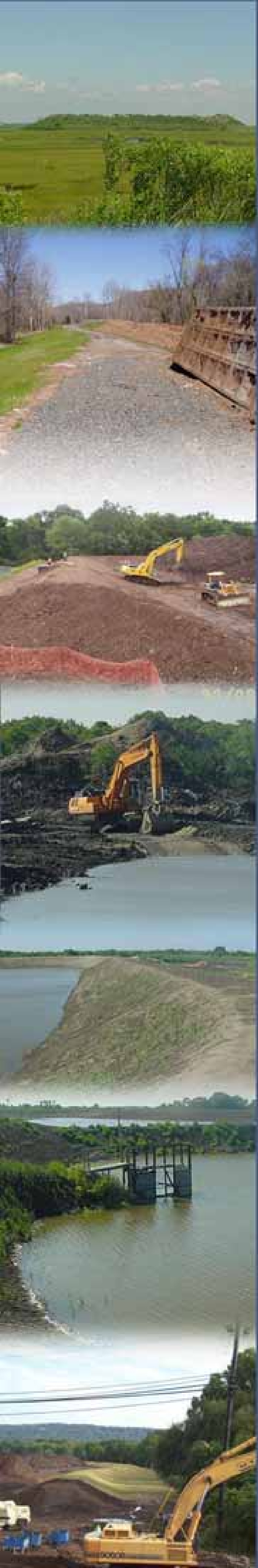

Feasibility Analysis

Reclamation of Confined Disposal Facility Storage Capacity Through Opportunities Presented by USACE Projects

Prepared for New Jersey Department of Transportation Office of Maritime Resources

January 2006

HDR | LMS

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Executive Summary

The New Jersey marine trade industry and a significant portion of the state's tourist economy depend upon adequate water depths for safe navigation of channels and marinas. Since most New Jersey coastal waters are naturally shallow, the provision of safe navigation channels and accessible marinas depends on a periodic dredging. Traditionally, the predominant means of handling dredged materials from these sites has been to place them in confined disposal facilities (CDFs). Over time, these facilities have either reached or nearly reached their practical capacity.

New CDFs are difficult to site due to environmental impacts and high property values. Emptying existing CDFs of their stored dredged materials would be a solution to this problem. However, many CDFs are difficult to access and the costs associated with the development of access routes and the transportation of excavated materials is high. In addition, concerns about potential contamination and the perception of dredged material as a waste hinder the development of possible solutions that would treat the material as a resource.

The State of New Jersey currently sponsors the construction of large civil works projects with the US Army Corps of Engineers (USACE). A number of these projects include the construction of earthen levees for the purpose of reducing flood damages. The construction of extensive levee systems generates a significant need for earthen materials. Some of these demands may be met by dredged material currently stored in CDFs. Materials used for levee construction can consist of a wide range of soil types. In fact, USACE design guidance for levees states that almost any soil is suitable for constructing levees, except very wet, fine grained soils or highly organic soils. The characteristics of soils required for levees may match the characteristics of dredged materials stored in CDFs.

This feasibility study examines the potential of removing the materials from CDFs and using them for the construction of USACE flood control projects. Due to difficulties in accessing CDFs and transportation costs, the use of CDF material can be significantly more expensive than the use of earthen material from normal borrow sources. However, large civil works projects such as those being undertaken by USACE and the state provide an opportunity to subsidize the removal of dredged materials from CDFs. Through the development of a Memorandum of Agreement with USACE, the state may be able to use CDF material on flood control projects, save a portion of the costs associated with removing this material from CDFs, and as a result replenish CDF capacity for future dredging projects.

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1.0 INTRODUCTION

New Jersey's marine trade industry and the related sector of the state's tourist economy depend upon adequate water depths for safe navigation of channels and marinas. Obstacles to dredging and dredged material management are hampering the provision of safe channels and marinas with adequate depths, potentially threatening this source of recreation and related revenue to the state. Obstacles to dredging include a lack of available dredged material placement options as well as the public perception of dredged material as a contaminated waste instead of a potential resource. The purpose of this Feasibility Analysis is to determine if a link can be established between the dredging needs of the State of New Jersey and the earthen material needs of the U.S. Army Corps of Engineers (USACE) projects that are being sponsored by the state. If this link can be established, a new dredged material placement option will have been created, and as an extension, the public's perception of dredged material as a potential resource may be enhanced.

Within the State of New Jersey, the lack of available sites to place wet dredged material is the limiting factor for completing many dredging projects on state Navigation Channels, as well as private channels and marinas. Traditionally, the predominant means of handling dredged materials from these sites has been to place them in confined disposal facilities (CDFs) located throughout the state. Over time, these facilities have either reached or nearly reached their practical capacity. Therefore, the ability of these CDFs to accept additional material has become limited. To further complicate the matter, the creation of new CDFs is problematic due to environmental impacts and resultant difficulties in obtaining necessary permits. Elevated property values within the state's coastal zone also prohibit the acquisition of less environmentally sensitive sites where dredged material could be processed in a more sustainable manner. The difficulties associated with the creation of new dredged material management sites encourage the reclamation of capacity within existing CDFs. Reclamation of dredged material storage capacity in existing CDFs would facilitate dredging projects and benefit the marine trades industry and the associated marine trades economy.

The issue of whether the state can reclaim CDF capacity and save money by using dredged material on USACE projects can only be answered by examining the following questions:

- Are the geotechnical properties and chemical characteristics of stored dredged material compatible with the material needs for USACE flood control projects?
- If not, can dredged material be mixed, processed, or amended to meet those needs?
- Does the anticipated schedule of material needs on USACE projects meet the dredged material management needs of the state?
- Is the use of dredged material on USACE projects economically viable?

The USACE's publication Engineering Manual (EM) 1110-2-1913, "Engineering and Design – Design and Construction of Levees," dated April 30, 2000 states that "almost any soil is suitable for constructing levees, except very wet fine grained soils, or highly organic soils. In some cases, though, even these soils may be considered for portions of levees." This wide range of allowable soil characteristics encourages the potential use of dredged materials on levee projects. Ecosystem restoration projects also have a generally broad range of allowable material characteristics and the direct placement of dredged material may be feasible for this category of projects. Other USACE projects, including beach nourishment and dune construction projects have more specific grain size requirements, but even these projects may make use of dredged materials when these materials consist primarily of sand.

As noted, USACE projects vary from flood control to ecosystem restoration, to beach nourishment and dune construction. Each of these project types has varying construction requirements and logistical issues. The following analysis focuses on the material requirements of USACE flood control projects and the feasibility of using materials stored in New Jersey CDFs.

2.0 NEW JERSEY CONFINED DISPOSAL FACILITIES (CDFS)

CDFs are located throughout the state's coastal areas and are traditionally within a relatively short distance of the channels and marinas that require periodic dredging. Ownership of these CDFs varies from those owned and operated on the federal level by the USACE, to facilities operated by the New Jersey Department of Environmental Protection (NJDEP), Bureau of Coastal Engineering, and to private CDFs owned by marina operators.

Dredging operations generally result in dredged material with very high water content. The use of CDFs is popular because they allow for the release of the water from the dredged material, while retaining dredged solids within a diked containment area. The following schematic taken from USACE EM 1110-2-5027, “Engineering and Design - Confined Disposal of Dredged Material**,** 30 September 1987,” depicts the typical components of a CDF.

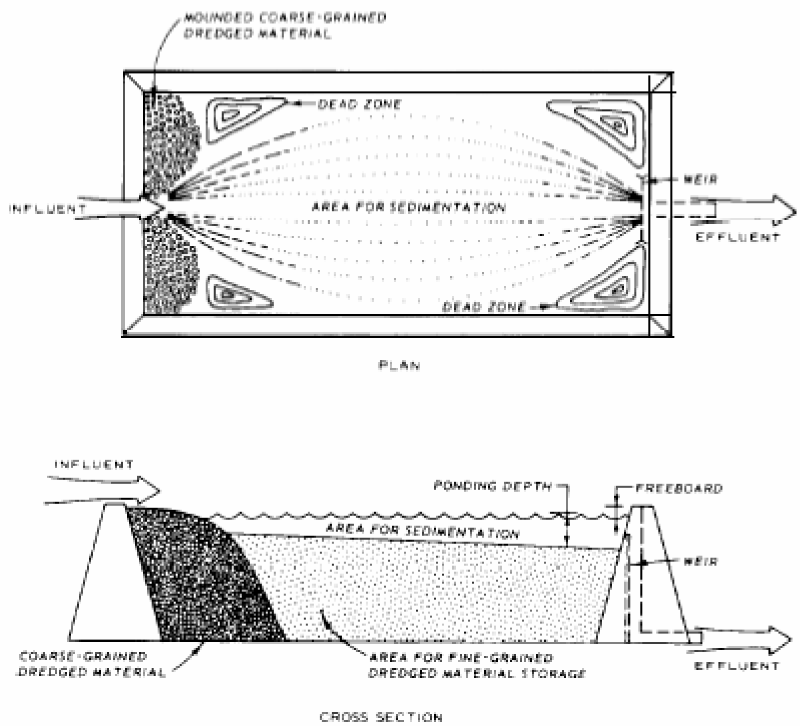


Figure 1- Conceptual diagram of a dredged material containment area

CDF containment dikes create a confined surface area into which dredged material is pumped in a slurry type state. The CDF is designed to have sufficient capacity to contain the volume of dredged material being added and to allow sufficient retention time for associated dredged solids to settle. Once solids settle, the residual clarified water is usually discharged from the CDF through a weir. Upon the completion of an active dredging operation and the discharge of associated water, natural drying forces dewater the material remaining in the CDF. Drying results in the consolidation of the original material, adding more storage capacity for the next dredging operation. The intermittent demand for dredging operations allows for this consolidation to take place, and results in an ability to use CDFs over an extended period.

