APPENDIX B

ENVIRONMENTAL REPORTS

APPENDIX B - ENVIRONMENTAL REPORTS

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SECTION B-1

INTRODUCTION

Included in the following sections are some of the reports that were done to gather information for the preparation of this document. The first report (Section B-2) is an environmental assessment that was prepared to evaluate possible impacts that may occur to endangered species under the jurisdiction of the U.S. Fish and Wildlife Service (FWS). The next two reports (Sections B-4 and B-5) are planning aid reports prepared by the FWS that provide information on the relationship of the beneficial use of dredged material in the aquatic disposal sites and the management of confined upland dredged material disposal sites to fish and wildlife resources.

SECTION B-2

BIOLOGICAL ASSESSMENT OF THE BALD EAGLE (*Haliaeetus leucocephalus*) AND THE PEREGRINE FALCON (*Falco peregrinus*) FOR THE DELAWARE RIVER, MAIN CHANNEL DEEPENING PROJECT, PHILADELPHIA DISTRICT, U.S. ARMY CORPS OF ENGINEERS, OCTOBER, 1995

BIOLOGICAL ASSESSMENT OF THE BALD EAGLE (HALIAEETUS LEUCOCEPHALUS) AND THE PEREGRINE FALCON (FALCO PEREGRINUS)

FOR

THE DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Prepared By:

U.S. ARMY
CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

OCTOBER, 1995

BIOLOGICAL ASSESSMENT FOR THE BALD EAGLE (Haliaeetus leucocephalus) AND THE PEREGRINE FALCON (Falco peregrinus) FOR THE DELAWARE RIVER COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT

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INTRODUCTION

Based on the findings of the February, 1992 Delaware River Comprehensive Navigation Study Main Channel Deepening Interim Feasibility Report and Environmental Impact Statement, the proposed channel deepening of the Delaware River was authorized by Congress in October, 1992 as part of the Water Resources Development Act of 1992. Preconstruction Engineering and Design (PED) Study efforts were initiated in April, 1992. In compliance with Section 7 (c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.), this biological assessment evaluates the potential effects of the Channel Deepening Project on the threatened bald eagle (Haliaeetus leucocephalus) and the endangered peregrine falcon (Falcon peregrinus). This assessment was prepared in accordance with the Joint Regulations on Endangered Species (50 CFR Section 402.12). A separate biological assessment is being coordinated with the National Marine Fisheries Service addressing those species that occur in the project area that are within their jurisdiction.

PROJECT DESCRIPTION

The proposed plan of improvement calls for modifying the existing Federal Navigation channel from 40 feet at mean low water to 45 feet. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia/Camden waterfront, a distance of about 102.5 miles (Figure 1). The proposed project includes all appropriate bend widenings as well as provision of a two space anchorage at Marcus Hook. Approximately 36 million cubic yards of dredged material would be removed for initial construction over a four year period. Dredged material from the river would be placed in confined upland disposal areas. Material excavated from the Delaware Bay would be primarily sand and would be considered for various beneficial purposes including wetland creation/restoration at Egg Island Point, NJ and Kelly Island, DE, and underwater sand stockpiling for future beach nourishment. Construction of the upland disposal areas is scheduled to begin about the year 2000 and take 1 year to complete. The dredging for the channel deepening is expected to take about 4 years to complete. The upland disposal areas will be used for 50 year maintenance of the proposed project.

Dredging Approximately 36 million cubic yards of material would be dredged from the navigation channel using hydraulic dredging. Approximately 26 million yards from the river portion, upstream of Artificial Island, would be placed in confined, upland disposal areas; 10 million cubic yards from the Bay would be used for beneficial uses.

Upland Disposal Sites Dredged material from the river portion of the project area will be placed in new and existing Federal confined disposal facilities (CDFs). The four new disposal areas are located in New Jersey (17G, 15D, 15G, and Raccoon Island) and were formerly used for dredged disposal about 25 years ago. All these sites are also shown on Figure 1. Figures 2 thru 5 show the habitat types that presently occur on the 4 new sites and Table 1 shows a compilation of the vegetation/habitats that exist on these sites. Sites 17G, 15D, and 15G are primarily used for row crop agriculture, while Raccoon Island is primarily covered by common reed (<u>Phragmites australis</u>). Under the project, the new CDFs will be managed to maximize wildlife/wetland values as much as is practicable while serving the need to confine dredged material (Table 2).

<u>Beneficial Use Sites</u> The following beneficial uses of the 10 million cubic yards of dredged material from Delaware Bay are being considered:

1. Egg Island Point, NJ, Wetland Restoration Site (See Figures 6 and 7).

a. Objective: To provide protection for existing wetlands and allow for restoration of wetlands.

b. Proposed Design

<u>EAST SIDE</u>

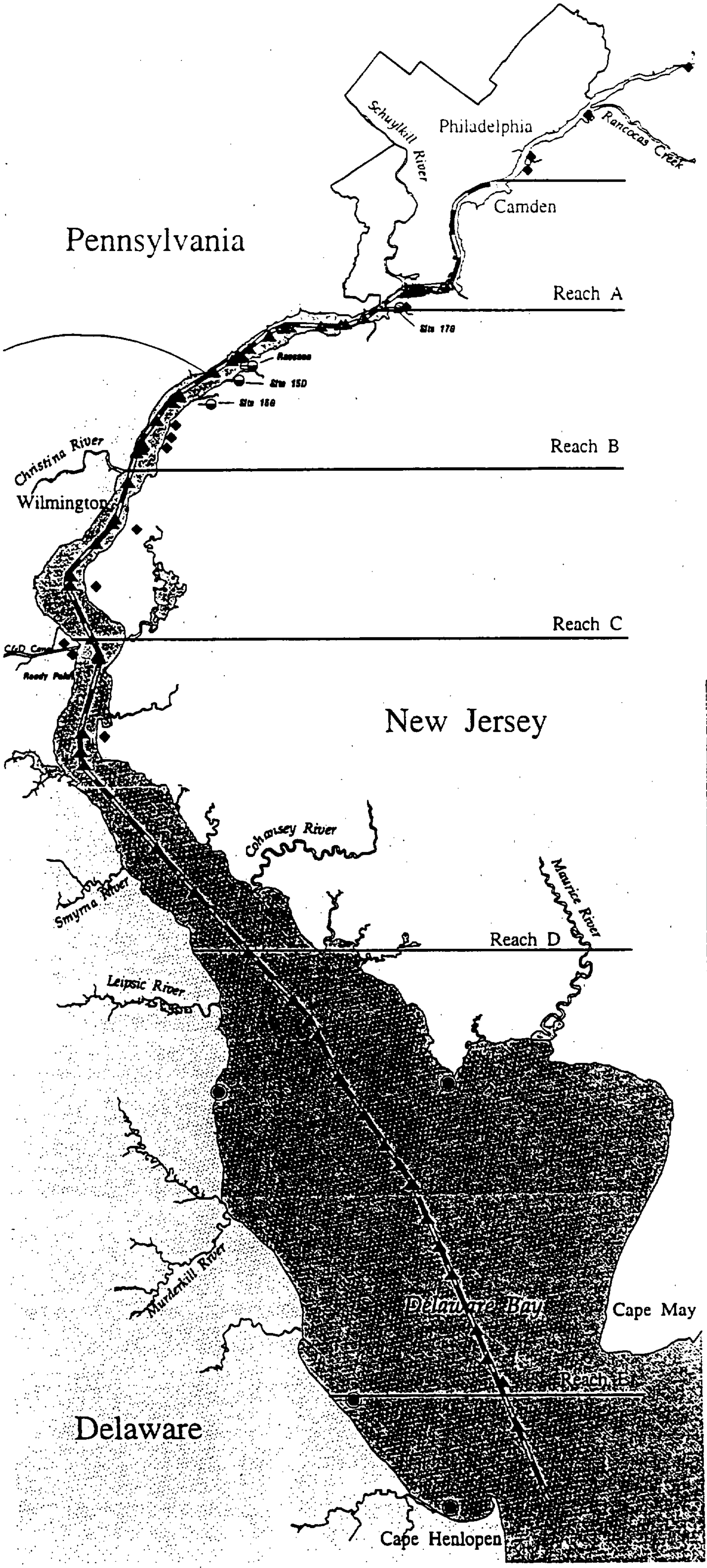
. Hydraulically place a sand foundation to elevation of 0 foot MLW along the alignment of the geotextile tube. The foundation will have a 80 to 100 foot top width and 1V to 15H sideslopes.

. Place a scour apron on top of the sand foundation extending 15 feet beyond the seaward edge of the proposed location of the tube. The apron will protect the tube from undermining scour.

. Place and fill 200' tubes, butted end to end on top of the scour blanket and foundation. The final tube elevation will be between elevation +5.0 and+6.0 MLW. Tidal exchange will occur through the open end of the area and over the top of the tubes. If necessary, additional openings will be provided during construction after natural exchange mechanisms have had time to develop. The entire area will be divided into compartments to reduce potential cumulative erosion problems. Interior geotextile tube groins will be placed to mitigate damaging tidal channels that will develop just inside of the tube alignment.

. Pump approximately 2.4 million cubic yards of sand behind the tubes to an elevation of +5.0 MLW. The project will restore approximately 145 acres of wetlands.

Delaware River Main Channel Deepening Project Area



N
W E
S

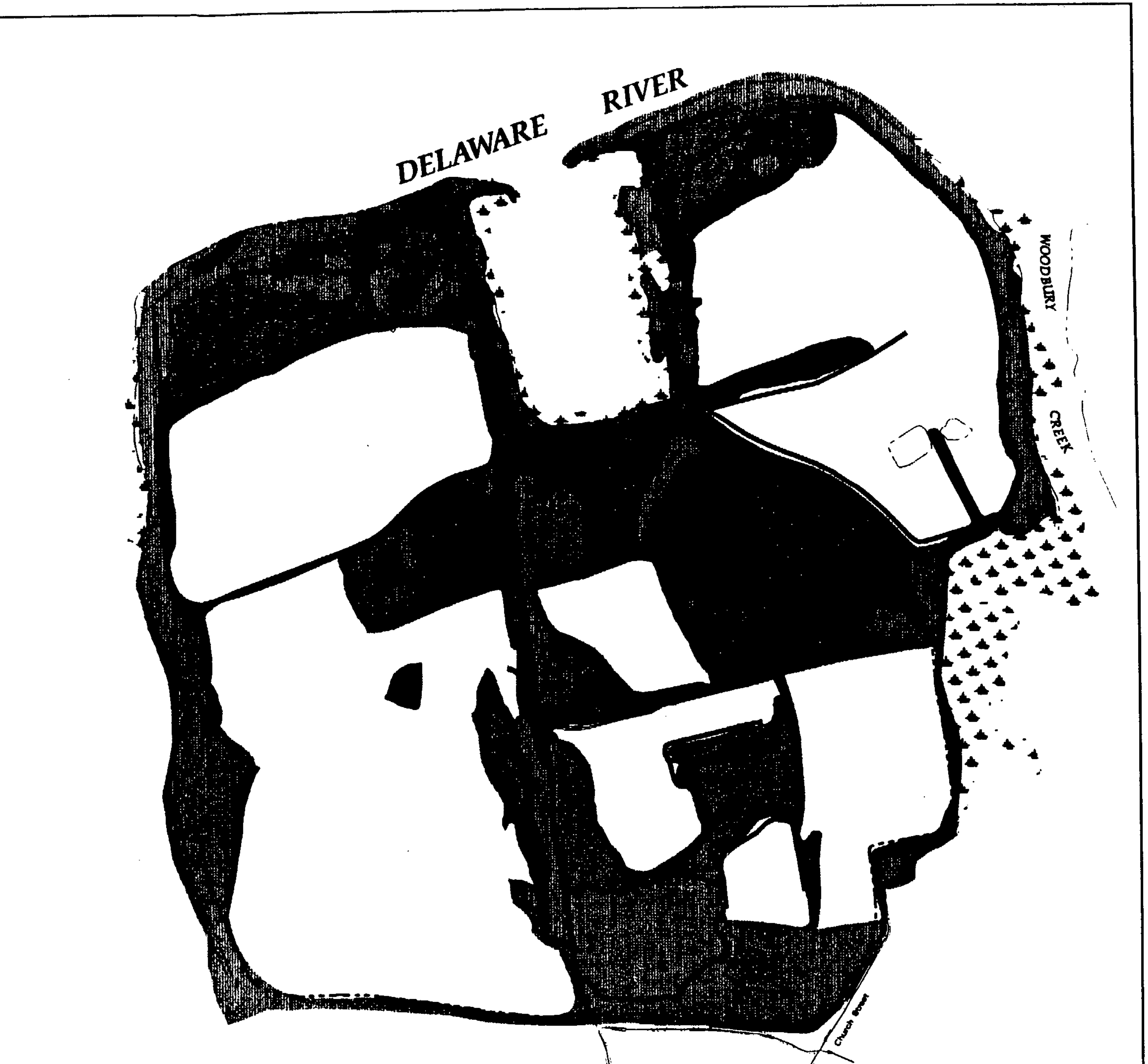
Scale: 1" = 6 Miles

Legend
Proposed Disposal Sites
Existing Disposal Sites
Aquatic Disposal Sites
Sediment Sample Locations
Limits of Reach
Main Channel

US Army Corps of Engineers
Philadelphia District

This map was produced by the U.S. Army Corps of Engineers. Philadelphia District, Planning Division Geographic Information System (GIS). Portions of digital data were provided by; NJDEP, PENNDOT and DELDOT.

Figure 1



LEGEND

- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

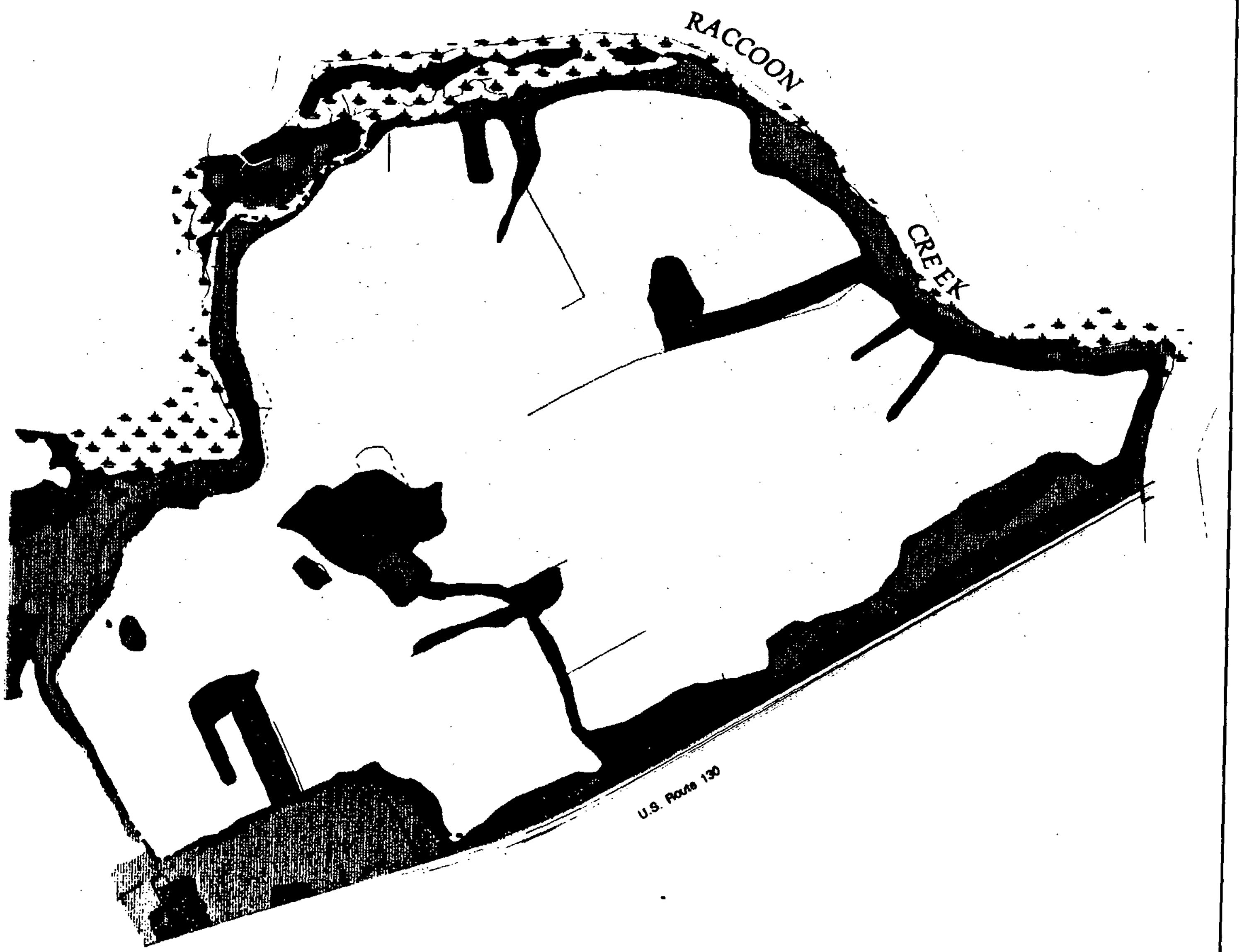
Scale: 1" = 600 Feet

DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 17G

Figure 2

U.S. Army Corps of Engineers, Philadelphia District



LEGEND

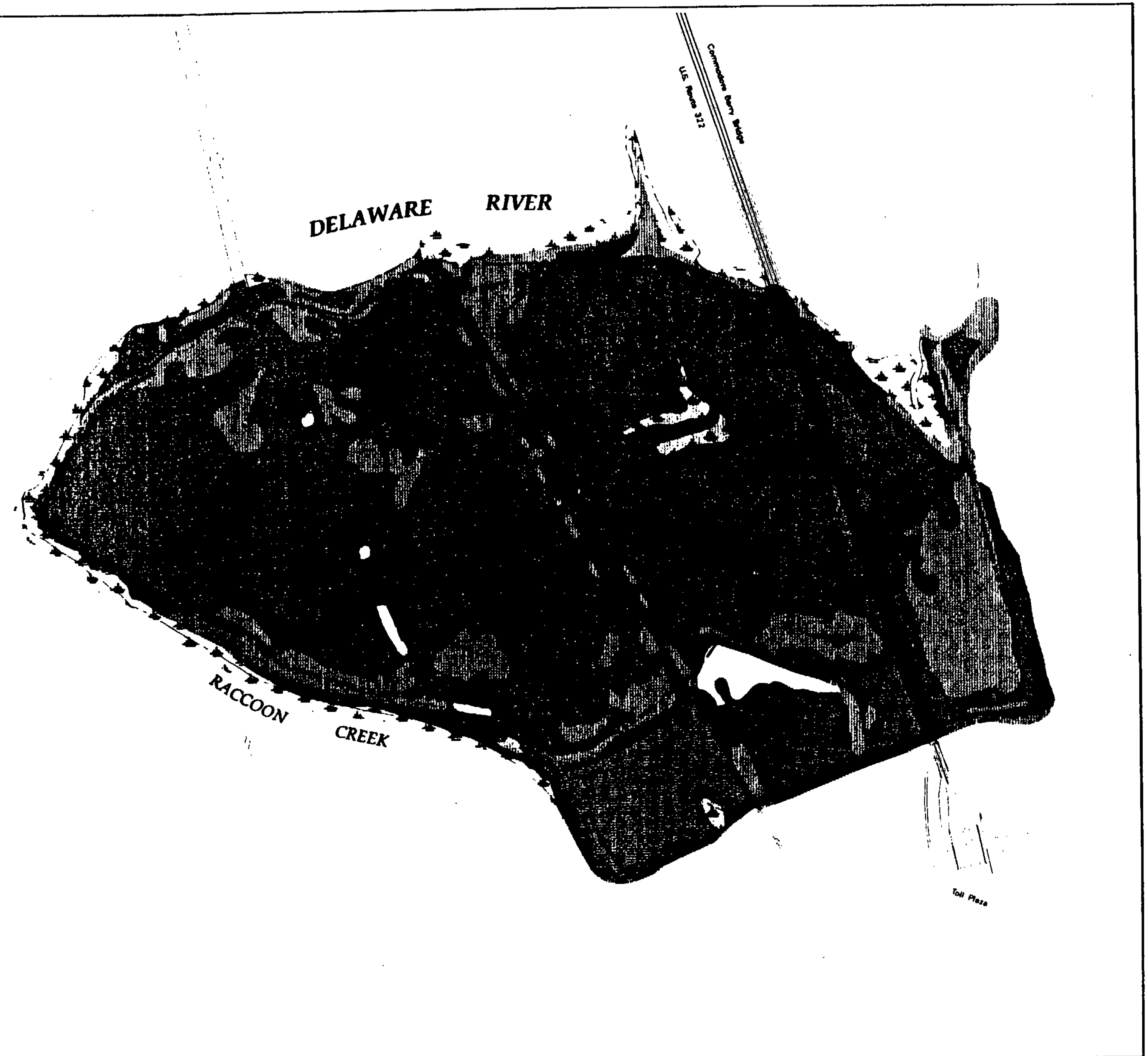
- Woodlands
- Shrubs
- Common Reed
- Tidal Marsh
- Non-Tidal Marsh
- Agriculture
- Ruderal Area
- Apparent Primary Berm Line
- Drainage
- Gas Transmission Line
- Highway
- Secondary Road
- Railroad
- Trail

Scale: 1" = 600 Feet

DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 15D

Figure 3
U.S. Army Corps of Engineers, Philadelphia District



LEGEND

Woodlands
Shrubs
Common Reed
Tidal Marsh
Non-Tidal Marsh
Agriculture
Ruderal Area
Apparent Primary Berm Line
Drainage
Gas Transmission Line
Highway
Secondary Road
Railroad
Trail

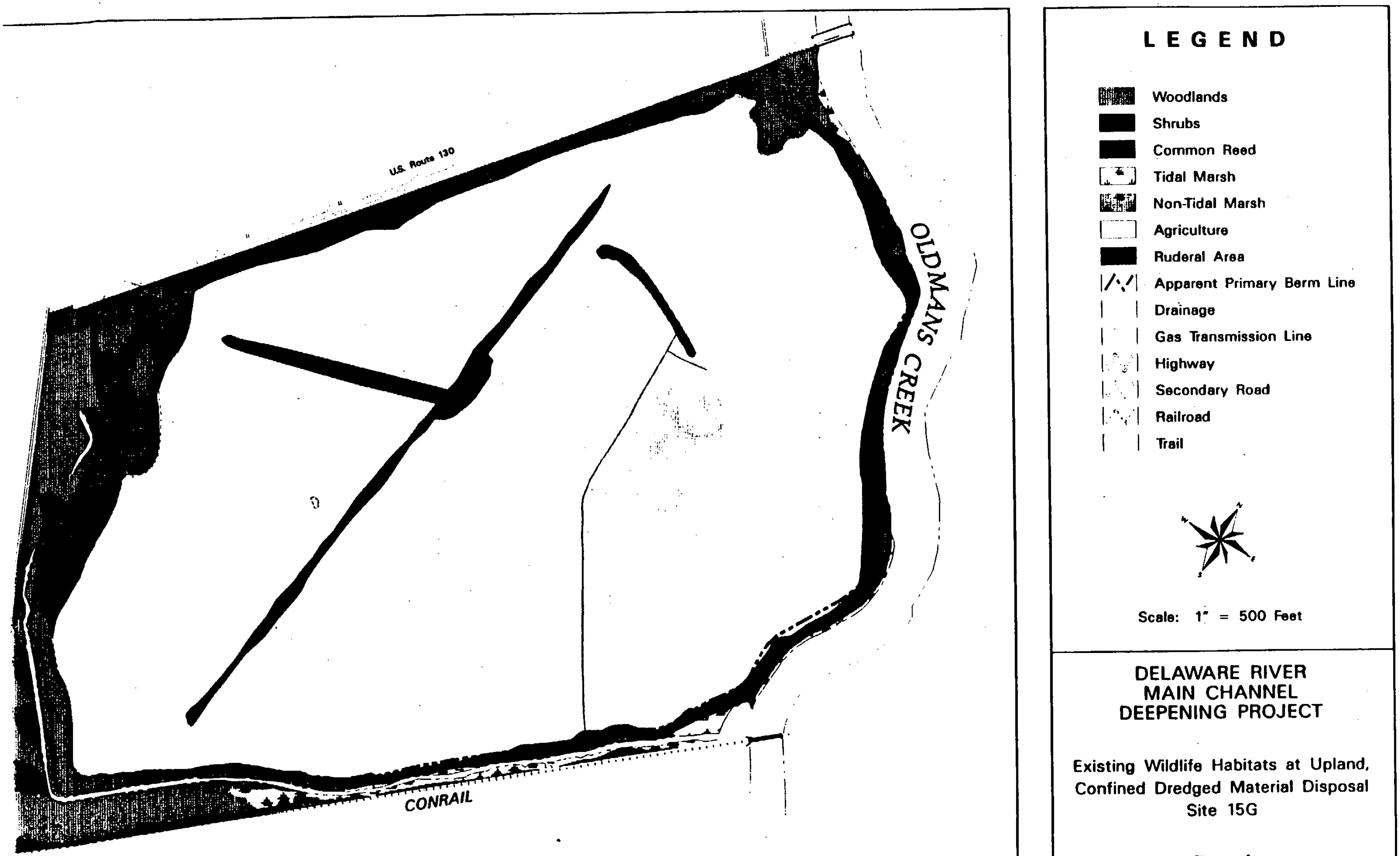
N
W
E
S

Scale: 1" = 800 Feet

DELAWARE RIVER
MAIN CHANNEL
DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site Raccoon Island

Figure 5
U.S. Army Corps of Engineers, Philadelphia District



DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

Existing Wildlife Habitats at Upland, Confined Dredged Material Disposal Site 15G

Figure 4

U.S. Army Corps of Engineers, Philadelphia District

TABLE 1. DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT
UPLAND DISPOSAL AREAS
WILDLIFE HABITAT/VEGETATION IMPACTS

	DISPOSAL SITES AREA				
Habitat Types	15G	17G	Raccoon Island	15D	Totals
Row Crops	246	191	-	248	685
Common Reed	24	65	320	60	469
Woodlands	-	21	20	7	48
Ruderal	5	18	6	5	34
Non-Tidal Marsh	-	-	4	-	4
Totals	275	295	350	320	1240

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TABLE 2. DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT ENVIRONMENTAL MANAGEMENT/ENHANCEMENT OF UPLAND DISPOSAL AREAS

- o Existing forest and scrub-shrub habitat will be avoided to the greatest extent practicable.

- o The placement of dredged material will be rotated between either diked subdivisions within each of the 4 new CDFs, and/or among the 4 new CDFs and 4 other existing CDFs in the vicinity, over a 6 - 8 year cycle.

- o Dredged material would be left in a wet or ponded condition for 3 - 4 years before draining would occur.

- o Approximately 50% of the area within the 4 new CDFs (550 to 600 acres) would be in a wet or ponded condition at any given time.

- o Wetlands created within the CDFs would be primarily palustrine emergent.

- o Wetlands in the CDFs would primarily benefit waterfowl, wading birds, and shorebirds.

- o Land within the purchase boundary, including wetlands, that is not used for as a CDF (approximately 469 acres) will be preserved as wildlife habitat/wetlands.

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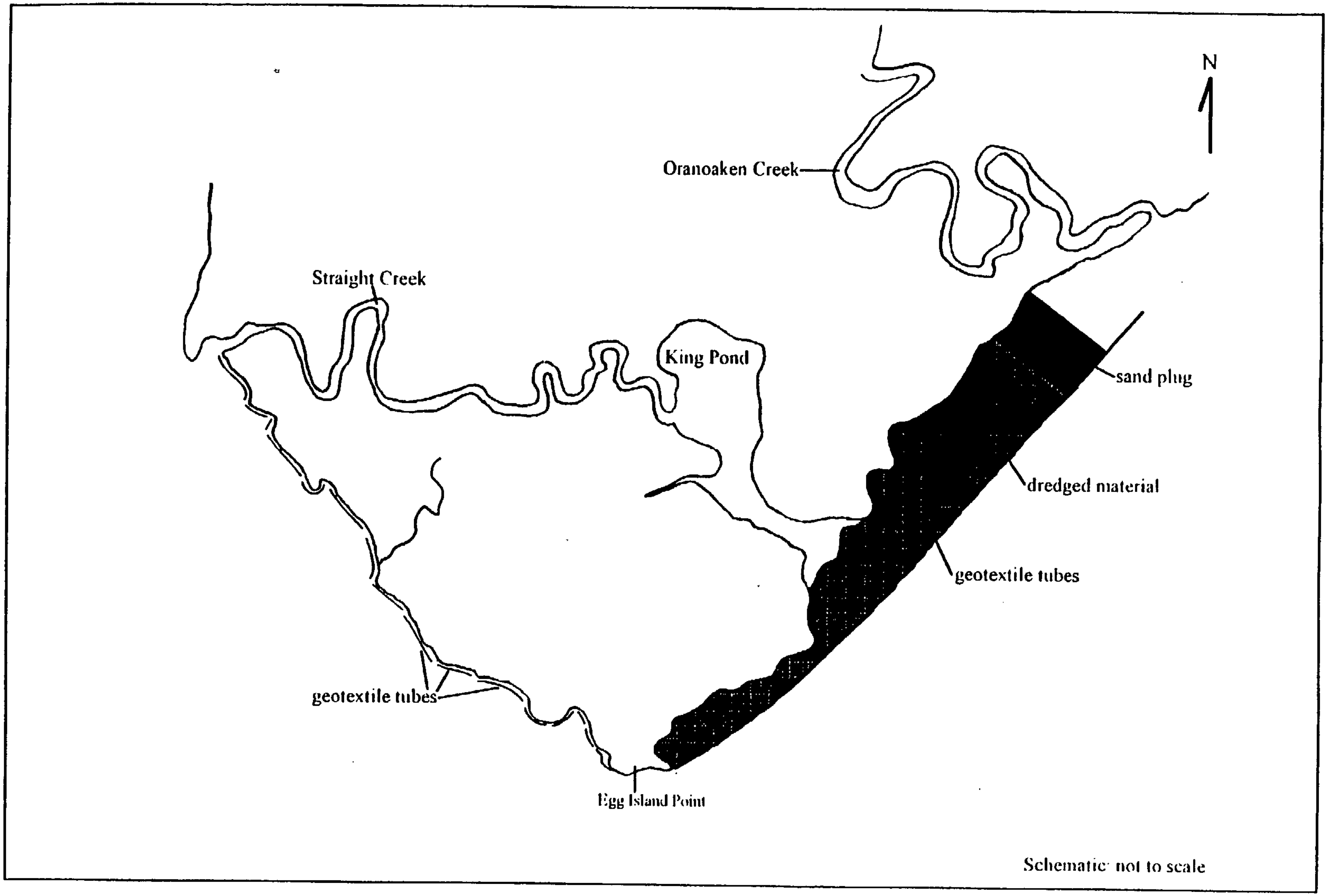
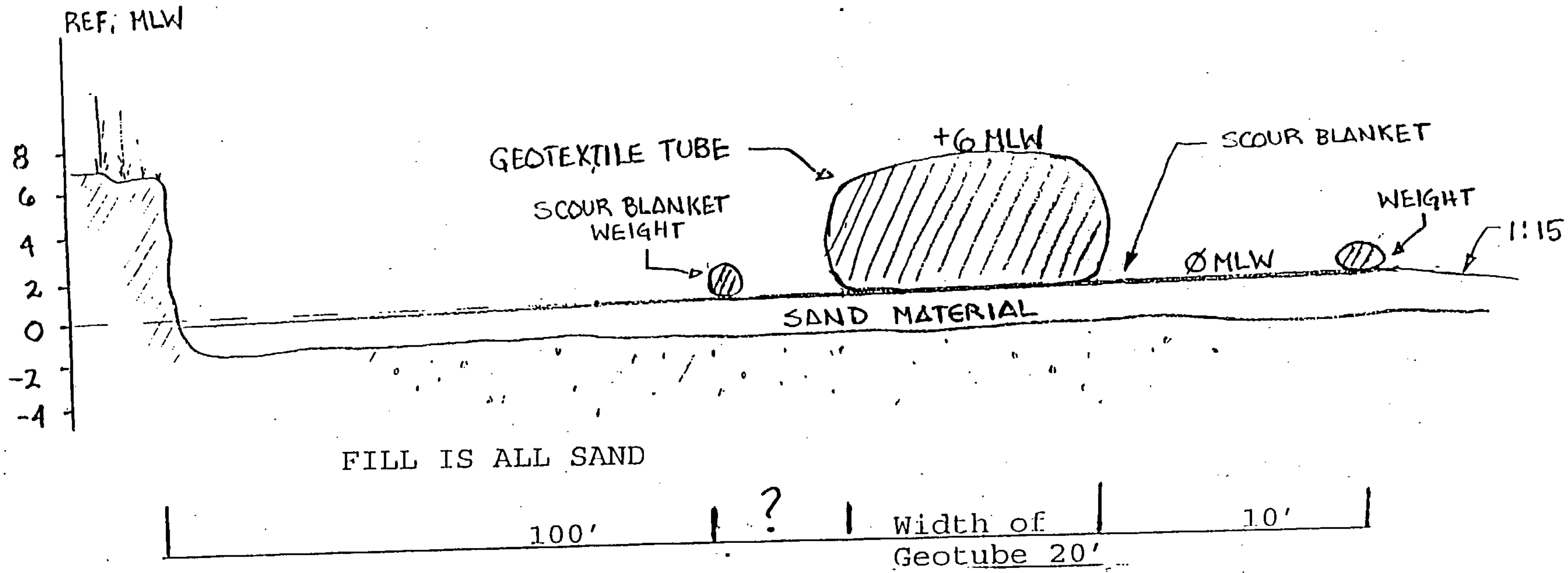


Figure 6. Preliminary shoreline stabilization and marsh restoration plan for Egg Island Point, New Jersey (overhead view).

Delaware River Main Channel Deepening

Preliminary Design

Egg Island Point, New Jersey



Elevations Referenced to MLW

Figure 7

. The tube and pumped fill areas will allow for some wave transmission at high tide; however the effect of the project will greatly reduce the wave energy on the existing marsh.

WEST SIDE

. Hydraulically place a sand foundation where required to elevation of 0 foot MLW along the alignment of the geotextile tube. The foundation will extend from the existing shoreline 100 foot top width and 1V to 15H sideslopes.

. Place a scour apron on top of the sand foundation extending 15 feet beyond the seaward edge of the proposed location of the tube. The apron will protect the tube from undermining scour.

. Place staggered line of 200' geotextile tubes from Egg Island Point to a location approximately 10,000 feet north of the point. The project will protect almost 2 miles of coastline and hundreds of acres of wetland from future erosion.

. The alignment will protect the existing marsh from further erosion while allowing horseshoe crabs and other organisms access to the coast.

2. Kelly Island,DE, Wetland Restoration Site (See Figures 8 and 9)

a. Objective: To restore wetlands with dredged material, and confinement of fine grained material.

b. Proposed Design

. Place a sand foundation to elevation of 0.0 feet MLW along the alignment of the geotextile tube.

. Place a scour blanket on top of the sand foundation extending 15 feet beyond the seaward edge of the tube.

. Place 200 foot geotextile tubes side by side on the sand foundation along the alignment shown on the drawing, approximately 1000 feet from the existing marsh scarp, 5600 feet in length. Fill the tubes to elevation +5 feet MLW.

. Place a third tube on the top of the previous two to form a pyramid shape and fill the top tube to elevation +10 feet MLW.

. Place a single line of tubes bayside along the existing peninsula approximately 800 feet in length to prevent additional erosion and possible breaching of the peninsula by the Mahon river. A single line of tube will also be installed along the center line of the proposed sand plugs

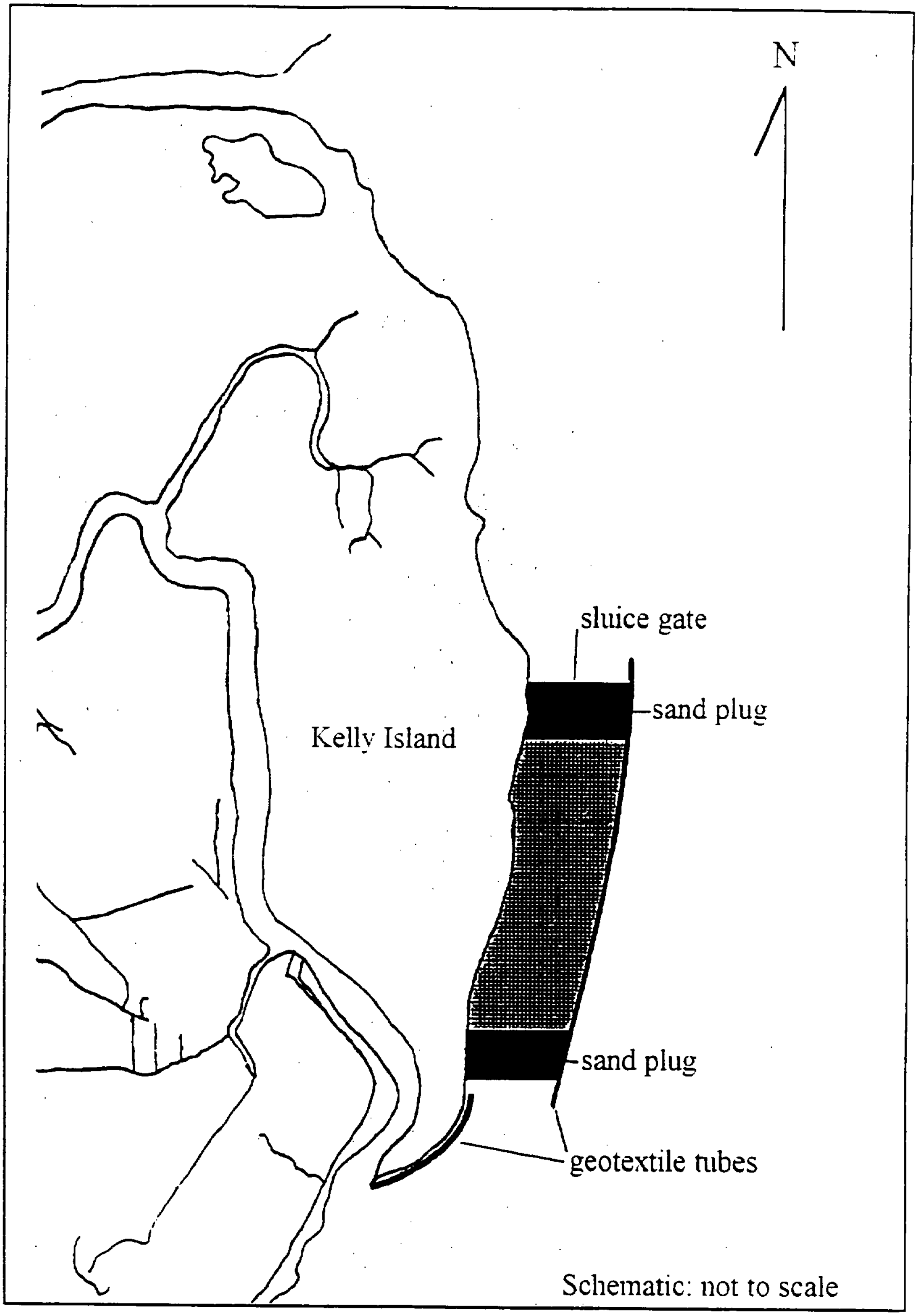


Figure 8 Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (overhead view).

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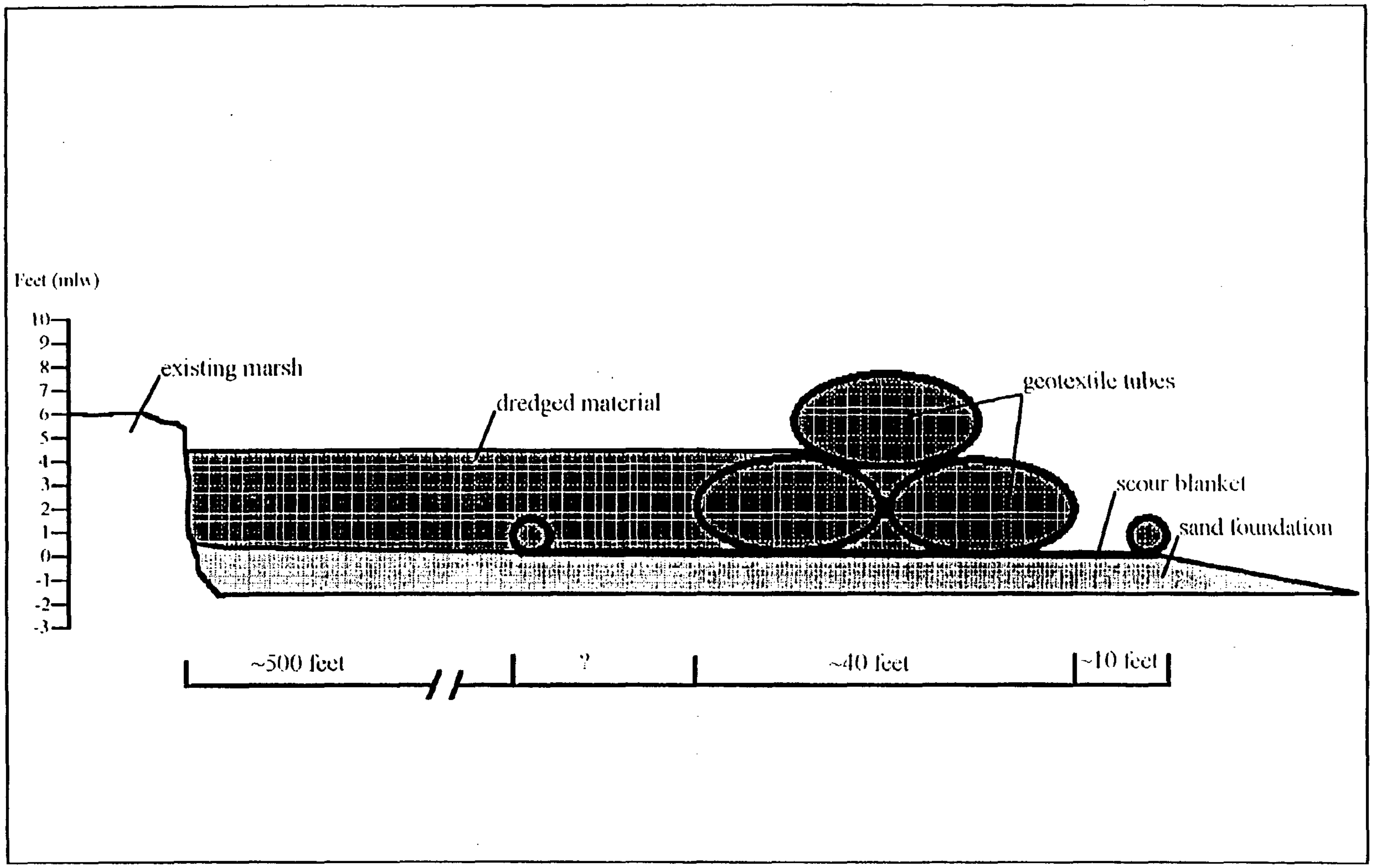

Figure 9 Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (cross-sectional view).

to prevent future deep cutting of the sand plugs.

