sand source needs of the Atlantic Coast Shoreline Protection Project***, and Assateague Island***, (3) improving navigation, and (4) restoring fish and wildlife habitat. This investigation has been conducted as authorized by a resolution of the Committee on Environment and Public Works of the United States Senate, adopted May 15, 1991.

As part of this study, I have given consideration to the relevant aspects of public interest, including environmental, social, economic, and engineering concerns. On the basis of this evaluation, and with the support of the project sponsors, I recommend that the U.S. Army Corps of Engineers, along with the project sponsors, implement the recommended plans described in this report (i.e., ***short-term restoration of Assateague Island,*** long-term sand management, navigation improvements, and environmental restoration). Through the Water Resources Development Act of 1996, Congress has directed the U.S. Army Corps of Engineers to pursue the restoration of Assateague Island under the authority of Section 111 of the River and Harbor Act of 1968, as amended. I recommend the short- and long-term restoration of Assateague Island. For the short-term restoration, I recommend the placement of 1.4 million m^3 (1.8 million yd^3) of sand on Assateague Island to partially mitigate for past sediment starvation that began with construction of the jetties in the mid-1930’s. The ***baseline*** cost of the short-term restoration is $17.2 million. I also recommend the long-term restoration through mobile bypassing of approximately 145,000 m^3 (189,000 yd^3) of sand to Assateague Island annually. The ***baseline*** estimated cost for the long-term sand management, in support of the restoration of Assateague Island is $25,243,000. The first year baseline cost of the long-term sand management in support of the restoration of Assateague Island is $1,385,000. At an annual cost of more than $1.1 million for long-term sand management, the project as authorized will ***be funded*** through fiscal year 2011, assuming the project is fully Federally funded. For the 25 economic year project duration, the estimated fully funded long-term sand management cost is ***approximately $44 million***. ***If both projects are fully Federally funded,*** additional authorization to raise the current Federal appropriations limit of $35 million ***will be needed in subsequent years***. Further, I recommend that 15,000 m^3 (20,000 yd^3) of sand be back-passed ***annually*** to selected areas along the Atlantic Coast of Maryland Shoreline Protection Project at Ocean City to address areas of high erosion***, as needed***. The back-passing should be combined with the annual long-term Assateague Island restoration project and implemented under the existing authorization of the shoreline protection project.

To address the navigational problems, I recommend dredging the Ocean City harbor channel to a depth of 4.3 m (14 ft) and the inlet channel to a depth of 4.9 m (16 ft) and using this material to restore fish and wildlife habitat ***to the degree possible***. The cost for deepening the existing harbor and inlet channels is ***estimated to be*** $1,672,000. Deepening of the inlet and harbor channels will be implemented through the Continuing Authorities Program, as authorized by Section 107 of the River and Harbor Act of 1960, as amended.

Finally, I recommend restoring lost fish and wildlife habitat to the region by restoring a total of ***4*** ha (***10*** ac) of salt marsh at the Isle of Wight Wildlife Management Area and 3.4 ha (8.5 ac) of salt marsh at Ocean Pines, stabilizing the eroding South Point Island to its 1997 size of approximately 0.9 ha (2.3 ac), constructing a new 1.2 ha (3 ac) island in proximity to South Point, and creating a 1.2 ha (3 ac) island near Dog Island. The island created near Dog Island will also include additional cells that will be available to local citizens, businesses, and government for the placement of material dredged locally. These stabilized, restored, and created areas, ***some of*** which ***may*** be constructed with material dredged from the harbor and inlet, will provide lost habitat to a variety of water birds and aquatic creatures. The environmental restoration components of the project will be implemented under Section 206 of ***the Water Resources Development Act of 1996***. The cost of construction is ***estimated to be $5,747,000***.

The recommendations contained herein reflect the policies governing formulation of individual projects and the information available at this time. They do not necessarily reflect program and budgeting priorities inherent in local and state programs, or the formulation of a national Civil Works water resources program. Consequently, the recommendations may be modified at higher levels within the executive branch before they are used to support funding.

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