To determine the feasibility of utilizing the materials stored in CDFs, a number of test locations in the State of New Jersey have been selected based on ownership and geographical location. Specific CDFs selected for analysis include:

- USACE CDFs known as Site C and Site D, Cape May
- Middle Thoroughfare CDF, Cape May
- Nummy Island CDF, Stone Harbor
- Ocean City South CDF, South Site, Ocean City
- Gull Island CDF, Point Pleasant Beach
- Waackaack Creek CDF, Keansburg

The relative locations of these CDFs are depicted on a map of the state (Figure 2), and specific locations and photographs of these CDFs are depicted on Figures 3 through 9.

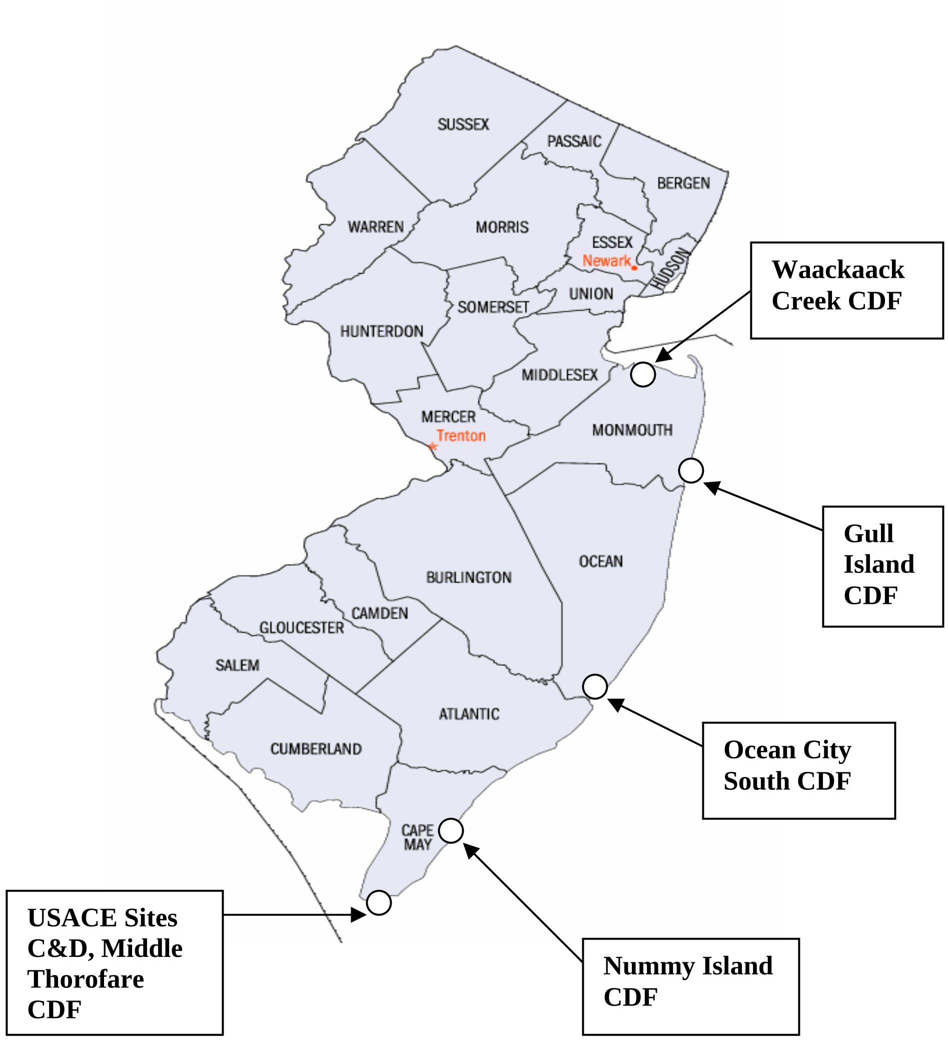


Figure 2 – CDF Locations

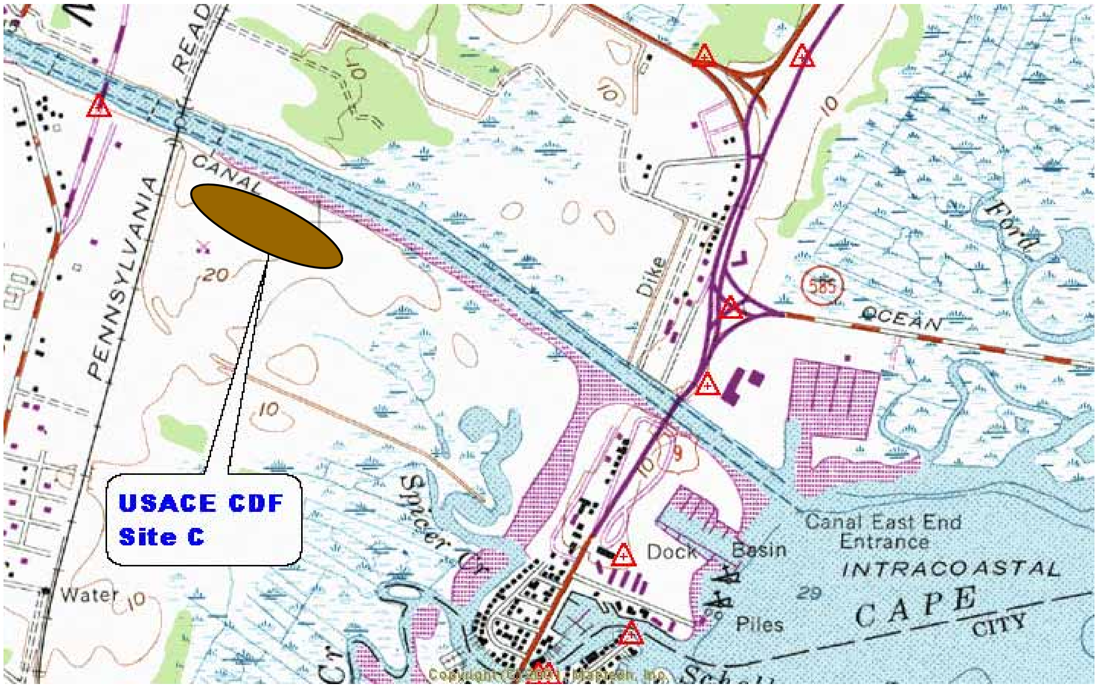
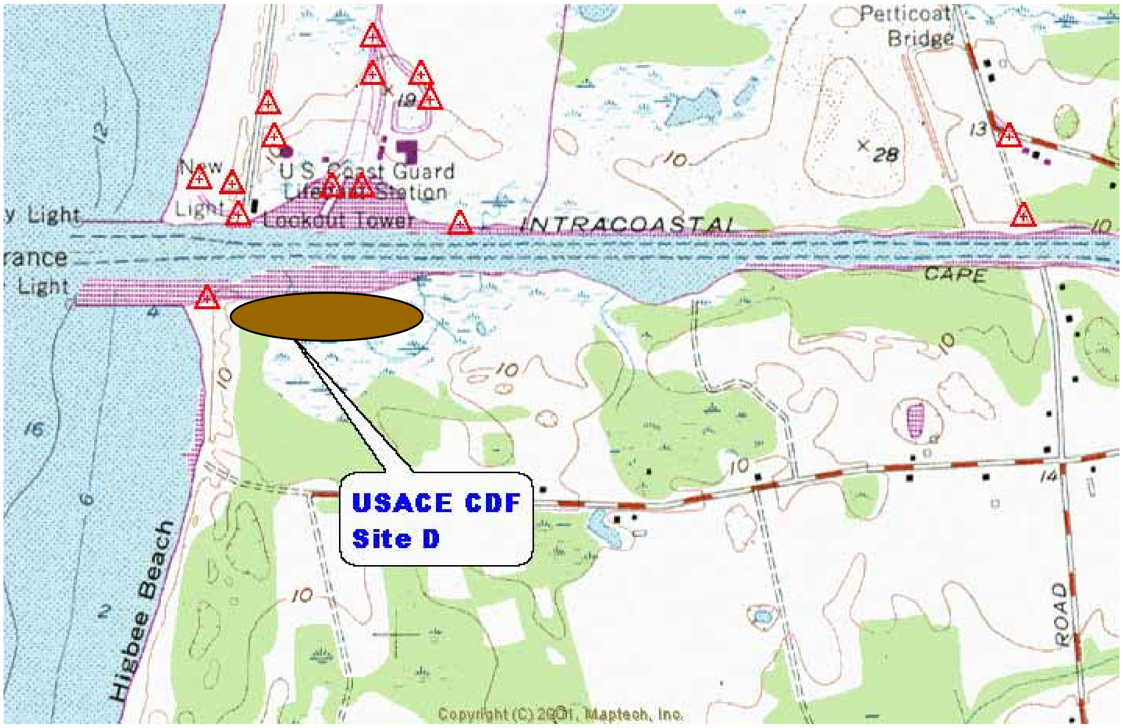


Figure 3 – USACE – Site C CDF, Cape May



Cape May USACE CDF Site D - photo from top of berm, cell currently full. Cape May Ferry in background.