. Pump sand plugs at the northern and southern ends of the project to complete the confined disposal area. The plugs will provide 1500 feet of beach for horseshoe crab access. Install a sluice for drainage of ponding water from the disposal operation.

. Place dredged material behind the tubes to a final elevation of approximately +4.5 feet MLW. The final project will restore 90 -100 acres of wetland.

. Tidal exchange will be provided by either removing several 200' top tubes along the alignment as required or cutting channels between the Mahon river and the project site.

3. Sand Stockpiles

a. LC-5. Approximately 2.1 million cubic yards of sand would be placed at this location. The sand stockpile would cover approximately 150 acres. The bottom depths would be decreased approximately 8 feet to a maximum elevation of 0 feet MLW. It would be located about 0.33 miles offshore of Broadkill Beach, Delaware.

o MS-19. Approximately 3.6 million cubic yards of sand would be placed at this location. This stockpile would cover about 250 acres. The bottom depths would be decreased approximately 8 feet to a maximum elevation of 0 feet MLW. It would be located about 0.5 miles offshore of Slaughter Beach, Delaware.

Sediment Testing

Introduction: Concerns were expressed during the Feasibility Study regarding the chemical quality of sediments that would be disturbed during project construction, and the potential adverse effects on aquatic resources. In the riverine section of the project area, from Philadelphia to Artificial Island, channel sediments would be dredged and placed in several confined, upland dredged material disposal sites. Sediment quality concerns in this portion of the project regard turbidity generated at the point of dredging, and the turbidity associated with the discharge of effluent from the disposal areas. In Delaware Bay, channel sediments comprised primarily of sand would be used for various beneficial uses that involve placement of sediments in open water. Sediment quality concerns in this area include turbidity generated at the point of dredging and impacts associated with open water placement.

Two types of chemical quality concerns can be raised with regard to dredging and dredged material disposal activities. The first is potential short-term water quality degradation arising from disturbance of bottom sediments, and ensuing impacts to aquatic biota. Aquatic ecosystems concentrate biological and chemical

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substances such as organic matter, nutrients, heavy metals and toxic chemical compounds in bottom sediments. When introduced to the water column, these substances tend to bind with suspended particulate matter and eventually settle to the bottom. Dredging operations typically elevate levels of suspended particulates in the water column through agitation of the sediment. Suspension of sediment exposes associated biological and chemical constituents to dissolved oxygen, which can result in a variety of chemical reactions. Adverse impacts to water quality may include oxygen depletion and the release of chemical substances, making them biologically available to aquatic organisms through ingestion or respiration. It is generally believed that carefully designed and conducted dredging operations do not pose a significant adverse environmental threat, primarily because dredging is a temporary localized phenomenon that does not supply a persistent load of suspended sediment. The turbidity associated with temporary dredging activities is usually less than the turbidity associated with natural flooding. In addition, most rivers that are used for navigation, including the Delaware River, are naturally turbid.

The second type of concern is long-term contamination problems associated with the dredged material disposal site. Generally, the greatest potential for environmental effects from dredged material discharge to open water lies in the benthic environment. Deposited dredged material is not mixed and dispersed as rapidly or as greatly as the portion of the material that may remain in the water column. Bottom dwelling animals living and feeding on deposited material for extended periods represent the most likely pathways by which adverse effects to aquatic biota can occur. Placement of contaminated sediment at upland disposal sites can also result in long-term impacts such as groundwater contamination and direct uptake of contaminants by plants and animals.

To address these concerns the Corps has conducted various sediment quality studies as outlined in the national comprehensive testing strategy, developed jointly by the Corps and the U.S. Environmental Protection Agency. This tiered testing approach provides for successive levels of investigation to be implemented on a "reason to believe" that there is potential for unacceptable adverse effects.The following provides a summary of the work efforts and an overview of the findings. A summary of the data collected by these tests is attached as Appendix A.

<u>Sediment Testing (Bulk Analysis)</u>

<u>Work Effort</u>: If there is reason to believe that contaminants are present, which was the case with the main channel deepening project, the first level of evaluation consists of bulk sediment analysis. This is essentially an inventory of contaminants to identify those that could potentially have an impact on the environment during dredging and dredged material disposal activities. A series of 97 sediment cores have been collected

within channel and bend widening locations that would be dredged during project construction (Figure 1). Bend widening locations provide a "worst case" picture of contaminant concentrations that would potentially be in the dredged material. These areas are not currently dredged, as such contaminants could accumulate over a long period of time. Within the channel, accumulated sediment is quickly removed to maintain project dimensions, thus precluding contaminant accumulation over time. Sample locations were determined with the assistance of the U.S. Environmental Protection Agency and the U.S. Fish and Wildlife Service.

Sediment cores were collected with vibracoring equipment that employed a collection tube approximately three inches in diameter. Sediment cores were collected to proposed project depths and divided into 153 distinct sediment strata. Each sediment strata greater than six inches constituted a separate sample. Strata were then individually evaluated through grain size and chemical analyses. Sediment was removed from the interior portion of the core to minimize chemical contamination associated with the core tube. If a core consisted of a single, homogenous unit, the interior portion of the core was removed over the entire length of the core, thoroughly homogenized, and sub-sampled. Sediment from the exterior portion of the core was used for grain size analyses. Bulk chemical analyses were conducted on each strata to determine the range of contaminants and their total concentrations. The chemical parameter list included a host of heavy metals, pesticides, PCBs, PAHs and a variety of volatile and semi-volatile organics. All results were reported on a dry weight basis.

Findings: Bulk analysis of sediments did not identify high concentrations of organic contaminants within the channel or bend widening locations. PCBs were detected in two samples. One sample was collected in the Bellevue Range, and the other was collected in the upper portion of Liston Range. The Bellevue sample contained PCB arochlors 1248 and 1254 at concentrations of 0.53 and 1.19 parts per million (ppm), respectively. The Liston sample contained PCB arochlors 1248 and 1260 at concentrations of 0.12 and 0.19 ppm, respectively. DDE, DDD, endosulfan and heptachlor epoxide were the only pesticides detected. Endosulfan was detected once in the Bellevue Range sample; DDE and DDD were detected once in the Liston Range sample; and heptachlor epoxide was detected once in a sample collected from Mifflin Range. Concentrations of these pesticides were below 0.1 ppm. Polynuclear aromatic hydrocarbons (PAHs) were detected in several channel bends between Philadelphia Harbor and Artificial Island. PAHs are primarily formed through combustion of fossil fuels, and are expected to be found in highly industrialized and populated regions. PAHs were not detected in the Delaware Bay portion of the project area. PAH concentrations were generally below 2 ppm. The only exception was fluoranthene, which was detected in one sample collected in the vicinity of Tinicum Island at a concentration of 2.25 ppm. The U.S. Environmental Protection Agency has proposed sediment quality criteria (SQC) for

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fluoranthene, which are intended to predict toxicological effects of fluoranthene on organisms living in sediment. The freshwater criteria include a median concentration of 620 ppm, with a lower level 95 percent confidence interval of 290 ppm. These concentrations are orders of magnitude above levels found in the Delaware River navigation channel.

Of the remaining volatile and semi-volatile organic contaminants evaluated, only methylene chloride, acetone, 2-butanone, styrene and phthalates were detected at quantifiable levels. Styrene was detected in one sample and 2-butanone was detected in two samples. Concentrations of these chemicals were below 0.1 ppm. Methylene chloride was detected in several samples. Methylene chloride is mainly used as a low-temperature extractant of substances which are adversely affected by high temperature. It is also used as a solvent and as a paint remover. Because of its utility as a chemical extractant, methylene chloride is commonly used in laboratory analyses. It is likely that detection of methylene chloride was a byproduct of laboratory testing. Acetone was also detected in several samples. Acetone is also a common laboratory solvent, which was used to clean glassware and sampling implements for sample collection. Detection of acetone is also attributed to laboratory procedures.

Phthalates were also detected at more than one location. Phthalates are used in large quantities as plasticizers to improve the quality of plastics. A plasticizer is a substance added to plastics to keep them pliable or soft. Phthalates may also be used as starting or intermediate materials for a variety of industrial processes. The highest concentration was 2.67 ppm, which was reported for di-n-butyl phthalate from one sample collected in the vicinity of the Philadelphia Naval Base.

Heavy metals were found to be widely distributed throughout the project area, which was to be expected. Metal concentrations were generally highest at the surface, with lower concentrations found below the top strata. Concentrations of metals in the predominantly sandy Delaware Bay sediments were generally lower than up-river areas. Other than that, there were no apparent contamination trends. The presence of heavy metals in channel sediments is attributed to the urban and industrialized nature of the river basin.

To evaluate potential human health impacts associated with disposal of channel sediments, bulk data were compared to New Jersey Department of Environmental Protection (NJDEP) Residential, Non-Residential and Impact to Groundwater Soil Cleanup Criteria (NJAC 7:26D). Compliance with the Residential Standards allows maximum unrestricted future use of property, including residential use. Compliance with Non-Residential Standards is also acceptable provided the property owner agrees to limit future uses to non-residential activities. The Non-Residential Standards are most applicable to material that would be placed in confined, upland dredged material disposal sites. These areas would remain undeveloped as a result of disposal activities. Material dredged from Delaware Bay would be used for beneficial uses, primarily beach nourishment. The Residential Standards are more applicable here as people visiting the beaches would come in contact with the sand. A total of 91 chemical parameters were evaluated.

To facilitate this evaluation, the main channel project area was divided into five reaches (Reaches A through E; see Figure 1), which correspond to disposal area locations. Material from Reaches A through D would be placed in several upland disposal sites. Reach A extends from the upstream project limit in Philadelphia Harbor to the Billingsport Range. Reach B extends from the Tinicum Range to the Cherry Island Range. Reach C extends from Deepwater Point Range to the New Castle Range. Reach D extends from Reedy Island Range to Ship John Light (Liston Range). Reach E is located in Delaware Bay, this material would be used for beneficial uses, such as sand stockpiling for beach nourishment and wetland creation.

To evaluate the sediment quality data relative to the NJDEP criteria, samples collected within each reach were grouped and the mean concentration of each chemical parameter was calculated. In many cases a chemical parameter was not detected in a sediment sample, and the laboratory reported a result that represented the lowest quantifiable concentration that could be achieved with the test procedure. To include these data points in the analysis, the reported quantification limit was calculated into the mean, as if the chemical parameter had actually been present in the sediment at that concentration. This made the evaluation very conservative, because it is unlikely that the contaminant would be present at that concentration in all cases.

All 91 parameters in all five reaches met the NJDEP Impact to Ground Water Soil Cleanup Criteria, without exception. All 91 parameters in all five reaches met the NJDEP Residential and Non-Residential standards, with the exception of the pesticide toxaphene and the heavy metals thallium and cadmium. Toxaphene has Residential and Non-Residential standards of 0.10 and 0.20 ppm, respectively. While toxaphene was not detected in any of the 153 sediment samples tested, the laboratory detection levels were consistently above NJDEP standards. As such, a definitive conclusion with regard to toxaphene is not possible. Worst case concentrations of toxaphene in channel sediments, calculated solely on laboratory detection levels, range from 0.26 ppm in Reach E to 0.56 ppm in Reach A. There is no reason to believe that toxaphene is a contaminant of concern in the Delaware Estuary. Therefore, the risk that actual concentrations of toxaphene in channel sediments are above NJDEP standards is considered low.

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Both the Residential and Non-Residential standards for thallium are two ppm. Mean concentrations of thallium were above the standard in Reaches A and B. Mean concentrations were 3.76 and 2.48 ppm, respectively. Thallium and its compounds are used as rodenticides, fungicides, and insecticides; as catalysts in certain organic reactions; in the manufacture of optical lenses, plates and prisms; in photoelectric cells; in dyes and pigments; in fireworks; and imitation precious jewelry.

A total of 82 separate sediment samples were collected from Reaches A and B over three sampling events. All of these samples were analyzed for thallium. The initial event in 1991 collected 42 samples. Thirty of these samples had laboratory detection levels greater than two ppm. Four samples had actual thallium detections greater than two ppm (5.5-9.0 ppm). Twenty additional sediment samples were collected in 1992, and the final 20 samples were collected in 1994. These 40 samples showed thallium concentrations in channel sediments to be less than two ppm. All 40 samples had laboratory detection levels or actual detections of thallium below 0.4 ppm. While mean thallium concentrations for channel sediments in Reaches A and B are above the NJDEP standard, it appears that high detection levels from the 1991 sampling event is responsible for skewing the means. Two subsequent sampling events failed to reproduce the earlier results. Like toxaphene, there is no reason to believe that thallium is a contaminant of concern in the Delaware Estuary. Based on the above information, it is concluded that the calculated mean concentrations are high, and that the true mean thallium concentration in channel sediments is actually below two ppm.

The mean cadmium concentration of channel sediment samples collected from Reach A was 1.66 ppm. This is above the NJDEP Residential standard of one ppm, but well below the Non-Residential standard of 100 ppm. Cadmium was detected in a number of samples at concentrations above one ppm, so there is no reason to suspect that the calculated mean is high. Since the material dredged from Reach A would be placed in an upland, dredged material disposal site that would not be used for residential development, and since the mean concentration of cadmium is so far below the NJDEP Non-Residential sediment standard of 100 ppm, it is concluded that the concentration of cadmium in sediments from Reach A would not pose any human health concerns.

Overall, concentrations of contaminants in channel sediments are considered low. Channel sediments to be dredged from Reaches A through D are sufficiently clean for placement in confined, upland sites. In the Delaware Bay portion of the project area, where material would be used for beneficial uses such as beach nourishment, comparison of data to NJDEP Residential criteria suggests that the proposed plan is also acceptable.

Sediment Testing (Elutriate Analysis)

Work Effort: While bulk analysis provides an accurate characterization of contaminants associated with the sediments, it does not provide insight into the potential impacts on water quality and aquatic resources associated with sediment disturbance. To predict contaminant levels that would be liberated from sediment during dredging and disposal activities, which would then be biologically available to impact aquatic resources, 109 individual sediment strata were also evaluated through an elutriate analysis. This test mimics the sediment disturbance that would occur, and determines contaminant levels that would be released. The elutriate test provides the second tier of testing in the national comprehensive testing strategy. The results of this test can be compared to water quality standards after consideration of mixing, as described in the Clean Water Act 404(b)(1) Guidelines. This analysis is currently under way. We are considering water quality standards adopted by the States of New Jersey, Pennsylvania and Delaware, as well as those developed by the U.S. Environmental Protection Agency and the Delaware River Basin Commission. This comprehensive review of criteria will insure that the most stringent standards that apply to a particular section of the river are used in the evaluation. The results of this analysis will be used to design the confined disposal facilities, such that all water quality standards are met.

Biological Effects Based Testing

Introduction: Bulk and elutriate tests provide valuable data regarding the nature of sediment contamination within the project area, and the concentration of contaminants that could be expected with dredging. In a letter of comment on the draft Environmental Impact Statement, the USEPA stated: "Overall, the levels of organics and metals in bulk sediment analyses and elutriate tests are low. As such, disturbance or disposal of the sediments from the project would not cause a significant adverse environmental impact." In a letter of comment on the final EIS, USEPA reiterated: "Based on the sediment data presented, EPA believes that there will be no adverse impacts associated with the disposal of sediments generated by the project."

In the Record of Decision, which was prepared at the end of the Environmental Impact Statement process, the Corps committed to conducting biological effects based testing to more fully evaluate sediment quality concerns. These tests provide the third tier of sediment investigations. A water column, or suspended solid particulate phase bioassay can be run to evaluate water quality concerns associated with the release of contaminants from sediment into dredging or disposal site water. A whole sediment, or benthic bioassay can be run to evaluate impacts to benthic organisms residing at open water disposal sites. These bioassays are used to provide information on the toxicity of individual contaminants, and also to indicate possible interactive effects of multiple contaminants. Lastly, if there is reason to believe that bioaccumulation is of concern, the potential uptake of contaminants by aquatic organisms at an open water disposal site can be evaluated with a bioaccumulation test. Unless there is continuous dredging/discharge, bioaccumulation from the material remaining in the water column is considered to be of minor concern due to the short exposure time and low exposure concentrations resulting from rapid dispersion and dilution.

Bioassays and bioaccumulation tests have been run to directly test the toxic effects of Delaware River channel sediments on aquatic organisms. The water column and whole sediment bioassays exposed living organisms to sediments, to evaluate any differences in mortality between Delaware River channel sediments and clean laboratory sediments used as a control. Early life stages of fish, crustaceans, molluscs, zooplankton and polychaete worms were tested. Young organisms are more sensitive than adults to the effects of sediment contamination, and are considered to be better indicators of problems.

Water Column and Whole sediment Bioassays

Work Effort: In the riverine portion of the project area, which is defined as the navigation channel from Beckett Street Terminal, Camden, New Jersey to Artificial Island, New Jersey, dredged material would be placed in several confined upland dredged material disposal sites. Water quality concerns in this portion of the project regard turbidity generated at the point of dredging, and turbidity associated with the discharge of effluent from upland disposal sites. In Delaware Bay, dredged sediments would be used for various beneficial uses, such as sand stockpiling for beach nourishment purposes, and wetland restoration. Water quality concerns in this area include turbidity at the point of dredging and at open water placement sites. To assess the potential effects of dredging and disposal activities on water quality, acute water column bioassays were run on the elutriate of sediment samples and unfiltered Delaware River water. Procedures followed those outlined in the draft USACE/USEPA Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (EPA-823-B-94-002).

A total of 38 water column bioassays were run. In the riverine portion of the project area, 28 sediment samples were collected. One sample was collected from each channel range and each channel bend from Beckett Street Terminal to Artificial Island. In Delaware Bay, an additional 10 sediment samples were collected from the channel in areas that would require dredging. Each sediment sample was combined with unfiltered Delaware River water in a sediment - to - water ratio of 1:4 on a volume basis. The mixture was thoroughly agitated, allowed to settle for one hour, and the supernatant was removed. This solution was then used to run the

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bioassays. The larval stages of three aquatic species were exposed to the 100 percent sediment elutriate for each of the 38 bioassays. For the 28 riverine samples, test species were the fathead minnow (Pimephales promelas), a water flea (Ceriodaphnia sp.) and an amphipod (Hyalella azteca). For the 10 Delaware Bay samples, test species were the sheepshead minnow (Cyprinodon variegatus), the American oyster (Crassostrea virginica) and a mysid shrimp (Mysidopsis sp.). Five replicate samples were run for each species per test; 10 organisms were tested in each replicate sample. Each test was run for a duration of 48 hours.

In Delaware Bay, dredged material would be placed in open water for beneficial uses, as previously discussed. Acute whole sediment bioassays were run to assess the potential sediment quality impacts to benthic organisms that would reside at the site after placement. The 10 Delaware Bay sediment samples were tested. Procedures again followed those outlined in the USACE/USEPA testing manuals. Sediments were placed in containers, and test organisms were exposed to the sediment for a period of 10 days. Test species included an infaunal amphipod (Ampelisca sp.), a burrowing polychaete (Nereis virens) and a bivalve mollusc (Mercenaria mercenaria). Immature individuals of each species were tested. Five replicate samples were run for each species per test; 20 amphipods and polychaetes, and 10 molluscs were tested in each replicate sample.

Bioaccumulation Testing

Work Effort: Bioaccumulation tests were run with Delaware Bay sediment to evaluate the potential for bioaccumulation of contaminants by aquatic organisms that would reside in the sediment after placement in the beneficial use sites. Two separate bioaccumulation tests were run. In 1993, five of the 10 Delaware Bay sediment samples collected for bioassays were tested. The five Delaware Bay samples with the highest percentage of fine grain silts and clays were used as, fine grain sediment has a greater potential to retain contaminants than coarse grain sands. The bivalve mollusc Mercenaria mercenaria was used as the test organism. In 1994, two additional samples of channel sediment were collected from areas containing fine grained material. The burrowing polychaete Nereis virens was used as the test organism. In both cases individuals were exposed to the sediment for 28 days. After the exposure period, the soft body tissues were chemically analyzed and compared to data obtained from individuals exposed to clean laboratory sediment. Chemical parameters included heavy metals, pesticides, PCBs and PAHs.

Findings: All water column and whole sediment bioassays resulted in 100 percent survival of all test species. The results of the water column bioassays suggest that sediment disturbance, and associated water column turbidity, at the point of dredging and at dredged material disposal locations would not result in mortality of aquatic organisms in the vicinity. Likewise, the results of the whole sediment bioassays suggest that aquatic organisms that colonize sediment placed for beneficial uses in Delaware Bay would also be unaffected by sediment contaminants. With regard to bioaccumulation, there was no evidence that contaminants accumulated in clam tissue exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean laboratory sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material. With regard to bioaccumulation and the polychaete Nereis virens, there were no statistical differences between contaminants in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of the heavy metal arsenic. The mean arsenic concentration in worms exposed to one channel sediment sample (0.700 ppm) was statistically higher than concentrations in worms exposed to reference sediment samples (0.360 and 0.460 ppm). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 ppm), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 ppm). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 ppm in the USEPA Guidance Manual for Bedded Sediment Bioaccumulation Tests (EPA-600-R-93-183). Overall, test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

CONSULTATION HISTORY

In a planning aid report (Plage. 1989), the U.S. Fish and Wildlife Service (FWS) stated that the endangered peregrine falcon has nested or attempted to nest on Delaware River bridges within the project area, and that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area. The report further states that it is unlikely that the areas potentially impacted by the proposed project provide essential habitat for peregrines.

In a letter forwarding the Draft Fish and Wildlife Coordination Act Report, Section 2(b) (Day. 1992), the FWS stated that both the peregrine falcon and the bald eagle nested within the project area and requested that the Corps prepare a biological assessment to address potential project related adverse impacts to these species. The letter further stated that aside from occasional transient individuals, no other federally listed or proposed threatened or endangered species under FWS jurisdiction are known to occur within the project area.

A meeting was held in the Philadelphia District office on December 14, 1994 with representatives from the FWS. Ms Dana Peters, FWS, stated that the species of concern are the bald eagle and the peregrine falcon. For the bald eagle, the concerns are possible exposure to contaminants from the additional dredging, and disturbance during nesting. A pair of eagles has nested in various locations near the upland disposal areas in recent years. The FWS requires a buffer zone of 0.25 miles or a line of site buffer of 0.5 miles from the nest from January to July to avoid disturbance. At this time we can not tell if an eagle nest will be located near an upland disposal area in the year 2000. Ms Peters recommended that a contingency plan be developed based on FWS recommendations. It is believed that construction could be staged to avoid disturbance impacts. The FWS recommended that the following potential impacts be addressed in a biological assessment: disturbance, increased development, contaminants, and increased oil spills. FWS recommended that the assessment be coordinated with Larry Niles of the NJDEP. For the peregrine falcon, FWS recommended that disturbance at their nest/roosting sites at the Walt Whitman and Commodore Barry bridges, as well as contaminants, would need to be addressed in the biological assessment. There are presently no restrictions for dredging in the Delaware River for the peregrine falcon.

BIOLOGY, DISTRIBUTION AND STATUS RELATED TO THE PROJECT

BALD EAGLE

The bald eagle was listed as an endangered or threatened species throughout the United States in 1978; the Chesapeake Bay Region (CBR) bald eagle population was determined to be threatened in 1995. The bald eagles in the project area are covered under the Chesapeake Bay Region Bald Eagle Recovery Plan: First Revision (USFWS. 1990).

The CBR bald eagle occupies shoreline habitat of the Chesapeake and Delaware Bays and their tributaries. The eagle requires large blocks of undisturbed mature forested habitat in proximity to aquatic foraging areas. The principal threat to its continued recovery is habitat loss due to shoreline development and other land use changes. The CBR eagle is also threatened by acute toxicity caused by continued use of certain contaminants, shooting, accidents, and natural environmental events (USFWS. 1990).

Bald eagles have been documented to be sensitive to human activity and disturbance, particularly during the breeding season, although sensitivity varies greatly between individuals (Mathisen, 1968; Stalmaster and Newman, 1978; USFWS, 1990; Grubb and King, 1991). The breeding cycle of CBR bald eagles can generally be divided into four phases with each phase having an associated level of sensitivity to human disturbance (Cline, 1990; Figure 10). Eagles are most sensitive early in the nesting cycle when nest selection,

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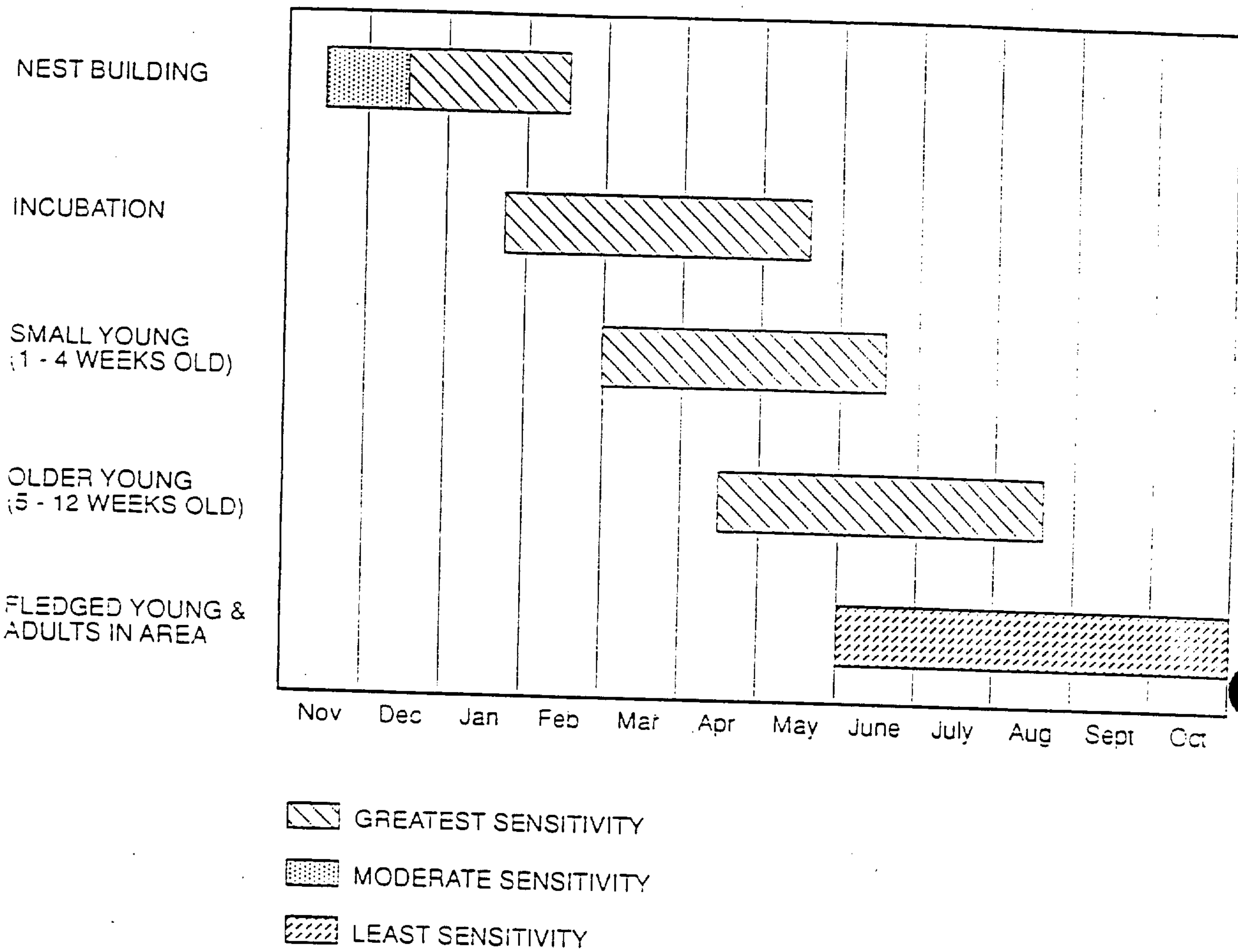


SOURCE: Cline, 1990

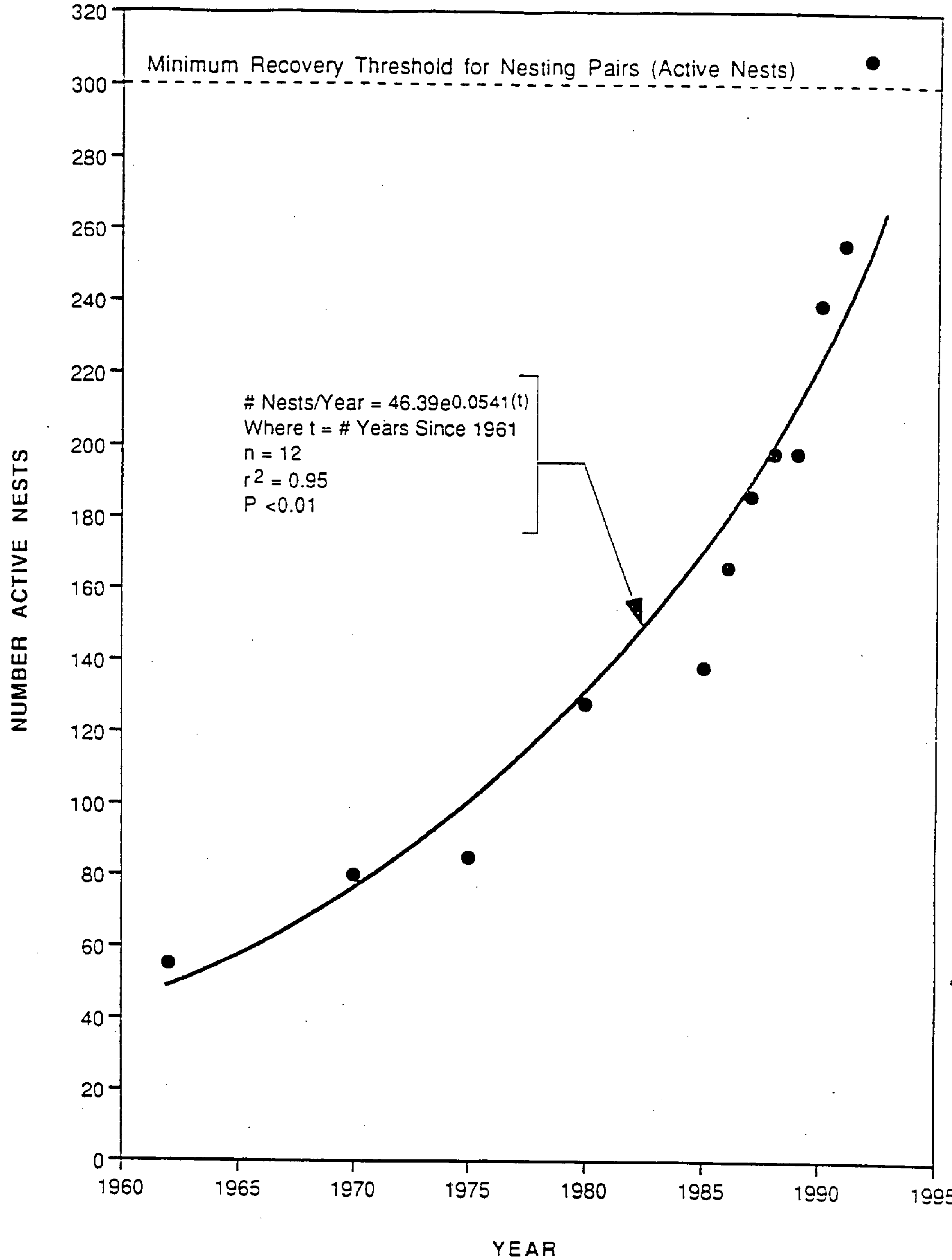
Figure 10. Bald Eagle Sensitivity to Human Disturbance

nest building, incubation and brooding occur (Mathisen, 1968). Bald eagles are moderately sensitive to disturbance when young are older and preparing to fledge. After young are fledged and before nest selection begins, the bald eagles are least sensitive to disturbance. Most bald eagle nests are located in large wooded areas associated with marshes and other water bodies. Sometimes nests are built in isolated trees located in marshes, farmland or clear cuts. Nest sites are typically remote from areas of intense human activity, although some have been observed near railroad tracks, highways, airfield runways and human residences (USFWS, 1990). Primary factors contributing to breeding habitat suitability are distance from human activity, availability of suitable nest trees, and an adequate forage base (USFWS, 1986).

In the CBR, the bald eagle is found feeding most often along river, lake, and bay shoreline, or perched in the trees bordering them; and in extensive freshwater marshes on hillocks, muskrat houses, bare sand or mud bars, and isolated trees. Since they typically snatch fish from the water's surface, shallow water is an important component of live fish availability to eagles. Most bald eagle nests are less than 1.6 km from feeding areas, although some nests are up to 3.2 km from their primary food source (USFWS. 1990).

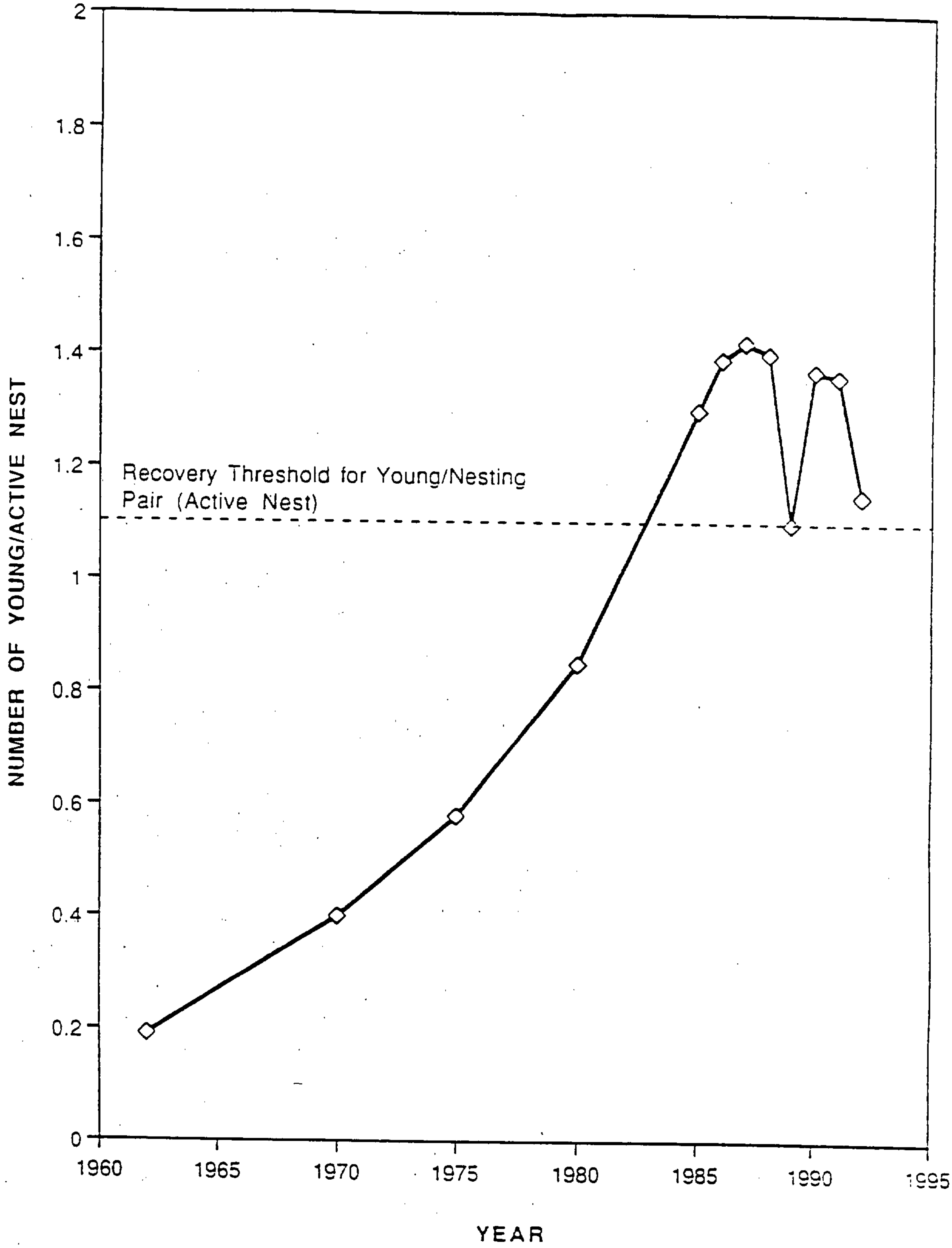
The CBR bald eagle population was listed as endangered in 1978 (43 CFR 6233) and, at that time, the major limiting factor for the population was identified as lowered productivity resulting from pesticide contamination (USFWS, 1990). Secondary limiting factors included shooting, disturbance, and habitat destruction. A recovery plan for the CBR bald eagle population was released in 1982. The original plan was revised in 1990 (USFWS, 1990). The draft version of the revised recovery plan lists 11 known major bald eagle concentration areas in the CBR, including one in southern New Jersey (USFWS. 1990).

The CBR bald eagle population has exponentially increased from 1962 to 1992, as evidenced by increases in the number of active nests (an index of nesting pairs) (Figure 11). In part, this has been a result of improved population recruitment, indexed by young/nest/year, since 1985 (Figure 12). The population growth curve (Figure 12) exhibits an instantaneous rate of increase of 0.0541 (N = 46.39e; where t = number of years since 1961). This translates into a 5.6% average increase in the number of active nests per year, although from 1991-1992 the number of active nests increased by nearly 20%. These rates compare favorably with the maximum growth rate of 11% predicted by the USFWS for the Northern States bald eagle population (USFWS, 1983). The population would double to roughly 600 nests by the year 2007, based on these population data and growth rates and in absence of increased environmental resistance (i.e., density dependent factors such as limited available habitat) (NASA. 1993).



SOURCE: USFWS, 1990; USFWS, 1993b

FIGURE 11 NUMBER OF ACTIVE BALD EAGLE NESTS IN THE CHESAPEAKE BAY REGION FOR SELECTED YEARS FROM 1962 TO 1992



SOURCE: USFWS, 1990; USFWS, 1993b

FIGURE 12 BALD EAGLE YOUNG/NEST IN THE CHESAPEAKE BAY REGION FOR SELECTED YEARS FROM 1962 TO 1992

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The CBR bald eagle population is approaching thresholds judged to indicate full recovery. For full recovery, the CBR must contain 300 to 400 nesting pairs with a productivity level of 1.1 eaglets per active nest sustained over 5 years (USFWS, 1990). The current documented population of 307 nesting pairs already exceeds the lower range of the goal. Based upon the population data discussed above and in absence of increased environmental resistance, the CBR bald eagle population would exceed 400 nesting pairs around 2001. The goal of producing 1.1 or more eaglets per active nest per year has been sustained from 1985 to 1992 (1993 data were not available), exceeding the 5 year requirement (NASA. 1993).

Nesting habitat availability has recently replaced pesticide contamination as the major limiting factor on the CBR bald eagle population (USFWS, 1990). Density dependent influences will limit the availability of unoccupied nesting habitat and will ultimately slow the population growth as the number of nesting pairs increases. One result of the increased competition for nesting areas will be greater use of suboptimum nest areas.

Additional factors limiting population growth include habitat destruction and disturbance, shooting, continued use of certain environmental contaminants, natural phenomena, and accidents. Although all limiting factors are addressed to the extent possible, current recovery efforts are particularly focused on improving habitat availability, protecting existing habitat, and eliminating mortality due to shooting (USFWS. 1990).

<u>Bald Eagle Populations in the Project Area</u>

1. New Jersey. Clark et. al. (1994) reports that there were six (6) active bald eagle nests in the project area. Four (4) of these nests produced 8 young in 1994 while two (2) of the nests failed to produce young that year. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located less than 2 miles from one of the proposed dredged material upland disposal sites (15D). This site and one near Welchville (the Home Run site) have not produced young in the last 2 years and are believed to have contaminant problems. Infertile eggs collected from the Home Run site had a high enough level of PCBs to cause death (Clark. 1995. Personal Communication). None of the other nests are located within 4 miles of either the navigation channel, upland disposal areas, or beneficial use sites; however, eagles from all the nests would be expected to forage along the Delaware Bay.

Thirty-one bald eagles were counted in the 1994 bald eagle winter survey along the Delaware Bay coastline. The Maurice and Cohansey River drainages held the highest concentrations, while the Maurice River watershed continued to support the greatest number of wintering bald eagles in southern New Jersey (Clark et. al. 1994).

2. Delaware. Gelvin-Innvaer (1994) reports that there were 10 active bald eagle nests in Delaware in 1994. Six of these nests produced 7 chicks to banding age, yielding a productivity of 0.7 chicks per occupied nest. In 1995 there are about 10 past or present eagle nest locations where the birds would be expected to forage along the Delaware Bay (Gelvin-Innvaer. Personal Communication). Trends in the numbers of banding-aged chicks, occupied nests, and successful nests have increased in the past 17 years, especially since the mid-1980's (Gelvin-Innvaer. 1994). One nest that is located in the Bombay Hook National Wildlife Refuge is about 6 miles from the Kelly Island beneficial use site (Smith. Personal Communication). Another eagle nest is located in the Prime Hook National Wildlife Refuge about 0.5 miles from the shore of Delaware Bay (O'Shea Personal Communication). As in New Jersey, contaminants are suspected to be a factor in nest failures at three nest sites including the one at Bombay Hook. Disturbance, habitat loss and habitat degradation increasingly threaten the long-term maintenance and expansion of eagle numbers in Delaware (Gelvin-Innvaer. 1994).

Eighteen bald eagles were reported to have wintered in Delaware in 1994; however, no significant concentrations of wintering eagles occur in Delaware (Gelvin-Innvaer. 1994).

3. Pennsylvania. In the Pennsylvania portion of the study area, the bald eagle is a transient; there are no nests or wintering concentrations (Brauning. 1995. Personal Communication).

<u>Environmental Contaminants</u> (USFWS. 1990)

Organochlorine pesticides, primarily DDT (especially its metabolite DDE) and dieldrin, were a significant reason for the past decline of the CBR bald eagle population, causing major reductions in reproductive success and direct mortality of eagles during the 1950s and 1960s. Although DDE concentrations have decreased markedly, other contaminants continue to have a negative impact on the population.