Figure 4 – USACE – Site D CDF, Cape May

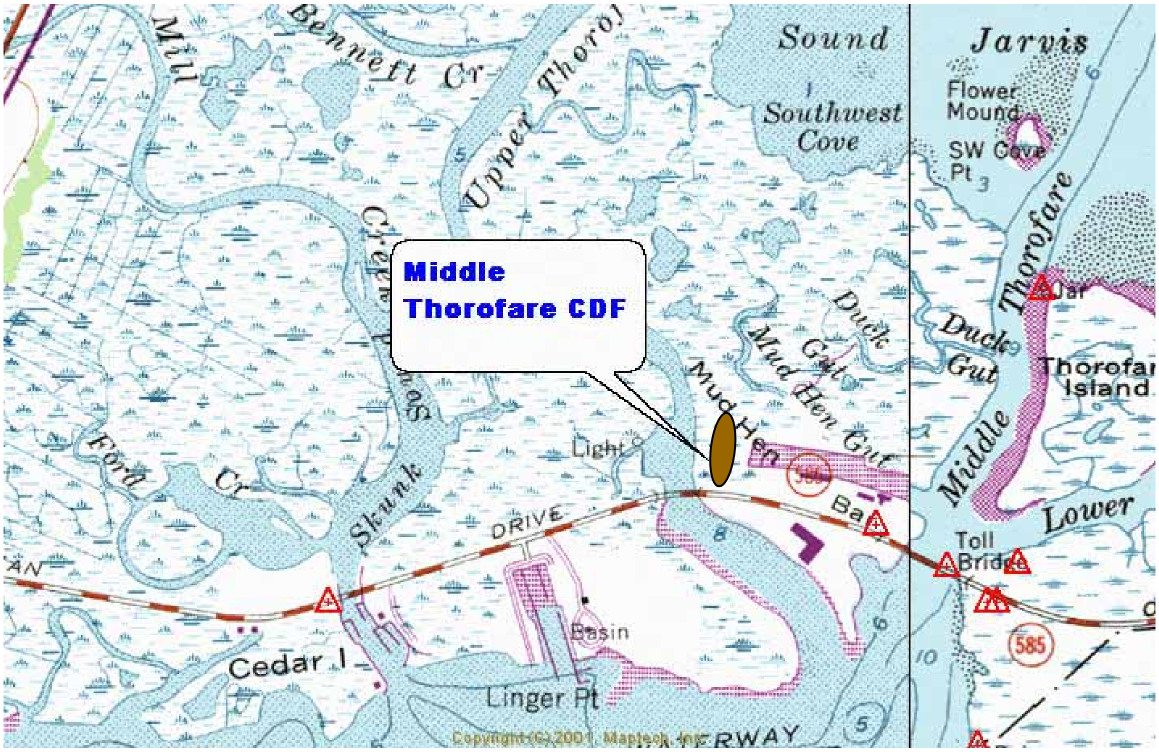


Figure 5– Middle Thorofare CDF, Cape May

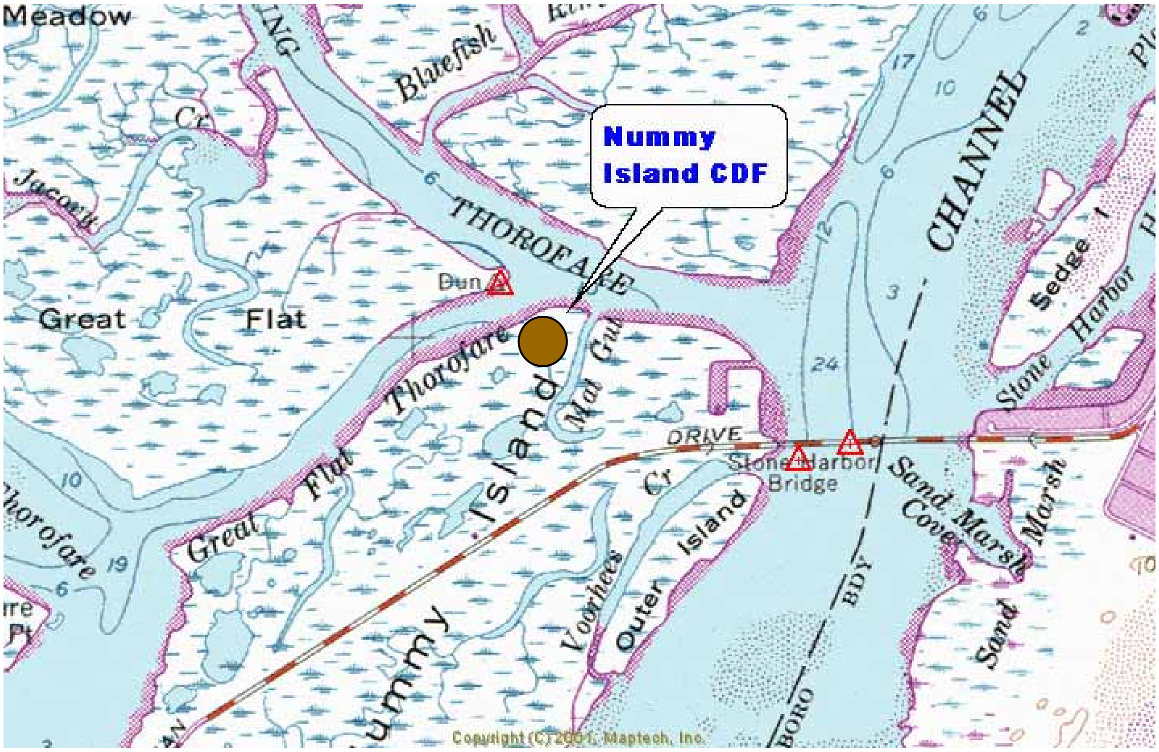


Figure 6 – Nummy Island CDF, Stone Harbor

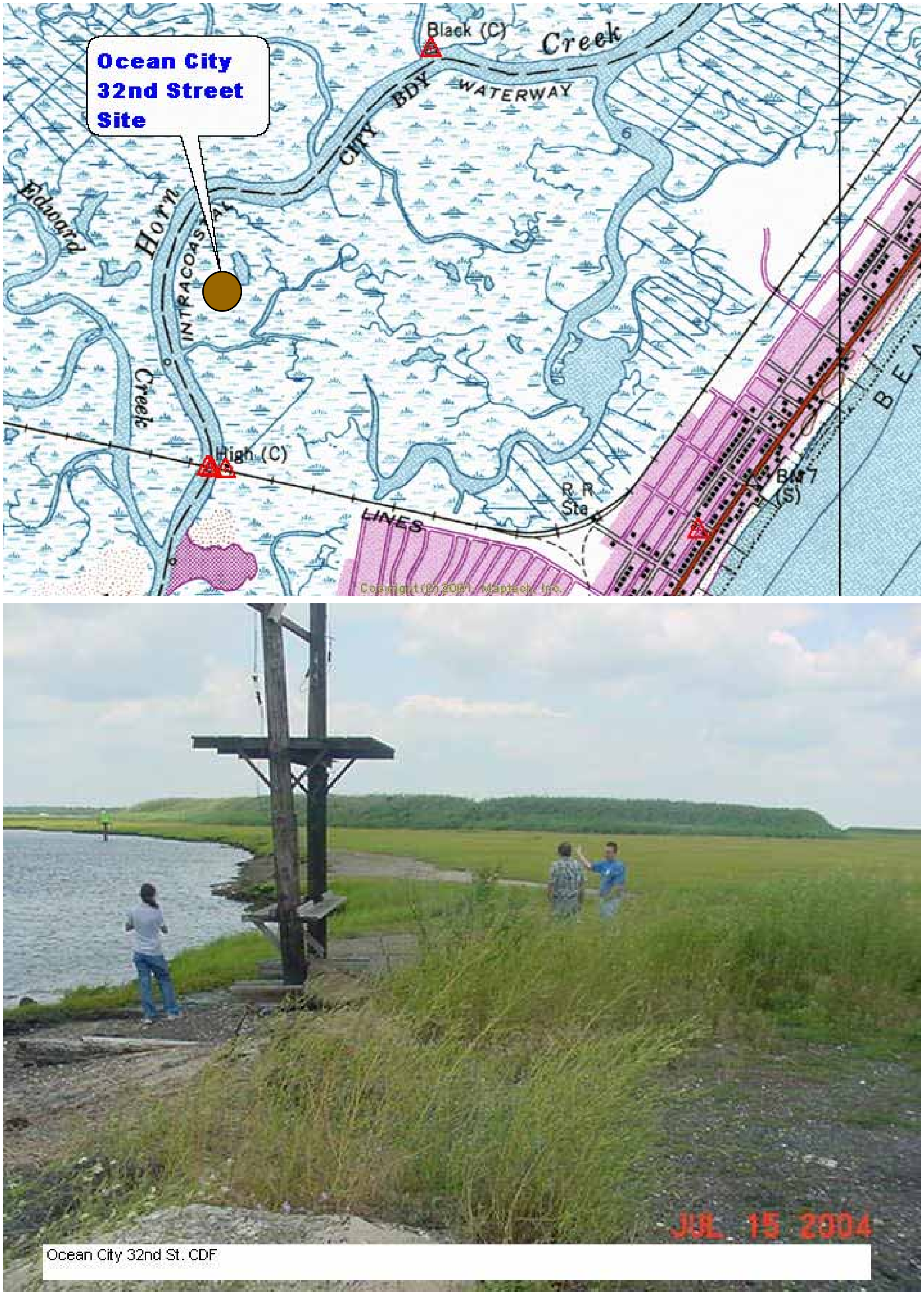
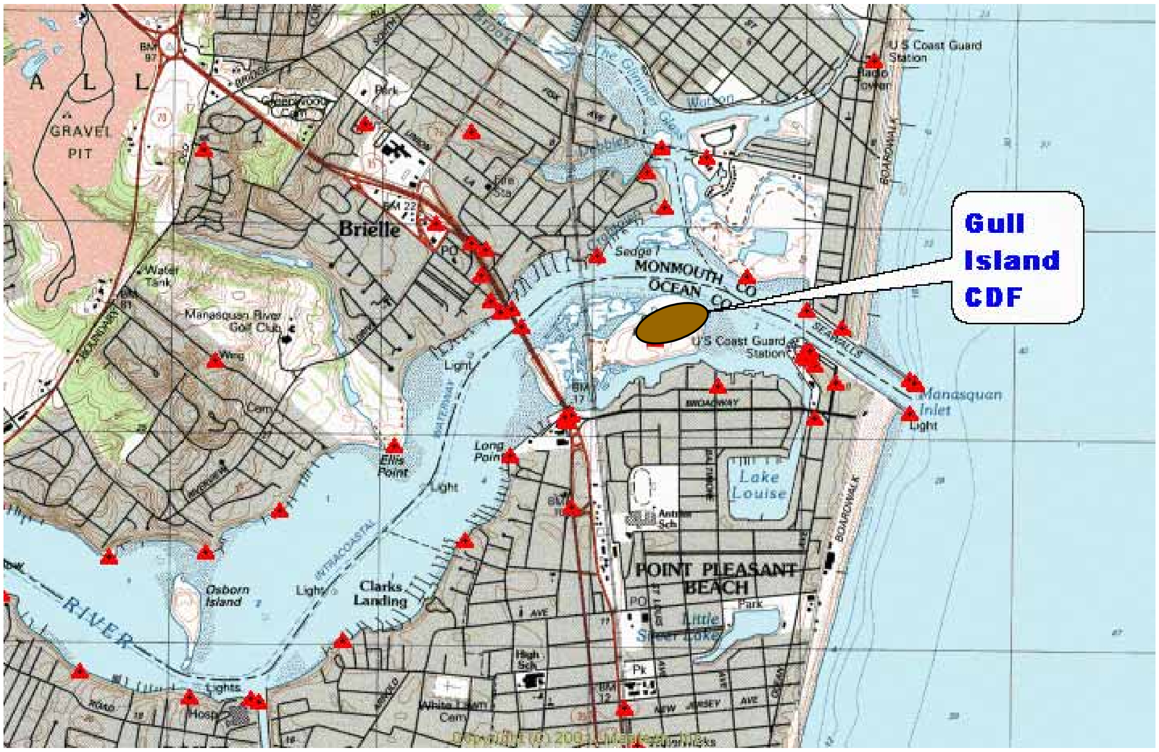
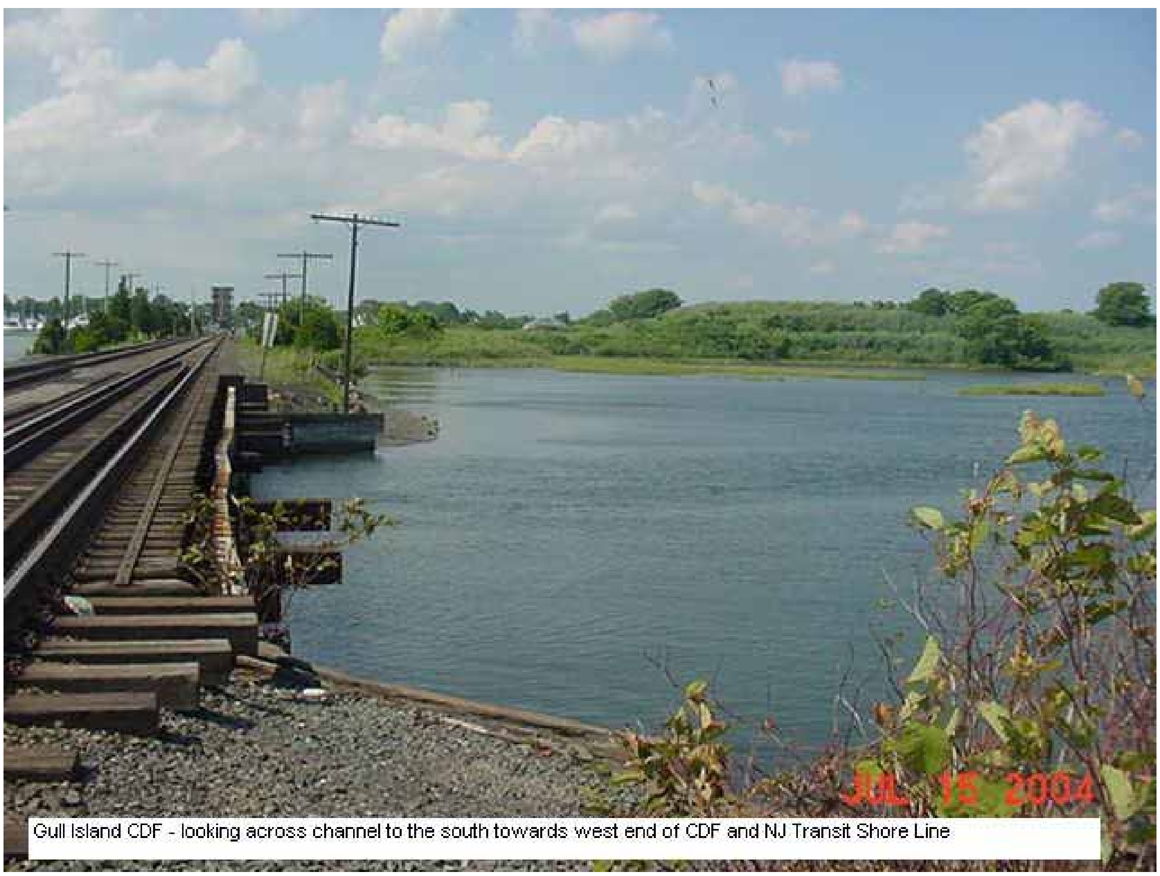


Figure 7 – Ocean City South CDF, Ocean City





Gull Island CDF - looking across channel to the south towards west end of CDF and NJ Transit Shore Line