The historical effects of DDT and current threats from other environmental contaminants on bald eagles are discussed below.

1. Organochlorines. It was first reported in 1957 that the Chesapeake Bay bald eagle population appeared to be declining. It was hypothesized that the cause of the population decline and reproductive failure in Florida at that time might be DDT contamination of the environment. The extremely low rate of production by the Chesapeake Bay population in 1962 provided additional support to this hypothesis, as did a decline in reproduction for the New Jersey bald eagle population observed in the late 1950s.

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Residues in eggs: The residue levels of several organochlorines found in CBR bald eagle eggs that failed to hatch for the years 1973-79 were among the highest for any bald eagle population in the United States. DDE, shown to cause eggshell thinning in several species of birds in experimental studies occurred at especially high levels. It was found that DDE in bald eagle eggs was much more closely associated with eggshell thickness and production of young than other toxicants.

A DDE concentration of 1.3 ppm in eggs was associated with a production level of 1 young per active breeding pair, whereas a concentration of 3.5 ppm was associated with a mean production of 0.7 young per pair. When DDE levels reached 15 ppm, production of young was reduced to 0.25 young per active breeding area. The geometric mean DDE concentration for Maryland and Virginia bald eagle eggs collected in 1973-79 was 9.6 ppm. Concentrations of DDE declined to 4.7 ppm for the years 1980-85.

The mean PCB concentration for these years declined from 27 to 15 ppm, whereas the mean dieldrin concentration declined from 1.0 to 0.3 ppm. Concentrations of other contaminants also declined. These declining concentrations of contaminants correlate with improvements in reproductive success that were reported during the years of sterile egg collection, although mean shell thickness has not significantly improved (see Table 3). The mean shell thickness of bald eagle eggs from Delaware, Maryland, and Virginia for the years 1975-79 was significantly thinner than the pre-DDT norm. No consistent or major improvement in shell thickness was noted for the area in the years 1980-85, and shell thinning exceeded 15% for the nest in New Jersey for the years 1982-86. This trend, however, may be biased by the fact that only eggs that did not hatch were collected and submitted for analysis. Young production in sample breeding areas was somewhat lower than in the overall population, confirming the bias in sampling.

Residues in tissues: Formerly, all bald eagles found dead or dying in the wild were submitted to the National Wildlife Health Research Center (NWHR) and PWRC for necropsy and chemical analysis. A number of the adult bald eagles acquired in the Mid-Atlantic region showed residue concentrations of organochlorines in their brains and carcasses. The concentrations in these bald eagles indicated that this population was one of the more highly contaminated populations in the United States. Current levels of reproductive success suggest that this is no longer the case, and tissue analysis is no longer conducted on a routine basis.

Elimination of DDT, aldrin (which is metabolized to dieldrin), and dieldrin since the early 1970s has been the major reason for the steadily increasing numbers and productivity rates in the CBR bald eagle population. However, although organochlorines are no longer a major threat to the CBR bald eagle population overall,

TABLE 3. SHELL THICKNESS OF BALD EAGLE EGGS COLLECTED FROM 1973 TO 1986.

	Years	N	Mean thickness (mm)	% changed from pre-1946 norm
New Jersey	1982-86	1	0.481	-22
Delaware	1977-78 1982-85	1 3	0.473 0.523	-23 -15
Maryland	1977-78 1982-85	7 8	0.548 0.530	-11 -14
Virginia	1975-79 1980-85	5 11	0.506 0.539	-18 -13

N = Number of breeding territories represented their persistence may still impair the reproduction of a few pairs, especially in more contaminated areas such as Delaware Bay. DE Department of Natural Resources has noted that recurrence of contamination is a serious problem around the Delaware Bay. Their work on peregrine falcons and ospreys indicates increasing contaminant loads and corresponding shell thinning in both species that may be related to the age of the population; reproductive declines in bald eagles due to the continued presence of DDE and shell thinning in CBR bald eagles may not yet be apparent only because the population is young.

Preliminary results of contaminant testing by the New Jersey Department of Environmental Protection of blood and feather samples from eaglets along the New Jersey side of the Delaware Bayshore indicate that eaglets have moderate to high levels of DDT compounds compared to eaglets from the Great Lakes (Clark et. al. 1994). Studies by Steidl et. al. (1991 a and c) compared reproductive success in Delaware Bay and Atlantic coast osprey populations in New Jersey. The Delaware Bay population had lower reproductive success and the eggs from this population contained significantly higher levels of DDE, DDD, PCB's, dieldrin, and heptachlor epoxide than Atlantic coast eggs. This suggests that contaminants from within the Bay contributed to reduced hatching success in this population.

2. Organophosphorus and Carbamate Pesticides. Use of organophosphorus and carbamate compounds continue to pose threats to bald eagles in the region. The type and magnitude of threat differ from that formerly posed by DDT: the newer contaminants cause localized effects from acute toxicity.

These pesticides have been associated with the lethal poisonings of both bald and golden eagles in the United States. Since there is no national system for monitoring and reporting wildlife poisonings related to pesticides, records of eagles poisoned by pesticides are only an indication that such poisonings have occurred and continue to occur. There is no accounting of the total number of eagles in the CBR and elsewhere that are affected by pesticides.

Still, NWHR records show that the CBR has the most concentrated clustering of organophosphate/carbamate poisonings of bald eagles in the country. Their records also indicate that carbofuran was the major factor in the death of bald eagles from the Chesapeake Bay area in 1988.

Other pesticides also continued to affect bald eagles survivorship in the CBR, although to a lesser extent than carbofuran.

3. Oil. With increased petrochemical transport activities in the Chesapeake Bay region, the potential exists for eagles to come into contact with oil. Oil on their breast feathers could be transferred to their eggs. Small quantities of oil (as little as

one microliter of No. 2 fuel oil) on the surface of duck eggs have been showed to cause a significant reduction in ability to hatch. At least 146 bald eagles are known to have died in association with the 1989 oil spill in Prince William Sound, Alaska. Furthermore, reproductive success was depressed among eagles nesting in that area.

4. Other contaminants. Mercury has not been a threat to the CBR bald eagle population. However, other sources of contamination such as sedimentation and excessive nutrients have the potential to adversely affect Chesapeake Bay and Delaware Bay water quality, prey populations secondarily, and ultimately the CBR bald eagles.

PEREGRINE FALCON

The peregrine falcon was placed on the Federally Protected Migratory Bird List in March, 1972. In 1970, the U.S. Fish and Wildlife Service listed the American peregrine falcon under the Endangered Species Conservation Act of 1969, and in 1984, all peregrines in the lower 48 states were listed under the Endangered Species Act of 1973 as endangered by similarity of appearance. The peregrine falcons in the project area are covered under the Peregrine Falcon (Falco peregrinus), Eastern Population Recovery Plan - 1991 Update (USFWS. 1991).

The peregrine falcon nests on high cliffs, tall buildings, and bridges. It requires an uncontaminated avian prey base and undisturbed nest sties. The primary threats to the eastern population at the present time are disturbance of habitat by humans at existing sites and predation by great horned owls, which may limit population expansion in the southern Appalachians, Great Lakes, and southern New England/Central Appalachians recovery regions, except at urban sites.

Prey for the peregrine consists primarily of common passerine bird species such as bluejays, flickers, meadowlarks and pigeons. During migration and on the wintering grounds, passerines, shorebirds and waterfowl are taken while starlings, other passerines, and pigeons serve as the principal source of food for falcons occupying metropolitan areas.

Population trends of peregrines can be monitored with greater reliability than with many other birds because these falcons exhibit a high degree of nest site fidelity. An inventory of eastern peregrine eyries conducted in the late 1930s and early 1940s showed 408 eyries in the eastern United States, Canada, Labrador, and Greenland. Of these sites, 275 were located in the eastern United States and at least 210 were active eyries.

Former breeding distribution of the eastern population extended from northern New England through the Adirondacks and along the Appalachian Range to Georgia and Alabama. Populations also existed in the upper Mississippi River area of Wisconsin and Minnesota. Tree nesting populations were also present in Tennessee and Kentucky.

Falcons generally reach sexual maturity at age three. Usually, the male arrives first at a cliff site and performs a series of aerial acrobatic displays to attract a mate. Historically in the eastern region, peregrine pairs were usually on their breeding grounds and had re-established territories by March. Their eggs, usually four in a clutch, were laid in late March and April; if this clutch was lost early in the laying period, a second clutch was laid. Reintroduced birds are following this pattern. Peregrines vigorously defend the immediate area surrounding their nesting ledge, but are more tolerant to human intrusion into their hunting territory.

Incubation lasts 32-34 days. The female does most of the incubating and brooding while the male hunts. The juvenile peregrines are most vulnerable during their first year when they are still developing their flying skills and learning to hunt. This is the period when the birds are especially vulnerable to shooting or predation, and the first year mortality from all causes is much higher than in subsequent years.

In the early 1960s the number of peregrine falcons nesting in the United States declined rapidly, with extensive use of organochlorine pesticides considered to be the primary cause. High levels of organochlorines, particularly the widely used insecticide DDT, proved lethal to birds, and sublethal doses induced reproductive failure. DDE, a metabolite of DDT, disrupted calcium metabolism so that peregrine falcons accumulating sufficient DDE residues produced abnormally thin-shelled eggs, which often broke before hatching. Eggshell thinning in combination with other effects of organochlorines upon reproduction greatly reduced the nesting success of peregrine falcons, and the recruitment rate of young peregrine falcons fell below the number necessary to replace natural and pesticide-caused mortalities. Subsequently, peregrine falcon numbers dwindled to the point where, by the mid-1960s, the breeding population of the peregrine falcon in the eastern United States was extirpated. Due to successful efforts to captively breed and reintroduce peregrine falcons into areas where they once bred, as well as new areas, the peregrine again breeds in many regions of the Northeast, and have steadily increased in numbers (Steidl et. al. 1991).

Protection of peregrines from the effects of pesticides has been indirectly enhanced through the Federal Pesticide Control Act and similar state laws. These acts led to restricted use of chlorinated hyrodcarbons in the United States. As a result, the mean DDT and dieldrin levels in indicator species such as starlings have declined significantly since 1967. During the past few years, there have been eggs recovered from coastal sites in the mid-

Atlantic region that contained relatively high residues of DDE. The source of the material is uncertain, but migrating prey is suspected. Although the worst offenders have been banned, environmental contamination persists as a localized threat to the full recovery of these raptors.

Direct human disturbance of nesting birds is the primary threat to the eastern peregrine population at this point. In combination with this, great horned owls prey on young (and occasionally adult) peregrines.

Alteration of peregrine falcon nesting and migrating/wintering habitat is occurring at a low to moderate level, particularly in the coastal reaches of the eastern population's range. Many nests have been established within publicly owned areas; protection of this habitat is secured. Migratory and wintering peregrine habitat is more at risk, although protection of this habitat is also proceeding in many areas concomitant to protection of shorebird habitat. In addition, illegal shooting of peregrine falcons in the eastern United States remains a sporadic cause of bird mortality.

Natural increases in peregrine population levels are anticipated over the long run, given sufficient protection of the species' habitat. If implementation of recovery activities continues, reclassification of this population of the peregrine falcon should be possible when the number of nesting pairs reaches approximately one-fourth to one-third of the historical population level. As the population continues to grow, full recovery will be achieved when approximately one-half the historical number of 350 nesting pairs is shown to be self-sustaining and distributed across the falcon's former range (USFWS. 1991).

<u>Peregrine Falcon Populations in the Project Area</u>

1. New Jersey. Within the study area in New Jersey there are 5 nest locations. Three of the locations are on bridges over the Delaware River between New Jersey and Pennsylvania (Benjamin Franklin, Walt Whitman, and Commodore Barry). The other locations are at the Heislerville Wildlife Management Area and near Egg Island Point, both in Cumberland County. The same pair may be using the last two locations in different years (Clark. 1994 and Clark. Personal Communication). Production of young at New Jersey sites near the Delaware River and Bay has been lower than those from other parts of the state. Eggshell thinning due to contaminants continues to be a problem. Eggshell thickness reported from eggs collected from 1985-88 in New Jersey averaged 16.4% below pre-DDT levels and apparently has decreased steadily since 1979. This decrease in eggshell thickness suggests that falcons continue to be exposed to environmental contaminants. All peregrine populations where egg thinning exceeded 17% were either declining or became extirpated (Steidl, et. al. 1991). In addition, total PCBs and chlordane in New Jersey and other eastern peregrine falcon eggs continue to be

higher than those from other parts of the country, while total DDT remains high (Clark. 1994).

2. Delaware. Peregrine falcons have nested on the Delaware Memorial Bridge that connects Delaware to New Jersey. They have also attempted to nest on high buildings in Wilmington. There is no recent data on peregrine falcons in Delaware (Gelvin-Innvaer. Personal Communication).

3. Pennsylvania. Peregrine falcons have nested on two bridges in the project area (Walt Whitman and Commodore Barry) that have been cooperatively monitored by the Pennsylvania Game Commission and the New Jersey Department of Environmental Protection. Eggs from the first clutch from these two nests were removed and hacked in urban locations in Pennsylvania and New Jersey. The two pairs of falcons failed to renest (Clark. 1994). Productivity in captive-rearing facilities was higher than historically has been experienced with bridge-nesting peregrines (Brauning. 1994).

4. Migratory. In addition to the peregrine falcons that nest within the project area, many migrate through with up to 800 passing by Cape May, New Jersey in the fall, as well as a few birds that winter in the area (Herpetological Associates, Inc. 1992).

ASSESSMENT OF POTENTIAL IMPACTS

BALD EAGLE

Disturbance of Nest Sites

1. Construction and use of Upland Dredged Material Disposal Areas. One pair of eagles that nested near Raccoon Creek (designated as the Raccoon Creek site) is suspected to be the same pair that nested near Gibbstown in the past. The nest is located between 1.5 and 2 miles from one of the proposed dredged material upland disposal sites (15D). The FWS requires a buffer zone of 0.25 miles or a line of site buffer of 0.5 miles from the nest from January to July to avoid disturbance (Peters. Personal Communication). There would be no adverse impact provided that the eagles continue to nest in the locations that have been used in the past. At this time we can not tell if an eagle nest will be located near an upland disposal area in the year 2000 when the upland sites would be constructed. A contingency plan will be developed based on FWS recommendations. Construction of the site and use of the site for disposal of dredged material could be staged to avoid disturbance impacts where work would be performed within the dates recommended by Cline (1985).

2. Construction of Kelly Island and Egg Island Point Wetland Restoration Sites. The Kelly Island beneficial use site is about 6 miles from an eagle nest in the Bombay Hook National Wildlife Refuge, and there would be no impacts to the nesting bald eagles

from construction of the site. There are no suitable bald eagle nesting trees near either the Kelly Island wetland restoration site or the Egg Island Point wetland restoration site.

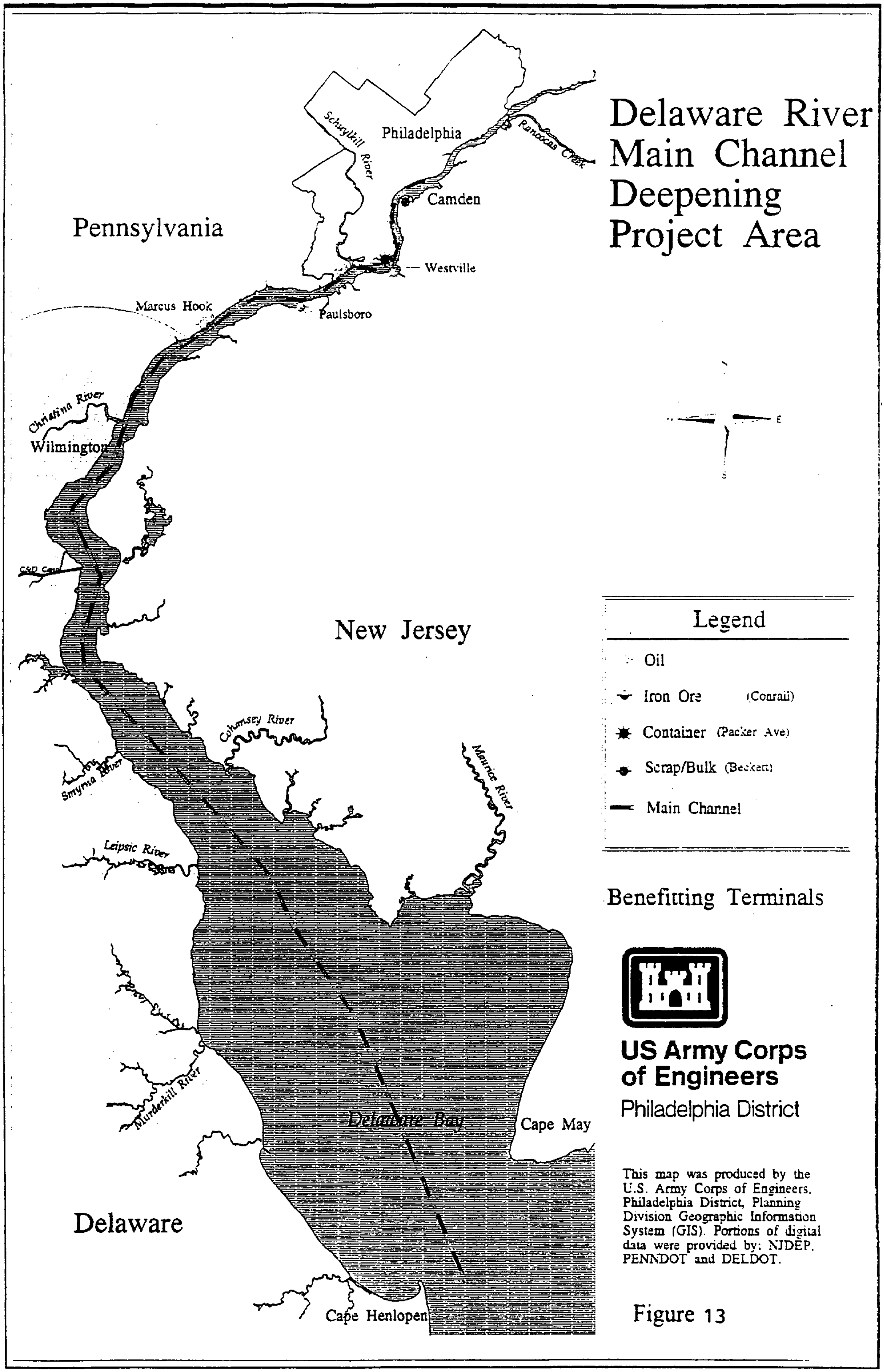
Potential for Increased Development

There should be no impacts to bald eagles from increased development due to the channel deepening project. Although the greatest economic benefit for the channel deepening project is to the petroleum industry, the oil refining facilities in the project area are not expected to increase as a result of this project. The import level for crude oil is forecasted to be 79 million tons in 2055 without the channel deepening project. The refineries will need to expand their current 60 million ton capacity in order to process the projected tonnage. The refinery capacity is expected to increase in the future through technology changes, upgrading facilities, expansion, and new development in order to accommodate projected commodity flow. However, the economic benefits of this project will result from increased efficiency of oil transportation due to decreased lightering, and there is no additional increased development projected due to this project. The locations of the six oil refineries that will benefit from this project are shown in Figure 13 and consist of the following facilities: Sun Oil, Marcus Hook, PA; BP Oil, Marcus Hook, PA; Mobil Oil, Paulsboro, NJ; Sum Oil, Ft. Mifflin, PA; Sun Pipeline, Ft. Mifflin, PA; and Coastal Eagle Point Oil, Westville, NJ. None of the known current locations of eagle nests are near these refineries.

Potential for Increased Oil Spills

There should be no impacts to bald eagles from increased oil spills due to the channel deepening project. Although the channel deepening project will enable oil tankers to bring larger quantities of oil directly to the oil refineries, this will be done more safely than it is under present conditions. Under present conditions, large oil tankers with full cargos need to transfer a portion of their cargos to smaller tankers in the lower, deeper portion of Delaware Bay so that they can negotiate the 40 foot channel upriver. This process is called "lightering", and it is in this operation that there is a greater possibility for oil being spilled. With the new, deepened channel, lightering will be reduced 40% for benefitting facilities. In addition, the navigation channel will be widened at certain bends such as the bend at Marcus Hook, PA. This is the only location in the estuary where bedrock is exposed, and over 37% of the major oil spills that have occurred since 1973 have taken place at this location by groundings (see Table 4). The widening and deepening of the navigation channel at Marcus Hook should reduce the possibility of oil spills in the Delaware Estuary.

The input of oil into the Delaware River results from several activities, including refinery and other industrial operations,


Delaware River Main Channel Deepening Project Area
Pennsylvania
Philadelphia
Schuylkill River
Rancocas Creek
Camden
Westville
Marcus Hook
Paulsboro
Christina River
Wilmington
C&D Canal
New Jersey
Cohansey River
Smyrna River
Maurice River
Leipsic River
Murderkill River
Delaware Bay
Cape May
Delaware
Cape Henlopen
Legend
Oil
Iron Ore (Conrail)
Container (Packer Ave)
Scrap/Bulk (Beckett)
Main Channel
Benefitting Terminals
US Army Corps of Engineers
Philadelphia District
This map was produced by the U.S. Army Corps of Engineers, Philadelphia District, Planning Division Geographic Information System (GIS). Portions of digital data were provided by: NJDEP, PENNDOT and DELDOT.
Figure 13

urban runoff, municipal waste, and tanker traffic. In 1975, the input of oil from onshore operations (not including that resulting from tanker operations) was estimated at 59,000 gallons per day or about 21.5 million gallons per year. Following enactment of the Clean Water Act in 1977, this oil discharge decreased by over one-half (COE. 1992).

The potential for oil spills and concern over the negative environmental impacts involved is very much a public concern. Any oil spill event in the Delaware River must be reported to the National Response Center. Under the National Oil Spill Contingency Plan (NCP), there are National, Regional, and Local Response Teams. The Region III and Region II Emergency Response Teams have jurisdiction in the Delaware River Comprehensive Navigation Study area. The Region III Response Team consists of representatives of the following:

- Environmental Protection Agency
- U.S. Coast Guard
- Department of Agriculture
- Department of Commerce
- Department of Defense
- Department of Energy
- Department of Health and Human Services
- Department of the Interior
- Department of Labor
- Federal Emergency Management Agency
- Commonwealths of Pennsylvania, Virginia, and District of Columbia
- States of Delaware, Maryland, and West Virginia

The Region II Response Team is composed of the same Federal agencies plus the States of New Jersey and New York. Under the Regional Contingency Plan (RCP) in the Delaware River Comprehensive Navigation Study Area the U.S. Coast Guard Captain of the Port, Philadelphia (COTP) is designated as the on scene cleanup coordinator (OSC). The OSC can call upon support for spill clean up from the Atlantic Strike Team (located at Fort Dix, NJ), a specially trained and equipped contingent of NCP's National Strike Team; the Delaware Bay and River Cooperative (DB&RC), a consortium of oil, chemical, and petroleum transportation companies which operate two cleanup vessels and have an assortment of other kinds of cleanup equipment at their disposal; members of the Regional Response Team; and representatives of the Local Response Team such as the New Jersey State Police and the Philadelphia Fire Department. The Regional Contingency Plan is updated on a continual basis and would be updated to reflect any changes in current vessel traffic patterns due to a modified project.

Table 4 - Major Oil Spills in the Delaware River, 1973-1989

Year	Volume (gallons)	Vessel Source	Location	Accident Type
Spills Greater than 100,000 Gallons				
1973	126,000	Tanker	Marcus Hook	Grounding
1974	285,000	Tanker	Philadelphia/Camden	Collision
1975	500,000	Tanker	Marcus Hook	Collision
1976	134,000	Tank Barge	Marcus Hook	Grounding
1978	630,000	Tank Barge	New Castle-Reedy Island	Sinking
1979	189,000	Tank Barge	Marcus Hook	Collision
1985	525,000	Tank Barge	Philadelphia/Camden	Grounding
1989	200,000-300,000	Tanker	Marcus Hook	Grounding
Spills Greater than 10,000 Gallons but less than 100,000				
1973	14,720	Tanker	Ocean Throughway to Delaware Bay	Grounding
1974	13,000	Tanker	Philadelphia/Camden	Fire/Explosion
1975	12,000	Tanker	Marcus Hook	Collision
1975	73,000	Tugboat	Philadelphia/Camden	Capsizing
1976	84,000	Tanker	Philadelphia/Camden	Collision
1979	16,800	Tanker	Philadelphia/Camden	Pipe Rupture

U.S. Coast Guard data from 1973 to 1989 on vessel-related oil spills in the Delaware River revealed a gradual decline in both the number of spill incidents and the volume. Much of it can be attributed to the increase in tanker vessel size and the use of larger tank barges for lightering. Twenty-five percent of the spills analyzed involved residual fuel oil, 20 percent involved crude oil, and another 20 percent involved diesel fuel. Additional petroleum-related materials spilled in the river were gasoline, other distillate fuel oils, and waste oil. On a volume basis, crude oil comprised 44 percent of material spilled followed by residual fuel oil with 26 percent.

Lightering operations have occurred at the Big Stone Beach Anchorage since the 1960's. Transfer accidents in the Delaware River occur at a rate one-half that of the national average of 8 accidents per 1000 transfers. The average national lightering spill is about 32 gallons. For the Delaware such spills are immediately cleaned up using an oil skimmer which is permanently stationed at Lewes, Delaware and operated by the Delaware Bay and River Cooperative.

Most of the oil spilled into the Delaware River has been the result of tanker and barge accidents. Refer to Table 4 for a listing of the major oil spills which have occurred in the Delaware River from 1973 to 1989. Major incidents such as these are usually the result of human error and structural or mechanical failures. After an oil spill event, a prompt and efficient oil spill cleanup can reduce many adverse impacts. The amount of oil that is recovered after an oil spill can vary from 5% to 80% depending on the weather conditions, location, tidal condition, and type of oil spilled. The conditions are worse when the spill occurs in the open Bay where it is difficult to contain and when the oil is light and disperses quickly. In these conditions recovery will fall below 50% (Dillon. 1995. Personal Communication). In the aftermath of the catastrophic Exxon Valdez oil spill in Prince William Sound Alaska, several actions have been taken to lessen the chances and reduce the impacts from similar spills that may occur in the future. Since the enactment of the Oil Pollution Act of 1990, all vessels must have spill response plans to deal with the worst case oil spill that could occur.

These plans were in place on February 18, 1993. Also, the Marine Spill Response Corporation (MSRC) was created and incorporated in 1989. This not-for-profit corporation was created to assist in the cleanup of large oil spills using state of the art technology. Lastly, there is increasing public pressure to require vessels that transport oil to have double hulls, back-up steering and emergency back-up propulsion systems.

If an oil spill occurs, the oil Pollution Act of 1990 (OPA) requires that the impacts be documented and the area restored. The Oil Spill Liability Trust Fund is money set aside by oil companies. Money from this fund can be accessed by either the Department of the Interior or the National Oceanographic and Atmospheric Administration, the Federal Trustees, and can be used to restore damaged resources and lost services. The responsible party is identified and must replace the money that was used.

Although spills also occur periodically, the Delaware River has functioned safely considering the huge volume of oil that is transported on the river. Channel dimensions have not been identified as a contributing factor to the previous accidents or oil spills on the Delaware River. Through proper planning and design of waterway improvements and navigation aids, the potential for accidents can be minimized. There is potential to reduce oil pollution due to lightering operations by main channel deepening. This would alleviate the need for lightering vessels in the 40' to 45' sailing draft range.

PEREGRINE FALCON

Disturbance of Nest Sites

1. Construction and Use of Upland Dredged Material Disposal Areas. A pair of peregrine falcons has nested on the Commodore Barry bridge which crosses the Delaware River between Pennsylvania and New Jersey. The bridge is adjacent to the proposed Raccoon Island upland dredged material disposal site. The time when nesting peregrines are the most sensitive to disturbance is at the beginning of the nesting period (15 March to 15 April). During this period no work should be initiated; however, it may be possible to continue ongoing work without disturbing the falcons (Clark. 1995. Personal Communication). The Philadelphia District will coordinate closely with the NJDEP before work would be performed during this critical period.

2. Restoration of Wetlands at Egg Island Point and Kelly Island. Another pair of peregrine falcons has nested on a structure near Egg Island Point where the Philadelphia District plans to restore a wetland that is eroding at a rate of up to 30 feet per year. Conversations with the NJDEP (Clark. 1995. Personal Communication) indicate that the nest structure is in danger of being destroyed by the continuing erosion. The Philadelphia District would move the nest structure to a safer location as determined in coordination with the NJDEP. The restoration of wetlands at Egg Island Point and Kelly Island should have a beneficial impact by restoring and protecting tidal wetlands that provide habitat for waterfowl and shorebirds which are prey species for peregrine falcons.

CONTAMINANTS

After review of available data for dredged material derived from the Delaware River Main Channel Deepening Project, it would appear that the relative risk of contaminants in the dredged material to wildlife and especially endangered species such as the bald eagle and peregrine falcons should be very low and consequently, should not be a significant concern. The frequency of detection of contamination in sediment samples collected throughout the project was low and therefore any detected contamination when placed in the designated disposal sites will be mixed to such a large extent that contaminant concentrations will end up very low.

PCBs. The highest concentrations of PCB-1254 and PCB-1248 observed in one out of 49 samples from Reach B of the project were 1.19 and 0.53ppm, respectively. After dredging and placement in a disposal site, the overall final PCB concentration will be no doubt be below 0.25 ppm. Bioaccumulation of PCBs in wetland and upland soil dwelling animals have been observed to be less than one half the concentration measured in the dredged material. For example, at the Corps of Engineers' Field Verification Program field sites, both earthworms in the upland site and sandworms in the wetland site bioaccumulated approximately 3 ppm PCBs from dredged material containing 6.7 ppm PCBs (Lee et al. 1995). FDA action levels for human consumable food have been set at 2 ppm PCBs. While there are no set action levels for wildlife food, it is reasonable to assume that foodchain components that contain above 2 ppm could represent significant risk to wildlife. It would appear that reduced concentrations of sediment PCBs, such as 0.25 ppm, should not be a significant risk to wildlife exposed to an ecosystem developed on the proposed disposal sites for dredged material from Delaware Estuary.

Pesticides. Few sediment samples showed detected pesticides. One sediment sample out of 33 showed 0.060 ppm heptachlor epoxide (Reach A), while another sample out of 49 showed 0.06 ppm Endosulfan (Reach B) and finally a third sample out of 19 showed 0.026 and 0.045 ppm of DDD and DDE, respectively. Dredging and placement of sediments in the disposal sites will result in reduced concentrations of these pesticides. The reduced concentrations should not represent a significant risk to wildlife.

PAHs. Sediment samples did show detectable amounts of PAHs. The highest concentrations of PAHs were observed in 2 out of 49 samples in Reach B. One sample approached a total PAH concentration of 10 ppm. Concern for exposure of foodchain components to sediments containing 10 ppm or more of PAHs could be warranted. However, when this sediment is dredged and placed in a disposal site with the other 48 sampled sediments within the

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Reach, the resultant reduced concentration of PAHs should be approximately 0.2 ppm and of little concern or risk.

Metals. Most sediment samples showed detectable metals. Metals that were detected at levels that might be of concern were cadmium (1.66 ppm, mean concentration for Reach A) and thallium (3.76 and 2.48 ppm mean concentration for Reaches A and B, respectively). These concentrations were above NJ DEP Residential Direct Contact Soil Cleanup Criteria, which can give some perspective of sediment chemical data, but may not relate well at all to the risk to wildlife. All other metals were low and should not be a significant risk.

1. Cadmium. Up to 1994, 2.7 ppm cadmium was the soil concentration allowed for land receiving sewage sludge and used in crop production for human and animal food (Lee et al. 1991). Newly established EPA 503 regulations for land application of sewage sludge raised the soil levels to 34 ppm cadmium for unrestricted use of land. It would appear that dredged material containing an average concentration of 1.66 ppm cadmium should be of low risk in light of the 503 limitations. Bioaccumulation of cadmium in foodchains has been observed on dredge material containing 11 ppm cadmium (Stafford et al. 1987). Cottonwood trees that colonized the Times Beach Confined Disposal Facility at Buffalo, NY took up cadmium from the dredged material into their leaves. The leaf litter on the soil surface was inhabited by earthworms which bioaccumulated cadmium up to 100 ppm, resulting in a significant potential risk to wildlife foodchains on the disposal site. This example is an order of magnitude more sediment cadmium than that observed in Delaware River sediments and illustrates that bioaccumulation can occur at higher soil cadmium concentrations.

2. Thallium. The risk of thallium to foodchains is unknown. While there are water quality criteria for thallium for human risk assessment, there are no FDA action levels for thallium in human or animal food. The concentration of thallium observed 2.48 and 3.76 ppm appears to be above the NJDEP Residential Direct Contact Soil Cleanup Criteria of 2.00 ppm, however, the magnitude above the criteria is below 2X times. Concern for concentrations of potential contaminants usually becomes warranted when magnitudes above criteria approach 5X times. Until a more applicable criterion is established for the risk of thallium to wildlife foodchains, the risk to wildlife should be considered low.

Water Column Impacts The discussion above is related to disposal site impacts. The potential for impacts and risk to wildlife and especially the bald eagle and peregrine falcon is minimal from the dredging of sediments in the Delaware River, based on the collected data. Elutriate test show very little release of contaminants of concern to the water column. Dredging will temporarily suspend sediments, but the duration and exposure will be temporary and should not result in significant risk to fish or wildlife. Bioassay tests with suspended sediments showed no toxicity or bioaccumulation of any significance. Therefore, the risk to fish and ultimately the bald eagle or peregrine falcon should be insignificant.

Bioassay and Bioaccumlation Testing

All water column and whole sediment bioassays resulted in 100 percent survival of all test species. The results of the water column bioassays suggest that sediment disturbance, and associated water column turbidity, at the point of dredging and at dredged material disposal locations would not result in mortality of aquatic organisms in the vicinity. Likewise, the results of the whole sediment bioassays suggest that aquatic organisms that colonize sediment placed for beneficial uses in Delaware Bay would also be unaffected by sediment contaminants.

With regard to bioaccumulation, there was no evidence that contaminants accumulated in clam tissue exposed to Delaware Bay sediment at greater concentrations than clam tissue exposed to clean laboratory sediment. All of the tissue residues were representative of what one would expect in organisms exposed to uncontaminated material. With regard to bioaccumulation and the polychaete Nereis virens, there were no statistical differences between contaminants in worms exposed to channel sediments and worms exposed to reference sediments, with the exception of the heavy metal arsenic. The mean arsenic concentration in worms exposed to one channel sediment sample (0.700 ppm) was statistically higher than concentrations in worms exposed to reference sediment samples (0.360 and 0.460 ppm). The measured tissue concentration of arsenic in worms exposed to the channel sediment did not appear to be deleterious. No more mortality was observed in the channel sediment test worms than in worms exposed to other sediments. Furthermore, a mean tissue concentration of arsenic in worms exposed to the control sediment (0.680 ppm), which was obtained in Maine where the worms were collected, was virtually identical to that measured for the channel sediment worms (0.700 ppm). Both of these values are well below the range of acceptable background tissue arsenic concentrations for test organisms from East Coast sites, which is reported to be 1.5 to 3.9 ppm in the USEPA Guidance Manual for Bedded Sediment Bioaccumulation Tests (EPA-600-R-93-183). Overall, test results suggest that open water placement of Bay sediment is acceptable with regard to bioaccumulation concerns.

ALTERNATIVES CONSIDERED

A number of alternatives to the selected plan were considered by the Philadelphia District. In addition, a number of dredged material disposal alternatives and sites, and a number of beneficial uses of dredged material were evaluated using economic, engineering and environmental criteria and are discussed in detail in the Final Interim Feasibility Report and Environmental Impact Statement (COE. 1992).

CONCLUSIONS

No significant adverse impacts will occur to either the bald eagle or the peregrine falcon provided the following measures are done:

BALD EAGLE

Prior to construction of the upland dredged material disposal areas, the Philadelphia District will coordinate with the USFWS and the NJDEP to determine if there are any bald eagle nests within 0.25 miles or a line of site distance of 0.5 miles from the dredged material disposal area. If there is an active nest within these distances, construction of the site and the use of the site for the disposal of dredged material will be staged to avoid disturbance impacts.

PEREGRINE FALCON

1. Coordinate with the NJDEP before initiating any new work at the Raccoon Island upland dredged material disposal site between 15 March and 15 April.

2. The Philadelphia District will move the nest structure located at Egg Island Point to a safer location as determined in coordination with the NJDEP.

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SECTION B-3

PLANNING AID REPORT, COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT, DELAWARE RIVER FROM PHILADELPHIA TO THE SEA, BENEFICIAL USE OF DREDGED MATERIAL

U.S. FISH AND WILDLIFE SERVICE

AUGUST, 1995

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY
MAIN CHANNEL DEEPENING PROJECT
DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

BENEFICIAL USE OF DREDGED MATERIAL

Prepared by:

U.S. Fish and Wildlife Service
Region 5
Delaware River / Delmarva Coastal Ecosystem Team

August 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE

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IN REPLY REFER TO:

FP-95/25

Tel: 609-646-9310
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August 18, 1995

Lt. Colonel Robert P. Magnifico
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Magnifico:

Enclosed is the U.S. Fish and Wildlife Service (Service) planning aid report on the Philadelphia District Corps of Engineers' (District) Comprehensive Navigation Study, Main Channel Deepening Project, Delaware River from Philadelphia to the Sea (Beneficial Use of Dredged Material). This report has been prepared pursuant to a Fiscal Year-1995 interagency agreement between the District and the Service.

This planning aid report is provided as technical assistance and does not constitute the report of the Secretary of Interior pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*). Planning aid is valid only for the described conditions and must be revised if changes to the proposed project take place prior to initiation.

This report is also provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. Therefore, these comments do not preclude separate review and comments by the Service on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Federally-listed Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) nests near the Delaware Bay, and feeds throughout the project area. Additionally, the federally-listed endangered peregrine falcon (*Falco peregrinus*) also nests on Egg Island Point in the vicinity of the proposed project. Peregrine falcons may be expected to forage for prey throughout the project area and generally feed on songbirds, gulls, terns, shorebirds, and wading birds. Additionally, peregrine falcons use the Delaware Bay shoreline during migration, especially in the fall.

It is the Service's understanding that the District is preparing a Biological Assessment to address potential project-related adverse impacts to the bald eagle, and peregrine falcon. Other than the aforementioned species, no other federally-listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area. It is also our understanding that the District is coordinating with the National Marine Fisheries Service regarding the federally-listed shortnose sturgeon (*Acipenser brevirostrum*) (endangered), Atlantic Ridley turtle (*Lepidochelys kempii*) (endangered), and loggerhead turtle (*Caretta caretta*) (threatened). Appendix A provides lists of federally-listed endangered and threatened species and federal candidate species in New Jersey and Delaware.

Any questions regarding this report or federally-listed endangered or threatened species should be directed to John Staples or Peter Benjamin of my staff. The Service looks forward to continued cooperation with the District in the planning stages of the proposed project.

Sincerely,

Clifford G. Day

Clifford G. Day
Supervisor

Enclosure

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY
MAIN CHANNEL DEEPENING PROJECT
DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

BENEFICIAL USE OF DREDGED MATERIAL

Prepared for:

U.S. Army Corps of Engineers
Philadelphia District
Philadelphia, Pennsylvania 19107

Prepared by:

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August 1995

EXECUTIVE SUMMARY

In accordance with a Philadelphia District, U.S. Army Corps of Engineers (Corps) Fiscal Year - 1995 scope-of-work agreement, the U.S. Fish and Wildlife Service (Service) has prepared this planning aid report for the Corps' Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. The material presented in this planning aid report summarizes available data and information on the fish and wildlife resources of Delaware Bay, with an emphasis on those resources that would be most affected by plans currently under consideration by the Corps for the disposal of material dredged from the Delaware Bay portion of the Main Channel.

The proposed Main Channel Deepening Project, authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992, would involve the deepening of the existing federal navigation channel for the Delaware River and Delaware Bay from 40 feet below mean-low-water (mlw) to 45 feet below mlw. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia / Camden waterfront, a distance of approximately 102.5 miles. Approximately 50 million cubic yards of dredged material would be removed for initial construction over a five year period. Approximately 40 million cubic yards of material to be dredged from the Delaware River would be placed in confined upland disposal areas. An estimated 10 million cubic yards of dredged material, which would be generated by the Delaware Bay portion of the Main Channel Deepening project, is available to be used beneficially to help combat the severe erosion that is threatening bayshore wetlands and properties. Potential beneficial uses evaluated for this report include the use of geotextile tubes for wetland restoration and shoreline stabilization at Egg Island Point, New Jersey, and Kelly Island, Delaware; beach nourishment along the Delaware shoreline; and, the formation of sand stockpiles in Delaware Bay. Such stockpiles would provide a readily available source of sand for future beach nourishment projects.

Information presented in this report includes an assessment of the effects of various dredged material disposal scenarios on fish and wildlife resources and provides Service recommendations regarding the preferred locations and designs for projects that would provide beneficial uses of dredged material, in terms of improving fish and wildlife habitat. Additionally, this planning aid report presents identified data gaps and additional information needed to fully evaluate the effects of the various disposal scenarios, and includes recommendations for future studies.

Based upon review of available information, numerous site visits, and coordination with local sources of expertise, the Service has concluded that the proposed wetland restoration projects at Egg Island Point, New Jersey, and Kelly Island, Delaware, would provide positive benefits to fish and wildlife resources. The Service further concludes that beach nourishment would have the greatest positive effects on beaches between Port Mahon and South Bowers Beach, Delaware, while nourishment of beaches in the more southern sections of the Delaware shoreline would be less beneficial, although still worthwhile. Additionally, the Service concludes that the proposed disposal of dredged material in sand stockpiles would adversely affect fish and wildlife resources and that the use of sand stockpiles should be minimized or eliminated as an alternative.

While the Service supports the proposed wetland restoration and beach nourishment plans, in concept, substantial additional coordination and planning are necessary to ensure maximum project benefits with minimal adverse effects on fish and wildlife. The Service is particularly concerned that the proposed wetland restoration projects at Kelly Island and Egg Island Point may adversely impact oyster beds through increased turbidity and sedimentation. The Service recommends that the Corps continue to coordinate project planning with the Service, the New Jersey Division of Fish, Game and Wildlife (NJDFGW), and the Delware Department of Natural Resources and Environmental Control (DNREC).