Figure 8 – Gull Island CDF – Point Pleasant Beach

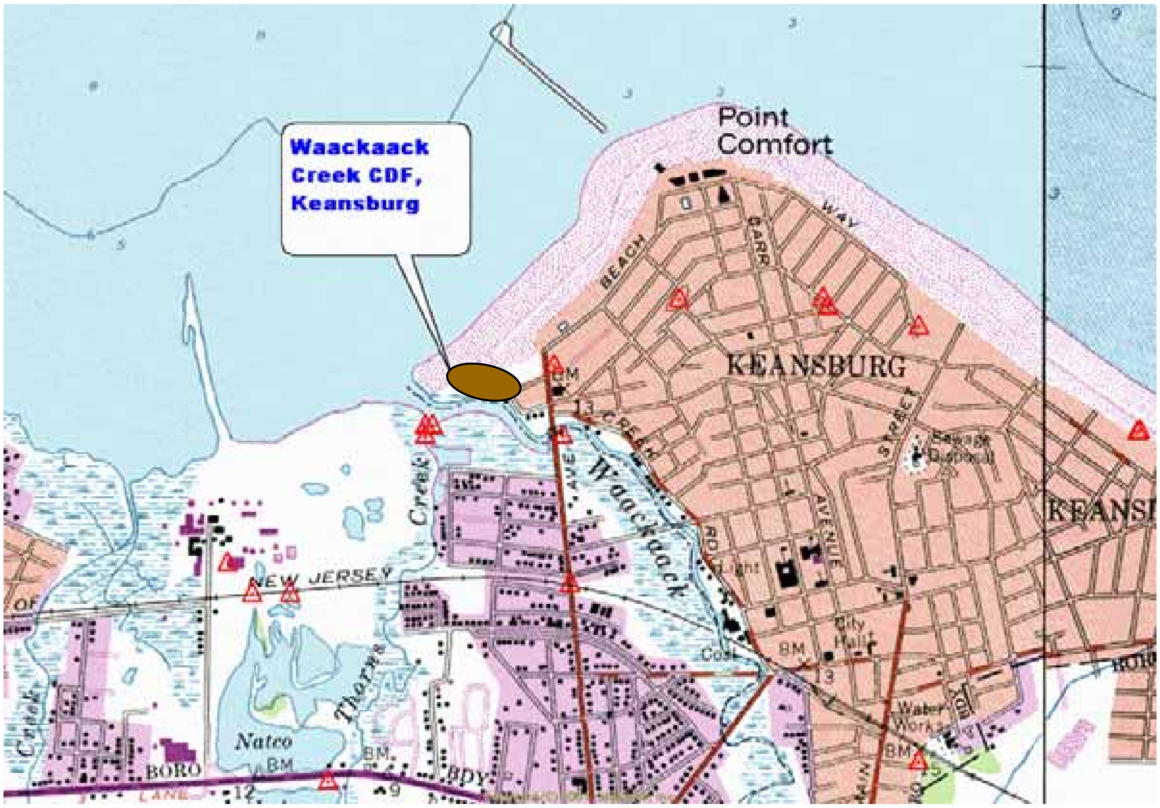


Figure 9 – Waackaack Creek CDF, Keansburg

The volume of dredged materials contained within these CDFs is currently unknown. A rough estimate of material volume has been developed based on conversations with the NJDEP Bureau of Construction, a field tour of the CDF locations with the NJDEP Bureau of Construction and Engineering (NJDEP/BCE) and the New Jersey Department of Transportation Office of Maritime Resources (NJDOT/OMR), and gross level calculations based on measurements of aerial photographs and estimated depths based on field visits. Table 1 provides the total volume of dredged material anticipated within each of these representative CDFs.

Table 1 – Estimated Volume of Materials in CDFs

CDF	**CDF Location**	**Estimated Volume of Dredged Material**
USACE Site C	Cape May	265,000 cubic yards
USACE Site D	Cape May	175,000 cubic yards
Middle Thorofare	Cape May	62,500 cubic yards
Nummy Island	Stone Harbor	155,000 cubic yards
Ocean City South CDF	Ocean City	300,000 cubic yards
Gull Island	Point Pleasant Beach	500,000 cubic yards
Waackaack Creek CDF	Keansburg	100,000 cubic yards

The State of New Jersey recently completed a project to remove dredged material at the Site C - USACE CDFs in Cape May. Material removed from Site C was used to remediate the Harbison & Walker site in the Township of Lower, Cape May County. This project re-established CDF capacity at this site. In conjunction with this project, the State of New Jersey and the USACE Philadelphia District have entered into an agreement granting the state volume credits for the removal of dredged material from the CDF. This project is representative of the potential for beneficial use of dredged material. As previously noted, this feasibility analysis is being performed to assess the potential use of dredged materials on federal flood control projects.

3.0 U.S. Army Corps of Engineer Projects

The USACE and the State of New Jersey co-sponsor projects to accomplish a number of objectives, including flood control, hurricane protection, recreation and navigation. A number of these projects create a substantial demand for earthen materials for construction. The purpose of this study is to determine if the materials currently contained within CDFs can be used to supplement or completely satisfy the material needs of these projects.

3.1 New York District Flood Control Projects

Currently, the New York District of the USACE and the State of New Jersey are undertaking or planning a number of significant projects within the state. The Civil Works boundary for the New York District in New Jersey includes Hudson River drainage and Atlantic Ocean drainage south to Manasquan Inlet. Projects within this geographic area fill the full range of the USACE mission and include navigation, flood control, and ecosystem restoration projects. Of greatest significance to this analysis are a number of the flood control projects currently being worked on with the state. These projects hold promise for beneficial use of dredged materials because there is a significant need for earthen materials for levee construction. Dredged material stored within the CDFs selected for analysis may exhibit many of the properties required for the materials on these projects, or can possibly be tailored to meet requirements through amendments or mixing with other soils. A photograph of a typical levee under construction is shown in Figure 10.

Figure 10 - Green Brook Flood Control Project – Segment T Levee

Following is a synopsis of a number of the major current New York District USACE flood control projects including each project's approximate schedule and the approximate volumes of needed fill /embankment materials. Scheduling of these projects is dependent on the continued allocation of planning and construction funds by the U.S. Congress and the provision of local cost share by the state. Project locations are depicted on Figure 11.

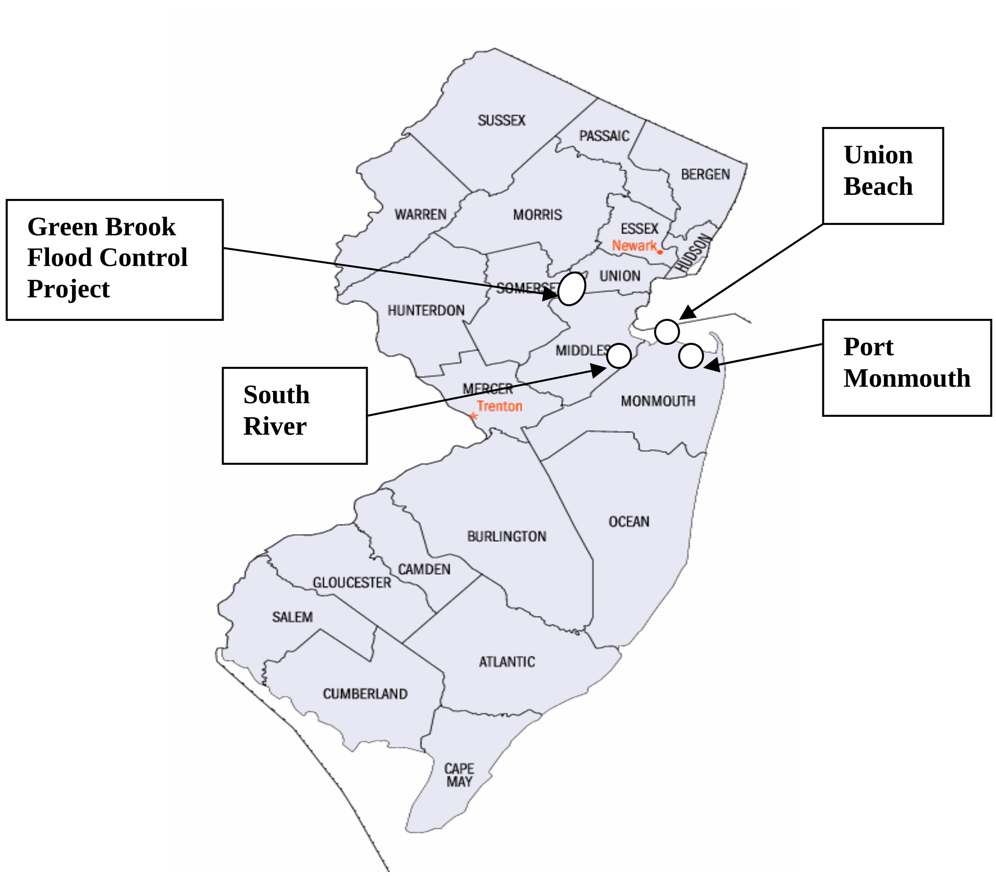


Figure 11 – USACE – New York District Flood Control Projects

Table 2 provides a synopsis of the noted New York District USACE Flood Control Projects with their anticipated project schedules and potential fill material needs. A description of each project follows the table.