The Service recommends that the Corps proceed with plans to conduct a pilot project to study the effectiveness of geotextile tubes in Delaware Bay. Such a pilot project would greatly improve the prospects for successful implementation of the proposed Egg Island Point and Kelly Island wetland restoration projects. Such a pilot project should also include expanded horseshoe crab and shorebird surveys, and assessments of horseshoe crab spawning habitat requirements. The Service recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of the pilot project, and related monitoring studies.

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I. INTRODUCTION

This U.S. Fish and Wildlife Service (Service) planning aid report has been prepared in conjunction with a Philadelphia District, U.S. Army Corps of Engineers (Corps) Fiscal Year - 1995 scope-of-work agreement, and is submitted for the Corps' Delaware River Comprehensive Navigation Study, Main Channel Deepening Project. The material presented in this planning aid report summarizes available data and information on the fish and wildlife resources of Delaware Bay, with an emphasis on those resources that would be most affected by plans currently under consideration by the Corps for the disposal of material dredged from the Delaware Bay portion of the Main Channel. Previous Service reports have documented the effects of the proposed dredging on fish and wildlife resources (U.S. Fish and Wildlife Service, 1985, 1989, 1992). Information presented in this report includes an assessment of the effects of various dredged material disposal scenarios on fish and wildlife resources and provides Service recommendations regarding the preferred locations and designs for projects that would provide beneficial uses of dredged material, in terms of improving fish and wildlife habitat. Finally, this planning aid report presents identified data gaps and additional information needed to fully evaluate the effects of the various disposal scenarios, and includes recommendations for future studies.

II. PROJECT DESCRIPTION

The Feasibility Study for the Main Channel Deepening Project was completed in 1992. The proposed Main Channel Deepening Project was authorized by Congress in October 1992 as part of the Water Resources Development Act of 1992, based on the findings of the Feasibility Study. The authorized project would involve modification of the existing federal navigation channel from 40 feet below mean-low-water (mlw) to 45 feet below mlw. The proposed project provides for a full width channel that would follow the existing channel alignment from the Delaware Bay to the Philadelphia / Camden waterfront, a distance of approximately 102.5 miles. The proposed project includes all appropriate bend widenings as well as provision of a two-space anchorage at Marcus Hook.

Approximately 50 million cubic yards of dredged material would be removed for initial construction over a five year period. The approximately 40 million cubic yards of material dredged from the Delaware River would be placed in confined upland disposal areas. The environmental effects of the use of these proposed upland disposal areas are discussed in a separate planning aid report (U.S. Fish and Wildlife Service, 1995a). Various disposal options, including beneficial uses for dredged material, are currently being considered for the approximately 10 million cubic yards of material to be dredged from the Delaware Bay.

The Delaware Bay shoreline is experiencing severe erosion, subjecting shoreline properties to storm damage from waves and tidal inundations. Continual erosion of the Delaware Bay shoreline over the past century has also resulted in substantial wetland losses. These wetlands provide not only valuable habitat for fish and wildlife, but also protect bayside properties and structures from storms (U.S. Fish and Wildlife Service, 1994a). The estimated 10 million cubic yards of dredged material that would be generated by the Delaware Bay portion of the Main Channel Deepening project could be used beneficially to help combat the severe erosion that is threatening bayshore wetlands and properties. Potential beneficial uses include wetland restoration, shoreline stabilization, beach nourishment, and the formation of sand stockpiles in Delaware Bay. Such stockpiles would provide a readily available source of sand for future beach nourishment projects.

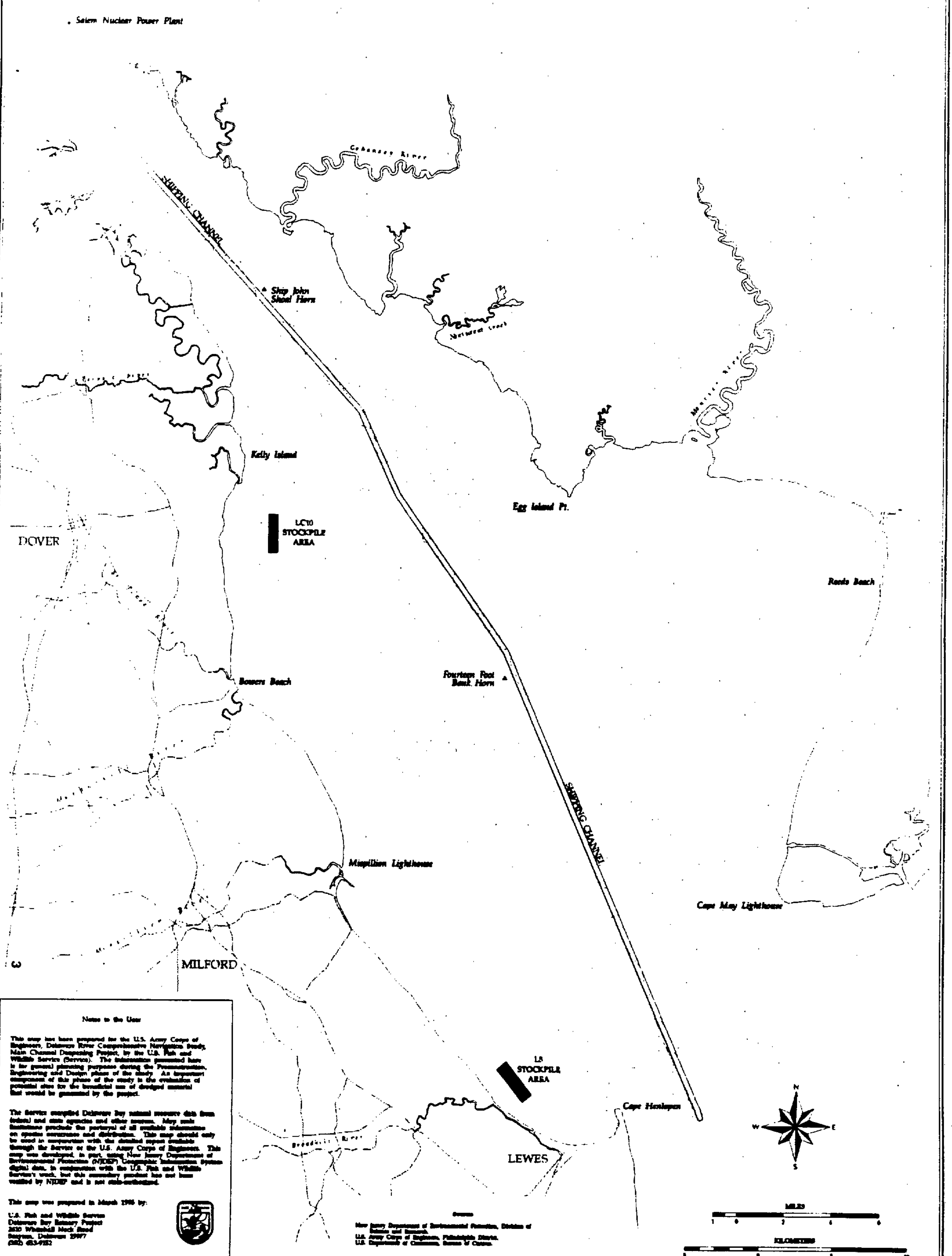
The Corps is currently engaged in the Preconstruction, Engineering and Design phase of the study. The purposes of this phase are to: re-affirm and refine the authorized plan; respond to comments received on the Feasibility Study; establish the final design of the project features; and, finalize the project cooperative agreement with the Delaware River Port Authority, the non-federal project sponsor. A critical component of this phase of the study is to identify and design disposal areas for dredged material from the Delaware Bay portion of the Main Channel. Because the costs of dredged material disposal increases as the distance from the Main Channel to the disposal site increases, the sites evaluated in this report are only those sites closest to the Main Channel, that have the highest potential for providing economically feasible alternatives, as identified by the Corps. These sites include the following: Kelly Island, Delaware, and Egg Island Point, New Jersey, wetland restoration / shoreline protection sites; possible beach nourishment sites along the Delaware shore of the Bay; and, possible sand stockpile sites in Delaware Bay (Figure 1) (J. Brady, pers. comm., 1995). It is recognized that many other areas of Delaware Bay could be suitable sites for beneficial use projects.

The Corps has prepared preliminary designs for the Kelly Island and Egg Island Point wetland restoration / shoreline protection sites. The existing conditions of these sites are described in Section IV below. In summary, the shoreline in both of these areas consists of rapidly eroding tidal marsh. The preliminary plan for both of these sites is to use geotextile tubes and material dredged from the Main Channel to restore wetlands and to stabilize the shoreline.

On the Kelly Island site, the goal is to protect the southern tip of Kelly Island and to restore a portion of the historic shoreline to tidal marsh. The preliminary plan (Figure 2a) includes the placement of a single geotextile tube filled with dredged material 50 to 100 feet seaward of the existing shoreline from the southern tip of Kelly Island to approximately 500 feet north of the tip. The tube would be placed on a layer of sand and a geotextile scour blanket for support.

From a point approximately 500 feet north of the southern tip of Kelly Island to Deepwater Point (a distance of 5,000 to 8,000 feet), a second geotextile tube structure would be constructed approximately 500 to 800 feet seaward of the existing shoreline. The structure would consist of a stack of three geotextile tubes filled with dredged material and supported by a layer of sand and a geotextile scour blanket placed on top of the existing substrate (Figure 2b).

Figure 1. Delaware Bay Reference Map
for the Delaware River Beneficial Use Plan



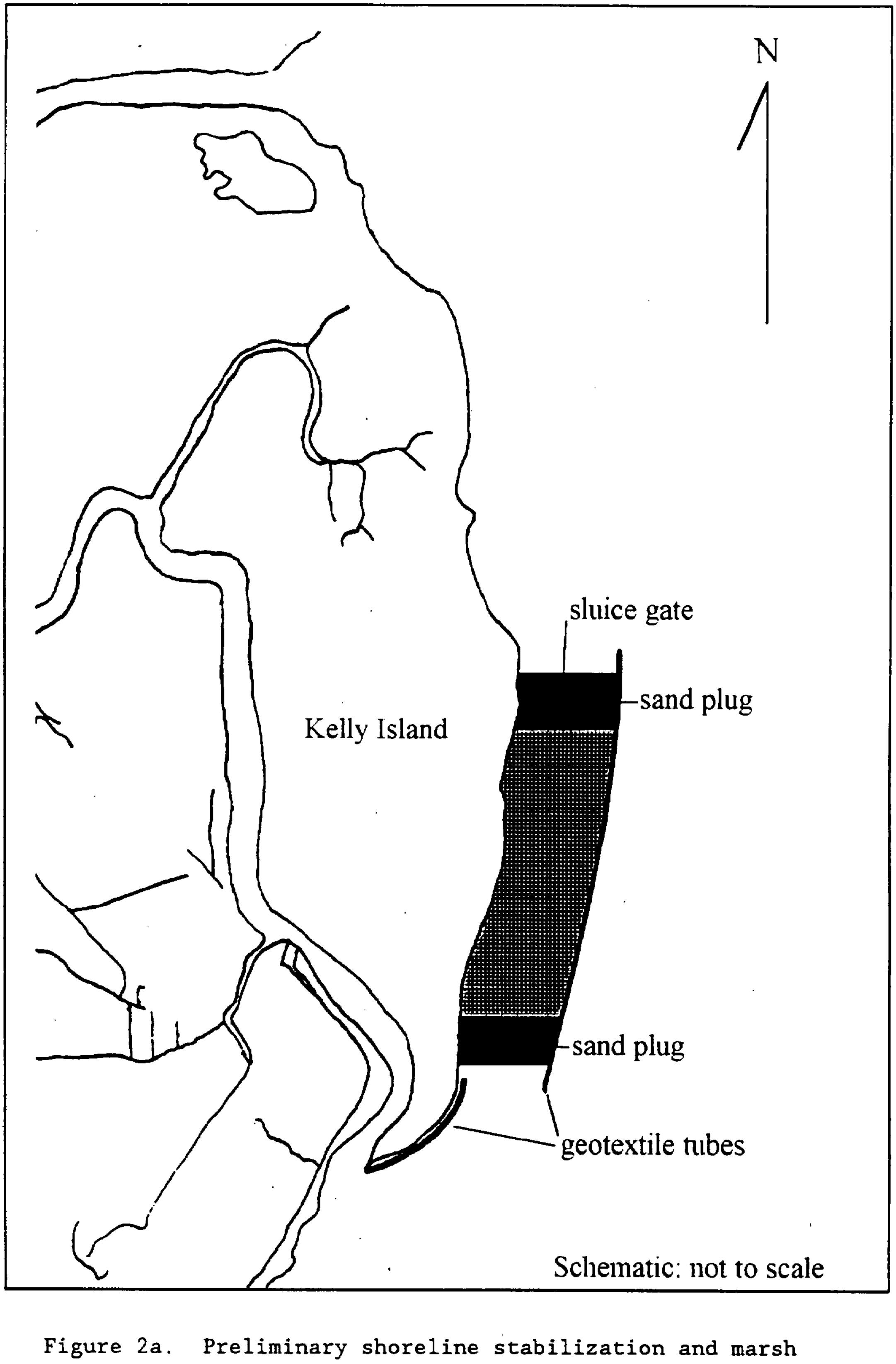


Figure 2a. Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (overhead view).

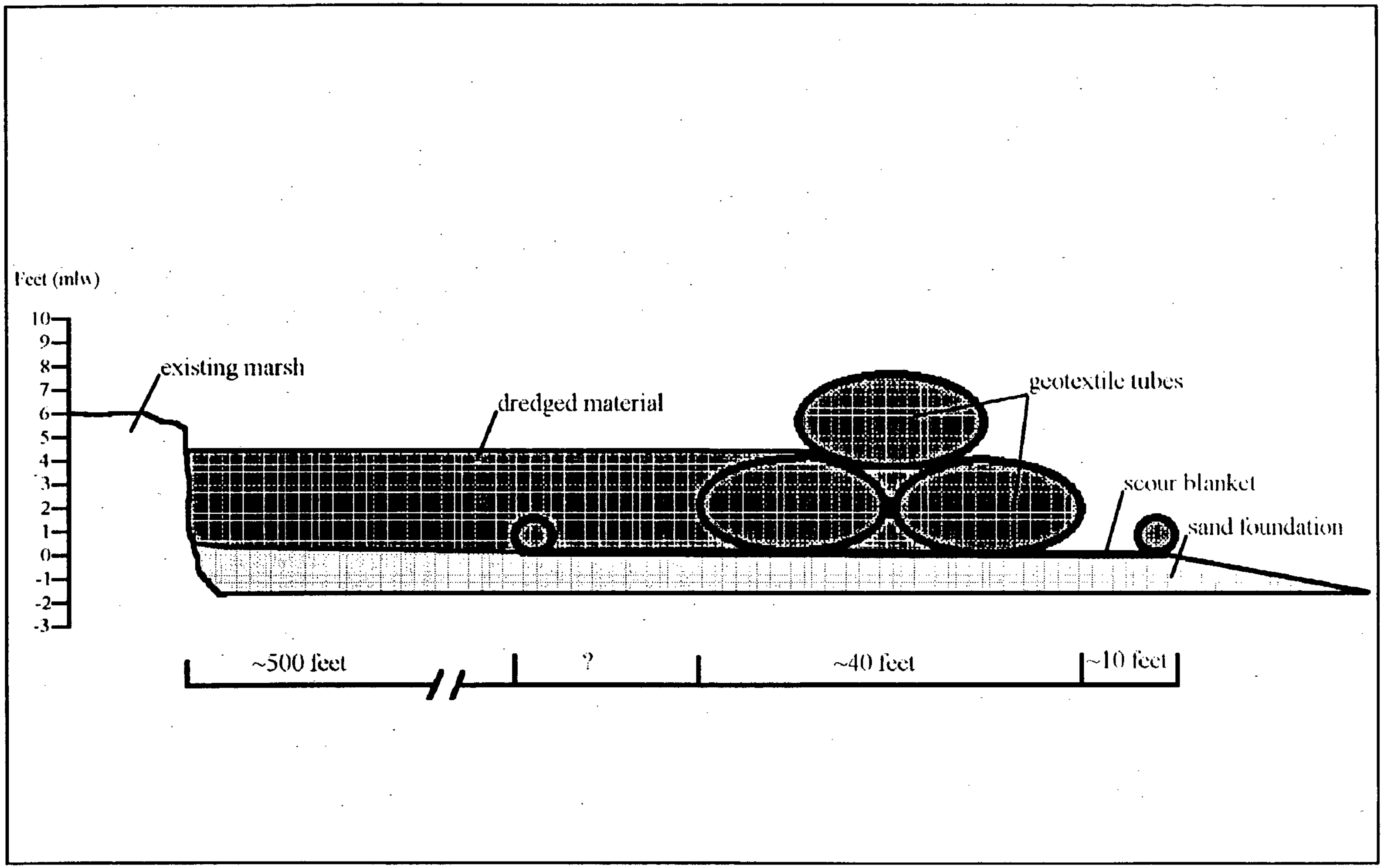


Figure 2b. Preliminary shoreline stabilization and marsh restoration plan for Kelly Island, Delaware (cross-sectional view).

The top elevation of the sand foundation would be approximately mean low water (mlw). The top elevation of the top tube would be approximately 10 feet above mlw. The areas between the shoreline and the northern and southern ends of the geotextile tube structure would be plugged with sand berms to create a confined compartment for the placement of dredged material.

Once the geotextile structure is in place, approximately one million cubic yards of silt and fine-grained material from the Main Channel would be deposited within the compartment. The site would be designed such that the dredged material would settle to the approximate elevation of the adjacent low marsh (4.5 to 5 feet above mlw). The drainage of slurry water from the site would be controlled by one or more sluice gates installed in the sand plugs. The filled area would then be planted or allowed to naturally vegetate with salt marsh cordgrass (*Spartina alterniflora*) and other native salt marsh vegetation. Approximately 80 to 125 acres of wetland would be restored, depending on the location of the geotextile tube structure.

The preliminary plan for the Egg Island Point site is similar to the Kelly Island plan in that geotextile tubes would be used to provide wetland restoration and shoreline protection (Figure 3). The structure would extend approximately two miles in each direction from Egg Island Point; northwest to Straight Creek, and northeast to Oranoaken Creek. The Corps is considering a number of design options for the proposed structure, including whether or not to place dredged material landward of the geotextile tubes. If dredged material is placed behind the structure it would be designed to stabilize at the approximate level of the adjacent low marsh, similar to the Kelly Island site. If dredged material is not placed landward of the structure, it is expected that the existing marsh would gradually advance to seaward toward the structure via sedimentation. These and other specific design options are discussed in Section VI below.

The Corps is also considering plans to nourish beaches along the Delaware shoreline using sand dredged from the Main Channel. Sites currently under consideration include the entire shoreline from Port Mahon to Lewes Beach, Delaware. The Corps is currently assessing whether beach nourishment is economically feasible.

The Corps is currently proposing to use the sand dredged from the Main Channel that is not used for either wetlands restoration or beach nourishment to create two or more sand stockpiles near the Delaware shoreline. Depending on the volume of sand used for other projects, the sand stockpiles could contain up to 9.5 million cubic yards of sand. The stockpiled sand would be available for use by the State of Delaware for erosion control, shoreline stabilization and beach nourishment (U.S. Army Corps of Engineers, 1994). The proposed stockpile sites were chosen based upon the economics of future use by the State of Delaware and environmental considerations (J. Brady, pers. comm., 1995).

Sand stockpile Site L-5 is approximately 500 acres, and is located approximately 1,000 yards offshore from Broadkill Beach, Delaware (Figure 1).

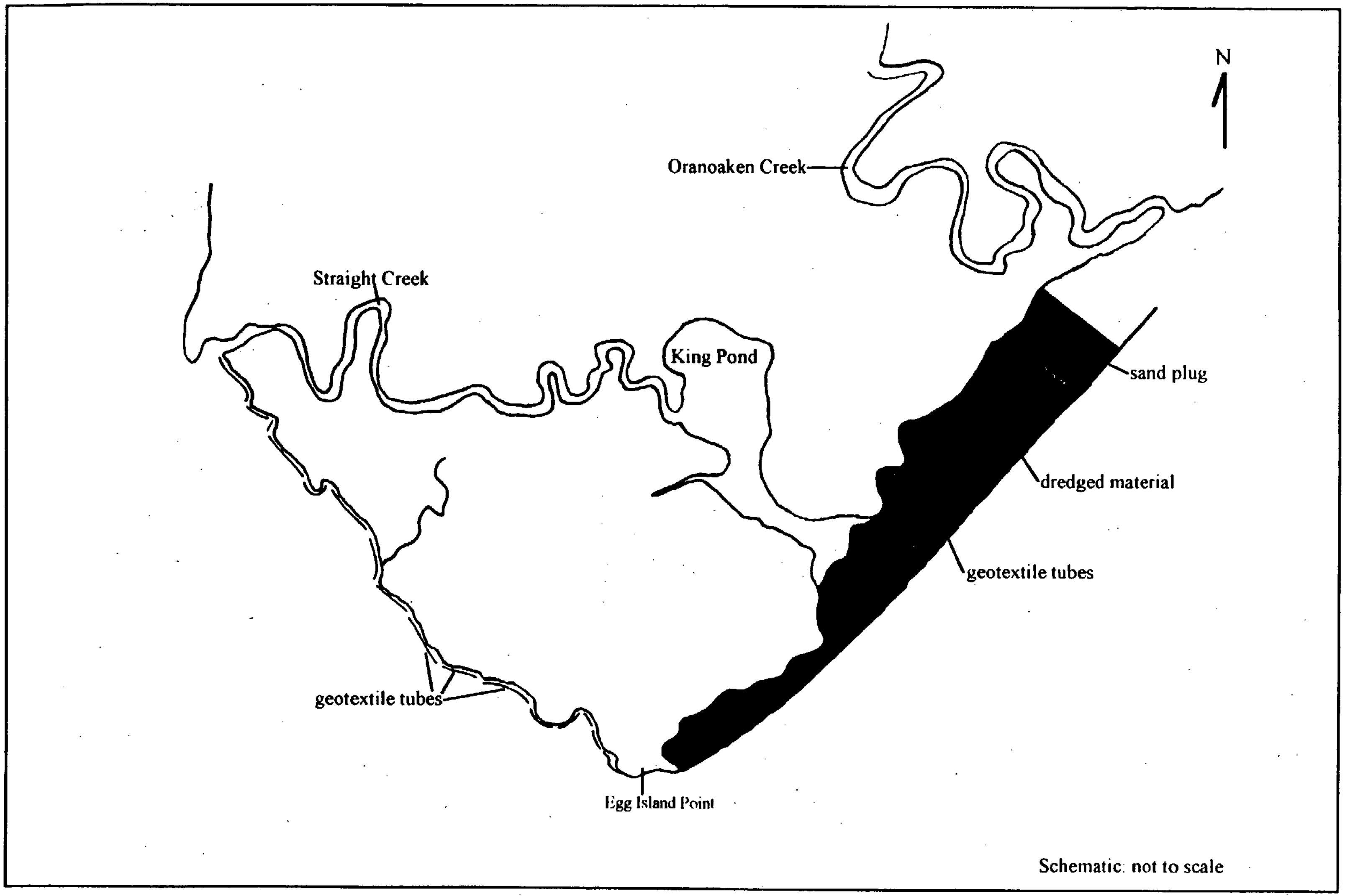


Figure 3. Preliminary shoreline stabilization and marsh restoration plan for Egg Island Point, New Jersey (overhead view).

The Corps had previously identified Site LC-10 (also 500 acres) as a second site for sand stockpiling; however, further coordination with the Service and the Delaware Department of Natural Resources and Environmental Control (DNREC) indicated that deposition of dredged material in this area would have serious environmental consequences, as discussed below. Therefore, Site LC-10 has been eliminated from further consideration (J. Brady, pers. comm., 1995). The Corps is presently considering an alternative site in the vicinity of Big Stone Beach, Delaware. No information is currently available regarding the exact location or areal extent of the proposed alternative sand stockpile site; however, the site would most likely be located in the vicinity Site MS-19, which was previously investigated by the Corps. The top elevation of the proposed stockpiles would be approximately 5 feet below mlw.

III. METHODOLOGY

The information for this planning aid report was compiled from reports provided by the Corps, searches of Service field office files and libraries, meetings and telephone conversations with local sources of expertise and representatives from DNREC and the New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife (NJDFGW). Several site visits were conducted by Service biologists to the following beaches in Delaware during February 1995: Kelly Island; Port Mahon; Pickering Beach; Kitts Hummock; South Bowers; Bennetts Pier; Big Stone Beach; Cedar Beach; Mispillion Jetty; Slaughter Beach; Fowler Beach; Roosevelt Inlet (Beach Plum Island); Lewes Beach; and, Cape Henlopen Breakwater Harbor. Additionally, Egg Island Point, New Jersey, was visited in January 1995. Two helicopter trips in February 1995 allowed for aerial observation of the area between Egg Island Point and the mouth of the Maurice River; and, from Kelly Island to Cape Henlopen.

Beach nourishment using sand dredged from the Main Channel could potentially improve spawning habitat for horseshoe crabs (*Limulus polyphemus*). Therefore, a major focus of this report is to identify those areas that are currently providing below optimal spawning habitat for horseshoe crabs as potential sites for beneficial use projects. As discussed in detail below, horseshoe crabs are habitat generalists and will spawn in a wide variety of shoreline conditions; as such, the presence of large numbers of horseshoe crabs on a given beach is not necessarily an indication of habitat quality (Shuster, 1994). However, spawning success is highest on gently sloping beaches consisting of sand at least 8 inches deep.

To assess the current suitability of individual beaches as horseshoe crab spawning habitat, field observations were recorded during the February site visits. Specifically, beach characteristics, including beach slope, sand depth, and sediment composition were recorded. Because beach conditions may vary substantially between winter and summer, the field observations discussed below may not necessarily reflect beach conditions during the horseshoe crab spawning season; however, these observations should be useful in assessing the relative suitability of individual beaches for horseshoe crabs.

Measurements for beach slope were taken with a Staedtler Mars 964 51-10 split protractor wired with a spirit level and placed on a board. Readings in degrees were taken every two meters from the highest Spring tide wrack line to the waterline. Observations were also recorded regarding the nature of the beach substrate in the area of each beach estimated to be the center of horseshoe crab spawning activity. This area is generally several meters below the wrack line, and is the area that would be uncovered between the Spring high tide and one to two hours after high tide, when horseshoe crab spawning is likely to be most intense. Sediment was sieved to ascertain suitability for spawning by horseshoe crabs. Sieve sizes of 0.425 mm and 4.25 mm were used to obtain percentages by weight of fine sand, medium and coarse sand, and gravel. Samples have been retained at the Service's Delaware Bay Estuary Project for further analysis by the Corps if desired. In sandy areas, the approximate depth of sand was also recorded.

Maps produced in a Geographic Information System have been included in this report to aid the reader in visualizing biologically sensitive areas and species distributions along the Delaware shoreline of the Bay. These maps are graphical representations of electronic data obtained by the Service from a variety of sources (listed on the maps). Only the Delaware shoreline area was mapped for this report because of the wide range of disposal scenarios currently under consideration by the Corps along the Delaware shoreline.

IV. STUDY AREA DESCRIPTION

A. DELAWARE BAY

The Delaware Bay covers a 782 square-mile area from the point at which the Delaware River widens at Liston Point, Delaware, to the mouth of the Bay between Cape Henlopen, Delaware, and Cape May, New Jersey. The general orientation of the Delaware shoreline is from the northwest to the southeast, except for Cape Henlopen, which turns north. The lower Delaware Bay is semicircular, with minimal shoreline topographic development. This flat shoreline topography has resulted in the long contiguous sandy beaches that are typical of the Delaware Bay. In fact, the Delaware Bay contains the longest contiguous sandy beaches of any estuary on the mid-Atlantic coast (C. Shuster, pers. comm., 1995).

The open mouth of the Delaware Bay exposes much of the shoreline to the open ocean. The fetch (distance across open water to shore) is large, and the shoreline can experience fully developed seas even when they are created within the bay under local wind conditions. Much of the wave energy responsible for the constant, incremental (non-storm) erosion is thought to be developed from local wind patterns (Kraft *et al.*, 1976). However, severe tropical and extra-tropical storms are responsible for the most damaging events (French, 1990). A long history of erosion, subsidence, and sea level rise continues to result in dynamic, unstable shoreline conditions in many areas. Tidal amplitude is high; from 4 to 7 feet compared to the Chesapeake Bay, which averages about 1.5 feet. There are also strong currents in Delaware Bay; up to 4 knots (Kraft *et al.*, 1976).

The average net change for the Delaware shoreline from Kelly Island to Lewes, Delaware, between the years 1882 and 1977 was 419.3 feet to landward or approximately 2.6 feet per year (French, 1990). Average net change for the more highly erosive northern portion of the shoreline, north of the Mispillion River Inlet, between 1842 and 1977 was 978.9 feet to landward (French, 1990). This translates to an average rate of erosion of 7.2 feet per year (French, 1990). Unlike the southern and central sections of the Delaware shoreline, the pattern of erosion in the northern areas does not appear to be storm-driven. Instead the shoreline appears to be retreating at a relatively regular rate (French, 1990). The reasons for these differences in erosion rates in various sections of the Bay are not clear, but erosion is expected to continue or possibly accelerate (French, 1990).

The pattern of shoreline change along the New Jersey shoreline of the Bay is less well documented than on the Delaware side. The shoreline in the vicinity of Fortescue, New Jersey, which is approximately two miles northwest of the Egg Island Point project site, experienced average erosion of approximately one foot per year between 1940 and 1978. However, the area around Maurice River Cove, immediately to the east of Egg Island Point, had erosion rates between 3 and 12 feet per year over the same period (U.S. Army Corps of Engineers, 1991). Egg Island Point itself appears to be eroding more rapidly, and the Corps estimates the shoreline at Egg Island Point to be eroding at a rate of between 15 and 30 feet per year (J. Brady, pers. comm., 1995).

B. DESCRIPTION OF SITES UNDER CONSIDERATION FOR DREDGED MATERIAL DISPOSAL

For the purposes of this report the Delaware shoreline of Delaware Bay has been divided into four segments: (1) Kent Island and Kelly Island; (2) Port Mahon to South Bowers Beach; (3) Bennetts Pier to Big Stone Beach; and, (4) Mispillion Jetty to Lewes Beach. While this division is somewhat arbitrary, and considerable variation occurs among the beaches within each segment, the beaches within each of these segments share certain properties that make this grouping useful for discussion.

Additional information regarding beach characteristics and historic shoreline changes along the Delaware shoreline can be obtained from the following sources:

Robert Henry
Division of Soil and Water
Delaware Department of Natural Resources
and Environmental Control
89 Kings Highway
P.O Box 1401
Dover, Delaware 19903
(302) 739-4411

Jonathan Sharp
University of Delaware
College of Marine Studies
700 Pilottown Road
Lewes, Delaware 19958
(302) 645-4259

Robert Jordan
Delaware Geological Survey
University of Delaware
Delaware Geological Survey Building
Newark, Delaware 19716
(302) 831-2833

1. Egg Island Point

This section of the New Jersey shoreline is characterized by eroding salt marsh, with limited areas of sandy beach. Most of the shoreline consists of steep scarps of eroded peat four to six feet tall interfacing directly with open water of Delaware Bay. Some areas, particularly along the southwestern shoreline, have small sandy beaches consisting of thin layers of sand over eroded peat. These areas and the tip of Egg Island Point are the only areas of the site with substantial sandy beaches. Scattered small dunes immediately landward of the shoreline are vegetated primarily by common reed (*Phragmites australis*) and high-tide bush (*Iva frutescens*). The salt marsh in this area is typical of Delaware Bay salt marshes with the dominant vegetation being salt marsh cordgrass. There are also numerous shallow tidal and non-tidal ponds and tidal creeks scattered across the surface of the salt marsh.

2. Kent Island and Kelly Island

This section of the Delaware shoreline is part of the Bombay Hook National Wildlife Refuge. The shoreline in this area can be characterized as eroding salt marsh, with limited areas of sandy beach. The shoreline of Kent Island consists of approximately 1.5 miles of salt marsh interfacing directly with open water of Delaware Bay. The erosional rate in this portion of the Bay is extremely high. Recession averaged nearly 20 feet per year between 1848 and 1972 (Kraft *et al.*, 1976). The marsh substrate is a thick layer of peat; 18 to 30 feet deep (Kraft *et al.*, 1976). The dominant vegetation is a mixture of salt marsh cordgrass and common reed.

Kelly Island has approximately 2.5 miles of shoreline consisting of sheltered tidal flats, small mixed sand and gravel beaches, and outcrops of salt marsh in erosional areas. The small beaches in this area consist of thin layers of sand and gravel over exposed peat. Service biologists visited the southern tip of Kelly Island on February 13, 1995. The substrate consists of compacted peat with vertical scarps 3 to 5 feet high at the waterline. Large sections of the marsh mat at the island's southern tip have been broken off by recent wave action. The southern tip of the island is eroding rapidly, and has migrated northward more than 5,000 feet since 1842; an average of over 37 feet per year (French, 1990). The marsh substrate in this area exceeds 30 feet in depth (Kraft *et al.*, 1976). Sand taken from a small beach face in front of Bombay Hook Marsh just north of Kent Island in 1978 had a mean sediment size of 0.339mm (French, 1990).

According to a map of percent silt / clay in Delaware Bay sediments (Maurer *et al.*, 1978), sediments in Kelly Island area were between 70 and 100 percent silt / clay. Similarly, the Greeley-Polhemus Group (1994) found that substrates at this site included sandy areas and areas consisting of silt / clay.

In the event of an oil or hazardous materials spill, three Boom Deployment sites have been identified in the Delaware Bay and River Cooperative's Oil Spill Response Plan Appendices (Delaware Bay and River Cooperative, Inc., 1991) along the Kent Island shoreline, along a 1.5-mile-long section between the Leipsic River and the Simons River, indicating the sensitivity of this area to disturbance and pollution.

3. Port Mahon to South Bowers Beach

This section of the Delaware Bay shoreline can be characterized as experiencing moderate to severe erosion. The individual beaches in this section vary in their physical characteristics depending upon whether beach nourishment or other shoreline stabilization mechanisms have been employed. There is little to no longshore sediment transport in the area between Port Mahon and Pickering Beach (French, 1990).

The Port Mahon site extends approximately one mile from the mouth of the Mahon River to the mouth of Little Creek. The shoreline is rip-rapped and bulkheaded for most of this length; however, small beaches of sand and crushed oyster shell occur in areas where the bulkhead has collapsed or at the ends of the bulkhead, and salt marsh has filled in some areas behind the bulkhead. Numerous pilings and remnant piers are scattered along the shoreline. Rip-rapped sections of the Port Mahon site are washed over in some areas by spring tides and storm tides. There is a fishing fleet at the road's northern terminus, and the boat ramp is heavily used by small-boat traffic. Hundreds of bird watchers come to Port Mahon in May and conflicts often arise because too many cars block the narrow, washed out road that runs parallel to the beach.

The most suitable horseshoe crab spawning habitat at Port Mahon is the approximately 660-foot-long section of shoreline just north of the Dover Air Force Base Aviation Gas pipeline / barge unloading pier. Field observations of beach conditions in this area collected during a February 1995 Service site inspection indicated that the sand was fairly uniform in grain size from the surface to a depth of about 8 inches. Buried rip-rap was encountered at two sample spots, and a layer of gravel and oyster shells was found at a depth of approximately 10 inches along the mid-tide line. Sediment samples taken at the southern end of Port Mahon, near the mouth of Little Creek were composed almost entirely of unconsolidated peat.

The thickness of the coastal mud offshore of Port Mahon ranges from 30 feet or less near the mouth of the Mahon River at the north end of the site to greater than 30 feet along the remainder of shoreline. These deep mud deposits extend south most of the way to Kitts Hummock (Kraft *et al.*, 1976).

Pickering Beach is a small summer resort community, with approximately 40 summer cottages located about 20 feet behind the landward edge of the barrier dune. Pickering Beach consists of approximately 0.75 mile of mixed sand and gravel beach, grading into exposed marsh substrate covered with a thin layer of sand at the northern and southern ends of the site. An extensive mud flat occurs in the offshore area.

Pickering Beach has experienced an average, long-term erosion rate of 5.6 feet per year (French, 1990). This rate is higher than Kitts Hummock, but lower than Port Mahon. The Pickering Beach community is extremely vulnerable to storm damage, and has experienced severe erosion following storms events.

Pickering Beach is part of the State's beach replenishment program, and was also one of six sites selected for a demonstration project of low-cost shoreline protection (U.S. Army Corps of Engineers, 1981). The scrap-tire breakwater structure located about 300 feet off the mid-southern portion of the beach was installed in 1978, and aerial observation indicates some accretion of sediment around it. Sand taken from Pickering Beach in 1978 had a mean sediment size of 0.724mm (French, 1990).

Kitts Hummock consists of approximately 0.5 mile of mixed sand and gravel beaches surrounded by extensive tidal mud flats and marshes. Sand taken from Kitts Hummock in 1978 had a mean sediment size of 0.550mm (French, 1990). Long-term erosion rates for Kitts Hummock average approximately 4.2 feet per year (French, 1990).

The normal tidal range at Kitts Hummock is approximately 5 feet, and nearly tops the barrier dunes at high tide (National Oceanic and Atmospheric Administration, 1995). This renders the small coastal community of Kitts Hummock vulnerable to storm damage. While beach nourishment has slowed the rate of erosion somewhat, the area is still undergoing landward recession. Three breakwaters were installed by the Corps in 1978 and 1979 as part of the above-mentioned demonstration project (U.S. Army Corps of Engineers, 1981). Each breakwater was constructed of different materials. The northernmost breakwater is approximately 300 feet in length and was constructed of pre-cast concrete boxes; the center breakwater is also approximately 300 feet in length and was constructed of nylon sandbags, which have apparently failed; and the southernmost breakwater is a 300-foot-long mound of rubble. The breakwaters are separated by gaps of about 300 feet. Conversations with a local resident suggested that extensive buildup of mud in front of the beach has accelerated since the breakwaters were built.

Bowers Beach consists of approximately 2,400 feet of medium sand and gravel beaches. The average grain size of sand taken from Bowers Beach in 1978 was 0.586mm (French, 1990). Analysis of Corps data indicates that shoreline erosion in the Bowers Beach area averaged slightly over 4 feet per year between 1843 and 1954 (Kraft *et al.*, 1976). Bowers Beach is periodically renourished by the State of Delaware, and the mouth of the Murderkill River is stabilized on both sides by large sand-filled bags. The combination of sandbag groins and beach nourishment has performed reasonably well in reducing beach loss (U.S. Army Corps of Engineers, 1981); although the net erosion over the long term has still averaged 5.4 feet per year (French, 1990). While littoral sediment transport in this area is weak and erratic (French, 1990), wave heights averaging 1-2 feet with a maximum of 4 feet have the potential to move significant amounts of sediment (U.S. Army Corps of Engineers, 1981).

The beaches of South Bowers Beach are mixed sand and gravel. The area of the beach near the waterline consist of a thin layer of sand and gravel over peat, whereas the upper portions of the beach have thicker layers of sand and gravel. There are extensive mud flats offshore. The distance from the wrack line to the beginning of the mud flats (with 0 degrees slope) was approximately 55 feet during February 1995 site investigations.

Field observations of beach conditions collected during a February 1995 Service site inspection indicated that the sand depths on South Bowers Beach are somewhat variable, ranging from less that 2 inches in depth near the mean low water line to in excess of 15 inches near the high tide line.

In the event of an oil or hazardous materials spill, two boom deployment sites have been identified in the Delaware Bay and River Cooperative's Oil Spill Response Plan Appendices (Delaware Bay and River Coopratives, Inc., 1992) at Port Mahon; they are at the mouths of Little Creek and the Mahon River. Additionally, there are boom placement sites at the mouth of the Little River, along the marshes off the Little Creek Wildlife Management Area, and at the mouth of Lewis Ditch.

4. Bennetts Pier to Big Stone Beach

This section of the Delaware shoreline consists of relatively stable to slightly accreting beaches; in part due to the more erosion-resistant Pleistocene neck formations in this area. The shoreline on either side of the Murderkill River has oscillated between periods of erosion and periods of accretion. These beaches eroded substantially between 1842 and 1943 (French, 1990), followed by slight accretion during the period between 1943 and 1954, and again by erosion between 1954 and 1969. From 1969 to 1977 the area experienced the highest average annual accretion rate in recorded history (French, 1990).

Nothing remains of the pier that once stood at Bennetts Pier except for a few rotted pilings. Sand taken from Bennetts Pier in 1978 had a mean sediment size of 0.587mm (French, 1990). Field observations taken during the Service's February 1995 site inspection indicate that large segments of the beach between Bennetts Pier and Big Stone Beach can be characterized as either predominantly sand or sand-covered peat outcrops ranging in height from 1 to 3 feet. Mud flats occur adjacent to the beach in some areas, particularly near Clark Point. In this area, 3.2 miles south of Bennetts Pier, the beach is very narrow with steeper slope and peat scarps at the waterline; high tide completely inundates this beach up to the dune.

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The Big Stone Beach portion of the Delaware shoreline appears to be experiencing relatively little erosion. Sand taken from Big Stone Beach in 1978 had a mean sediment size of 1.117mm (French, 1990). The Nature Conservancy and Delaware Wildlands own a significant portion of Big Stone Beach in the Milford Neck area.

5. Mispillion Jetty to Lewes Beach

Cedar Beach (at the Mispillion Jetty) consist of approximately 0.6 mile of unconsolidated peat, eroded marsh embankments and a thin layer of mixed sand and gravel. Most of Cedar Beach (the undeveloped portion) is in the shadow of the large jetty at the mouth of the Mispillion River. The jetty extends more than 1.1 miles from the shore toward the southeast. There is no sand on the northern portion of Cedar Beach except for a small pocket near the foot of the large jetty and a small sand island about halfway out from the jetty. Sand taken from Cedar Beach at the Mispillion River in 1978 had a mean sediment size of 0.708mm (French, 1990). The entire northern half of the beach is composed of unconsolidated peat with shell fragments and common reed stem fragments in three or more large scarps beginning at the waterline and ending near the edge of detrital marsh grass, an average distance of 50 feet. Peat outcrops from relict marshes are also present. Unconsolidated peat is at least 25 inches deep at a point 20 feet below the highest wrack line. Bordering the peat beach is a dense stand of common reed. The southern portion of Cedar Beach, most of which is inhabited, is a layer of mixed sand and gravel of variable thickness overlying densely packed peat.

Extensive mud flats lie offshore from Cedar Beach. The thickness of the mud exceeds 30 feet (Kraft *et al.*, 1976). The silt dredged out of the Mispillion River by the Corps has been historically deposited in the area immediately to the south of the jetty (J. Brady, pers. comm., 1995), but will in future operations be placed on the Bay side of the rubble breakwater along the north shore of the inlet (T. Mercer, pers. comm., 1995).