Table 2 – NY District USACE Flood Control Projects Material Needs

Project	Anticipated Schedule	Estimated Volume of Fill Requirements
Green Brook Flood Control Project	Under Phased Construction, Initial Segment Completion 2007	100,000 cubic yards
Port Monmouth Hurricane and Storm Damage Reduction Project	Construction Start 2-3 years	200,000 cubic yards
Union Beach Hurricane and Storm Damage Reduction Project	Construction Start 3-4 years	200,000 cubic yards
South River Flood Damage Reduction and Ecosystem Restoration Project	Construction Start 5-6 years	300,000 cubic yards
	Total Estimated Volume	600,000 cubic yards

<u>Green Brook Flood Control Project</u>

The Green Brook Sub Basin is located within the Raritan River Basin in north-central New Jersey in the counties of Middlesex, Somerset and Union. It encompasses 13 municipalities and drains approximately 65 square miles of suburban, urban and industrialized area. The recommended plan includes approximately 14 miles of levees and floodwalls along Green Brook and its tributaries. Construction on the first phases of the project in the vicinity of Bound Brook has begun and will require up to 100,000 cubic yards (CY) of earthen material over the next 2 years along the Raritan River. The remainder of the project entails the construction of levees along the Green Brook and its tributaries. The construction of these levees will result in substantial material demands over the remainder of the project schedule, which is likely to extend beyond 2010.

Port Monmouth Hurricane and Storm Damage Reduction Project

The Port Monmouth Project involves the construction of about 7,070 feet of levees, 3,585 feet of floodwalls, 2,640 feet of dune, and beach renourishment at 10-year intervals along the Raritan Bay and Sandy Hook Bay in Port Monmouth in Middletown Township, Monmouth County, New Jersey. The project provides protection to low-lying residential and commercial structures, built upon and near salt and freshwater marshes that are experiencing flooding caused by coastal storm inundation. This problem has progressively worsened in recent years due to the loss of protective beaches and increased urbanization in the area with structures susceptible to flooding from rainfall and coastal storm surges, erosion and wave attack, combined with restrictions to channel flow in the tidal creeks (description taken from USACE, New York District Project Fact Sheet). The construction of this project is likely to require 200,000 CY of earthen material. Project construction is likely to begin within 2 to 3 years depending on the level of funding provided by the Federal and State sponsors.

Union Beach Hurricane and Storm Damage Reduction Project

The Union Beach project area is located in the northern portion of Monmouth County, New Jersey. It occupies an approximate 1.8-square-mile area of land along the coast of Raritan Bay. The Borough of Union Beach is surrounded by the Raritan Bay to the north, East Creek to the east, the Township of Hazlet to the south and Chingarora Creek to the west. Low-lying residential and commercial structures in the area experience flooding caused by coastal storm inundation. This problem has progressively worsened in recent years due to the loss of protective beaches and increased urbanization in the area with structures susceptible to flooding from rainfall and coastal storm surges, erosion and wave attack, combined with restrictions to channel flow in the tidal creeks . The project plan for storm damage reduction would consist of a levee/floodwall element including approximately 14,258 feet of levees, 6,885 feet of floodwalls, and 11 primary and 37 secondary outlet structures; along with a shorefront element consisting of 3,160 feet of beach and dune (description taken from USACE, New York District Project Fact Sheet). This project is expected to require up to 200,000 CY of earthen material with construction starting within 3 to 4 years.

South River Flood Damage Reduction and Ecosystem Restoration Project

The South River project is located within the lower Raritan Basin in Middlesex County, New Jersey. The South River is the first major tributary of the Raritan River, situated approximately 8.3 miles upstream of the Raritan River's mouth at Raritan Bay. Areas within the South River Watershed are prone to severe flooding from hurricanes and other storms. The study area for this project focused on river reaches below the Duhernal Lake Dam, specifically flood-prone areas within the Boroughs of South River and Sayreville, the Township of Old Bridge, and the Historic Village of Old Bridge (located within the Township of East Brunswick). This portion of South River also includes the areas of greatest ecological degradation (and greatest potential for ecosystem restoration).

The Hurricane Storm Damage protection components of the plan consists of a storm surge barrier spanning the South River for a length of 320 feet, with a clear opening of 80 feet, two combined levees (10,712 feet long)/floodwalls (1,655 feet long) constructed along the east and west bank of the South River in the boroughs of Sayreville and South River, and interior drainage facilities (i.e., pump stations, outlets, etc.). The ecosystem restoration consists of returning 379.3 acres of *Phragmites* wetlands to wetland forest, upland forest, low emergent marsh, mudflat, and open water (description taken from USACE, New York District Project Fact Sheet). Earthen material needs on this project are expected to surpass 300,000 CY and construction is anticipated to start within 5 to 6 years. Project Fiscal Year (FY) 2005 funding is being used to initiate design activities and is currently concentrated on survey and mapping.

3.2 Other USACE Projects

The Philadelphia District of the USACE and the State of New Jersey are also co-sponsoring projects within the Philadelphia District Civil Works Boundaries, which include Delaware River drainage and Atlantic Ocean drainage south of Manasquan Inlet. Projects being cosponsored by the Philadelphia District and the state include Navigation, Shore Protection and Ecosystem Restoration projects. Of potential significance to this analysis are a number of the shore protection project and ecosystem restoration projects. Shore protection projects generally consist of beach nourishment activities. However, many of the projects also entail the construction of dune systems. Dredged material may be suitable for dune construction depending on material properties. Where dredged materials consist of beach grade sand, it can be readily used for beach nourishment or dune development projects. The other potential for the use of dredged material relates to ecosystem restoration projects. Ecosystem restoration projects can require significant materials to restore habitats. Projects within the Philadelphia District which could potentially make use of dredged material include:

- Abescon Island Shore Protection Project requiring dune construction for Atlantic City, Vetnor, Margate, and Longport.
- Barnegat Inlet to Little Egg Inlet Shore Protection Project requiring dune construction.
- Lower Cape May Meadows to Cape May Point Shore Protection Project.
- Manasquan Inlet to Barnegat Island Shore Protection Project.
- Townsends Inlet to Cape May Inlet Shore Protection Project.
- Barnegat Bay Dredged Hole #6 Ecosystem Restoration Project.

4.0 COMPATIBILITY OF MATERIAL PROPERTIES AND REQUIREMENTS

There are two considerations that govern the suitability of dredged materials stored in CDFs for levee borrow materials:

- Whether the dredged materials meet the geotechnical requirements of the USACE, or if these requirements can be achieved through the use of soil amendments or soil mixing.
- Whether the physical and chemical properties of the dredged materials meet the criteria established by the NJDEP Office of Dredging and Sediment Technology (ODST) for the issuance of an Acceptable Use Determination (AUD).

A determination of the suitability of materials found in CDFs requires data on the material's geotechnical properties and characterization of potential contaminants. The evaluation and permitting of dredging in the State of New Jersey is the responsibility of the NJDEP/ODST. The NJDEP/ODST enforces the policies and procedures under which regulatory reviews of proposed dredging activities are conducted. Permit requirements and procedures are outlined under the NJDEP's dredging technical manual entitled "The

Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, October 1997."

Chapter III of the manual outlines the information required for dredging projects. Of interest to this analysis is the characterization of dredged material and specifically dredged material that may have been placed in the representative CDFs. New dredging projects require the characterization of sediments to be dredged with the exception of testing exclusions for sand, residential, and small projects, as outlined in the manual. The characterization of sediments to be dredged includes overall volume, potential for contamination, grain size, Total Organic Carbon , and percentage moisture. Data of this nature on the materials contained within CDFs would provide significant insight into the potential for the material's beneficial use.

4.1 Available Data on the Properties of Dredged Materials Stored in CDFs

Data Collected by NJDEP

The CDFs selected for this study have been in operation for decades and they all contain materials that were neither tested nor characterized prior to placement. Data associated with more recent dredging operations discharging to these CDFs were collected but not retained in a central database subsequent to the issuance of permits. As a consequence, data characterizing the dredged material in these CDFs is not readily available.

Data Collected by the Philadelphia District USACE

While developing the "New Jersey Intracoastal Waterway Final Selection Report, December 2001" for the purpose of identifying long term dredged material management options, the Philadelphia District of the USACE recognized that the data gap on materials stored within CDFs presented obstacles to the development of comprehensive management strategies. Though testing of all CDFs along the intracoastal waterway was well beyond the scope of that study, tests were conducted on a number of CDFs to determine the engineering suitability of materials. Table 3 presents the data collected on two CDF sites.

Table 3 – CDF Data Collected for USACE Philadelphia District New Jersey Intracoastal Waterway Final Selection Report, December 2001

	CDF Site 83	**CDF Site 84**
Location	Approximately 8000 feet northeast of Ocean City South CDF	Approximately 2000 feet Northeast of the Ocean City South CDF
Type of Material	Primarily Silt	Silt up to a depth of 20 feet, sand below 20 feet
Moisture Content	22%	181%

The moisture content of the materials stored in Site 83 and Site 84 was extremely high, ranging from 22% to 181% water content (expressed as the weight of water ÷ the weight of solids). The material less than 20 feet below the surface is generally more liquid than solid in consistency (i.e., greater than 85% water content). This indicates that the material from these CDFs would need to be dewatered and/or amended prior to its use in USACE projects. However, it is possible that the CDF was sampled shortly after dredging project material was placed in the CDF. If that is the case, the high water content of the material may not be representative.