The sand island about halfway out from the jetty measures approximately 150 feet wide by 800 feet long, and is surrounded by mud flats. The sand along the mid-tide line was at least 12 inches deep during the February 1995 site inspection. The distance from the waterline at low tide to the vegetation near the jetty was approximately 100 feet.

Slaughter Beach consists of approximately 2.8 miles of mixed sand and gravel beach interspersed with peat outcrops and offshore mud flats. No tidal creeks intersect this segment of beach, but several are located just behind the dunes. Sand taken from Slaughter Beach in 1978 had a mean sediment size of 1.125mm (French, 1990).

Slaughter Beach has experienced an oscillatory pattern of low accretion or limited erosion, followed by periods of substantial accretion (French, 1990). Long-term analysis shows an average annual accretion rate of +1.0 foot per year (French, 1990). These relatively stable shoreline conditions are due, in part, to shoreline stabilization efforts in this area.

Approximately one mile south of the southernmost house on Slaughter Beach is a large washover or dune blowout. During February 1995 site inspections, the opening in the dune was approximately 250 feet wide at the top of the dune, and sand extended into flats over the marsh, covering it for a distance of approximately 1,000 feet. Large numbers of horseshoe crab remains were observed, especially in a low muddy spot just inside the opening. The beach to seaward of the washover consists of a thin layer of sand overlying peat outcrops near the water's edge.

Fowler Beach is primarily mixed sand with some gravel. From the wrack line to 75 feet down slope, the beach is primarily sand and gravel. The sand is fairly deep (greater than 15 inches) in the upper portion of the intertidal zone. Sand taken from Fowler Beach in 1978 had a mean sediment size of 0.739mm (French, 1990). The sand is eroded near the waterline, exposing peat in hard, rib-like formations about 4 inches wide oriented perpendicular to the shoreline.

Broadkill Beach was not visited during field investigations for this project. However, information on this area is available from a previous Service Planning Aid Report (U.S. Fish and Wildlife Service, 1994a). A Service biologist inspected the Broadkill Beach shoreline on November 11, 1994, just after a beach replenishment effort by the State of Delaware. The existing beach is exposed to a fetch of 12 miles or more across Delaware Bay. Houses along Broadkill Beach are linearly distributed in a narrow zone between the beach and an extensive salt marsh. There is only a narrow low vegetated dune between the back of the beach and the houses. The vegetation is primarily beach grass (*Ammophila breviligulata*). Sand taken from Broadkill Beach in 1978 had a mean sediment size of 0.669mm (French, 1990).

The beach north of the jetty at Roosevelt Inlet is mixed sand and gravel, thinning out to the north. Immediately inside the inlet at the foot of the jetty are large peat outcrops covered with a thin layer of sand that appears to have been blown or washed over the jetty from the north side.

Lewes Beach consists of approximately 2 miles of mixed sand and gravel from Roosevelt Inlet to the ferry terminal. The site was recently nourished by the State of Delaware as part of an ongoing program of beach maintenance. Lewes Beach is lined with houses for the entire distance from the ferry terminal to the breakwater at Roosevelt Inlet.

The DNREC, Division of Soil and Water, has identified the northern 1,000 to 2,000 feet of Lewes Beach as an area in continual need of replenishment because the sand from this location is carried by water currents and deposited beside the jetty at the ferry terminal (R. Henry and T. Pratt, pers. comm., 1995).

6. Sand Stockpiles

The Corps evaluated a number of aquatic sites for potential use as locations for sand stockpiles. Preliminary assessments conducted by the Corps and the Greeley-Polhemus Group (1994) identified two sites (L-5 and LC-10) as the most

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practicable sites for sand stockpiles (Figure 1). Based on additional information and interagency coordination during the preparation of this report, the LC-10 site was eliminated from consideration due, in part, to the environmental constraints discussed below. The Corps is currently considering an alternative sand stockpile site to be located in the vicinity of Big Stone Beach. The nearest site for which data are available is the previously evaluated Site MS-19, located near Slaughter Beach. Information on Site MS-19 is summarized below because it is expected that the offshore area in the vicinity of Big Stone Beach is similar in nature to Site MS-19; although, once a site is selected for the proposed sand stockpile, site specific conditions should be verified.

Site L-5 is 500 acres located approximately 1,000 yards offshore of Broadkill Beach, Delaware. Water depths in this area range from 10 to 17 feet at mlw. The Greeley-Polhemus Group (1994) characterized the sediments at this site as mostly sand, with some areas of silt / clay. Site LC-10 is a 500-acre site located approximately one mile offshore of Kelly Island in approximately 9 to 12 feet of water. Maurer *et al.* (1978), characterized the LC-10 area as mostly composed of 70 to 100 percent silt / clay sediments, with slightly sandier (40 to 70 percent silt / clay) sediments to the immediate north. This concurs with the Greeley-Polhemus Group (1994) who characterized the sediments at Site LC-10 as mostly fine sand and silt / clay. Site MS-19 is a 500-acre site located approximately 1,000 feet offshore of Slaughter Beach, Delaware, in approximately 8 to 10 feet of water. Maurer *et al.* (1978) characterized the area around the MS-19 site as having sediments ranging from 0 to 40 percent silt / clay (i.e., consisting mostly of sand or other hard substrate). The Greeley-Polhemus Group (1994) characterized the substrate at this site as consisting of sand and silt / clay.

V. FISH AND WILDLIFE RESOURCES

A. GENERAL

The Delaware Bay supports diverse and abundant fisheries and shellfisheries resources of high ecological, commercial and recreational value. Additionally, the extensive tidal marshes and shallow water areas bordering most of the Delaware Bay receives heavy use throughout the year by migratory shorebirds, waterfowl, raptors, and passerines. The interspersion of beach and marsh cover types annually hosts the second largest concentration of migrating shorebirds in the Western Hemisphere, including 80 percent of the hemispheric population of red knots (*Calidris canutus*) (Myers *et al.*, 1987; Clark *et al.*, 1993).

09

1. Macroinvertebrates

a. Horseshoe crabs

The largest population of spawning horseshoe crabs in the world is found in Delaware Bay (C. Shuster, pers. comm., 1995). Each spring, adult horseshoe crabs migrate from deep water in the Delaware Bay and the Atlantic continental shelf to spawn on Delaware Bay beaches. The minimal geologic shoreline development and smooth morphology of Delaware Bay's lower shoreline facilitates movement of horseshoe crabs and enables them to find suitable spawning beaches in large numbers. Spawning generally occurs from April to July, with the peak spawning activity occurring on full moon high tides in May and June. The average width of the intertidal area used by horseshoe crabs for spawning is about 45 feet on Delaware Bay beaches (C. Shuster, pers. comm., 1995). Eggs are deposited in the upper portion of the intertidal zone in clusters approximately 6 to 8 inches below the surface. The average cluster contains between 3,000 and 4,000 eggs.

Horseshoe crab reproductive success is greatest under the following conditions: (1) the egg clusters are moistened by water with salinity of at least 8 parts per thousand; (2) the substrate around the egg clusters is well oxygenated; (3) the beach surface is exposed to direct sunlight to provide sufficient incubation; and, (4) the slope of the beach is adequate for larvae to orient and travel downslope to the water upon hatching (Shuster, 1994). These conditions are found on sandy beaches along the lower portion of Delaware Bay.

The mechanism by which horseshoe crabs locate preferred spawning habitat is not completely understood. While horseshoe crabs spawn in greater numbers and with greater fecundity along sandy beaches, horseshoe crabs can tolerate a wide range of physical and chemical environmental conditions, and will spawn in less suitable habitats if ideal conditions are not encountered. Therefore, the presence of large numbers of horseshoe crabs on a beach is not necessarily an indicator of habitat suitability (Shuster, 1994). It is known that shoreline areas with high concentrations of silt or peat are less favorable to horseshoe crabs, because the anaerobic conditions reduce egg survivability. It also appears that horseshoe crabs can detect hydrogen sulfide, which is produced in the anaerobic conditions of peat substrates, and that horseshoe crabs actively avoid such areas (Shuster, 1994).

Beach slope is also thought to play an important role in determining the suitability of beaches for horseshoe crab spawning (C. Shuster, pers. comm., 1995). Horseshoe crabs generally travel downslope after spawning and appear to become disoriented on flat areas (T. Jacobsen, pers. comm., 1995). Although the optimal beach slope is unknown, beaches visited by the Service during February 1995 had slopes of between 3 and 7 degrees to seaward. As previously noted, beach conditions vary substantially from season to season, and these observations may not reflect beach conditions during the horseshoe crab spawning season.

In addition to the intertidal zone used for spawning, horseshoe crabs also use shallow water areas (less than two fathom depths) such as intertidal flats and shoal water as nursery habitat for juvenile life stages. Adult horseshoe crabs forage in deep water habitat during most of the year, except during the breeding season when they move into shallow and intertidal water.

The presence of offshore mud flats may also influence the use of certain beaches by spawning horseshoe crabs. Horseshoe crabs may congregate on mud flats to wait for full moon high tides, because these areas provide protection from wave energy. Female horseshoe crabs can carry over 88,000 eggs per animal (Shuster and Botton, 1985). Therefore, several tidal cycles are required to complete spawning. Offshore mud flats may provide safe areas to rest between tide cycles.

Under normal conditions spawning mortality on beaches averages approximately 10 percent of the spawning individuals. Factors contributing to normal mortality include age, excessive energy expenditure during spawning, stranding, desiccation, or predation by gulls. Entrapment in man-made structures such as rip-rap, bulkheads, and jetties, and commercial harvest also account for significant additional mortality.

Annual beach surveys of Delaware Bay horseshoe crab spawning activity conducted by volunteers since 1990 appear to indicate an overall decline in the horseshoe crab population in recent years (Swan *et al.*, 1994). Preliminary results from the 1995 beach surveys appear to further support the conclusion that horseshoe crab numbers are declining (B. Swan, pers. comm., 1995). Additionally, trawl surveys conducted by DNREC appear to corroborate the findings of the beach surveys (S. Michels, pers. comm., 1995). Weather and other factors influence the timing and intensity of spawning; therefore, additional data are needed before valid conclusions can be drawn regarding population trends. Nonetheless, the observed downward trend in the existing data is reason for concern.

The beach surveys are also useful in documenting relative use of various shoreline segments by spawning horseshoe crabs. For example, the survey data indicate declining numbers of spawning horseshoe crabs on beaches experiencing the highest erosion; Kelly Island and Port Mahon, in particular. The most consistent spawning beaches in Delaware appear to be those between Kelly Island and South Bowers Beach, which have extensive mud flats offshore.

While horseshoe crabs have some commercial value, the primary importance of this species is food chain support, particularly for migratory shorebirds. Shorebirds congregate along the Delaware Bay shoreline during their northward migration each spring because the massive amounts of horseshoe crab eggs provide a food source unlike that in any other site in the Western Hemisphere. Shorebirds passing through Delaware Bay spend, on average, 15 days replenishing body fat reserves before continuing their migration to nesting areas in the Arctic. During that period, these shorebirds consume massive quantities of horseshoe crab eggs. For example, sanderling (*Calidris alba*) have been estimated to eat 9,000 eggs per individual per day (Castro *et al*., 1989).

The bills of most shorebirds are too short to allow them to dig up horseshoe crab egg clusters (C. Shuster, pers. comm., 1995). Most, shorebirds rely on successive waves of horseshoe crabs to come ashore and inadvertently dig up previously deposited egg clusters while attempting to deposit new egg clusters. Therefore, a large population of horseshoe crabs, laying many more eggs than are needed to maintain the population, is necessary to provide a sufficient food supply for migrating shorebirds. However, the minimum size of the population needed to sustain shorebird populations is unknown.

b. Other macroinvertebrates

Commercially and recreationally important macroinvertebrate species found in Delaware Bay include Blue crab (*Callinectes sapidus*), American oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*). Blue crabs are abundant throughout the area, foraging in tidally influenced waters and wetlands from May through November. During the Winter (December through April) blue crabs stay in water greater than 15 feet deep.

In waters within the State of Delaware, oysters occur in naturally reproducing seed beds offshore and north of Kelly Island and in leased bed areas south of Kelly Island down to the Mispillion River area. In New Jersey waters, oyster seed beds occur from south of Artificial Island to Fortescue; lease beds occur from southwest of Egg Island Point throughout much of the lower Bay. Hard clams occur throughout the area, on soft sandy bottoms in water with salinity greater than 12 ppt (J. Dobarro, pers. comm., 1995).

Maurer *et al*. (1978) found a total of 169 species of benthic macroinvertebrates in the Delaware Bay over two summers of sampling (1972 and 1973). Maurer *et al*. (1978) noted that there are marked seasonal and annual fluctuations in the distributions of animal assemblages. The number of species and number of individuals increased with increasing salinity and increasing median sediment grain size.

The general composition of the benthic invertebrate community is similar to that of other temperate estuaries in the Northern Hemisphere (Maurer *et al*., 1978). Dominant species include the polychaetes *Glycera dibranchiata*, *Heteromastus filiformis*, and *Scoloplos fragilis*; and mollusks such as *Tellina agilis*, *Ensis directus*, *Nucula proxima*, *Gemma gemma*, *Mulinia lateralis*, *and Mytilus edulis*. These species are found in community assemblages throughout the Mid-Atlantic Bight (Pratt, 1973).

2. Finfish

The Delaware Bay supports substantial recreational and commercial fisheries. Weakfish (*Cynoscion regalis*), summer flounder (*Paralichthys dentatus*), and bluefish (*Pomatomus saltatrix*) are the most popular recreational species, but the recreational catch also includes striped bass (*Morone saxatilis*), scup (*Stenotomus chrysops*), tautog (*Tautoga onitis*), spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), red hake (*Urophycis chuss*), black sea bass (*Centropristis striata*), skates, and sharks (Seagraves, 1988). The Delaware Bay also supports important anadromous fish species including American shad (*Alosa sapidissima*), alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). Stocks of several of these species, most notably weakfish, have declined in recent years due largely to over-fishing (R. Miller, pers. comm., 1995).

Weakfish are one of the most important species in Delaware Bay in terms of abundance and value to the recreational and commercial fisheries. Weakfish are seasonal residents of Delaware Bay from April through October and spawn throughout the project area. Spawning occurs throughout the summer, but peaks in June and July. The larvae are transported by currents to the middle and upper portions of the Bay where they develop into juveniles. During the fall, after juveniles have attained a length of 4 to 6 inches, weakfish migrate to wintering areas off Virginia and North Carolina (Mercer and Moran, 1989).

Striped bass occur in all seasons, throughout the project area; although young-of-the-year use the project area only sporadically, concentrating primarily in the spawning area, which is in the Wilmington / Philadelphia area of the Delaware River.

Black sea bass, scup, and tautog stay in close proximity to reefs or other hard irregular structures. These species can be found throughout the project area, during any time of the year.

American shad use the project area during two time periods. In the spring and early summer (April through July) the channel and other deep areas of the bay serve as a "multi-stock" staging area for adults as they wait for water temperatures to warm upstream in the Delaware River and further up the Atlantic coast. Fish from the north Atlantic then move back out to the coast, while the Susquehanna and Delaware River stocks migrate upstream to spawn. In the fall (September through November) the "young-of-the-year" move down into the Bay as the water temperatures decrease, and then leave the Bay for the open ocean (MacKenzie *et al.*, 1985).

3. Reptiles

The northern diamondback terrapin (*Malaclemys t. terrapin*) is relatively common throughout the study area. Estuarine emergent marshes and associated creeks and near shore waters are used for foraging (April through December) (Palmer and Cordes, 1988). Salt marsh snails and fiddler crabs form the bulk of the diamondback terrapin diet. Egg laying occurs from early June through mid-July on sandy beaches with little or no vegetation, as well as on bayshore beaches surrounding the mouth of tidal marsh creeks. Hibernation occurs in mud banks and creek bottoms within the foraging areas, as well as within the nests themselves.

The northern diamondback terrapin is a candidate for inclusion on the federal List of Endangered and Threatened Wildlife and Plants, pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.). Candidate species receive no protection under the Endangered Species Act; however, the Service encourages federal agencies and other planners to consider candidate species in project planning. Additional information on federally-listed species is provided in section V.A.5 below.

4. Avifauna

a. Waterfowl

Waterfowl are abundant in tidally influenced wetlands and shallow water areas throughout the study area, reaching peak numbers in the fall and winter months. The Little Creek Management Area south of Kelly Island and the Bombay Hook National Wildlife Refuge area are important concentration areas for snow goose (*Chen caerulescens*), Canada goose (*Branta canadensis*) and dabbling ducks such as mallard (*Anas platyrhynchos*), American black duck (*Anas rubripes*), northern pintail (*Anas acuta*), and green-winged teal (*Anas crecca*). Black ducks are known to concentrate in the scalloped, cut-out areas along Kelly Island, created as the shoreline erodes (E. Smith, pers. comm., 1995). In addition, diving ducks such as scaup (*Aythya sp.*) and canvasback (*Aythya valisineria*) use the Little Creek area of the Bay itself (generally within the oyster leasing area).

b. Shorebirds

As many as 1.5 million shorebirds may pass through the Delaware Bay each spring (Niles *et al.*, 1994); the largest concentration of shorebirds on the east coast. As previously mentioned, the shorebird stopover coincides with the spawning period of horseshoe crabs. The most commonly occurring shorebird species that migrate through Delaware Bay are the red knot, ruddy turnstone (*Arenaria interpres*), semipalmated sandpiper (*Calidris pusilla*), sanderling, dunlin (*Calidris alpina*), and dowitchers (*Limnodromus* spp.). The first four species listed comprise 97 percent of all shorebirds observed in aerial surveys conducted since 1986 (Clark *et al.*, 1993).

Shorebirds are dependent on a mosaic of beach and salt marsh cover types to meet their requirements for foraging, roosting, and resting (Burger *et al.*, in press; Niles *et al.*, 1994). While the horseshoe crab eggs found on Delaware Bay beaches are an essential food source for migrating shorebirds, other cover types are also used extensively by shorebirds. Shorebirds feed in salt marsh ponds and creeks during high tide when bayshore beaches are inaccessible, and shorebirds roost in protected areas of the salt marsh.

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Little information exists on the historical use of the Delaware Bay by migrating shorebirds. Since 1985, the NJDFGW, Endangered and Nongame Species Program, and the DNREC, Endangered and Nongame Species Program, have conducted annual shorebird surveys along Delaware Bay. Aerial surveys of approximately 50 miles of shoreline in both Delaware and New Jersey are conducted once per week for six weeks each May and June. The Delaware portion of the survey extends from Woodland Beach south to Cape Henlopen. The New Jersey portion of the survey extends from the Cohansey River to Cape May Canal. Estimates are made of total bird numbers, by species. Clark *et al.* (1993) summarize 7 years of data (1986-1992) by upper and lower portions of the Bay. Niles *et al.* (1994) summarize data for the same period, using 18 shoreline segments to cover the Delaware and New Jersey shorelines. Clark (1991) summarizes five years of data (1986-1990), using individual beaches as organizing units.

The survey data indicate that the beach areas from the Mispillion River north to Simons River are the most heavily used by shorebirds (Clark, 1991). In 1990, this area accounted for over 80 percent of all the shorebirds observed in the Delaware portion of the survey (Gelvin-Innvaer, 1991). The Mispillion River area, including the mud flats of the Mispillion jetty, experience the heaviest use, both in terms of total numbers of birds and species density. Survey data also indicate heavy shorebird use along the entire New Jersey shoreline, particularly near Dennis Creek, Moores Beach, Thompson Beach, Egg Island Point, and Fortescue.

Two trends in shorebird abundance are important to note from the surveys. First, the number of sanderlings using the Delaware Bay has apparently declined markedly (Howe *et al.*, 1989; Clark *et al.*, 1993). In 1990, sanderling were observed at only four Delaware beaches, all south of Big Stone Beach (Gelvin-Innvaer, 1991). Second, there is also evidence that semipalmated sandpipers are declining significantly (Clark *et al.*, 1993).

5. Federally-listed and State-listed Threatened and Endangered Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) is known to nest near the Delaware River and Delaware Bay in New Jersey and Delaware, and also winters in, and migrates through, the area. There are currently 11 active eagle nests in New Jersey, most of which are located within 10 miles of the Delaware Estuary. Additionally, adult eagles from many of these nests appear to be year-around residents of the Delaware Estuary area (K. Clark, pers. comm., 1995).

The federally-listed endangered peregrine falcon (*Falco peregrinus*) is known to feed on waterfowl and shorebirds in the vicinity of Kent Island in spring and fall. Additionally, the NJDFGW, Endangered and Nongame Species Program, maintains a peregrine falcon nesting tower on Egg Island Point. This tower is currently used by nesting peregrine falcons (K. Clark, pers. comm., 1995).

The active peregrine falcon nesting tower on Egg Island Point is located near the existing shoreline in an area that is eroding rapidly. If steps are not taken in the near future to either relocate the tower or halt the shoreline erosion, this tower will be lost. Additionally, if the tower is still functional when the proposed project is implemented it is likely that project construction activities would disturb nesting peregrine falcons. The Endangered and Nongame Species Program has expressed interest in having a new tower constructed in an area that is less susceptible to erosion. The Service recommends that the Corps coordinate with the Endangered and Nongame Species Program and the Service to incorporate relocation of the peregrine tower into the current project plans.

The National Marine Fisheries Service (NMFS) has jurisdiction over the federally-listed endangered shortnose sturgeon (*Acipenser brevirostrum*), the endangered Atlantic Ridley turtle (*Lepidochelys kempii*) and leatherback turtle (*Dermochelys coriacea*), and federally-listed threatened loggerhead turtle (*Caretta caretta*), and green turtle (*Chelonia mydas*).

The shortnose sturgeon has been found throughout the Delaware Bay study area, though spawning is limited to areas upstream of the study area. Little information is available regarding shortnose sturgeon use of Delaware Bay, but it is believed that this area is used by all age classes to some extent, except young-of-the-year. Shortnose sturgeon orient to the channel and channel-like linear depressions or troughs. The Main Channel may provide localized areas where shortnose sturgeon currently concentrate or may concentrate as the population recovers (J. O'Herron, pers. comm., 1995).

Sea turtles, especially the loggerhead turtle, but also the Atlantic Ridley turtle, green turtle, and leatherback turtle, may occur in the lower Delaware Bay from June to November. Current lists of federally listed, proposed, and candidate species in New Jersey and Delaware, are provided in Appendix A.

Project-related activities could adversely affect the above-mentioned species. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment if the project is a construction project that requires an Environmental Impact Statement and the project may affect federally-listed species. The Service is aware that the Corps is currently preparing a Biological Assessment to address potential project-related adverse impacts to the above-mentioned species. The Service recommends that the Corps continue to consult with the Service and the NMFS during preparation of the Biological Assessment.

A list of State-listed threatened and endangered species in New Jersey is provided in Appendix B. For additional information on State-listed species, the Service recommends that the Corps contact the NJDFGW, Endangered and Nongame Species Program at the following address:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609) 292-9101

B. SITE SPECIFIC FISH AND WILDLIFE RESOURCES

1. Egg Island Point

Information regarding fish and wildlife resources of the Maurice River Cove area, immediately east of the proposed Egg Island Point project site, has been summarized in previous Service reports (U.S. Fish and Wildlife Service, 1994b, 1995b).

Based on survey information collected at Fortescue to the northwest and East Point to the east of the project site, Egg Island Point receives moderate to heavy use by horseshoe crabs. However, the shoreline conditions are generally not conducive to high spawning success, except at the tip of Egg Island Point and along the small sandy beach segments on the southwestern shoreline.

Commercially important oyster lease beds are located throughout the offshore area around Egg Island Point. Most of these lease beds are located 500 to 800 feet offshore; but in some cases lease beds are located within close proximity to the shoreline (J. Dobarro, pers. comm., 1995). Oyster seed beds occur to the northwest of Straight Creek and this area also supports a commercially important blue crab fishery.

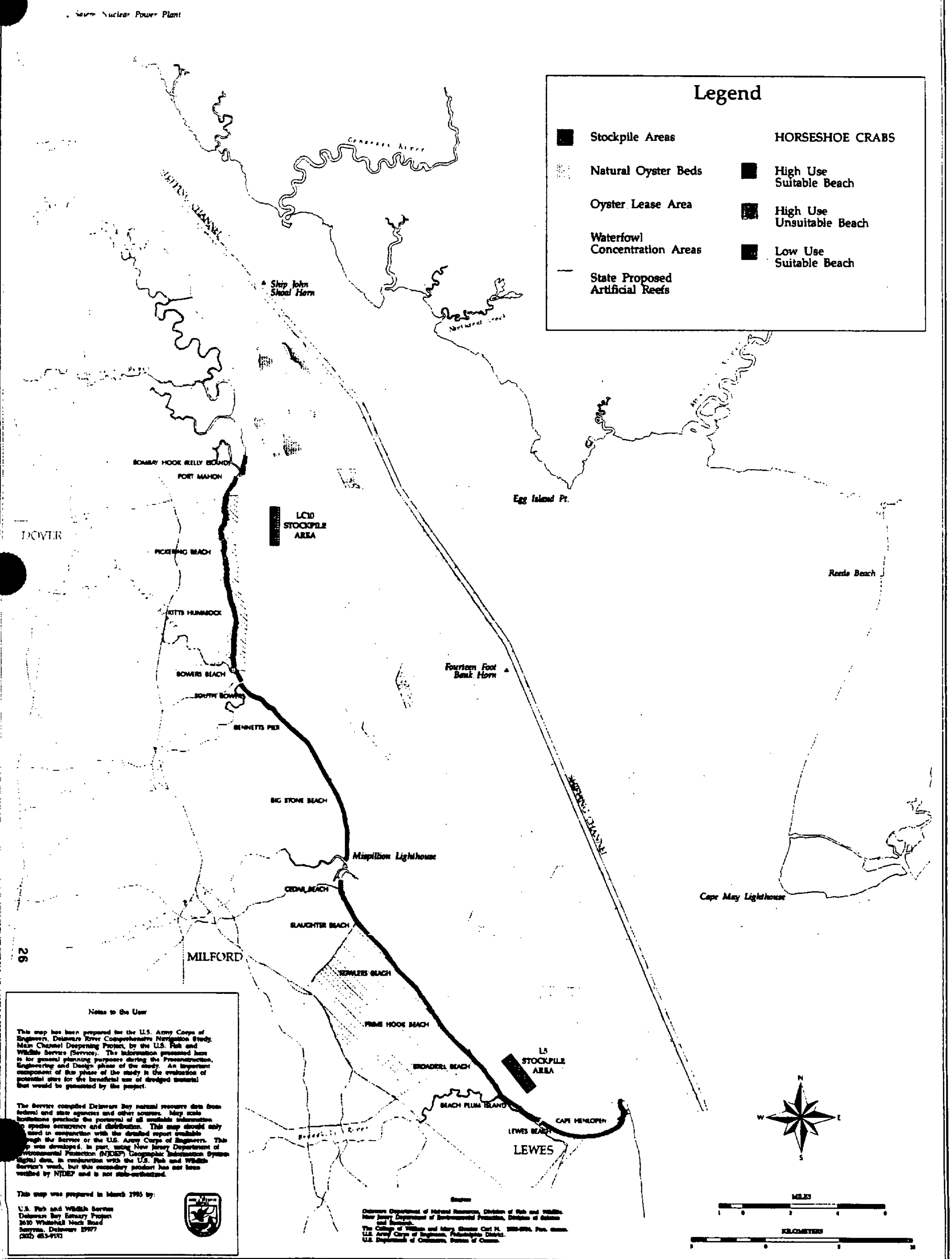
The Egg Island Point area receives heavy use each spring by migratory shorebirds. Shorebirds feed in large numbers along the shoreline and along the sandy deltas at creek mouths. Additionally, the numerous small tidal and non-tidal ponds on the adjacent salt marsh provide valuable shorebird feeding and roosting habitat. The most common species using this area include ruddy turnstone, red knot, and semipalmated sandpiper.

The wetlands and nearshore shallows of Egg Island Point also provide valuable habitat for a large number of migratory waterfowl. Species identified during mid-winter waterfowl surveys conducted between 1985 and 1989 include mallard, American black duck, green-winged teal, scaup, merganser (*Mergus sp.*), gadwall (*Anas strepera*), bufflehead (*Bucephala albeola*), American widgeon (*Anas americana*), Northern shoveler (*Anas clypeata*), Canada goose, and snow goose (New Jersey Division of Fish, Game and Wildlife, 1990).

2. Kent Island and Kelly Island

While horseshoe crabs spawn in the Kent Island area, conditions are generally not conducive to egg development, and reproductive success is probably low (Figure 4a). The value of horseshoe crab eggs at this site may be more as a food source for migrating shorebirds, than as a source for sustaining horseshoe crab populations.

Preliminary Delaware Bayshore Ecological Analysis
for the Delaware River Beneficial Use Plan



Notes to the User

This map has been prepared for the U.S. Army Corps of Engineers, Delaware River Comprehensive Navigation Study, Main Channel Deepening Project, by the U.S. Fish and Wildlife Service (Service). The information presented here is for general planning purposes during the Preconstruction, Engineering and Design phase of the study. An important component of this phase of the study is the evaluation of potential sites for the beneficial use of dredged material that would be generated by the project.

The Service compiled Delaware Bay natural resource data from federal and state agencies and other sources. Map scale limitations preclude the portrayal of all available information on species occurrence and distribution. This map should only be used in conjunction with the detailed report available through the Service or the U.S. Army Corps of Engineers. This map was developed, in part, using New Jersey Department of Environmental Protection (NJDEP) Geographic Information System digital data, in conjunction with the U.S. Fish and Wildlife Service's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

This map was prepared in March 1995 by:

U.S. Fish and Wildlife Service
Delaware Bay Estuary Project
2610 Whitehall Neck Road
Smyrna, Delaware 19977
(302) 653-9152

Sources

Delaware Department of Natural Resources, Division of Fish and Wildlife.
New Jersey Department of Environmental Protection, Division of [illegible] and [illegible].
The College of William and Mary, [illegible]
U.S. Army Corps of Engineers, Philadelphia District.
U.S. Department of Commerce, Bureau of Census.

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Commercially important oyster seed beds exist in the area offshore of Kent Island and Kelly Island (Figure 4b). There are also oyster beds inside the mouth of the Leipsic River. Additionally, hard clams and blue crabs are distributed throughout the Kelly Island area. Blue crabs in this area are commercially important.

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Kelly Island area by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Nephtys picta*, *Glycera capitata*, *Glycera dibranchiata*, and *Heteromastus filiformis*; mollusks such as *Tellina agilis*, *Nassarius trivittatus*, *Ensis directus*, *Mulinia lateralis*, and *Nucula proxima*; and, crustaceans including *Cancer irroratus*, *Paraphoxus spinosus*, *Protohaustorius wigleyi*, and *Pagurus longicarpus*.

The Greeley-Polhemus Group (1994) found 23 macroinvertebrate species at the Kelly site in 1993. Crustaceans (11 species) and polychaetes (5 species) dominated the samples. Dominant species included mollusks such as *Mulinia lateralis*, and polychaetes including *Glycera dibranchiata*. Small horseshoe crabs were also collected. The Greeley-Polhemus Group (1994) reported sampling problems associated with the thick cohesive silt / clay substrate, which made it difficult to dredge for commercially or recreationally important species.

Striped bass use the mouth of the Leipsic River in all seasons. This area is also a spawning area in spring and summer for riverine and anadromous fish such as American shad, river herring, and white perch (*Morone americana*) (R. Miller, pers. comm., 1995).

Kent Island marshes provide significant shelter, wintering and breeding habitat for American black duck and other waterfowl species (E. Smith, pers. comm., 1995). Gulls, terns, and large numbers of wading birds such as glossy ibis (*Plegadis falcinellus*) use the Kent Island and Kelly Island areas, especially in spring.

The beach on the southern tip of Kelly Island historically supported large numbers of spawning horseshoe crabs, with corresponding heavy use by shorebirds, particularly ruddy turnstones and semipalmated sandpipers. As the beach at the southern tip of Kelly Island has eroded, horseshoe crab spawning activity has declined. While horseshoe crabs still spawn here in large numbers, conditions are generally no longer suitable for egg survival. Although horseshoe crab spawning activity has declined, shorebird use of this area has remained high. In fact, the area between Kelly Island and South Bowers Beach still supports one of the largest springtime concentrations of shorebirds in the entire Delaware Bay (Niles *et al.*, 1994). This large shorebird concentration could be due in part to the inaccessibility of this area to humans.

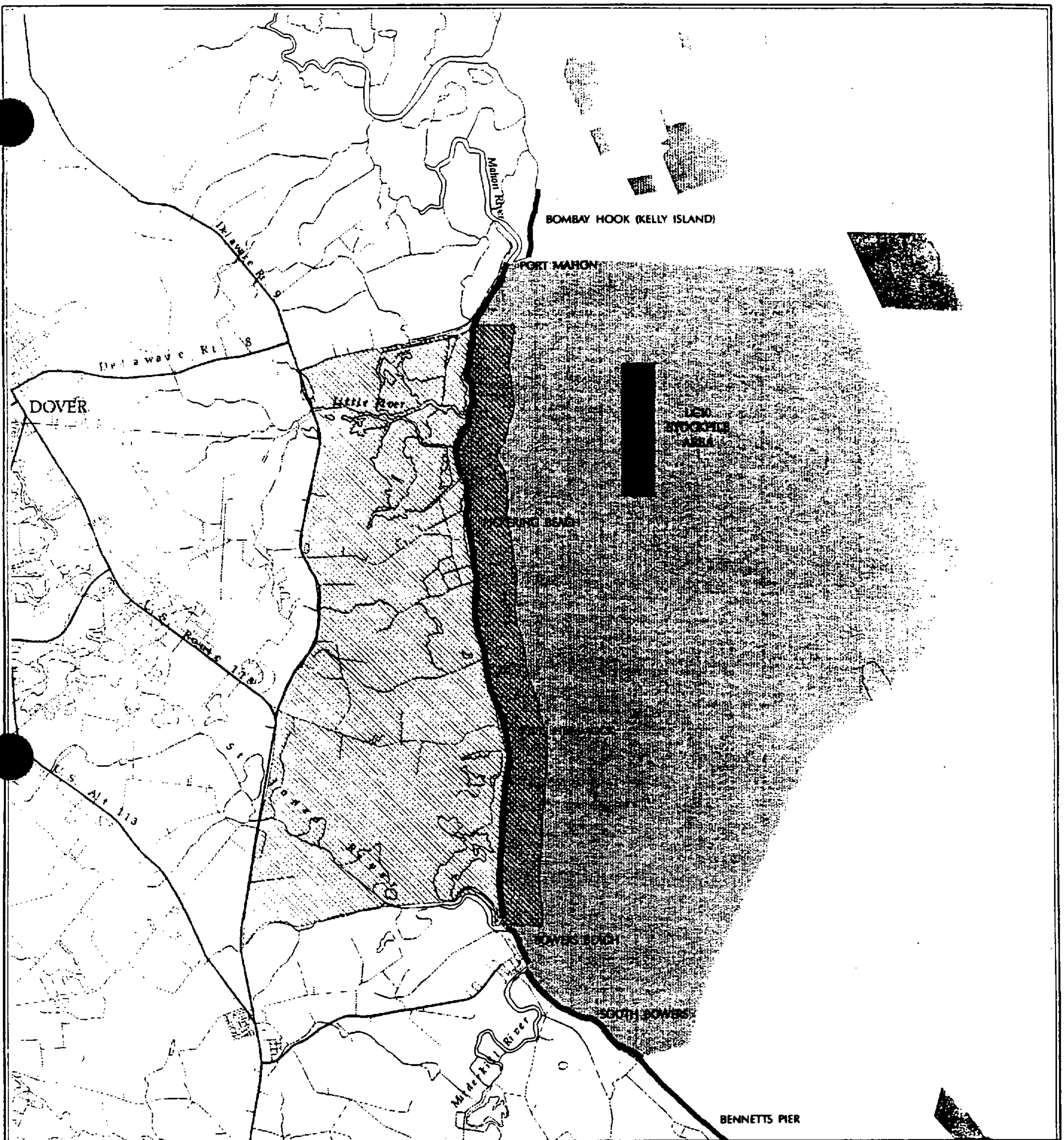

Figure 4b. Kelly Island Vicinity

Notes to the User

This map has been prepared for the U.S. Army Corps of Engineers, Delaware River Comprehensive Navigation Study, Main Channel Deepening Project, by the U.S. Fish and Wildlife Service (Service). The information presented here is for general planning purposes during the Preconstruction, Engineering and Design phase of the study. An important component of this phase of the study is the evaluation of potential sites for the beneficial use of dredged material that would be generated by the project.

The Service compiled Delaware Bay natural resource data from federal and state agencies and other sources. Map scale limitations preclude the portrayal of all available information on species occurrence and distribution. This map should only be used in conjunction with the detailed report available through the Service or the U.S. Army Corps of Engineers. This map was developed, in part, using New Jersey Department of Environmental Protection (NJDEP) Geographic Information System digital data, in conjunction with the U.S. Fish and Wildlife Service's work, but this secondary product has not been verified by NJDEP and is not state-authorized.

This map was prepared in March [illegible] by:

U.S. Fish and Wildlife Service
Delaware Bay Estuary Project
2610 Whitehall Neck Road
Smyrna, Delaware 19977
(302) 653-9152

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MILES

KILOMETERS

Sources

Delaware Department of Natural Resources, Division of Fish and Wildlife.
New Jersey Department of Environmental Protection, Division of [illegible]
The College of William and Mary, [illegible]
U.S. Army Corps of Engineers, Philadelphia District.
U.S. Department of Commerce, Bureau of Census.

Legend

- Stockpile Areas
- Natural Oyster Beds
- Oyster Lease Area
- Waterfowl Concentration Areas
- State Proposed Artificial Reefs

HORSESHOE CRABS

- High Use Suitable Beach
- High Use Unsuitable Beach

3. Port Mahon to South Bowers Beach

Port Mahon receives heavy use by horseshoe crabs and shorebirds (Figure 4b). However, the high level of human disturbance and continued erosion threaten the area's continued suitability for horseshoe crabs and shorebirds. The sand strip to seaward of the rip-rap has been eroding noticeably each year, and the shorebirds and horseshoe crabs using this area are being forced closer to, and often onto, the road. Additionally, horseshoe crabs may be legally harvested by permit at Port Mahon.

The narrow (less than 30 feet wide) strip of sandy beach just north of the Dover Air Force Base Aviation Gas pipeline / barge unloading pier comprises the best spawning area for horseshoe crabs at Port Mahon. Although the sand along this 600-foot-long section of shoreline is covered by water at high tide, horseshoe crabs have been observed spawning on falling tides in this area. The viability of horseshoe crab eggs is probably minimal on beaches that are covered by high tides such as this area, but the value of eggs as food for shorebirds and juvenile fish remains high. Other small sections of shoreline, totalling approximately 300 feet in length are scattered among the rip-rap and bulkheads. These areas generally do not support favorable spawning conditions. Service field observations revealed that large numbers of horseshoe crabs become trapped in the rip-rap, and the normal 10 percent mortality from spawning activities on more natural beaches is probably exceeded substantially at this site.

Extensive oyster lease beds occupy the offshore area from Port Mahon to South Bowers Beach. Additionally, many species of marine fish, particularly weakfish, spawn in the offshore area from approximately 600 feet to 3,600 feet offshore of Port Mahon to the mouth of the Little River near Pickering Beach. Juvenile fish, particularly weakfish, also concentrate just offshore of Port Mahon in spring (R. Miller, pers. comm., 1995).

Port Mahon, especially near the mouth of Little Creek, supports large numbers of birds during all seasons. Numerous species of waterfowl and shorebirds use the area in fall, winter and spring (Clark *et al.*, 1993). Many species of gulls and terns use the area during the spring, summer and fall, and numerous wading birds are found here all year. Shorebirds have been observed feeding on inviable horseshoe crab eggs in the thick, unconsolidated peat deposits at the mouth of Little Creek in all seasons.

Pickering Beach receives high use by spawning horseshoe crabs, and migratory shorebirds. Site visits revealed that Kitts Hummock also supports large number of spawning horseshoe crabs and migrating shorebirds; however, the only suitable spawning habitat for horseshoe crabs at Kitts Hummock is the 0.5-mile-long sand and gravel beach.

The mud flats offshore of Kitts Hummock have accumulated since the three breakwaters were constructed. These mud flats contain benthic invertebrates that support large numbers of shorebirds in the spring. Blue crabs and hard clams are distributed throughout this area. Winter flounder *(Pleuronectes americanus)* and summer flounder are distributed throughout the area, along with numerous species of finfish (R. Miller, pers. comm., 1995).

Spawning horseshoe crabs and migrating shorebirds also occur in large numbers at Bowers Beach and South Bowers Beach. Additionally, blue crabs, hard clams, and oysters are distributed throughout the area, and numerous species of riverine, anadromous, and marine fish also use this area. Riverine and anadromous fish spawn in the Murderkill and Saint Jones Rivers.

4. Bennetts Pier to Big Stone Beach

Big Stone Beach experienced extraordinarily high horseshoe crab spawning in 1993, with light spawning activity in other years (Swan *et al.*, 1994). It appears that this area is not extensively used by spawning horseshoe crabs in most years, despite the presence of apparently suitable spawning habitat. Similarly, the area from Bennetts Pier to Big Stone Beach does not appear to be heavily used by shorebirds. Additionally, there are no oyster lease beds offshore of Bennetts Pier and Big Stone Beach (J. Tinsman, pers. comm., 1995).

5. Mispillion Jetty to Lewes Beach

Horseshoe crabs attempt to spawn at Cedar Beach in large numbers. However, due to the relatively flat beach slope, thousands of horseshoe crabs become stranded on the intertidal mud flats and die. The small sand deposit halfway along the south jetty is surrounded by soft mud, and is probably only marginally suitable for spawning horseshoe crabs; however, this area is heavily used by shorebirds. More than 50,000 shorebirds concentrate in the immediate vicinity of this sandy area (Niles *et al.*, 1994).

Hard clams and blue crabs are distributed throughout the offshore area in the vicinity of Cedar Beach. Additionally, marine, anadromous and riverine fish spawn in the Mispillion River. Fish species found here include striped bass, American shad, tautog, bluefish, black sea bass, spot, Atlantic croaker, weakfish, red hake, and white perch (R. Miller, pers. comm., 1995).

Numerous species of waterfowl, wading birds, and gulls and terns are distributed throughout the Cedar Beach area. Osprey *(Pandion haliaetus)* are also found here in spring, summer, and fall.

Slaughter Beach supports a moderate shorebird population during the spring and early summer. Historically, Slaughter Beach experienced heavy spawning by horseshoe crabs, and harvesting these animals here was a healthy industry during the 1800s (Shuster and Botton, 1985). Current use by horseshoe crabs is sporadic and unpredictable; although the large dune washover south of slaughter beach appears to receive heavy use by spawning horseshoe crabs, based on the large number of molts observed in this area during Service site inspections. Numerous species of gulls and terns, as well as waterfowl, wading birds, and raptors frequent the area. Similarly, Fowler beach currently supports low numbers of spawning horseshoe crabs and migratory shorebirds.

Broadkill beach appears to receive higher use by spawning horseshoe crabs and migratory shorebirds than other beaches in this section of the shoreline; although, the numbers of horseshoe crabs and shorebirds seen here are substantially lower than in the Port Mahon to South Bowers Beach section (L. Gelvin-Innvaer, pers. comm., 1995). Semipalmated sandpiper and red knot are the most common species of shorebirds at Broadkill Beach.

The peat area inside the mouth of the Roosevelt Inlet, although experiencing rapid erosion, is the only part of Roosevelt Inlet beach where horseshoe crabs have spawned recently in substantial numbers, according to the annual volunteer horseshoe crab survey (W. Hall, pers. comm., 1995). In 1990, 1,000 horseshoe crabs were counted during the annual survey. In 1991, 60,800 crabs were counted. Since 1991, spawning activity has been light.

Some riverine and anadromous fish may spawn in the mouth of the Broadkill River at Roosevelt Inlet. Distributed throughout are summer and winter flounder, bluefish, black sea bass, Atlantic menhaden (*Brevoortia tyrannus*), spot, Atlantic croaker, weakfish, scup, and northern kingfish (*Menticirrhus saxatilis*).

6. Sand Stockpile Areas

The most frequently occurring species of benthic macroinvertebrates in samples taken in the vicinity of Site L-5 area by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Nephtys picta*, *Scoloplos fragilis*, *Glycera americana*, *Glycera capitata*, *Glycera dibranchiata*, *Aricidea cerruti*, and *Heteromastus filiformis*; mollusks such as *Tellina agilis*, *Nassarius trivittatus*, *Ensis directus*, and *Nucula proxima*; and, crustaceans including *Cancer irroratus*, *Paraphoxus spinosus*, *Protohaustorius wigleyi*, and *Pagurus longicarpus*.

The Greeley-Polhemus Group (1994) found 51 macroinvertebrate species at Site L-5 in 1993. Crustaceans (19 species) and polychaetes (18 species) dominated the samples. Dominant species included crustaceans such as *Ampelisca sp.*, and *Cerapus tubularis*; mollusks such as *Mulinia lateralis*, and *Nucula proxima*; and, polychaetes including *Glycera americana* and *Nephtys incisa*.

The most frequently occurring species of benthic macroinvertebrates found in samples taken in the vicinity of Site LC-10 by Maurer *et al.* (1978) in 1972 and 1973 included polychaetes such as *Heteromastus filiformis*, *Glycera dibranchiata*, *Glycera capitata*, and *Nephtys picta*; crustaceans including *Melita nitida*, *and Protohaustorius wigleyi*; and mollusks such as *Mulinia lateralis*, and *Tellina agilis*.

The Greeley-Polhemus Group (1994) found a total of 50 species, including 20 crustaceans and 16 polychaetes, at Site LC-10. Dominant species included the polychaetes, *Scoloplos sp.*; crustaceans such as *Ampelisca sp.*, and *Neomysis americana*; mollusks *Mulinia lateralis*, and *Ensis directus*; and, the nemertean *Cerebratulus lacteus*. This site contained more commercially or recreationally important species than other sites sampled, including the knobbed whelk (*Busycon carica*), the channeled whelk (*Busycon canaliculatum*), hard clams, blue crab, and horseshoe crab.

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Site LC-10 is within an American oyster lease area. Sampling in this area by the Greeley-Polhemus Group (1994) did not detect oysters; however, this was likely due to the sampling techniques used in that study.

The area in the vicinity of Site MS-19 was sampled by Maurer *et al.* (1978) in 1972 and 1973. The dominant species included mollusks such as *Ensis directus*, *Tellina agilis*, and *Nucula proxima*; polychaetes including *Glycera americana*, *Glycera capitata*, *Glycera dibranchiata*, *Nereis succinea*, *Nephtys picta*, *Capitella capitata*, *Aricidea cerruti*, *Polydora ligni*, *Sabellaria vulgaris*, and *Heteromastus filiformis*; and, crustaceans including *Protohaustorius wigleyi*, *Paraphoxus spinosus*, *Pagurus longicarpus*, *Cancer irroratus*, *Melita nitida*, *Neopanope sayi*, *Corophium simile*, *Paracaprella tenuis*, and *Eurypanopeus depressus*.

The Greeley-Polhemus Group (1994) found a total of 62 species at Site MS-19 in samples collected in 1993. The mean density of individuals collected at this site (26,562.5 individuals per square meter) was much higher than that of any other proposed sand stockpile site. Most species were crustaceans (24 species) and polychaetes (20 species). Dominant species included crustaceans such as *Ampelisca sp.*, *Corophium sp.*, *Cerapus tubularis*, and *Eurypanopeus depressus*; and, mollusks such as *Crepidula fornicata*, and *Ensis directus*. Commercially and recreationally important species included knobbed whelk, horseshoe crab, blue crab, and hard clam.

The offshore areas in the vicinity of all three proposed stockpile sites support important fisheries for weakfish. Additionally, the offshore areas in the vicinity of Sites L-5 and MS-19 support summer flounder, black sea bass, and drum (Figley and McCloy, 1988).

VI. EFFECTS TO FISH AND WILDLIFE AND SUGGESTED MITIGATIVE MEASURES

A. SHORELINE PROTECTION / WETLAND RESTORATION

Estuarine emergent wetlands such as those on Egg Island Point and Kelly Island are among the most productive natural systems on earth. The detritus produced by the annual death and decay of saltmarsh vegetation and other wetland vegetation contributes to estuarine productivity and the aquatic food web. In some estuaries, the detrital material exported from salt marshes is more important than the phytoplankton-based production in the estuary (Mitsch and Gosselink, 1986). Additionally, salt marshes provide important spawning and nursery habitat for many species of marine and estuarine fish, shellfish and crustaceans, and provide feeding, resting and breeding habitat for a wide variety of migratory waterfowl, shorebirds, wading birds, raptors, and passerine birds.

The continual loss of estuarine wetlands through shoreline erosion not only eliminates habitat for marsh-dwelling organisms; but also reduces the productivity of the entire estuary. Therefore, measures designed to slow or reverse the erosion of Delaware Bay salt marshes, if successful, would be expected to produce many positive benefits for the Delaware Bay ecosystem as a whole.

Although erosion control has many desirable benefits, shoreline stabilization measures such as beach nourishment and the use of hard structures such as geotextile tubes may also have a number of site-specific adverse impacts that must be carefully weighed against the expected project benefits in order to determine the net effect. In particular, the effects of the proposed geotextile tube structures on spawning horseshoe crabs is unknown. While the Egg Island Point and Kelly Island sites do not currently support high quality breeding habitat, as discussed above, significant numbers of horseshoe crabs still spawn in these areas. Although most eggs deposited in these areas may be inviable, the eggs still provide a valuable food source for migratory shorebirds and other organisms.

It is almost certain that the geotextile tube structures would not provide suitable spawning habitat for horseshoe crabs, given the lack of open sandy area above mean low water. It is uncertain whether horseshoe crabs would continue to attempt to spawn along these structures. Additionally, horseshoe crabs may become trapped behind these structures, which could result in increased mortality.

1. Egg Island Point

The estuarine wetlands on Egg Island Point provide valuable habitat for a wide variety of fish and wildlife, particularly species of migratory shorebirds and waterfowl; therefore, carefully designed measures that slow or reverse erosional wetland loss would benefit these species. However, careful planning will be necessary to ensure that these shoreline protection measures are effective in controlling erosion without adversely affecting important fish and wildlife resources.

The initial construction of the proposed project, particularly the deposition of the sand foundation, would most likely create a temporary increase in turbidity in the vicinity of the oyster lease beds. Additionally, the initial construction of the proposed project could adversely effect spawning horseshoe crabs and migrating shorebirds, if construction occurred between April 15 and June 30. To avoid impacts to spawning horseshoe crabs and shorebirds, the Service recommends that no construction activities be scheduled to occur between April 15 and June 30.

The potential exists for substantial quantities of dredged material to migrate out of the project area, and smother nearby oyster beds; however, the completed project would likely reduce shoreline erosion and sediment transport onto the oyster beds. Insufficient information exists regarding sediment transport in the Egg Island Point area to accurately predict the movement of

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deposited dredged material. The Corps is currently conducting modeling studies to assess sediment transport. The Service recommends that a meeting be held among interested parties upon completion of these modeling studies to review and discuss the results.

Depending on design, the proposed geotextile tube structure at Egg Island Point may alter the tidal flow over the adjacent salt marsh. Altered tidal flow may interrupt nutrient transport over the marsh; thereby decreasing the value of the tidal ponds to migratory shorebirds and potentially encouraging the spread of common reed. The Corps has stated that the proposed structure would be designed to maintain 100 percent of the current tidal flow over the salt marshes (J. Brady, pers. comm., 1995). The Service supports this design specification and recommends that the Corps take all necessary steps to ensure that tidal flow over the marsh is maintained.

The proposed shoreline protection at Egg Island Point would result in the elimination of all subtidal benthic habitat directly under the footprint of the proposed geotextile tubes, supporting scour blanket, and areas of dredged material placement for wetland restoration. The current plan to deposit up to 2.6 million cubic yards of dredged material landward of the geotextile tube structure along the southeastern shoreline would restore between 150 and 200 acres of estuarine emergent wetlands, while eliminating the same amount of open water and benthic habitat. The area in the proposed footprint of the structure does not appear to support a particularly diverse or unusual benthic community; however, care must be taken to avoid nearshore areas that support oyster lease beds. It should be noted that geotextile tubes used for similar projects in other parts of the country frequently become colonized by a variety of benthic invertebrates (M. Landin, pers. comm., 1995).

The proposed geotextile tube structure could also block access to the beach for spawning horseshoe crabs. This is a concern along the southwestern shoreline and at the tip of Egg Island Point, where the most productive horseshoe crab spawning habitat exists. A possible design under consideration by the Corps would provide spaces between sections of geotextile tube placed along the southwestern shoreline. Such spaces would provide access points to the beaches for spawning horseshoe crabs, while still providing protection of the shoreline. Specific design features, such as the exact configuration of the geotextile tubes or the width of the spaces between tubes have not yet been determined (J. Brady, pers. comm., 1995). The Service recommends that the Corps continue to coordinate with the Service and the NJDFGW to develop site plans that would provide shoreline protection while allowing beach access for spawning horseshoe crabs along the tip of Egg Island Point and along the southwestern shoreline.

2. Kelly Island

The environmental consequences resulting from the proposed Kelly Island project are in many respects similar to those mentioned above regarding Egg Island Point. The proposed wetland restoration at Kelly Island would use up to one million cubic yards of dredged material to convert approximately 80 to 125 acres of nearshore shallow water habitat to estuarine intertidal wetlands.

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This conversion would result in a permanent loss of the benthic community in this area; however, the only commercially important species known to occur at this site is the horseshoe crab. It is also important to note that the project purpose is wetland restoration, and that the proposed project area was historically an emergent marsh.

The primary concerns regarding the proposed Kelly Island project are the avoidance of the ecologically sensitive area on the northern end of Kelly Island and the avoidance of potential effects on the oyster seed beds located offshore of Kelly Island. The wetlands on the northern end of Kelly Island, north of Deepwater Point, provide valuable waterfowl habitat. Additionally, the northern end of the island does not appear to be eroding as rapidly as the southern portion of Kelly Island. Therefore, the Service recommends that the proposed wetlands restoration project be limited to the area south of Deepwater Point.

The footprint of the proposed wetland restoration at Kelly Island would not directly affect oyster beds; however, increased sedimentation and turbidity resulting from the initial construction of the project could adversely affect oysters. Additionally, the movement of large volumes of dredged material from the proposed project site to the oyster beds due to storm events or structural failure of the geotextile tubes poses a significant threat to oyster seed beds. Adverse impacts to oysters through increased sedimentation is a greater threat at Kelly Island than at Egg Island Point due to the proposed deposition of fine-grained silt and clay material at the Kelly Island site.

Any benefits to fish and wildlife derived from the proposed wetland restoration at Kelly Island would be insufficient to offset the loss of oyster seed beds due to excessive sedimentation. As such, the over-riding design consideration for the Kelly Island site must be to minimize the risks of sediment transport from the project site to the oyster beds, both in terms of construction-related sedimentation and long-term sedimentation.

The concerns regarding sedimentation from the Kelly Island site would be substantially reduced or eliminated if the material deposited at the site were sand instead of silt and clay. Therefore, the Corps should carefully consider alternative disposal options for the fine-grained material, including upland disposal at one of the existing disposal sites along the Delaware River. If upland disposal of the fine-grained dredged material is not practicable, the Corps should investigate the feasibility of mixing or capping the fine-grained sediments with coarser-grained material.

It is important that the site be designed such that the dredged slurry is retained on site for sufficient time to allow suspended sediments to settle before water is discharged from the site. Additionally, the Service recommends water quality monitoring of the effluent from the site and the development of contingency plans to be implemented should monitoring indicate adverse impacts during site construction. Once the sediment deposited within the geotextile tube barrier settles and becomes vegetated, it is expected that less material would erode from the area than is currently eroding from the existing exposed marsh. Periodic water quality monitoring in the three to five year period following construction should be conducted to confirm that the site performs as expected.

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Overall, it is the Service's view that wetland restoration / shoreline protection projects at Egg Island Point and Kelly Island, similar to those currently proposed, would have a net positive effect on fish and wildlife resources. However, considerable additional planning will be necessary to ensure maximum project benefits with minimal adverse effects. Therefore, the Service recommends that the Corps continue to work with the Service, DNREC, and NJDFGW to evaluate and refine project plans for these two areas.

As previously stated, Kelly Island is part of the Bombay Hook National Wildlife Refuge. As such, the Corps' use of the Kelly Island site for dredged material disposal will require a Special Use Permit from the Service, pursuant to the National Wildlife Refuge System Administration Act of 1966 (80 Stat. 927, 16 U.S.C. 668dd-668ee). Application for the Special Use Permit should be made to the Refuge Manager at the following address:

Paul Daly
Bombay Hook National Wildlife Refuge
R.D. 1, Box 147
Smyrna, Delaware 19977
(302) 653-0684

B. BEACH NOURISHMENT

In the absence of continued beach nourishment, the current shoreline recession that is already severely affecting the beach systems and adjacent salt marshes along the Delaware shoreline is expected to continue. The rate and degree of adverse impact on surrounding beaches and their biological processes is difficult to assess, but it is clear that without intervention some beaches will be lost and wetlands will be converted from vegetated to open water conditions.

Few studies have examined the effects of beach nourishment on beach infaunal communities (Reilly and Bellis, 1978; Naqvi and Pullen, 1982; Fenchel, 1969; Martore *et al.*, 1991). The results of these studies have indicated various effects depending on the compatibility of the beach substrate and replenishment material, time of year, magnitude of the project, and the benthic community composition. One Corps study (Reilly and Bellis, 1978) found that beach infauna was completely eliminated by beach nourishment in North Carolina, and that after 20 months, the infaunal community had still not recovered in any significant degree to its pre-disturbance composition or biomass. Naqvi and Pullen (1982) found that in most cases, initial infaunal recruitment was primarily by opportunistic species and that these species prevented the re-establishment of the original community. Additionally, because beach infaunal organisms are sensitive to even slight changes in sand grain-size distribution and substrate porosity, the species composition of the infaunal community prior to beach nourishment could differ from the post-project community (Fenchel, 1969; Martore *et al.*, 1991).

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Beach nourishment conducted between mid-April and mid-July would adversely impact spawning horseshoe crabs, both through the potential disturbance or burial of spawning adults and through the burial of eggs and larvae. It is unlikely that eggs and larvae buried during beach nourishment activities would survive. Beach nourishment activity during this period would also disturb migrating shorebirds.

Aside from the above-mentioned dependency of migratory shorebirds on horseshoe crab eggs, the biomass and species composition of the infaunal community are also important for supplying the nutritional needs of shorebirds. Therefore, significant effects to spawning horseshoe crabs and / or the infaunal community would have congruent effects on migratory shorebirds.

There is little published information regarding the effects of beach nourishment on nearshore benthic and fish communities. A Florida study (Holland *et al.*, 1980) examined the effects of beach nourishment on nearshore species. This before-and-after-impact study found a temporary increase in fish abundance along the newly created beach, possibly due to the sudden and large-scale die-off of infaunal organisms resulting from the beach nourishment. However, long-term information is lacking. Beach nourishment activities could adversely effect offshore oyster beds through reduced water quality (i.e., higher turbidity and lower dissolved oxygen concentrations), and the deposition of fine-grained material.

The reduction in water quality that would likely occur adjacent to and down current from beach nourishment activities could also adversely effect anadromous fish. If water quality were reduced during the period in which anadromous fish make their spawning runs into inlets and up the Delaware River, their migration could be inhibited and their reproductive success compromised.

Not withstanding the above-mentioned potential adverse effects, properly conducted beach nourishment projects could produce a number of positive environmental effects, particularly in terms of retarding the above-mentioned adverse effects of shoreline erosion. The specific recommendations that follow should help the Corps select beach nourishment projects that would result in maximum benefits with minimum adverse effects.

1. Port Mahon to South Bowers Beach

This section of the Delaware shoreline is experiencing severe erosion that threatens existing wetlands and bayshore communities. The area between Port Mahon and South Bowers Beach is also an area of high biological sensitivity in terms of its value to spawning horseshoe crabs, migratory shorebirds, fish and shellfish. All beaches in this section of the shoreline receive high use by spawning horseshoe crabs; however, reproductive success is probably low at some of these beaches, particularly Port Mahon and Pickering Beach, due to unsuitable habitat conditions. Additionally, the offshore area of this section of shoreline supports commercially valuable oyster beds as well as important spawning areas for commercially and recreationally important fish species.

This section of the Delaware shoreline has the highest ecological value and the most severe erosion of the three sections analyzed for possible beach nourishment projects. Accordingly, the Service recommends that beaches in this section receive priority consideration for beach nourishment. Beach nourishment would have the greatest ecological benefits at Port Mahon and Pickering Beach; although all beaches in this section would benefit from nourishment. Beach nourishment projects should not be conducted between April 15 and June 30 in order to avoid potential adverse impacts to spawning horseshoe crabs, and migratory shorebirds.

2. Bennetts Pier to Big Stone Beach

This section of shoreline appears to have fewer biological constraints than the northern portion of the study area. Although high numbers of spawning horseshoe crabs have been observed in this section in some years, these beaches do not appear to receive consistently high use by horseshoe crabs. The reason for the lower use of this area by horseshoe crabs is not understood, because many of the beaches in this section appear to provide suitable spawning habitat. Factors other than beach habitat characteristics may limit the use of this section of the shoreline by spawning horseshoe crabs.

Significant numbers of shorebirds use the area in the spring, particularly Conch Bar Inlet; therefore, beach nourishment projects should not be conducted along this section of the shoreline during the spring migration period, April 15 through June 30. There are no significant American oyster lease or seed beds in the offshore area, with the exception of the offshore area north of Bennetts Pier; therefore, potential adverse impacts related to any beach nourishment project conducted outside the spring shorebird migration would be limited to temporary disturbances of the benthic infaunal community.

The Service recommends that beaches in this area be given lower priority for consideration as potential disposal sites. The rate of erosion in this section of shoreline is also slower than in the section between Port Mahon and South Bowers Beach. In addition, the potential ecological benefits of beach nourishment projects along the section of shoreline between Bennetts Pier and Big Stone Beach are generally less than could be realized from projects conducted between Port Mahon and South Bowers Beach.

3. Mispillion Jetty to Lewes Beach

This area receives the lowest use by spawning horseshoe crabs, despite the presence of apparently suitable spawning beaches. This area also receives proportionately less use by migratory shorebirds, with the exception of the mud flats adjacent to Cedar Beach. There are also no commercial oyster beds between Mispillion Jetty and Lewes Beach.

Nourishment of this section of the Delaware shoreline should receive the lowest priority in terms of providing beneficial uses for dredged material.

The anticipated effects of beach nourishment activities in this area would be short-term disturbance of the beach infaunal community. While beach nourishment projects would have positive economic benefits for local communities in terms of property protection, it is unlikely that beach nourishment in this area would greatly enhance habitat values for spawning horseshoe crabs or migratory shorebirds.

C. SAND STOCKPILES

It is unlikely that the habitat and aquatic resources in the vicinity of sites L-5, LC-10, and MS-19 would change significantly over time if sand deposition does not take place. Conversely, the use of these areas as dredged material disposal sites would have a number of environmental effects.

The environmental impacts of dredged material disposal in open water are similar in some ways to impacts resulting from sand dredging. Direct impacts include water quality degradation and temporary loss of the benthic community. Benthic community loss will in turn impact finfish species that feed on benthic organisms. Temporary water quality degradation is expected due to elevation of suspended sediments. Brief periods of elevated turbidity will occur as a result of sand placement. Extended periods of elevated turbidity would occur if wind or water currents cause sediments to remain in suspension. Water quality degradation would be more severe and widespread with unconfined open water disposal than if the sand were deposited behind containment devices such as geotextile tubes.

Placement of up to 9.5 million cubic yards of dredged material at the proposed sand stockpile sites would result in burial of the existing benthic community. Benthic recolonization depends upon a number of factors, which include substrate type, distance from similar habitat, and water currents. Recovery of the benthic community would be further hindered by future disturbance as the material is taken from the stockpiles for beach nourishment projects. Site LC-10, while not under consideration at this time, would have been placed directly on top of an economically important oyster lease bed. The Service supports the Corps decision to eliminate the Site LC-10 from further consideration as a sand stockpile area.

Deposition of large quantities of dredge spoil in sand stockpiles would decrease water depth at the sites from current depths to approximately 5 feet below mlw. This depth reduction could result in changes in the tidal regime and current patterns, which in turn could impact biological resources. Changes in the tidal regime may have some impact on biological resources associated with nearby rivers as well as resources associated with adjacent beaches.

Benthic recolonization is dependent upon recruitment from plankton dispersed by water currents. Changes in current patterns and velocities may alter dispersal of benthic larvae. The District is investigating the potential impacts to current patterns and velocities (J. Brady, pers. comm., 1995). When this information is available, the Service requests that it be provided for review.

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Except for oysters, the loss of the benthic community due to dredged material disposal would be expected to be a short-term adverse impact. The Corps has constructed twenty-three underwater berms for storm attenuation or beach nourishment throughout the United States (Landin, 1992). For example, results of detailed studies of benthic recovery and fish use on a berm constructed at Dauphin Island, Alabama, indicated rapid benthic recovery. Fish use of the area also was reported as greater than in surrounding waters. The benthic recovery and greater fish use are related to slope, configuration, and orientation of the berm in the current (Landin, 1992).

Long-term impacts would likely result from the use of the sites as sand sources for future beach nourishment projects if the area is subjected to repeated disturbances. A regularly disturbed bottom would not necessarily provide the same abundance or species composition as the present site condition.

Placement of dredged material would result in some loss of finfish nursery and feeding areas. The loss of the food source would be expected to result in a temporary and localized reduction in recreationally and commercially important finfish species. As with effects to the benthic community, the repeated disturbance of the sand stockpile sites for future beach nourishment projects would likely result in long-term adverse impacts to local fisheries.

The above-described adverse impacts of the sand stockpiles would not be offset by any appreciable environmental benefits, as would be the case with the other projects under consideration. Therefore, the use of sand stockpiles for the disposal of dredged material cannot be considered "beneficial" in terms of its effects on fish and wildlife resources.

The Service recommends that the disposal of dredged material in sand stockpiles be considered the disposal option of last resort, and that dredged material be used for wetland restoration and direct beach nourishment to the maximum extent possible. Current plans for Egg Island Point and Kelly Island may accommodate over 3.5 million cubic yards of the estimated 10 million cubic yards of material to be generated by the Delaware Bay portion of the Main Channel Deepening Project. Beach nourishment projects in the above-recommended areas along the Delaware shoreline could accommodate substantial additional quantities of dredged sand; thereby minimizing or eliminating the need for sand stockpiles.

The Service recommends that the Corps coordinate with the State of Delaware to schedule dredging activities to coincide with State-sponsored beach nourishment efforts in order to minimize the costs of conducting beach nourishment as part of the Main Channel Deepening Project. Additionally, the Corps should re-evaluate the economic feasibility of using the dredged material for projects outside the area evaluated for the current study, such as the Maurice River Cove area and beaches in Cape May County, New Jersey.

VII. DATA GAPS AND RECOMMENDATIONS FOR FURTHER STUDIES

Significant concerns remain regarding the potential erosion of large quantities of dredged material from the Kelly Island and Egg Island Point wetland restoration sites, and the effects of such erosion on commercially important shellfish resources. Additionally, there are similar concerns regarding the movement of dredged material placed in sand stockpiles. As previously mentioned, the Service is aware that the Corps is currently conducting modeling studies of sediment transport patterns in these areas. The Service recommends that meetings be held between the Corps, Service, DNREC and NJDFGW upon the completion of these studies to review the results.

There is currently little information regarding the performance or effectiveness of geotextile tubes in areas with tidal regimes and wave patterns similar to Delaware Bay. It is also uncertain whether the peat substrate surrounding Kelly Island and Egg Island Point would support such structures or how much settling would likely occur. Additionally, the effect of shoreline hardening structures such as geotextile tubes on beach access to spawning horseshoe crabs is unknown. The Corps has discussed the possibility of conducting a pilot project for the use of geotextile tubes in Delaware Bay (J. Brady, pers comm., 1995). Such a pilot project would allow an assessment of the effectiveness of geotextile tubes in the Delaware Bay environment. The Service supports the proposal to conduct a pilot project using geotextile tubes, and recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of such a project, and related monitoring studies.

A direct correlation appears to exist between the area of sand available on a given beach and the number of horseshoe crabs that will spawn there; however, this remains to be quantified (C. Shuster, pers. comm., 1995). Additionally, it is believed that beach slope plays an important role in determining horseshoe crab spawning success. In order to better design beach nourishment projects to benefit spawning horseshoe crabs, additional information is needed regarding the relationships between these habitat parameters and horseshoe crab beach utilization and spawning success. The Service recommends that the Corps coordinate with the Service and other sources of expertise to design and implement a study of horseshoe crab spawning habitat requirements as a component of the above-mentioned pilot project.

Migratory shorebirds are one of the main species groups intended to benefit from the proposed beach nourishment and wetland restoration projects, yet information regarding shorebird use of Delaware Bay beaches and wetlands is incomplete. The lack of complete information makes a thorough assessment of the effects of the various proposed projects on migratory shorebirds difficult. Additionally, without sufficient baseline data, it will not be possible to determine whether the projects achieve the goal of improving shorebird habitat. The Service recommends that the Corps coordinate with the NJDFGW, Endangered and Nongame Species Program, to continue and expand the annual shorebird surveys. Additional studies should focus on the use of specific project sites by migratory shorebirds, before and after project construction.

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VIII. CONCLUSIONS

Shoreline erosion poses a continuing threat to the diverse and abundant fish and wildlife resources of the Delaware Bay. The Service has evaluated three types of proposals by the Corps to use dredged material to combat shoreline erosion: wetland restoration using geotextile tubes, beach nourishment, and sand stockpiles. The Service concludes that the proposed wetland restoration projects at Egg Island Point and Kelly Island would provide positive benefits to fish and wildlife resources. The Service further concludes that beach nourishment would have the greatest positive effects on beaches between Port Mahon and South Bowers Beach, while nourishment of beaches in the more southern sections of the Delaware shoreline would be less beneficial, although still worthwhile. Finally, the Service concludes that the proposed disposal of dredged material in sand stockpiles would adversely affect fish and wildlife resources and that the use of sand stockpiles should be minimized or eliminated.

While the Service supports the proposed wetland restoration and beach nourishment plans, in concept, substantial additional coordination and planning are necessary to ensure maximum project benefits with minimal adverse effects. Therefore, the Service offers the following recommendations to assist the Corps in refining project plans.

In regard to protection of federally-listed threatened and endangered species, the Service recommends that the Corps:

1. coordinate with the NJDFGW, Endangered and Nongame Species Program, and the Service to incorporate relocation of the peregrine falcon nesting tower on Egg Island Point into the current project plans;
2. continue to consult with the Service and the NMFS in the preparation of the Biological Assessment necessary to address potential project-related effects to federally-listed species; and,
3. contact the NJDFGW, Endangered and Nongame Species Program for additional information regarding State-listed threatened and endangered species.

In regard to the proposed wetland restoration plans for Egg Island Point, New Jersey, and Kelly Island, Delaware, the Service recommends that the Corps:

1. avoid construction between April 15 and June 30 in order to minimize potential adverse impacts to spawning horseshoe crabs and migrating shorebirds;
2. continue modeling studies to determine the sediment transport patterns around Egg Island Point and Kelly Island, and coordinate with the Service, NJDFGW and DNREC to discuss the results of these studies;

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3. design the proposed geotextile tube structure to ensure maintenance of existing tidal flow over adjacent salt marshes;

4. avoid impacts to oyster lease and seed beds adjacent to the proposed project sites by locating project features outside of areas known to support oysters;

5. design the Egg Island Point site to allow beach access for horseshoe crabs along the southwestern shoreline and the tip of Egg Island Point;

6. limit the proposed Kelly Island project to the area south of Deepwater Point, in order to avoid the ecologically sensitive area of northern Kelly Island;

7. evaluate alternative disposal options for the fine-grain dredged material, including upland disposal, in order to avoid adverse impacts to oyster beds;

8. investigate the feasibility of mixing or capping fine-grained material with coarser-grained material, in order to minimize adverse impacts to oyster beds;

9. retain dredged slurry on site long enough to allow sediments to settle before discharging water, in order to further minimize potential sedimentation impacts to oyster beds;

10. conduct water quality monitoring of effluent from the Kelly Island wetland restoration sites, and develop a contingency plan to be implemented should monitoring indicate adverse impacts during construction;

11. conduct periodic water quality monitoring for three to five years following construction to ensure that the wetland restoration projects are performing as planned;

12. continue to coordinate project planning with the Service, NJDFGW and DNREC; and,

13. coordinate with the refuge manager of the Bombay Hook National Wildlife Refuge regarding the need for a Special Use Permit for the Kelly Island project.

In regard to proposed beach nourishment projects along the Delaware shoreline, the Service recommends that the Corps:

1. give highest priority for beach nourishment to the beaches between Port Mahon and South Bowers Beach, followed next by the beaches between Bennetts Pier and Big Stone Beach, and last by the beaches between the Mispillion Jetty and Lewes Beach; and,

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2. avoid beach nourishment between April 15 and June 30 in order to minimize potential adverse impacts to spawning horseshoe crabs and migrating shorebirds.

In regard to the proposed disposal of dredged material in sand stockpiles near the Delaware shoreline, the Service supports the Corps decision to eliminate Site LC-10 from further consideration as a dredged material disposal site. Additionally, the Service recommends that the Corps:

1. verify site conditions once a specific location is identified for a sand stockpile in the vicinity of Big Stone Beach;

2. minimize or eliminate the use of sand stockpiles for the disposal of dredged material by maximizing use of dredged material for beach nourishment and wetland restoration;

3. coordinate with the State of Delaware to identify cost-effective measures to use as much sand as possible to direct nourishment of Delaware beaches;

4. re-evaluate the potential for additional beach nourishment and wetland restoration projects outside the area evaluated for the current study including the Maurice River Cove area and beaches in Cape May County; and,

5. coordinate with the Service, NJDFGW, and DNREC regarding the results of the sediment transport modeling studies.

Finally, the Service recommends that the Corps proceed with plans to conduct a pilot project to study the effectiveness of geotextile tubes in Delaware Bay. Such a pilot project would greatly improve the prospects for successful implementation of the proposed Egg Island Point and Kelly Island wetland restoration projects. Such a pilot project should also include expanded horseshoe crab and shorebird surveys, and assessments of horseshoe crab spawning habitat requirements. The Service recommends that the Corps coordinate with the Service, DNREC, and NJDFGW regarding the design of the pilot project, and related monitoring studies.

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FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An **ENDANGERED SPECIES** is any species that is in danger of extinction throughout all or a significant portion of its range.

A **THREATENED SPECIES** is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Atl. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback*	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	PT
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Bat, Indiana	Myotis sodalis	E
Cougar, eastern	Felis concolor couguar	E+
Whale, blue*	Balaenoptera musculus	E
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sei*	Balaenoptera borealis	E
Whale, sperm*	Physeter catodon	E
Wolf, gray	Canis lupus	E+

INVERTEBRATES

Dwarf wedge mussel	Alasmidonta heterodon	E+
Beetle, northeastern beach tiger	Cicindela dorsalis dorsalis	T
Butterfly, Mitchell satyr	Neonympha m. mitchellii	E+
American burying beetle	Nicrophorus americanus	E+

PLANTS

Pogonia, small whorled	Isotria medeoloides	E
Swamp pink	Helonias bullata	T
Orchid, eastern prairie fringed	Platanthera leucophaea	T+
Knieskern's beaked-rush	Rhynchospora knieskernii	T
American chaffseed	Schwalbea americana	E
Joint-vetch, sensitive	Aeschynomene virginica	T
Pigweed, sea-beach	Amaranthus pumilus	T+

STATUS:

E: endangered species
T: threatened species
+: presumed extirpated
PE: proposed endangered
PT: proposed threatened

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

Note: for a complete listing of Endangered and Threatened Wildlife and Plants refer to 50 CFR 17.11 & 17.12, August 20, 1994

FEDERAL CANDIDATE SPECIES IN NEW JERSEY

CANDIDATE SPECIES in categories 1 and 2 are species that appear to warrant consideration for addition to the federal List of Endangered and Threatened Wildlife and Plants. Although these species receive no substantive or procedural protection under the Endangered Species Act, the U.S. Fish and Wildlife Service encourages federal agencies and other planners to give consideration to these species in the environmental planning process.

VERTEBRATES

Turtle, bog	Clemmys muhlenbergii	1
Terrapin, northern diamondback	Malaclemys terrapin terrapin	2
Snake, northern pine	Pituophis melanoleucus melanoleucus	2
Duck, harlequin	Histrionicus histrionicus	2
Goshawk, northern	Accipiter gentilis	2
Rail, Black	Laterallus jamaicensis	2
Shrike, migrant loggerhead	Lanius ludovicianus migrans	2
Sparrow, Henslow's	Ammodramus henslowii	2
Warbler, cerulean	Dendroica cerulea	2
Bat, eastern small-footed	Myotis leibii	2
Rabbit, New England cottontail	Sylvilagus transitionalis	2
Shrew, Tuckahoe masked	Sorex cinereus nigriculus	2
Woodrat, Alleghany	Neotoma magister	2

INVERTEBRATES

Mussel, brook floater	Alasmidonta varicosa	2
Mussel, yellow lamp	Lampsilis cariosa	2
Mussel, green floater	Lasmigona subviridis	2
Damselfly, lateral bluet	Enallagma laterale	2
Dragonfly, extra-striped snaketail	Ophiogomphus anomalus	2*
Dragonfly, banded bog skimmer	Williamsonia lintneri	2*
Beetle, cobblestone tiger	Cicindela marginipennis	2
Moth, Albarufan dagger	Acronicta albarufa	2
Moth, Buchholz' dart	Agrotis buchholzi	2
Skipper, eastern beard grass	Atrytone arogos arogos	2
Moth, precious underwing	Catocala pretiosa pretiosa	2
Moth, Daecke's pyralid	Crambus daeckeellus	2
Moth, Hebard's noctuid	Erythroecia hebardi	2
Moth, buck	Hemileuca sp.	2
Moth, Lemmer's pinion	Lithophane lemmeri	3C
Moth, Doll's merolonche	Merolonche dolli	2
Moth, noctuid	Papaipema aerata	2
Butterfly, tawny crescent	Phyciodes batesi	2*
Skipper, rare	Problema bulenta	2
Moth, annointed sallow	Pyreferra ceromatica	2*
Skipper, grizzled	Pyrgus wyandot	2*
Moth, Carter's noctuid	Spartiniphaga carterae	2
Butterfly, regal fritillary	Speyeria idalia	2*

PLANTS

Lakecress	Armoracia lacustris	3C
Bur-marigold	Bidens bidentoides var. bidentoides	2
Sedge, handsome	Carex formosa	2
Sedge, variable	Carex polymorpha	2
Sedge, Schweinitz's	Carex schweinitzii	2
Spring beauty yellow	Claytonia virginica var. hammondiae	2
Tick-trefoil, ground-spreading	Desmodium humifusum	2
Boneset, pine barrens	Eupatorium resinosum	2
Spurge, Darlington's	Euphorbia purpurea	2
Everlasting, clammy	Gnaphalium macounii	3B
St. Johnswort, Barton's	Hypericum adpressum	2
Butternut	Juglans cinerea	2
Rush, New Jersey	Juncus caesariensis	2
Blazingstar	Liatris borealis	2
Lobelia, Boykin's	Lobelia boykinii	2
Micranthemum, Nuttall's	Micranthemum micranthemoides	2*
Bog asphodel	Narthecium americanum	1
Panic grass, Hirst's	Panicum hirstii	2
Pondweed, algae-like	Potamogeton confervoides	2
Plum, Alleghany	Prunus alleghaniensis	2
Meadowbeauty, awned	Rhexia aristosa	2
Bulrush, Long's	Scirpus longii	2
Morning-glory, Pickering's	Stylisma pickeringii	2
Sea blite	Suaeda rolandii	2
False-foxglove, auriculate	Tomanthera auriculata	2*
Verbena	Verbena riparia	2*

Categories:

1: Taxa for which the U.S. Fish and Wildlife Service (Service) currently has substantial information to support the appropriateness of proposing to list the species as threatened or endangered. Development and publication of proposed rules on these species is anticipated.

2: Taxa for which information now in possession of the Service indicates that proposing to list the species as threatened or endangered is possibly appropriate, but for which conclusive data are not available to support proposed rules at this time.

3B: Names that, on the basis of current taxonomic understanding, do not represent distinct taxa meeting the Act's definition of "species." Such supposed taxa could be reevaluated in the future on the basis of new information.

3C: Taxa that have proven to be more abundant than previously believed and/or those that are not subject to any identifiable threat. If further research or changes in habitat indicate a significant decline in any of these taxa, they may be reevaluated for possible inclusion in categories 1 or 2.

PE: Proposed Endangered species

PT: Proposed Threatened species

* Signifies a lack of sightings, to the Service's knowledge, since 1963 for New Jersey.

Note: For complete listings of taxa under review, refer to Federal Register Vol. 59, No. 219, Nov. 15, 1994 (Animal) and Vol. 58, No. 188, September 30, 1993 (Plants).

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN DELAWARE

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Alt. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	T
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Squirrel, Delmarva peninsula fox	Sciurus niger cinereus	+
Whale, blue*	Balaenoptera musculus	E+
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sperm*	Physeter catodon	E

FEDERAL CANDIDATE SPECIES IN DELAWARE

VERTEBRATES

Turtle, bog	Clemmys muhlenbergii	1
Terrapin, northern diamondback	Malaclemys terrapin terrapin	2
Duck, fulvous whistling	Dendrocygna bicolor	2
Duck, harlequin	Histrionicus histrionicus	2
Goshawk, northern	Accipiter gentilis	2
Rail, black	Laterallus jamaicensis	2
Tern, black	Chlidonias niger	2
Shrike, loggerhead	Lanius ludovicianus	2
Warbler, cerulean	Dendroica cerulea	2

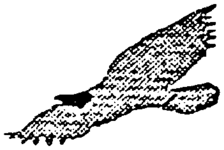
INVERTEBRATES

Skipper, rare	Problema bulenta	2
Butterfly, regal fritillary	Speyeria idalia	2+
Floater, brook	Alasmidonta varicosa	2+

APPENDIX B

State-listed endangered and threatened species in New Jersey

/4c



ENDANGERED AND THREATENED WILDLIFE OF NEW JERSEY

Endangered Species are those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to prevent future extinction in New Jersey.

Threatened Species are those who may become endangered if conditions surrounding them begin to or continue to deteriorate.

BIRDS

Endangered

Pied-billed Grebe,* *Podilymbus podiceps*
Bald Eagle, *Haliaeetus leucocephalus***
Northern Harrier,* *Circus cyaneus*
Cooper's Hawk, *Accipiter cooperii*
Red-shouldered Hawk, *Buteo lineatus* (Breeding)
Peregrine Falcon, *Falco peregrinus***
Piping Plover, *Charadrius melodus***
Upland Sandpiper, *Bartramia longicauda*
Roseate Tern, *Sterna dougallii*
Least Tern, *Sterna antillarum*
Black Skimmer, *Rynchops niger*
Short-eared Owl,* *Asio flammeus*
Sedge Wren, *Cistothorus platensis*
Loggerhead Shrike, *Lanius ludovicianus*
Vesper Sparrow, *Pooecetes gramineus*
Henslow's Sparrow, *Ammodramus henslowii*

Threatened

American Bittern*, *Botaurus lentiginosos*
Great Blue Heron*, *Ardea herodias*
Little Blue Heron, *Egretta caerulea**
Yellow-crowned Night Heron, *Nyctanassa violaceus*
Osprey, *Pandion haliaetus*
Northern Goshawk, *Accipiter gentilis*
Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
Black Rail, *Laterallus jamaicensis*
Long-eared Owl, *Asio otus*
Barred Owl, *Strix varia*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Cliff Swallow,* *Hirundo pyrrhonota*
Savannah Sparrow, *Passerculus sandwichensis*
Ipswich Sparrow, *Passerculus sandwichensis princeps*
Grasshopper Sparrow, *Ammodramus savannarum*
Bobolink, *Dolichonyx oryzivorus*

*Only breeding population considered endangered or threatened
**Federally endangered or threatened

REPTILES

Endangered

Bog Turtle, *Clemmys muhlenbergi*
Atlantic Hawksbill, *Eretmochelys imbricata***
Atlantic Loggerhead, *Caretta caretta***
Atlantic Ridley, *Lepidochelys kempi***
Atlantic Leatherback, *Dermochelys coriacea***
Corn Snake, *Elaphe g. guttata*
Timber Rattlesnake, *Crotalus h. horridus*

Threatened

Wood Turtle, *Clemmys insculpta*
Atlantic Green Turtle, *Chelonia mydas***
Northern Pine Snake, *Pituophis m. melanoleucus*

**Federally endangered or threatened

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF FISH, GAME AND WILDLIFE

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AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salamander, *Ambystoma t. tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysoscelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale *Physeter, macrocephalus***
Fin Whale, *Balaenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Endangered

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

**Federally endangered

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

List revisions: March 29, 1979
January 17, 1984
May 6, 1985
July 20, 1987
June 3, 1991

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP&E's Division of Fish, Game and Wildlife's, Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to insure the survival of the State's endangered and nongame wildlife. This work is made possible only through voluntary contributions received through the Wildlife Check-off on the New Jersey State Tax Form. The Wildlife Check-off is the only major funding source for the protection and management of the State's endangered and nongame wildlife resource. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife contact: Endangered and Nongame Species Program, Northern District Office, Box 383 R.D. 1, Hampton, NJ 08827 or call (908) 735-8975.