Data Being Collected under I BOAT NJ Grant

NJDOT/OMR has recognized that the lack of data on dredged material stored in CDFs is hindering the potential for beneficial use. In recognition of this data gap, NJDOT/OMR is currently undertaking a program, under an I BOAT NJ grant, to characterize dredged materials located in a number of CDFs along the New Jersey Atlantic Coast. These CDFs include:

- USACE CDF Site D, Cape May
- Middle Thoroughfare CDF, Cape May
- Nummy Island CDF, Stone Harbor
- Ocean City 32nd Street, Ocean City
- Waackaack Creek CDF, Keansburg

To date, the sampling and testing of materials stored within the Nummy Island CDF has been completed. Materials within Nummy Island CDF are relatively free from contaminants of concern and consist predominantly of sand. The test cores do reveal a number of locations within the CDF where there are materials with higher levels of silt and clay. This preliminary data appears to verify that the material within the CDF could be used in flood control projects. However, if the sand content is too high, the material may need to be mixed with other soils to make a suitable levee embankment material.

Sampling of Middle Thoroughfare and Waackaack Creek CDFs has been completed and laboratory analysis of the samples is underway. Sampling of the USACE Site D CDF is currently being performed and the sampling Ocean City 32nd Street site will commence as soon as the USACE Site D sampling is complete. Upon completion of this dredged material characterization project, a more accurate determination for the potential use of these materials on USACE flood control projects can be made.

4.2 Requirements for Physical Properties of Borrow Soils

One promising aspect of the potential use of dredged materials stored in CDFs on USACE projects is the fact that the allowable characteristics of materials used in levee construction have a relatively broad range. In fact, the USACE's publication EM 1110-2-1913, "Engineering and Design – Design and Construction of Levees," dated April 30, 2000 states that "almost any soil is suitable for constructing levees, except very wet fine grained soils, or highly organic soils. In some cases, though, even these soils may be considered for portions of levees."

Materials from hydraulic dredging operations tend to be extremely wet when initially placed in a CDF. However, most of materials in the CDFs considered for this analysis have been kept in the CDF over a prolonged period and have had an opportunity to dewater. In addition, each CDF contains both maintenance and virgin dredged materials, and likely contain both fine and coarse grained particles.

USACE laboratory testing programs for borrow materials to be used in levees can vary from minimal to extensive, depending on the nature and of the project, and the specific location for material placement. USACE recognizes that tests to determine the engineering properties of soils are expensive and time-consuming, and thus generally limit testing programs to water content and visual identification and classification on most samples. Tests for shear, consolidation and compaction properties are suggested only for representative samples. The following table is taken from the USCAE Levee Design Manual and outlines testing requirements for representative samples of fine-grained cohesive soils.

Table 4 – Lab Testing Requirement for Soils

Table 3-1
Laboratory Testing of Fine-Grained Cohesive Soils

Test	Remarks
Visual classification and water content determinations	On all samples
Atterberg limits	On representative samples of foundation deposits for correlation with shear or consolidation parameters, and borrow soils for comparison with natural water contents, or correlations with optimum water content and maximum densities
Permeability	Not required; soils can be assumed to be essentially impervious in seepage analyses
Consolidation	Generally performed on undisturbed foundation samples only where:
	a. Foundation clays are highly compressible
	b. Foundations under high levees are somewhat compressible
	c. Settlement of structures within levee systems must be accurately estimated
	Not generally performed on levee fill; instead use allowances for settlement within levees based on type of compaction. Sometimes satisfactory correlations of Atterberg limits with coefficient of consolidation can be used. Compression index can usually be estimated from water content.
Compaction	*a.* Required only for compacted or semi-compacted levees
	b. Where embankment is to be fully compacted, perform standard 25-blow compaction tests
	c. Where embankment is to be semi-compacted, perform 15-blow compaction tests
Shear strength	*a.* Unconfined compression tests on saturated foundation clays without joints or slickensides
	b. Q triaxial tests appropriate for foundation clays, as undrained strength generally governs stability
	c. R triaxial and S direct shear: Generally required only when levees are high and/or foundations are weak, or at locations where structures exist in levees
	d. Q, R, and S tests on fill materials compacted at appropriate water contents to densities resulting from the expected field compaction effort

4.3 Chemical Characteristics of Dredged Materials

Sediments within tidal water bodies can be contaminated by discharges from industrial activities, municipal storm sewer sources, atmospheric deposition, and marina and boating operations. These sediments, when dredged and placed in a CDF, can retain pollutants that could result in adverse impact to the environment and human health. However, some tidal waters within New Jersey have lower potential to have been impacted by pollution than others. This fact has been recognized by the state and is considered in the policies and procedures under which New Jersey reviews and manages dredged materials. Testing requirements for materials to be dredged are outlined in New

Jersey's technical manual entitled "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters, October 1997."

The NJDEP/ODST requires a full physical and chemical characterization of dredged material to issue an AUD for the upland placement and/or beneficial use application. The extent to which an applicant must characterize the dredged material is based upon the grain size composition, the location where the sediments originated within the State of New Jersey, and the volume to be dredged. If the dredged materials consist of more than 90% sand particles no further characterization is required, as long as the materials did not originate in areas where there are known historic spills or discharges of pollutants. This policy is in recognition of the fact that sand particles tend to carry fewer contaminants than smaller grain sized particles. For any beneficial use application for materials that are less than 90% sand, the following tests are required by NJDEP/ODST:

- Total Organic Carbon
- Percent Moisture
- Bulk Sediment Chemistry
- Modified Elutriate.

In some cases it is necessary to perform leaching tests and / or biological tests.

The data gap on dredged materials located within CDFs includes a lack of information on the chemical characteristics of stored material. Any program conducted to gather information on the physical characteristics of stored dredged material should be extended to include an analysis for potential pollutants as recommended in the NJDEP/ODST dredging manual.

5.0 DREDGED MATERIAL TRANSPORT SCENARIOS AND COSTS

One of the most significant issues affecting the feasibility of using dredged material on USACE projects is cost. The use of materials located in CDFs, and in particular CDFs with difficult access, will most likely cost more than materials taken from more traditional borrow sources. However, benefits associated with the use of materials in CDFs and the relative costs of using or disposing of these materials elsewhere must be considered. To initiate an analysis of this issue, the excavation and transport of material in CDFs is examined to determine associated costs.

The USACE design manual states that, “where compacted levees are planned, it is necessary to obtain material with water content low enough to allow placement and adequate compaction.” To facilitate the use of dredged materials located within CDFs, excavation and transport options are focused on moving materials in a dry state. Re-suspension of dredged material for hydraulic transport is an option, but prohibitive cost increases are likely to be experienced through an expansion in the volume of material to be moved and by adding the need for subsequent dewatering operations. Therefore, all transport options and costs examined in this Feasibility Study consider movement of material in a dry state. The representative CDF sites selected for this analysis include sites that can be readily accessed by trucks, sites that can be accessed by trucks with the construction of haul roads, and sites that have water access only requiring truck/barge combinations.

Two significant factors will impact the cost of removing materials from CDFs for use on a flood control project. The first factor consists of the logistics required to access the material in the CDF. Access to these materials will require mobilization, establishment of an access route, and development of a method to load material into a transport vehicle. For CDFs that are road accessible, the cost of accessing the CDF and loading material into a transport vehicle can be expected to range in the area $6/CYD to $8/CYD. For CDFs surrounded by salt marsh or open water, establishing loading operations through the construction of a haul road or conveyor system, and eventual restoration of disturbed areas, can significantly increase costs. The cost of removing materials from a CDF surrounded by salt marsh or open water, and loading the material into a transport vehicle, is estimated to range from $12/CYD to $14/CYD.

The second significant factor affecting the cost is the transportation of material from the CDF loading site to the location where it will ultimately be used. Figure 12 depicts the relative costs of transporting dredged material by various modes of transportation. The figure demonstrates that transport by rail can become competitive once a haul route exceeds 20 miles. However, since rail haul routes are fixed and truck routes are not, this mode of transportation may not be effective unless longer haul distances are required and loading and placement sites are located in close proximity to established rail lines. The figure also demonstrates that hauling by barge is a very cost effective means of transporting materials long distances. However, to take advantage of these efficiencies, the final material placement site needs to be barge accessible so that the introduction of another transportation mode, such as trucks, can be avoided.