SECTION B-4

PLANNING AID REPORT, COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT, DELAWARE RIVER FROM PHILADELPHIA TO THE SEA, UPLAND DISPOSAL SITES

U.S. FISH AND WILDLIFE SERVICE

JULY, 1995

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

UPLAND DISPOSAL SITES

U.S.
FISH & WILDLIFE
SERVICE
DEPARTMENT OF THE INTERIOR

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

July 1995

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232

Tel: 609-646-9310
FAX: 609-646-0352

IN REPLY REFER TO:

FP-95/25

July 13, 1995

Lt. Colonel Robert P. Magnifico
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Magnifico:

Enclosed is the U.S. Fish and Wildlife Service (Service) planning aid report on the Philadelphia District Corps of Engineers' (District) Comprehensive Navigation Study, Main Channel Deepening Project, Delaware River from Philadelphia to the Sea (Upland Disposal Sites). This report has been prepared pursuant to a Fiscal Year-1995 interagency agreement between the District and the Service.

This planning aid report is provided as technical assistance and does not constitute the report of the Secretary of Interior pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, 16 U.S.C. 661 *et seq.*). Planning aid is valid only for the described conditions and must be revised if changes to the proposed project take place prior to initiation.

This report is also provided pursuant to the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to ensure the protection of endangered and threatened species and does not address all Service concerns for fish and wildlife resources. These comments do not preclude separate review and comments by the Service on any forthcoming environmental documents pursuant to the National Environmental Policy Act of 1969 as amended (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

Federally-listed Species

The federally-listed endangered bald eagle (*Haliaeetus leucocephalus*) nests inland from the mouth of Raccoon Creek, but feeds extensively in riverine marshes. Bald eagles also roost in forested areas in the vicinity of the project area. Bald eagle use of these marshes reaches a peak in winter.

The federally-listed endangered peregrine falcon (*Falco peregrinus*) also nests on Delaware River bridges in the immediate vicinity of the proposed disposal areas. Peregrine falcons may be expected to forage for prey throughout the project area and generally feed on songbirds, gulls, terns, shorebirds, and wading birds. Additionally, peregrine falcons use the Delaware Bay shoreline during migration, especially in the fall.

It is our understanding that the Corps is preparing a Biological Assessment to address potential project-related adverse impacts to the bald eagle, and peregrine falcon. Other than the aforementioned species, no other federally-listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area. It is also our understanding that the Corps is coordinating with the National Marine Fisheries Service regarding the federally-listed shortnose sturgeon (*Acipenser brevirostrum*) (endangered), Atlantic Ridley turtle (*Lepidochelys kempii*) (endangered), and loggerhead turtle (*Caretta caretta*) (threatened). Appendix A provides lists of federally-listed endangered and threatened species and federal candidate species in New Jersey.

Any questions regarding this report or federally-listed endangered or threatened species should be directed to Eric Schrading of my staff. The Service looks forward to continued cooperation with the District in the planning stages of the proposed project.

Sincerely,

Clifford G. Day

Clifford G. Day
Supervisor

Enclosure

PLANNING AID REPORT

COMPREHENSIVE NAVIGATION STUDY, MAIN CHANNEL DEEPENING PROJECT DELAWARE RIVER FROM PHILADELPHIA TO THE SEA

UPLAND DISPOSAL SITES

Prepared for:

U.S. Army, Corps of Engineers
Philadelphia District
Philadelphia, Pennsylvania 19107

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

Preparers: Eric P. Schrading and Peter M. Benjamin
Assistant Project Leader: John C. Staples
Project Leader: Clifford G. Day

July 1995

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I. INTRODUCTION

The Delaware River provides an important avenue for waterborne commerce. However, the existing Delaware River navigation channel is of insufficient depth to accommodate bulk commodity vessels at design drafts. These commodities, which include crude oil, coal, and iron ore, are currently shipped in partially loaded vessels due to draft restrictions.

The U.S. Army Corps of Engineers, Philadelphia District (Corps) is currently studying feasible modifications to the Delaware River that would increase the efficiency of the Delaware River navigation channel. Alternatives have been evaluated based on their potential effects on natural and social environments and impacts on fish and wildlife resources within the study area.

This U.S. Fish and Wildlife Service (Service) planning aid report includes: an identification of fish and wildlife resources on the existing and proposed upland dredged material disposal sites; a discussion of the potential impacts on those resources from disposal activities; a preliminary discussion of possible mitigative measures; and, recommendations for fish and wildlife habitat improvements. The objective of this report is to provide the Corps with specific recommendations on mitigative measures and fish and wildlife habitat improvements for the Corps' proposed upland disposal sites. The report is based on project plans provided in the Delaware River Comprehensive Navigation Study, Main Channel Deepening Project, Final Draft Interim Feasibility Report and Final Environmental Impact Statement (FEIS) (U.S. Army Corps of Engineers, 1992). A previous planning aid report addressing fish and wildlife resources in three of the four proposed disposal sites was completed by the Service in November 1989 (U.S. Fish and Wildlife Service, 1989). In addition, the Service completed a Fish and Wildlife Coordination Act Section 2(b) Report on the proposed project in June 1992 (U.S. Fish and Wildlife Service, 1992).

The Service requests that no part of this report be used out of context and, if the report is reproduced, it should appear in its entirety. Any information excerpted from this report should be properly cited and include the page number from which the material was taken.

II. PROJECT DESCRIPTION

In the Delaware River Comprehensive Navigation Study, the Corps is evaluating existing conditions affecting waterborne commerce on the Delaware River and Delaware Bay and is recommending a plan of improvement to meet the current and future needs of users of Delaware River ports. For purposes of the Corps' feasibility study, the project area was divided into five reaches (Figure 1). The Corps' tentatively-selected plan calls for a navigation project extending from the deep water in Delaware Bay to the Beckett Street terminal in Philadelphia Harbor, a distance of 102.5 miles (Figure 2). The Corps selected a two-way, full-width channel with a maximum depth of 45 feet at mean low water (plus two feet of allowable overdraft) as the recommended plan of improvement.

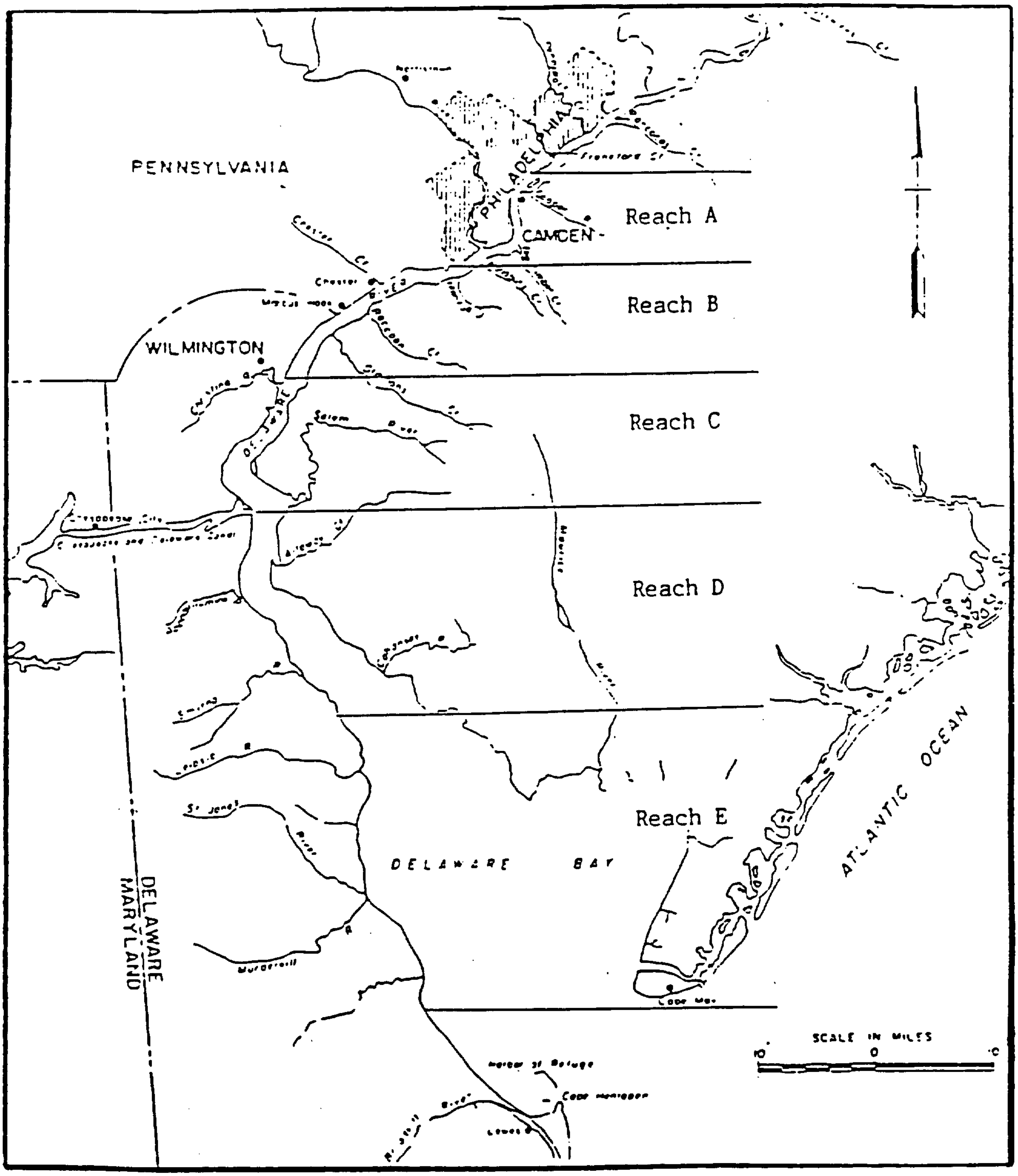

Figure 1. Study area for the Delaware River Comprehensive Navigation Study, Main Channel Deepening, showing the limits of study reaches A through E. Source: U.S. Army Corps of Engineers, 1990.

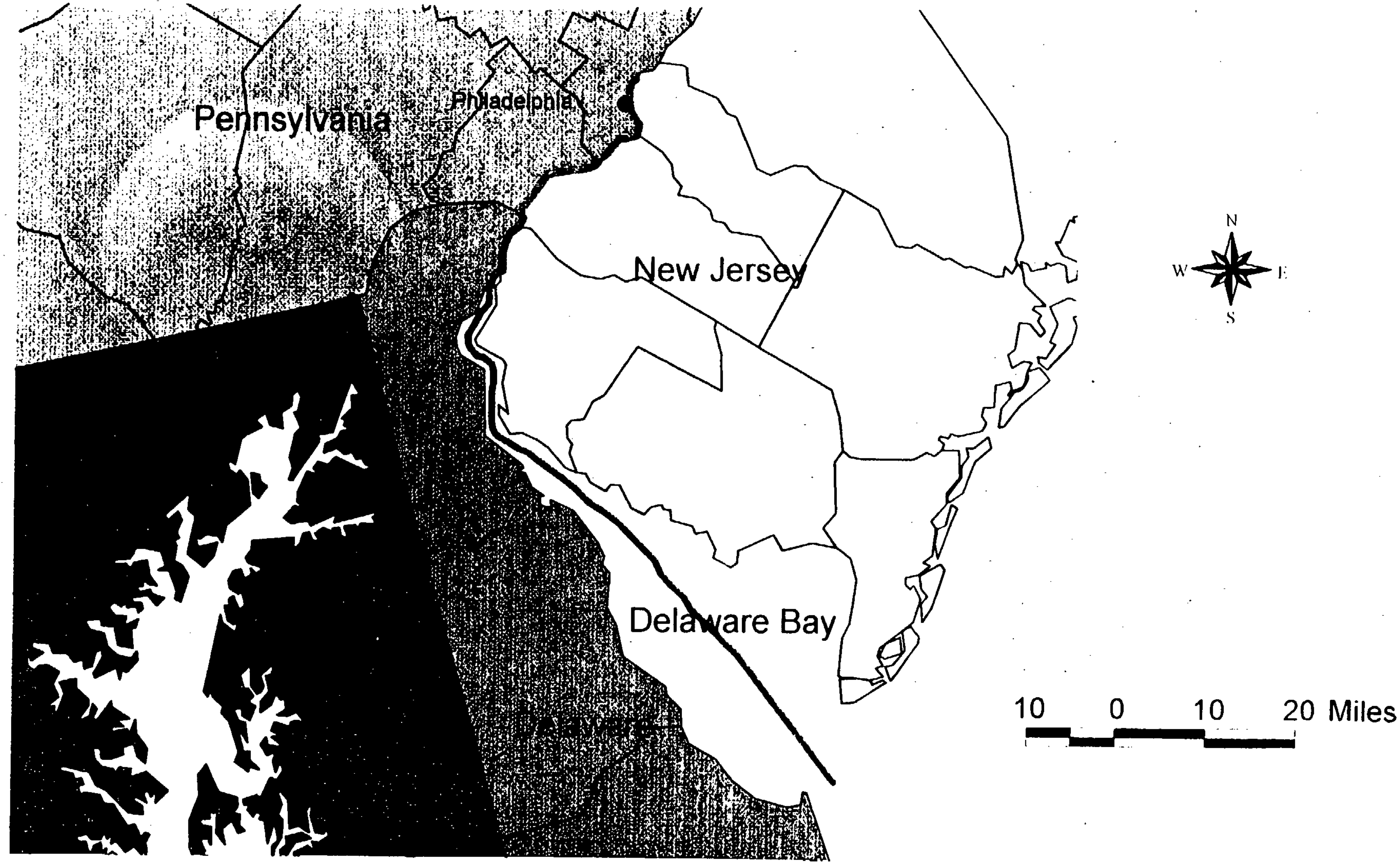

Figure 2. Delaware River, Comprehensive Navigation Study, Main Channel Deepening, showing the location of the main channel and channel bends.

From the Beckett Street Terminal in Camden, New Jersey through Philadelphia Harbor, the 400- to 500-foot-wide west side channel, now at a 40-foot depth relative to mean low water, would be deepened to 45 feet, while the east side channel would remain at the 37-foot depth. Between the Philadelphia Navy Yard and the Delaware Bay, the existing channel would be deepened to 45 feet for its entire 800-foot width. In the Bay, the full 1,000-foot-wide channel would be deepened to 45 feet. Other aspects of the selected plan include widening of 16 channel bends, partial deepening of the Marcus Hook Anchorage, and deepening of access to the bulk berths at Beckett Street Terminal. When required, advanced maintenance dredging of the channel to 47 or 49 feet below mean low water would occur depending on rate of shoaling. High shoaling areas would be dredged at a minimum of every year, while areas of less shoaling would be dredged at intervals of several years. Upon project completion, the channel would have three horizontal to one vertical side slope ratio.

The initial dredging quantity necessary to increase channel depths from the currently authorized 40 feet includes 50,100,000 cubic yards from the federal project (channel and anchorage) and 2,423,300 cubic yards from the non-federal project (berth areas). Maintenance dredging would increase by an estimated 756,000 cubic yards per year. Construction of the proposed project would also entail removal of approximately 420,000 cubic yards of rock in the vicinity of Marcus Hook, Pennsylvania.

For the initial construction, the selected dredged material disposal plan includes the use of Site 17G in Reach A; sites 15D and 15G for Reach B; the Raccoon Island disposal area for Reach C; and, Reedy Point North, Reedy Point South, and Raccoon Island for Reach D. Reedy Point North and Reedy Point South are existing federal disposal sites, whereas sites 17G, 15D, 15G, and Raccoon Island are proposed new upland disposal sites. The Corps is currently examining beneficial uses of Delaware Bay channel materials including wetland restoration / shoreline protection and offshore stockpiling for subsequent beach nourishment. Dredged material from maintenance dredging would be placed at currently used federal and non-federal disposal sites.

III. METHODS AND PROCEDURES

This planning aid report incorporates information compiled from searches of the Service's New Jersey Field Office library and files, personal interviews, and other sources. Additionally, two New Jersey Department of Environmental Protection databases (Notable Information on New Jersey Animals and the Biological and Conservation Database) were reviewed for information on federally-listed and State-listed species and on other fish and wildlife use in the vicinity of the upland disposal sites. The Service's November 1989 planning aid report on the proposed upland disposal sites was also reviewed with regard to fish and wildlife resources that occur on the proposed upland disposal sites (U.S. Fish and Wildlife Service, 1989). In addition, reports compiled for the Corps by Dames & Moore, Inc. (1994a; 1994b; 1994c; and 1994d) on each proposed new disposal site (i.e., Raccoon Island, 15D, 15G, and 17G) were reviewed and relevant information was incorporated into this planning aid report. Representatives of the Service have made numerous site visits (including one aerial overflight) of the proposed upland disposal sites between July 13, 1989 and October 23, 1989. More recently, all proposed new upland disposal sites were investigated in the field by a Service biologist on March 6, 1995 for preparation of this report. Information collected by the Service during the site visits was compared with information collected by Dames and Moore, Inc. to verify site conditions. Existing upland disposal sites Penns Grove, Pedricktown North, Pedricktown South, Oldmans site, and National Park were visited by a Service representative on April 12, 1995. Service site visits of existing upland disposal sites were beneficial toward visualizing future conditions on proposed new upland disposal sites and toward developing management recommendations. The active federal disposal sites, Reedy Point North and Reedy Point South, were not visited by the Service.

IV. EXISTING ENVIRONMENT

A. DELAWARE RIVER AND DELAWARE BAY

The Delaware Estuary drains 12,765 square miles and includes 782 square miles of water surface. Overviews of the project area and fish and wildlife resources present in the Delaware River and Delaware Bay are available in previous Service planning aid reports (see U.S. Fish and Wildlife Service, 1983; U.S. Fish and Wildlife Service, 1985).

The Delaware Estuary has higher water quality today than at any other time during this century (Albert, 1988). Water quality improvements are reflected in the great diversity and abundance of fish in portions of the river that until recently, were considered heavily polluted. However, studies in the upper reaches of the Delaware River associated with the proposed project revealed heavy metal concentrations in sediments (e.g., antimony, arsenic, beryllium, cadmium, chromium, mercury, selenium, thallium, and zinc) in excess of NJDEP Interim Soil Action Level criteria (U.S. Army Corps of Engineers, 1991). Sampling within the lower Delaware River and Delaware Bay revealed only trace levels of heavy metals and the Corps has concluded that sediments are clean within the area of the Delaware Bay where dredging is proposed (U.S. Army Corps of Engineers, 1991).

The Delaware Estuary supports many federal trust resources of interest to the Service. Anadromous fish such as American shad (*Alosa sapadissima*), blueback herring (*A. aestivalis*), and alewife (*A. pseudoharengus*), and semi-anadromous fish such as striped bass (*Morone saxatilis*), pass through or spawn within the project area. The Delaware Estuary also supports diverse and abundant waterfowl populations during migration and in winter. During a 1990 annual midwinter survey, the New Jersey Division of Fish, Game and Wildlife (NJDFGW) counted 174,600 migrating waterfowl within the Delaware Bay coastline (New Jersey Division of Fish, Game and Wildlife, 1990).

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The Delaware Estuary also supports the largest staging area for shorebirds in the Atlantic Flyway (New Jersey Division of Fish, Game and Wildlife, 1994). The NJDFGW (1994) documented peak counts of 200,000 to over 400,000 shorebirds in surveys conducted from May to June 1986 through 1992. Semipalmated sandpipers (*Calidris pusilla*), ruddy turnstones (*Arenaria interpres*), sanderlings (*Calidris alba*), and red knots (*Calidris canutus*) made up the majority of the shorebirds observed in the surveys. Dunlin (*Calidris alpina*) and dowitchers (*Limnodromus* spp.) also were commonly observed in the surveys.

B. FEDERALLY-LISTED AND STATE-LISTED ENDANGERED AND THREATENED SPECIES

1. Federally-Listed Species

The project site is within the breeding range of two federally-listed endangered species under Service jurisdiction: the peregrine falcon (*Falco peregrinus*) and the bald eagle (*Haliaeetus leucocephalus*). In recent years, peregrine falcons have nested or attempted to nest on various Delaware River bridges. One peregrine pair nested in 1992 on the Commodore Barry bridge immediately adjacent to the Raccoon Island disposal site. Peregrine falcons feed mostly on shorebirds, waterfowl, and passerines. Peregrines may travel 10 to 18 miles in search of prey and seek feeding opportunities in marshes and riparian areas where these prey concentrate.

The bald eagle is known to nest near the Delaware River and Delaware Bay in New Jersey and Delaware, and also winters in, and migrates through, the area. There are currently 11 active eagle nests in New Jersey, including one within five miles of Site 17G. Most of these nests are located within 10 miles of the Delaware Estuary. A currently-occupied nest is located near Gibbstown, New Jersey, less than 0.5 mile from the Delaware River. The eagles using this nest are known to feed along the river (Clark, pers. comm., 1995). Additionally, the adult eagles from many of these nests appear to be year-around residents of the Delaware Estuary area (Clark, pers. comm., 1995). No other federally-listed or proposed species under Service jurisdiction are known to regularly occur within the project boundary.

The National Marine Fisheries Service (NMFS) has jurisdiction over the federally-listed endangered shortnose sturgeon (*Acipenser brevirostrum*), the endangered Atlantic Ridley turtle (*Lepidochelys kempii*), and federally-listed threatened loggerhead turtle (*Caretta caretta*). The shortnose sturgeon has been found throughout the project area, though spawning is thought to be limited to areas upstream from the project area. Importance of the area to juveniles and post-spawning adults is not certain. Lists of federally-listed, proposed, and candidate species in New Jersey are provided in Appendix A.

Project-related activities could adversely affect the bald eagle and peregrine falcon. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment if the project is a construction project that requires an Environmental Impact Statement and the project may affect federally-listed species. The District is currently preparing a Biological Assessment to address potential project-related adverse impacts to the above-mentioned species. The Service recommends that the Corps continue to consult with the Service and the NMFS during preparation of the Biological Assessment.

2. State-Listed Species

A pair of osprey (*Pandion haliaetus*) nest on a transmission line tower immediately adjacent to the proposed Raccoon Island disposal site. This species is listed by the State of New Jersey as threatened. An American bittern (*Botaurus lentiginosus*) and seven great blue herons (*Ardea herodias*), both of whose breeding populations are listed as threatened by the State of New Jersey, were also observed on the proposed Raccoon Creek disposal area (Dames & Moore, Inc., 1994a). One great blue heron was also observed on the proposed Site 15D disposal area. However, no heron rookeries are known to occur within the vicinity of either Site 15D or Raccoon Creek proposed dredge disposal sites. A list of species considered endangered or threatened by the State of New Jersey is presented in Appendix B.

For additional information on State-listed species, the Service recommends that the Corps contact the NJDFGW, Endangered and Nongame Species Program at the following address:

Mr. Larry Niles
Endangered and Nongame Species Program
Division of Fish, Game and Wildlife
CN 400
Trenton, New Jersey 08625
(609) 292-9101

C. UPLAND DISPOSAL SITES

New sites proposed for the disposal of dredged material for this project are Raccoon Island, sites 15D, 15G, and 17G (Figure 3). Existing federal sites currently used for maintenance dredging and proposed for use for initial project construction are Reedy Point North and Reedy Point South.

All four of the proposed new sites are located in New Jersey adjacent to the Delaware River and have been used for dredged material disposal in the past. Cover types present range from agricultural fields and monotypic fields of common reed (*Phragmites australis*), to mature forest dominated by black willow (*Salix nigra*), black cherry (*Prunus serotina*), and other tree species. Wetlands are present on or adjacent to all four sites.

A diversity of wildlife species occur on the four proposed disposal sites including species of resident and migrating birds, mammals, reptiles, and fish (Dames & Moore, Inc., 1994a; 1994b; 1994c; and 1994d). In general, the species identified reflect the extensive open habitat present on the sites and their proximity to the Delaware River, various tidal creeks, and associate marshes.

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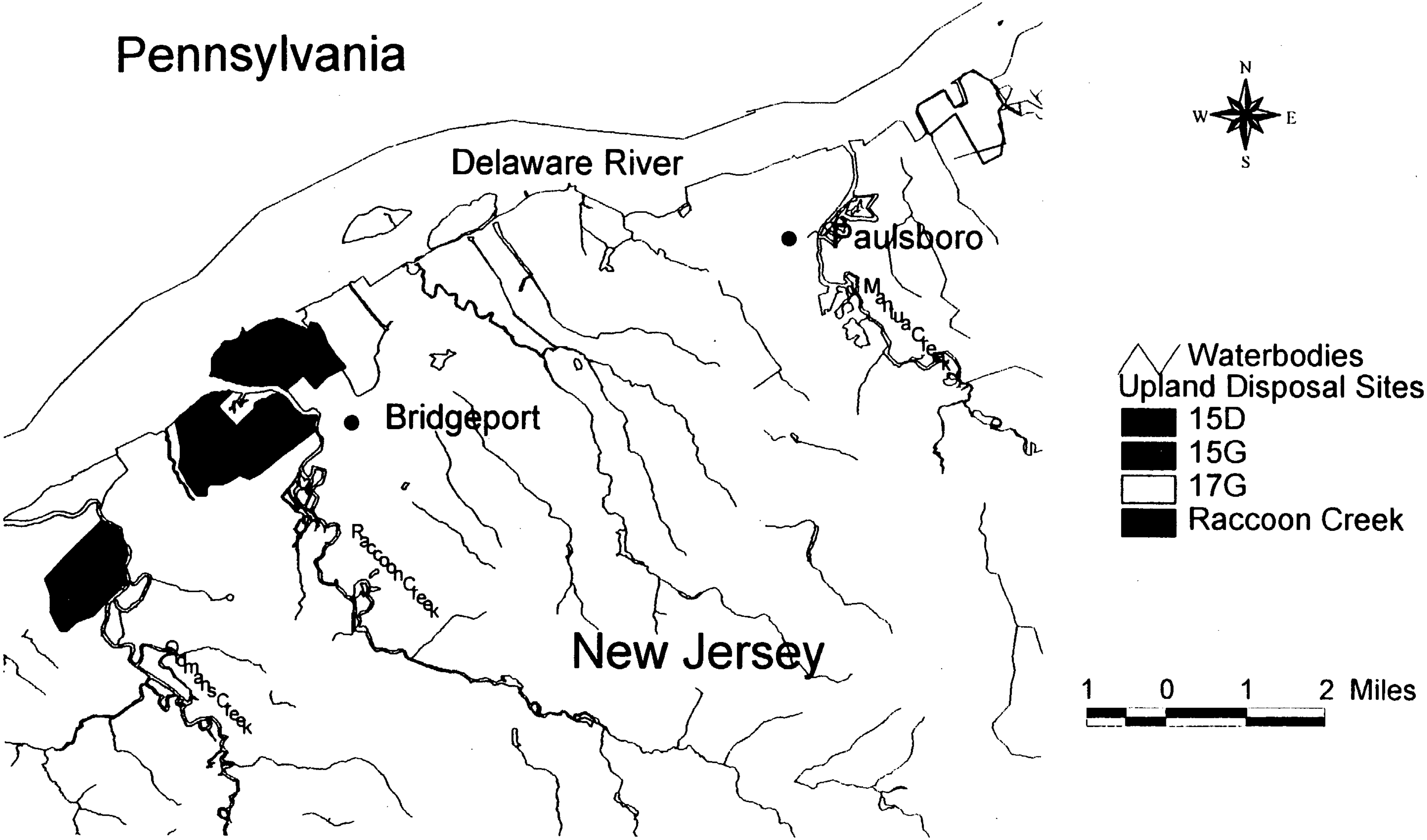

Figure 3: Proposed Upland Disposal Sites for the Delaware River Comprehensive Navigation Project

1. Raccoon Island

Raccoon Island is an approximately 640-acre site in Logan Township, Gloucester County, New Jersey, bordered by State Route 130 to the south, the Delaware River to the north, Raccoon Creek to the west, and private property to the east. Raccoon Island is currently a partially-active Delaware River dredged material disposal site. Approximately 15 to 20 feet of dredged material cover the original ground surface (Dames & Moore, 1994a). A number of dikes divide the proposed site into several raised units, which are approximately 20 feet above the elevation of the Delaware River. The Commodore Barry Bridge, a fixed span bridge that crosses the Delaware River, traverses the northeast portion of the site. Raccoon Island is relatively flat except for the dikes and berms.

Approximately 501 acres of wetlands occur on Raccoon Island. Most of these wetlands are classified as palustrine emergent wetland and are dominated by common reed (Figure 4) (Dames & Moore, 1994a). Several palustrine open water areas occur on the site and are surrounded by emergent vegetation such as spike rush (*Eleocharis obtusa*), shallow sedge (*Carex lurida*), arrowwood (*Viburnum recognitum*), and switch grass (*Panicum virgatum*). In addition, approximately 34 acres of forested wetlands occur on Raccoon Island and are dominated by black willow with a shrub understory of coastal plain willow (*Salix caroliniana*). One forested wetland unit (one acre) is dominated by green ash (*Fraxinus pennsylvanica*). The area surrounding Raccoon Island includes residential and agricultural land.

Approximately 139 acres of upland occur on Raccoon Island, which is typically dominated by tree-of-heaven (*Ailanthus altissima*), princess tree (*Paulownia tomentosa*), white mulberry (*Morus alba*), black cherry, and staghorn sumac (*Rhus typhina*). Raccoon Island supports 277 species of plants; however, the most abundant species are alien herbs (Dames & Moore, 1994a). Areas on the perimeter of Raccoon Island and along the berms and dikes in the interior of the site provide the most diverse habitat for wildlife species (Figure 4) when compared to monotypic stands of common reed in the center of the site.

Areas dominated by common reed cover 472 acres of the Raccoon Island site. Contrary to the popular view that common reed provides low value habitat, many areas dominated by common reed support a wide variety of wildlife species. This is particularly true in areas where common reed is interspersed with shallow water and/or areas of tidal influence, and when other species (particularly food plants such as duckweed) are present. However, most of the common reed areas on Raccoon Island consist of monotypic stands with little or no standing water and as such currently provide lower value habitat than other areas of the site. Overall, 7 species of mammals and 48 species of birds were observed on the site (Dames & Moore, 1994a). Species observed during the Service's March 6, 1995 site visit included white-throated sparrow (*Zonotrichia albicollis*) and northern harrier (*Circus cyaneus*). Wildlife on Raccoon Island is generally more abundant and diverse in woodland (102 acres) and tidal marsh (29 acres) areas as a result of the ability of these areas to meet the food, cover, and reproductive needs of more individuals and species. For this reason, the woodland and tidal marsh areas are generally classified as moderate to high value to wildlife.

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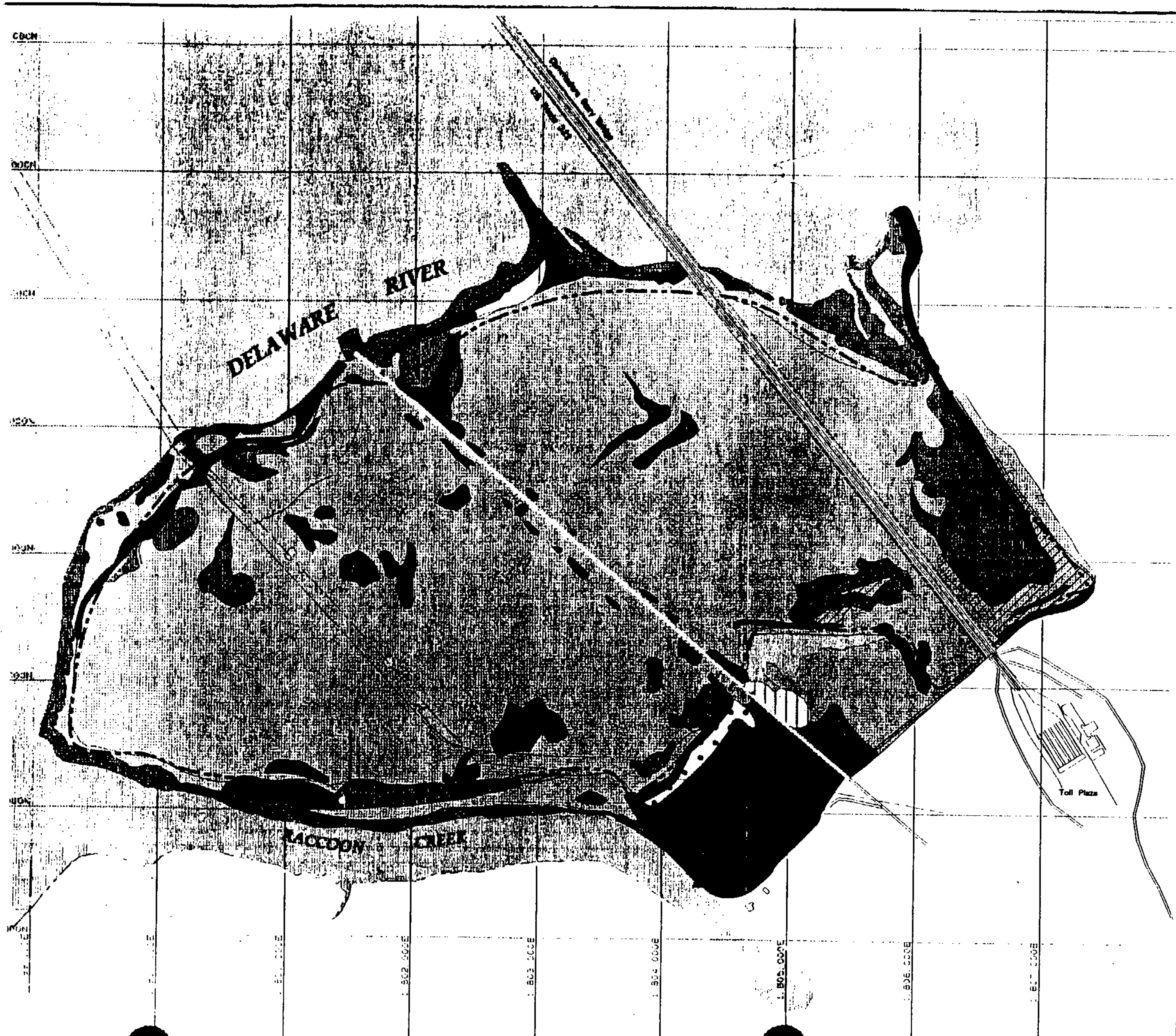
Figure 4:

VEGETATION/ LAND COVER TYPES
RACCOON ISLAND



Delaware River Comprehensive Navigation Study Main Channel Deepening Project

Legend:	Acreage:
Black Locust Dominated	2
Black Willow Dominated	49
Mixed Lowland Hardwoods	21
Mixed Upland Hardwoods	24
Arrowwood Dominated Thicket	2
Blueberry Dominated Shrublands	2
Shoreline Shrubs	2
Common Reed Dominated	458
Common Reed/Mixed Herb	8
Non-tidal Marsh	4
Switchgrass	2
Tidal Marsh	29
Ruderal Area	33
Water Body	6
Apparent Primary Berm Line	
Electrical Transmission Line	
Pipeline	
Highway	
Secondary Road	
Trail	

New Jersey High-Interest Specie Locations:

▲ *Rumex hastatulus*

1:9600

800 0 1600

feet

September 15, 1994

Notes:

1. Initial habitat delineations made via interpretations from [illegible] aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were digitized from the Philadelphia Corps of Engineers blue line maps, referenced to the New Jersey State Plane coordinate system.

Source: Dames & [illegible] Inc. 1994

2. Site 15D

Site 15D is located in Logan Township, Gloucester County, New Jersey and is approximately 470 acres (Dames & Moore, 1994b). The site is bounded by Raccoon Creek to the north and east, Route 130 to the south, and farmland and Birch Creek to the west. Site 15D is currently used for rotational agriculture, primarily soybean and corn cropping. However, most of the site was used for dredged material disposal between approximately 1955 and 1965. The thickness of dredged materials ranges from 10 to 20 feet over both uplands and wetlands (Dames & Moore, 1994b). Land use prior to the dredged material disposal activities was agricultural.

Site 15D is relatively flat except for numerous dikes and ditches that subdivide the site into ten compartments. Each compartment was used for dredged material deposition (Dames & Moore, 1994b). The land surrounding Site 15D consists of undeveloped land (primarily freshwater tidal marsh), residential, and heavy industry.

Wetlands occur on the north, east, and south edges of the Site 15D and in several pockets in the center of the site (Figure 5). Dames and Moore (1994b) identified fifteen wetland units on Site 15D totaling 51 acres. However, Dames and Moore (1994b) did not delineate the size of two tidal marshes along Raccoon Creek within the site. All of the wetlands on Site 15D are palustrine emergent and are dominated by common reed, reed meadowgrass (*Glyceria maxima*), Pennsylvania smartweed (*Polygonum pensylvanicum*), and soft rush (*Juncus effusus*). However, several units are also dominated by black willow, black gum (*Nyssa sylvatica*), red maple (*Acer rubrum*), box elder (*Acer negundo*), and white mulberry. One unit (identified as "BL") is approximately 12 acres and includes a particularly diverse plant community dominated by spotted touch-me-not (*Impatiens capensis*), Japanese honeysuckle (*Lonicera japonica*), royal fern (*Osmunda regalis*), sensitive fern (*Onoclea cylindrica*), skunk cabbage (*Symplocarpus foetidus*), soft rush, black gum, red maple, black willow, sweetgum (*Liquidambar styraciflua*), and duckweed (*Lemna* spp.) (Dames & Moore, 1994b). Many of the wetlands on the periphery of the site are tidally influenced (29 acres) and are dominated by arrowwood, spatter dock (*Nuphar luteum*), and pickerelweed (*Pontederia cordata*) (Dames & Moore, 1994b).

The majority (419 acres) of Site 15D is upland and much of the upland (299 acres) is under rotational row-crop agriculture (Figure 5). Mixed lowland hardwoods (18 acres) occur along the border of Raccoon Creek and are dominated by green ash, red maple, and black willow (Dames & Moore, 1994b). Mixed upland hardwoods (28 acres) are restricted primarily to berms. The canopy of this community is dominated by black cherry, white mulberry, tree-of-heaven, and princess tree. Mixed oak (4 acres), ruderal areas (6 acres), and black willow dominated communities (14 acres) also occur on Site 15D. Ruderal areas are disturbed areas such as roadsides and waste places that are often colonized by weedy herbaceous species. Site 15D supports 264 species of plants; however, the most diverse communities occur on the periphery of the site (Dames & Moore, 1994b).

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The agricultural areas, which comprise the largest cover type on the site, offer low to moderate habitat value. Ruderal areas (i.e., disturbed areas such as roadsides and waste places that are often colonized by weedy herbaceous species) and common reed communities also provide limited value to wildlife due to their low structural diversity. Woodlands and tidal marsh areas are generally more diverse, providing habitat for a variety of wildlife species and are classified as moderate to high value for wildlife. Thirteen species of mammals and 39 species of birds were observed on Site 15D (Dames & Moore, 1994b). Due to their high value to waterfowl, marshes of Raccoon Creek have been designated by the Service as focus areas for needed protection under the Atlantic Coast Joint Venture, an effort being undertaken pursuant to the North American Waterfowl Management Plan (NAWMP). Site 15D is also adjacent to a priority wetland as designated by the Department of the Interior (DOI) under the Emergency Wetlands Resources Act (EWRA) (P.L. 99-645; 100 Stat. 3582). Raccoon Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

3. Site 15G

Site 15G is an approximately 380-acre site located in Oldmans Township, Salem County, New Jersey. The site is bounded by Route 130 to the north, Oldmans Creek to the east, Conrail railroad tracks to the south, and Railroad Avenue to the west (Dames & Moore, 1994c). The site has been farmed since approximately 1980 (primarily rotational corn and soybean cropping). Site 15G has been completely bermed and partially filled with dredged material since at least 1959 (Dames & Moore, 1994c). Site 15G is relatively flat except for a perimeter dike and interior berm. The site has approximately 15 to 20 feet of deposited dredged material inside the dike. Surrounding land use includes a mixture of agriculture, residential development, and heavy industry (Dames & Moore, 1994c).

Seven wetland units, totaling approximately 6.5 acres occur on Site 15G. However, Dames & Moore (1994c) did not delineate one tidal marsh along Oldmans Creek within Site 15G. All of the wetland units within the site are palustrine emergent wetlands (Figure 6). The largest wetland unit (5 acres) is dominated by common reed and duckweed. The remaining smaller (<1 acre) wetland units are dominated by spatterdock, purple loosestrife (*Lythrum salicaria*), arrow arum (*Peltandra virginica*), common reed, jewelweed (*Impatiens capensis*), sensitive fern, and Pennsylvania smartweed (Dames & Moore, 1994c). Two very small (<0.1 acre) units are dominated by the above mentioned herbaceous vegetation and coastal-plain willow (*Salix caroliniana*), American elderberry (*Sambucus canadensis*), and black willow. Two of the seven wetlands are tidal marshes (approximately 5 acres) and occur immediately adjacent to Oldmans Creek.

Approximately 370 acres of upland occur on Site 15G. Much of this area (286 acres) is subject to rotational row-crop agriculture (Dames & Moore, 1994c) (Figure 6). Ruderal areas occupy approximately 15 acres. Site 15G has a thin band of mixed lowland hardwoods (13 acres) along Railroad Avenue on the western side of the site. This area is dominated by green ash, red maple, and black willow. Mixed upland hardwoods (20 acres) occur primarily on the berms

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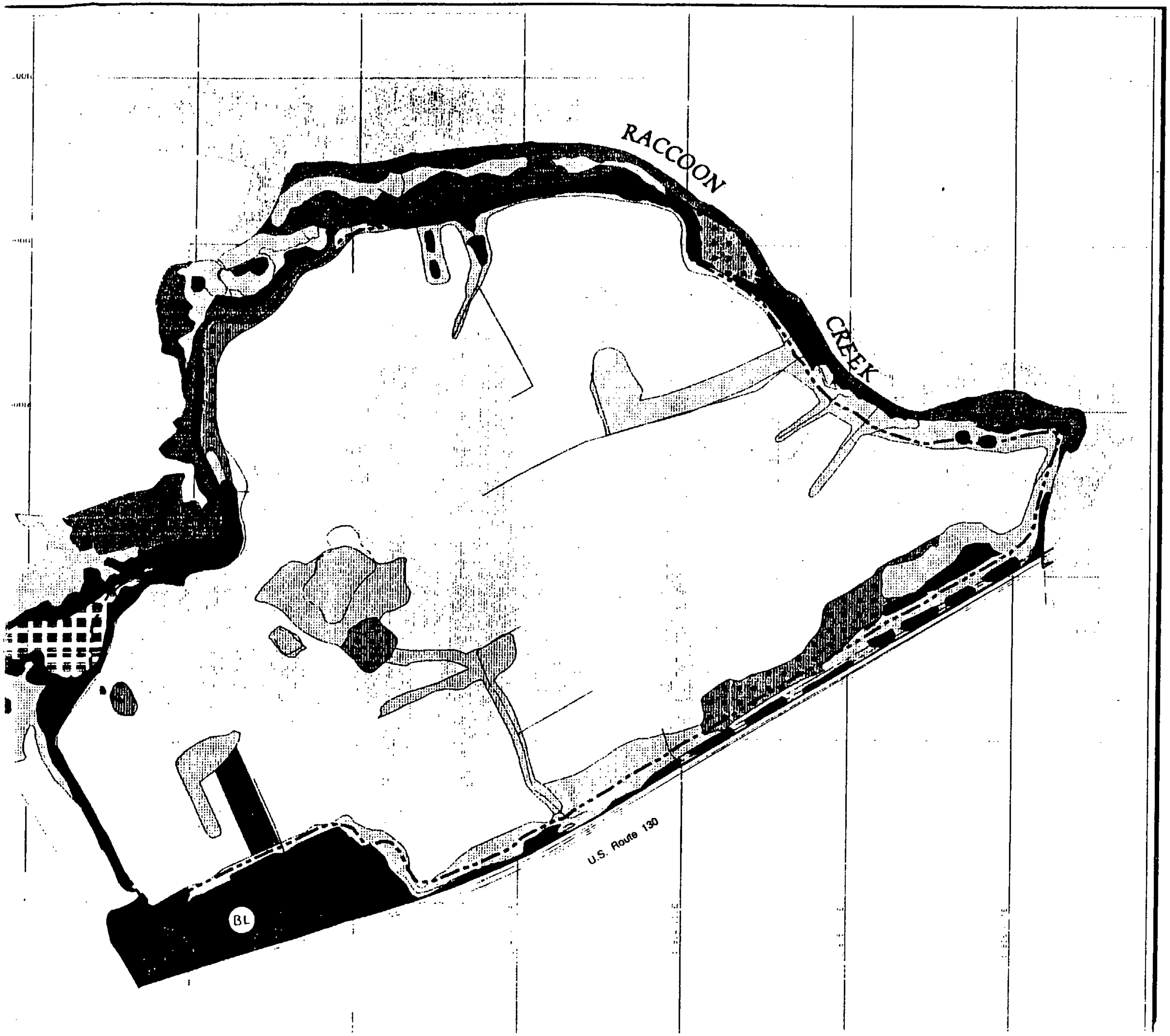

Figure 5:

VEGETATION/ LAND COVER TYPES

SITE 15D

Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project

Legend:	Acreage:
Black Willow Dominated	14
Mixed Lowland Hardwood	18
Mixed Oaks	4
Mixed Upland Hardwood	28
Common Reed Dominated	69
Tidal Marsh	29
Rotational Row crop Agriculture	299
Ruderal Area	6
Apparent Primary Berm Line	
Drainage Ditch	
Highway	
Secondary Road	
Trail	

1:7200

600 0 1200

feet

September 15, 1994

Notes

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed

2. Data used in creating base maps for habitat delineation were obtained from the Philadelphia Corps of Engineers in the form of digital exchange files (dxf), referenced to the New Jersey State Plane coordinate system

Source: Dames & Moore, Inc. 1994

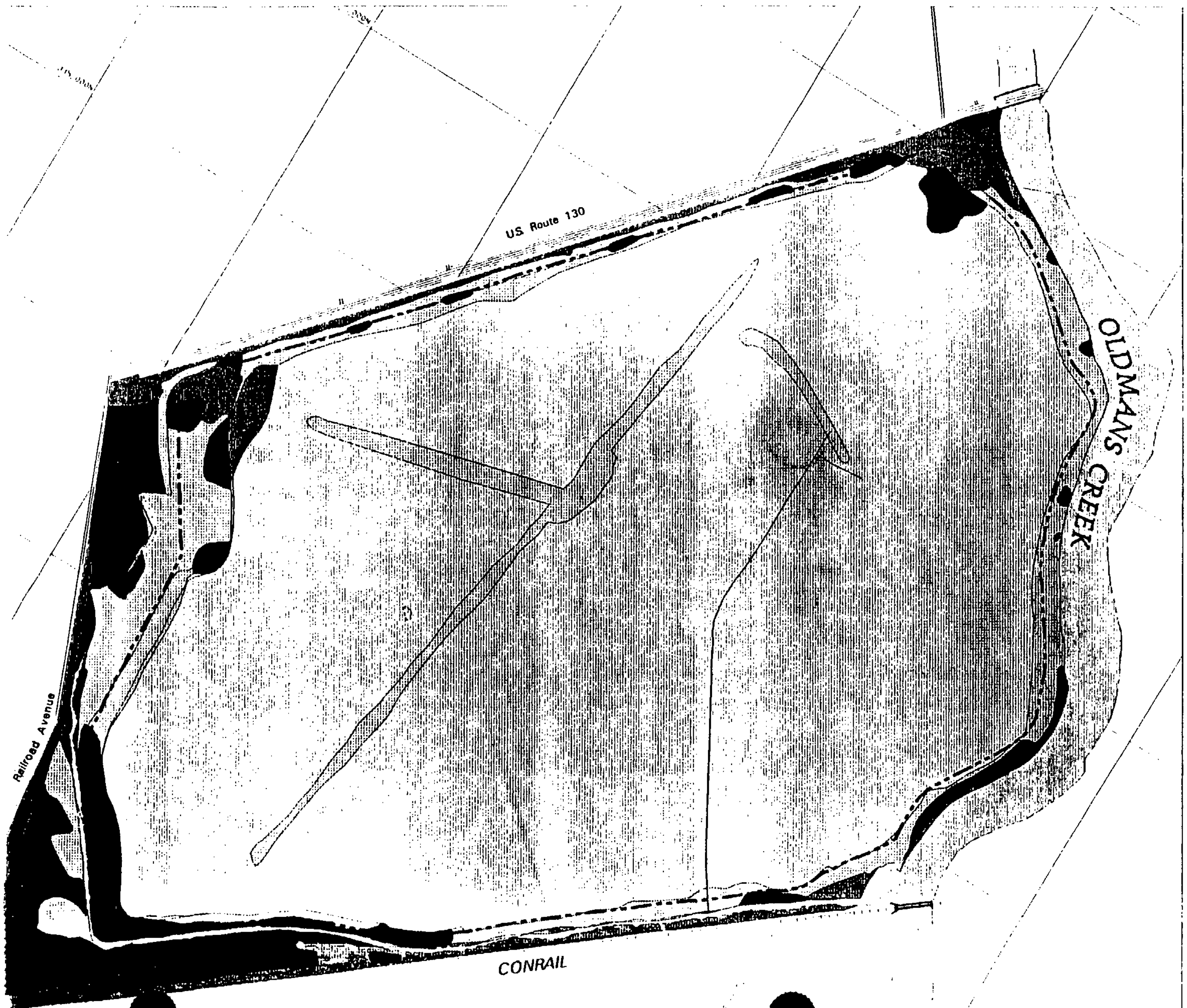

Figure 6:

VEGETATION/ LAND COVER TYPES
SITE 15G

Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project

Legend:	Acreage:
Mixed Lowland Hardwoods	13
Mixed Upland Hardwoods	20
Common Reed Dominated	42
Tidal Marsh	5
Rotational Row Crop Agriculture	286
Ruderal Area	15
Apparent Primary Berm Line	
Drainage	
Gas Transmission Line	
Highway	
Secondary Road	
Railroad	
Trail	

1:6000

500 0 1000

feet

September 15, 1994

Notes.

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were obtained from the Philadelphia Corps of Engineers in the form of digital exchange files (dxf), referenced to the New Jersey State Plane coordinate system.

Source: Dames & Mo Inc. 1994

and are dominated by black cherry, white mulberry, tree-of-heaven, and princess tree. Site 15G supports 217 species of plants; however, the most abundant species are agricultural crops and alien herbs (Dames & Moore, 1994c).

The largest cover type on Site 15G, agricultural areas, offer low to moderate habitat value. Cropped areas provide inadvertent food source for many wildlife species throughout the growing season (Dames & Moore, 1994c). Over 100 Canada geese (*Branta canadensis*) were observed in these fields during the March 6, 1995 site visit. Ruderal areas provide little to no wildlife habitat. Most of the areas dominated by common reed provide limited value for most wildlife species; however, the common reed area, which also supports duckweed, may provide higher value wildlife habitat. Woodland areas and tidal marshes, which occur on the periphery of the site, are the most diverse communities on Site 15G and provide moderate to high habitat value for wildlife species. Twelve species of mammals and 37 species of birds were observed on Site 15G (Dames & Moore, 1994c). Due to their high value to waterfowl, marshes of Oldmans Creek have been designated by the Service as focus areas for needed protection under the NAWMP. In addition, Site 15G and the adjacent wetlands are designated as a priority wetland by the DOI under the EWRA because of the national ecological significance of this wetland complex. Site 15G is also a priority wetland as designated by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1994) under the Clean Water Act (62 Stat. 1155, as amended; 33 U.S.C. 1251 *et seq.*). Oldmans Creek and adjacent marshes are of exceptional value to fish and wildlife resources.

4. Site 17G

Site 17G is located in West Deptford, Gloucester County, New Jersey and is approximately 560 acres. The approximate area within the berms is 465 acres (Dames & Moore, 1994d). Only the northern two-thirds of this site is currently proposed for use as a dredged material disposal site. The lower one-third of this site is currently proposed for use as a wetland mitigation bank by the New Jersey Department of Environmental Protection (Brady, pers. comm., 1995). Site 17G is relatively flat except for the perimeter dike and interior berms. The site is bounded by the Delaware River on the north, active agricultural land to the west, Woodbury Creek to the east, and agricultural and residential land to the south. Site 17G has been used for agriculture, primarily corn and soybean cropping, since 1980. The site was previously used as a dredge disposal site. The land use in surrounding areas is primarily agricultural with some undeveloped fields and woodlands (Dames & Moore, 1994d).

Forty-one non-tidal wetland units comprising 35 acres occur on Site 17G. However, one tidal wetland along Woodbury Creek within site 17G was not delineated by Dames and Moore (1994d). The majority of wetlands within the site are palustrine emergent (Figure 7). Dominant vegetation consists of

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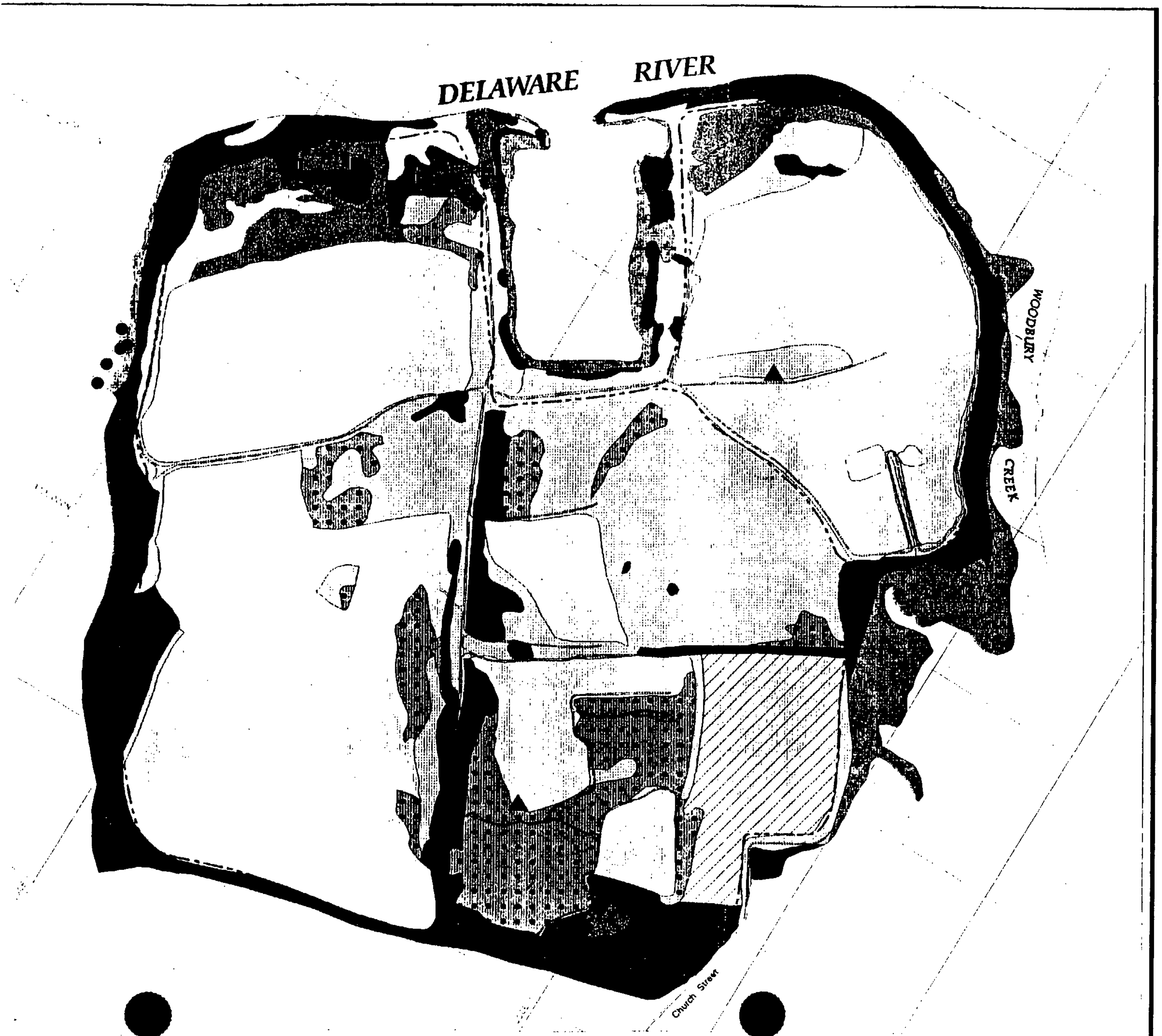


Figure 7:

VEGETATION/ LAND COVER TYPES
SITE 17G

Delaware River
Comprehensive Navigation Study
Main Channel Deepening Project

Legend:	Acreage:
Black Locust Dominated	18
Black Willow Dominated	42
Mixed Lowland Hardwoods	27
Mixed Upland Hardwoods	46
Shoreline Shrub	4
Common Reed Dominated	112
Tidal Marsh	27
Pasture	25
Rotational Row Crop Agriculture	237
Ruderal Area	22
Apparent Primary Berm Line	
Secondary Road	
Trail	

New Jersey High-Interest Species Locations:

● *Zannichellia palustris* ▲ *Carex frankii*

1:7200

600 0 1200

feet

September 16, 1994

Notes:

1. Initial habitat delineations made via interpretations from 1990 aerial photography. Interpretations were field checked and boundary adjustments made where needed.

2. Data used in creating base maps for habitat delineation were digitized from the Philadelphia Corps of Engineers blue line maps, referenced to the New Jersey State Plane coordinate system.

Source: Dames & M Inc. 1994

common reed with some interspersed black willow trees and saplings. One palustrine forested wetland (1 acre) is dominated by black willow, false indigo-bush (*Amorpha fruticosa*), purple loosestrife, and soft rush (Dames & Moore, 1994d). Several emergent wetlands that occur in actively farmed areas include vegetation such as celery-leaf butter-cup (*Ranunculus sceleratus*), blunt spike rush, clammy hedgehyssop (*Gratiola neglecta*), fall panic grass (*Panicum dichotomiflorum*), straw-color flatsedge (*Cyperus strigosus*), and Virginia bugleweed (*Lycopus virginicus*) when the areas are not plowed for corn cultivation. One tidal marsh along Woodbury Creek (approximately 15 acres) consists of black willow and silky dogwood (*Cornus amomum*) along the landward edge of the wetland and yellow cow-lily (*Nuphar luteum*), pickerelweed, and three-square bulrush (*Scirpus americanus*) along the tidal flats and shores of the wetland.

Approximately 510 acres of upland occur on Site 17G, much of which (237 acres) is subject to rotational row-crop agriculture (Dames & Moore, 1994d) (Figure 7). Mixed upland hardwoods (46 acres) are primarily restricted to berms and are dominated by black cherry, white mulberry, tree-of-heaven, and black locust (*Robinia pseudo-acacia*). Several forested areas (42 acres) are dominated by black willow, which has colonized wetlands created by dredge spoil deposition. These areas have since dried via drainage, evaporation, and transpiration. Mixed lowland hardwoods (27 acres) occur along the border of Woodbury Creek, the central tidal basin, and the Delaware River and are dominated by green ash, red maple, and black willow (Figure 7). Pasture areas (25 acres), which support cattle grazing for part of the year, and ruderal areas (22 acres) also occur on Site 17G. Black locust-dominated woodlands (18 acres) occur in well-drained disturbed areas of Site 17G. Site 17G supports 301 species of plants; however, the most abundant species are agricultural crops and alien herbs (Dames & Moore, 1994d).

The agricultural land, which is the largest cover type on the site, offers low to moderate habitat value. Ruderal areas and common reed communities on the site also provide limited value to wildlife due to their low structural diversity. Woodland areas on the perimeter of the site and along interior berms are generally more diverse, providing habitat for a variety of wildlife species. These wetlands may be classified as having moderate to high value for wildlife. Tidal marsh areas also occur on the perimeter of Site 17G and have moderate to high habitat value due to the vegetational diversity of these communities and their proximity to water. Six species of mammals and 50 species of birds were observed on Site 17G (Dames & Moore, 1994d). Species observed during the March 6, 1995 site visit included red-winged blackbird (*Agelaius phoeniceus*), white-throated sparrow, mourning dove (*Zenaida macroura*), northern harrier, and numerous Canada geese in the farm fields. Additionally, numerous waterfowl were observed in the tidal basin including common merganser (*Mergus merganser*), ruddy duck (*Oxyura jamaicensis*), mallard (*Anas platyrhynchos*), scaup (*Aythya* spp.), and pintail (*Anas acuta*). The Delaware River, Woodbury Creek, and adjacent marshes are of exceptional value to fish and wildlife resources.

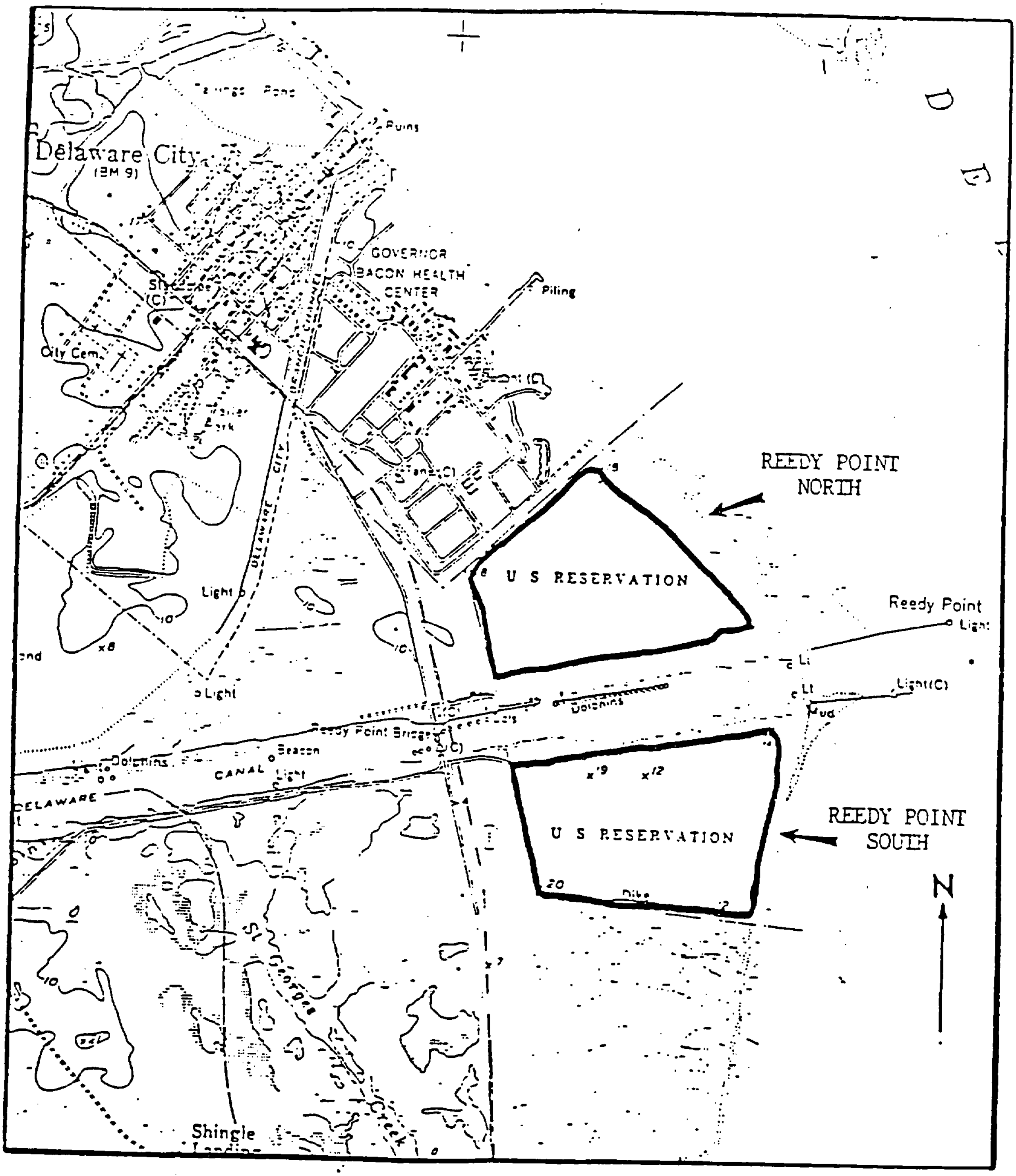
5. Federal Sites Currently in Use

Federal sites currently used for maintenance dredging, and proposed for deposition of material from channel deepening and maintenance dredging, include the following upland sites: Reedy Point North and Reedy Point South in Newcastle County, Delaware (Figure 8), and existing federally-owned disposal sites in New Jersey, including National Park (Reach A), Pedricktown North, Pedricktown South, and Oldmans site (Reach B), Penns Neck and Killcohook (Reach C), and, Artificial Island (Reach D). Reedy Point North and Reedy Point South are reportedly dominated by common reed (Brady, pers. comm., 1995), although the Service has not visited these sites.

The Service visited the National Park, Oldmans, Pedricktown North, Pedricktown South, and Penns Grove disposal sites on April 12, 1995. The predominant cover type on all of these sites is common reed. However, water collects in low-lying portions of these sites, providing valuable habitat for a variety of wetland-associated wildlife species. A large portion of the National Park site supports shallow water interspersed with common reed and duck weed. Many species of birds were observed in this area including American coot (*Fulica americana*), scaup, bufflehead (*Bucephala albeola*), common merganser, mallard, Canada goose, great egret (*Casmerodius albus*), and red-winged blackbird.

Several species were observed on a large shallow water area on the Oldmans site including northern shoveler (*Anas clypeata*), approximately 100 scaup, ruddy duck, northern pintail, Canada goose, greater yellowlegs (*Tringa melanoleuca*), and lesser yellowlegs (*Tringa flavipes*). Additionally, the following species were observed at a shallow ponded area adjacent to the Pedricktown North site: blue-winged teal (*Anas discors*), bufflehead, mallard, scaup, black-crowned night heron (*Nycticorax nycticorax*), green heron (*Butorides striatus*), and bank swallow (*Riparia riparia*). The Pedricktown South site was predominantly common reed with some small areas of black willow. Red-winged blackbird and ring-necked pheasant (*Phasianus colchicus*) were observed at this site.

The Penns Grove site is comprised of a large lake ranging in depth up to 30 feet. Species observed at this site during the Service's April 12, 1995 site visit included Canada goose, ring-necked pheasant, bank swallow, yellow-rumped warbler (*Dendroica coronata*), white-throated sparrow, and bank swallows. Additionally, mallards were observed nesting in the reed canary grass along the shore of the lake.



Scale = 1 : 24,000

Figure 8. Location of federally owned upland disposal sites, Reedy Point North, and Reedy Point South, in Newcastle County, Delaware. Source: U.S. Army Corps of Engineers, 1990.

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V. DISCUSSION OF POTENTIAL IMPACTS FROM ALTERNATIVE UPLAND DISPOSAL SITES

The majority of the four selected new upland disposal sites are of low to medium value for wildlife and typically support monotypic stands of vegetation (e.g., common reed, corn, or soybean). However, areas along interior berms, and particularly along the perimeter of the sites, provide medium to high quality habitat for various species of wildlife. Additionally, the tidal river shallows and vegetated wetlands adjacent to the proposed upland sites provide exceptionally valuable habitat for a variety of fish and wildlife species.

It is the Service's understanding that all new berm construction and subsequent dredged material disposal would occur within the existing berms on these sites (as indicated by the dashed lines labeled "Apparent Primary Berm Line" on Figures 4 through 7). Therefore, the majority of the impacts from the proposed project would be limited to areas of low to medium habitat value (i.e., agricultural fields, ruderal areas, and wetlands dominated by common reed). Additionally, it is likely that cover types similar in habitat value to those that currently exist on the proposed new disposal sites would quickly establish following disposal operations, based on the condition of the existing disposal sites visited by the Service.

The most substantive impacts on wildlife species would occur in the wooded portions of the sites. Some wooded areas of moderate habitat value would be adversely affected by the initial site preparation and subsequent disposal operations. Additionally, although most of the areas that would be affected contain cover types of relatively low habitat value, the large size of the affected areas indicates that considerable numbers of fish and wildlife would be adversely impacted by the proposed project. In order to minimize impacts on fish and wildlife, the Service recommends that the Corps avoid direct impacts on moderate to high value habitats, such as tidal wetlands adjacent to the proposed sites and mature forest along the perimeter of the sites, by focusing dike construction and disposal operations toward the interior of the sites to the extent possible.

Clearing of existing vegetation, and other construction-related activities required prior to use of the upland disposal sites, and inundation of remaining habitat on disposal sites with dredged material may cause direct mortality to wildlife present on the sites, including nesting migratory birds. Adverse impacts to nesting birds could be minimized by conducting site preparation activities outside of the primary migratory bird nesting season: April 1 through July 15.

In reference to new dredged material disposal sites, the Corps states in the DEIS that "construction of replacement habitats is not required to mitigate with-project losses" (U.S. Army Corps of Engineers, 1990). In contrast, the Service recommended full mitigation of all habitats adversely impacted by dredged material disposal (U.S. Fish and Wildlife Service, 1989). Mitigation for adverse impacts on wetland and upland sites should be addressed. The

Service's definition of mitigation is the same used by The Council on Environmental Quality, in which compensation is the least preferred approach. Mitigation may include (in order of preference): (1) avoidance of impacts; (2) minimization of impacts; (3) rectification by repairing, rehabilitating or restoring the effected environment; (4) elimination or reduction of impacts over time; and, (5) compensation through replacement. The Service only endorses mitigation plans that demonstrate compliance with the sequential mitigation process and that ensure the achievement of effective mitigation.

The NAWMP, an international cooperative agreement between the United States and Canada, is being implemented to restore, protect, and enhance aquatic habitats and increase waterfowl populations. The proposed project is within the Middle-Upper Atlantic Coast Habitat Area, one of five Priority Habitat Ranges in the United States. A January 1989 joint agreement between the Department of the Interior and the Department of the Army is designed to further the goals of the NAWMP. Under this agreement, consideration of NAWMP goals should be incorporated into the planning, engineering and design, and construction phases of Corps projects.

VI. OPPORTUNITIES FOR HABITAT ENHANCEMENT

The amount of habitat enhancement that could be accomplished on the disposal sites is constrained by the need to maintain the utility of the sites for future dredged material disposal. Any habitat enhanced following a disposal episode would be subject to elimination by future disposal episodes. In addition, disposal sites must be completely drained for one to two years prior to a disposal episode to allow the dredged material to dry and consolidate. There are also limits on the amount of water that can be retained on disposal sites without compromising the structural integrity of the containment dikes.

In spite of the above constraints, there are numerous opportunities for habitat enhancement on the four proposed upland disposal sites (Raccoon Island, Site 15D, Site 15G, and Site 17G) and on the existing upland disposal sites (National Park, Pedricktown North, Pedricktown South, Oldmans site, Penns Neck, Killcohook, Artificial Island, Reedy Point North, and Reedy Point South). Under the current management strategy for the existing disposal sites, water is drained from the sites as quickly as possible to allow the dredged material to dry and consolidate. This strategy encourages rapid colonization of the sites by common reed. As observed during the April 12, 1995 site visit of existing upland disposal sites, habitat value is much higher in areas with shallow standing water. Therefore, the Service recommends changing the water management strategy of each disposal site to allow the retention of standing water from 18 inches to three feet deep over as large an area as possible and for as long as possible between disposal episodes to enhance the habitat value.

Development of a management plan for the coordinated use of all of the disposal sites would also promote habitat enhancements. Using the sites in a coordinated sequential manner would maximize the amount of time between disposal episodes on each of the sites; thereby, extending the period during which each site could be managed for productive wildlife habitat. For example, if all the disposal sites in Reach B of the River (i.e., Site 15D, Site 15G, Pedricktown North, Pedricktown South, and Oldmans) were managed as one unit, such that a different site were used each year, there would be at least five years between the use of each site. Assuming a two-year drying period prior to re-use, each site would be capable of providing three years of productive shallow water habitat.

Many of the sites (e.g., Pedricktown North and Pedricktown South) appear to be large enough to sub-divide without compromising their effectiveness as disposal sites. Subdivision of these sites would increase the number of compartments available for sequential use; thereby, allowing greater flexibility in site management. Using the sites in Reach B again as an example, if Pedricktown North and Pedricktown South were sub-divided into two compartments each, there would be a total of seven compartments available for use in Reach B. Therefore, each compartment would be used for dredged material disposal only once every seven years, and each compartment would be capable of providing at least five years of productive habitat, assuming a two-year dewatering period.

The existing sites already have sluice gates and other structures for controlling water levels. Therefore, the implementation of a water management plan, in its simplest form, would not require any additional structures. The above-described management scenario is essentially a "passive" management option in that water levels would be maintained solely through control of the sluice gates, and there would be no manipulation of water levels once the desired depth is achieved following a disposal event.

There are a number of options for more "active" management of the disposal sites between disposal events. For example, pumps could be used in conjunction with the sluice gates to seasonally manipulate water levels in each compartment. Compartments could be flooded with one to three feet of water in the fall through winter to benefit migratory waterfowl, and drained in the spring to provide mudflats for migratory shorebirds. Additionally, active manipulation of water levels could facilitate the maintenance of a variety of water regimes on each site, with some compartments providing shallow water habitat and others providing mudflat or emergent wetland habitat. The periodic flooding of compartments would also help control common reed.

The management scenarios outlined above are essentially similar to the "moist soil management" strategies used to manage impoundments on many of the Service's National Wildlife Refuges, and on other wildlife management areas throughout the country. A number of sources of information are available regarding this type of water level management. The following are notable sources of information regarding moist soil management:

Hale Laskowski
South Zone Biologist
Blackwater National Wildlife Refuge
U.S. Fish and Wildlife Service
2145 Key Wallace Drive
Cambridge, Maryland 21613
(410) 221-1836

Leigh Fredrickson
Gaylord Memorial Laboratory
Route 1, Box 185
Puxico, Missouri 63960
(314) 222-3531

Joseph DeMartino
Ducks Unlimited, Inc. (New Jersey)
133 Fox Hollow Drive
Lanoka Harbor, New Jersey 08734
(609) 971-5845

Ray Whittemore, Regional Director
Ducks Unlimited, Inc.
219 Country Road
Bedford, New Hampshire 03110
(603) 626-7706

Other management options to enhance wildlife habitat on the proposed upland disposal areas include pond creation by mechanical excavation, shaping topography by manipulating the location of spoil deposition, and seeding or disking to establish desirable vegetation. Planting vegetation in inundated compartments may be costly considering that the area would be re-disturbed during the next disposal episode. Therefore, the Service recommends that only the interior berms and exterior dikes be seeded with vegetation that establishes quickly (e.g., perennial ryegrass). Seeding would assist in stabilization of such structures and may assist in controlling common reed via competition. Planning of any such management should be closely coordinated with the Service and the NJDFGW.

Finally, once disposal capacity is reached, the external and internal features of the disposal area (e.g., internal berms, sluice gates, water control structures, exterior dikes) should be made permanent. In addition, all disposal sites should be placed under conservation easement, possibly with the NJDFGW or a conservation organization, to protect the areas in perpetuity. If active management is pursued on the disposal sites (e.g., water pumps, adjustable water control structures) a fund should be set up to finance the continued management and operation of the disposal sites in perpetuity. Other agreements with the State or conservation organizations can be made to ensure the continued management of upland disposal sites as wildlife habitat.

VII. CONCLUSIONS AND RECOMMENDATIONS

The Service concludes that the conversion of Site 15D, Site 15G, Site 17G and Raccoon Island to dredged material disposal sites would cause significant adverse impacts to fish and wildlife resources. Therefore, in order to minimize adverse impacts to fish and wildlife, the Service recommends the following measures.

1. Continue to consult with the Service and NMFS in the preparation of a Biological Assessment to address potential project-related adverse impacts to federally-listed threatened and endangered species.

2. Contact the NJDFGW, Endangered and Nongame Species Program, for updated information regarding State-listed species.

3. Avoid direct impacts on moderate to high value habitats, such as tidal wetlands adjacent to the proposed sites and mature forest along the perimeter of the sites, by focusing dike construction and disposal operations toward the interior of the sites to the extent possible.

4. Avoid the clearing of vegetation and other site preparation activities between April 1 and July 15, in order to minimize adverse effects on nesting migratory birds.

5. Address mitigation for adverse impacts on wetland and upland cover types from dredged-material disposal activities at each of the proposed upland disposal sites.

6. Incorporate objectives of the NAWMP in the planning, engineering, design, and implementation of the proposed upland disposal sites.

The Service has further concluded that there are numerous opportunities to improve wildlife habitat on the proposed disposal sites (Raccoon Island, Site 15D, Site 15G, and Site 17G) and on the existing upland disposal sites (National Park, Pedricktown North, Pedricktown South, Oldmans site, Penns Grove, Penns Neck, Killcohook, Artificial Island, Reedy Point North, and Reedy Point South) that, if implemented, could adequately offset the adverse impacts resulting from the construction of the proposed disposal sites. The Service recommends that the Corps investigate the following measures to enhance wildlife habitat on these disposal sites.

1. Develop water management plans for each of the disposal sites with the goal of maintaining shallow water over as large an area as possible and for as long as possible between disposal episodes on each site.

2. Incorporate the water management plans for each site into a coordinated plan for the sequential use of disposal sites within each reach of the river.

3. Investigate the feasibility of sub-dividing each disposal site into compartments, in order to increase management options and flexibility.

4. Investigate the feasibility of using pumps in association with the sluice gates to more actively control water levels on the disposal sites.

5. Coordinate closely with the Service, the NJDFGW and other sources of expertise regarding opportunities for moist soil management and creation and maintenance of habitat for waterfowl and other wildlife on the proposed disposal areas.

6. Investigate other management options to enhance wildlife habitat on the proposed upland disposal areas including pond creation by mechanical excavation, shaping topography by manipulating the location of spoil deposition, and seeding or disking to establish desirable vegetation. Planning should be coordinated with the Service and the NJDFGW.

7. Once disposal capacity is reached at the current and proposed disposal sites, the Corps should make all external and internal features of the disposal area (e.g., internal berms, sluice gates, water control structures, exterior dikes) permanent, and place the disposal site under conservation easement in perpetuity. Conservation easements might be established with the New Jersey Division of Fish, Game and Wildlife or with a conservation organization (e.g., The Nature Conservancy). In addition, the Corps could negotiate an agreement or establish a fund with such organizations to maintain the continued management and operation of the disposal sites in perpetuity.

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VIII. REFERENCES

A. LITERATURE CITED

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B. PERSONAL COMMUNICATIONS

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APPENDIX A

Federally-listed endangered and threatened species
and candidate species in New Jersey

Revised 3/95

FEDERALLY-LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An **ENDANGERED SPECIES** is any species that is in danger of extinction throughout all or a significant portion of its range.

A **THREATENED SPECIES** is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

FISHES

Sturgeon, shortnose*	Acipenser brevirostrum	E

REPTILES

Turtle, Atl. Ridley*	Lepidochelys kempii	E
Turtle, green*	Chelonia mydas	T
Turtle, hawksbill*	Eretmochelys imbricata	E
Turtle, leatherback*	Dermochelys coriacea	E
Turtle, loggerhead*	Caretta caretta	T

BIRDS

Eagle, bald	Haliaeetus leucocephalus	PT
Falcon, Am. peregrine	Falco peregrinus anatum	E
Plover, piping	Charadrius melodus	T
Tern, roseate	Sterna dougallii dougallii	E

MAMMALS

Bat, Indiana	Myotis sodalis	E
Cougar, eastern	Felis concolor couguar	E+
Whale, blue*	Balaenoptera musculus	E
Whale, finback*	Balaenoptera physalus	E
Whale, humpback*	Megaptera novaeangliae	E
Whale, right*	Balaena glacialis	E
Whale, sei*	Balaenoptera borealis	E
Whale, sperm*	Physeter catodon	E
Wolf, gray	Canis lupus	E+

APPENDIX B

State-listed endangered and threatened species in New Jersey

INVERTEBRATES

Dwarf wedge mussel	Alasmidonta heterodon	E+
Beetle, northeastern beach tiger	Cicindela dorsalis dorsalis	T
Butterfly, Mitchell satyr	Neonympha m. mitchellii	E+
American burying beetle	Nicrophorus americanus	E+

PLANTS

Pogonia, small whorled	Isotria medeoloides	E
Swamp pink	Helonias bullata	T
Orchid, eastern prairie fringed	Platanthera leucophaea	T+
Knieskern's beaked-rush	Rhynchospora knieskernii	T
American chaffseed	Schwalbea americana	E
Joint-vetch, sensitive	Aeschynomene virginica	T
Pigweed, sea-beach	Amaranthus pumilus	T+

STATUS:

E: endangered species
T: threatened species
+: presumed extirpated
PE: proposed endangered
PT: proposed threatened

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

Note: for a complete listing of Endangered and Threatened Wildlife and Plants refer to 50 CFR 17.11 & 17.12, August 20, 1994

ENDANGERED AND THREATENED WILDLIFE OF NEW JERSEY

Endangered Species are those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to prevent future extinction in New Jersey.

Threatened Species are those who may become endangered if conditions surrounding them begin to or continue to deteriorate.

BIRDS

Endangered

Pied-billed Grebe,* *Podilymbus podiceps*
Bald Eagle, *Haliaeetus leucocephalus***
Northern Harrier,* *Circus cyaneus*
Cooper's Hawk, *Accipiter cooperii*
Red-shouldered Hawk, *Buteo lineatus* (Breeding)
Peregrine Falcon, *Falco peregrinus***
Piping Plover, *Charadrius melodus***
Upland Sandpiper, *Bartramia longicauda*
Roseate Tern, *Sterna dougallii*
Least Tern, *Sterna antillarum*
Black Skimmer, *Rynchops niger*
Short-eared Owl,* *Asio flammeus*
Sedge Wren, *Cistothorus platensis*
Loggerhead Shrike, *Lanius ludovicianus*
Vesper Sparrow, *Pooecetes gramineus*
Henslow's Sparrow, *Ammodramus henslowii*

Threatened

American Bittern*, *Botaurus lentiginosos*
Great Blue Heron*, *Ardea herodias*
Little Blue Heron, *Egretta caerulea**
Yellow-crowned Night Heron, *Nyctanassa violaceus*
Osprey, *Pandion haliaetus*
Northern Goshawk, *Accipiter gentilis*
Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
Black Rail, *Laterallus jamaicensis*
Long-eared Owl, *Asio otus*
Barred Owl, *Strix varia*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Cliff Swallow,* *Hirundo pyrrhonota*
Savannah Sparrow, *Passerculus sandwichensis*
Ipswich Sparrow, *Passerculus sandwichensis princeps*
Grasshopper Sparrow, *Ammodramus savannarum*
Bobolink, *Dolichonyx oryzivorus*

*Only breeding population considered endangered or threatened
**Federally endangered or threatened

REPTILES

Endangered

Bog Turtle, *Clemmys muhlenbergi*
Atlantic Hawksbill, *Eretmochelys imbricata***
Atlantic Loggerhead, *Caretta caretta***
Atlantic Ridley, *Lepidochelys kempi***
Atlantic Leatherback, *Dermochelys coriacea***
Corn Snake, *Elaphe g. guttata*
Timber Rattlesnake, *Crotalus h. horridus*

Threatened

Wood Turtle, *Clemmys insculpta*
Atlantic Green Turtle, *Chelonia mydas***
Northern Pine Snake, *Pituophis m. melanoleucus*

**Federally endangered or threatened

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF FISH, GAME AND WILDLIFE

AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salamander, *Ambystoma t. tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysoscelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale *Physeter, macrocephalus***
Fin Whale, *Balaenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Endangered

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

**Federally endangered

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

List revisions: March 29, 1979
January 17, 1984
May 6, 1985
July 20, 1987
June 3, 1991

ENDANGERED AND NONGAME SPECIES PROGRAM
GO WILD FOR WILDLIFE
CHECK-OFF N.J. Income Tax Conservation Fund
N.J. Division Fish-Game-Wildlife

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP&E's Division of Fish, Game and Wildlife's, Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to insure the survival of the State's endangered and nongame wildlife. This work is made possible only through voluntary contributions received through the Wildlife Check-off on the New Jersey State Tax Form. The Wildlife Check-off is the only major funding source for the protection and management of the State's endangered and nongame wildlife resource. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife contact: Endangered and Nongame Species Program, Northern District Office, Box 383 R.D. 1, Hampton, N.J. 08827 or call (908) 735-8975.

or (908) 735-5450.