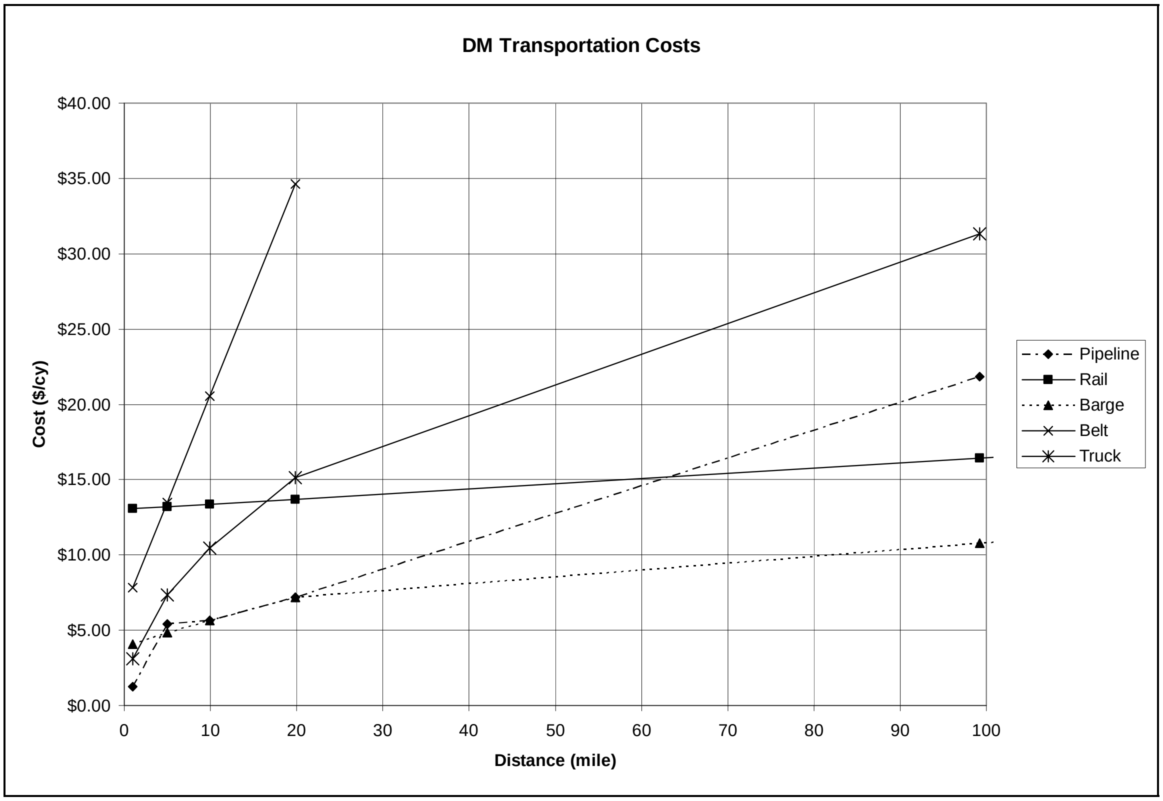


Figure 12 - Dredged Material Transportation Costs (CYD)

To determine feasibility of using the material from the representative CDFs, a site-specific strategy for loading material was developed for each location. In addition, since the flood control projects selected for this analysis fall within the same region of New Jersey, transportation costs were uniformly developed assuming final placement in the Green Brook Flood Control Project. Transportation costs to the other flood control project sites are not expected create a significant variation in the results of this analysis. Table 2 lists the representative CDFs, the loading and transportation mode selected, and the overall costs of transporting material to the flood control project.

Table 5 – CDF Dredged Material Transport Modes and Costs

CDF	Transportation Mode	Estimated Loading Costs	Estimated Transport Costs	Estimated Cost Dredged Material Loading and Transport
USACE Site D	Road Access / Transport by Truck	$6-8/CYD	$60-62/CYD	$66-70 / CYD
USACE Site D	Road Access / Transport by Barge and Truck	$6-8/CYD	$58-60/CYD	$64-68 / CYD
Middle Thorofare	Road Access / Transport by Truck	$6-8/CYD	$60-62/CYD	$66-70 / CYD
Nummy Island	Development of Access Road / Transport by Truck	$10-12/CYD	$54-56/CYD	$64-68 / CYD
Ocean City South CDF	Barge Access / Transport by Barge and Truck	$12-14/CYD	$58-60/CYD	$70-74 / CYD
Gull Island	Barge Access / Transport by Barge and Truck	$12-14/CYD	$28-30/CYD	$40-44 / CYD
Waackaack Creek CDF	Road Access / Transport by Truck	$6-8/CYD	$22-24/CYD	$28-32 / CYD

6.0 ECONOMIC IMPLICATIONS

The New York District of the USACE regularly estimates costs associated with the construction of flood control projects. Personnel with the USACE New York District have indicated that their normal unit cost estimate for common fill averages from $20-$25/cy. Assuming that a borrow source is within 10 miles of a given project, an independent assessment of this cost can be made using "Means Heavy Construction Cost Data" as follows:

- Common Earth Borrow Loaded $ 8/cy
- Hauling 20 mile Round Trip <u>$14/cy</u>
- Total Cost – Material in Place $22/cy

The cost of fill is highly dependent upon the relative location of the borrow source to the construction project, and will vary from project to project depending on the borrow source that a contractor can locate. For the purpose of this analysis, we will assume that the normal cost of borrow material delivered to the project is $25/cy.

Comparison of this cost against the cost of loading and transporting dredged material from CDFs (as shown in Table 2) demonstrates that at the low end of the cost range borrow material from CDFs can be cost competitive ($25/cy "normal cost" vs. $28/cy for material from CDF). However, at the high end of the cost range there is a significant disparity ($25 "normal cost" vs. $74 for material from CDF). This disparity in cost can grow even larger if the dredged material requires amendment with Portland cement or fly ash to enhance its geotechnical properties. If necessary, mixing dredged material with other soils may also be a means of gaining required physical properties, but this operation would also add costs.

Under current cost share regulations for flood control projects, a state sponsor bears responsibilities for project cost as follows:

- 5% Cash Contribution
- 100% of all Lands, Easements, Right-of-Ways, Relocations and Demolition (LERRDs)
- If the 5% cash contribution and LERRDs do not constitute 35% of the project cost and additional cash contribution is required to bring the total cost share to 35%.
- If the 5% cash contribution and LERRDs constitute more than 35% of the project cost, the local sponsors share is satisfied.

Assuming that the state's cost share contribution is satisfied through the cash payment requirement and LERRDs, the cost of borrow material paid by the federal sponsor of the project would be $25/cy. The state could take advantage of this federal contribution to a flood control project to assist in vacating dredged material from CDFs.

There are three potential methods that the State of New Jersey could use to take advantage of this opportunity. The basic logic of these three scenarios is as follows:

1) The state can enter into a Memorandum of Agreement (MOA) with USACE to designate a borrow source for a cosponsored project. The MOA would stipulate the normal cost of borrow material ($25/cy under this scenario) and would designate the borrow source to be utilized such as a CDF. The state would be responsible for the balance in the cost of the borrow material. Under the scenario examined herein, this cost could range from $3/cy to $49/cy ($25/cy from normal borrow source vs. $28/cy to $74/cy from CDF). Essentially, the MOA would reduce the State's cost of vacating material from a CDF by $25/cy.
2) It is possible that USACE may not be able to enter into such an MOA due to rules within the Federal Acquisition Regulations (FAR). If FAR were to prevent the development of an MOA, legislation could be adopted to enable the USACE to enter into such an MOA. A Water Resource Development Bill could be amended with authorizing language. However, since these bills are developed over a period of years and are adopted infrequently, it may be more expeditious to amend an annual appropriations bill.
3) A revision to current flood control project cost share rules could create even greater incentives to use borrow materials from alternate sources. However, cost share rules are relatively complex and adoption of new rules could have national implications that reach far beyond a single project. Therefore, the adoption of such legislation in the US Congress would likely be procedurally complex. However, if legislation of this type could be adopted; a state could potentially receive a credit for the value of construction materials contributed to a cosponsored project, reducing the cost of vacating dredged material from a CDF even further.

Given the immediate benefits that could be realized through the development of an MOA with USACE, it appears that the State should pursue this alternative initially.

7.0 CONCLUSIONS

The analysis herein demonstrates that use of dredged material in USACE flood control projects may be a viable component of a statewide dredged material management strategy. However, it is also apparent that to promote and maximize the use of dredged materials currently stored within CDFs, a number of issues need to be addressed.

- Much of the material in the CDFs throughout the State was placed prior to the testing requirements. Therefore, the characteristics of this material are unknown. This lack of data presents an obstacle to the potential beneficial of dredged material currently stored within CDFs. Clearly the materials stored within CDFs need to be characterized. The Philadelphia District of the USACE and NJDOT/OMR have begun this task on a number of representative CDFs. Once existing materials in CDFs are characterized, this data gap should not recur since future dredged materials placed within CDFs must be defined through the application of NJDEP/ODST's dredging regulations.

- The bulk of the costs associated with the beneficial use of dredged materials lie in transportation. A program of matching CDFs with local projects would significantly reduce these costs. These projects can consist of flood control projects or any other civil works project that requires large quantities of earthen materials.

- Use of dredged materials currently residing in CDFs would restore CDF capacity. This renewed capacity would then facilitate future dredging projects required to maintain safe and viable navigation channels and would directly benefit the marine based economy within the State.

- USACE flood control projects sponsored by the state present an opportunity to utilize a large quantity of dredged material currently stored within CDFs. The state should pursue the development of an MOA with USACE to take advantage of this opportunity. Under this scenario, the state would need to secure funding to pay for the balance of costs associated with using material from CDFs versus regular borrow sources.