PUBLIC AND PRIVATE DREDGED MATERIAL MANAGEMENT STRATEGIES IN NEW JERSEY:

A CASE STUDY ECONOMIC ANALYSIS

Prepared for New Jersey Department of Transportation Office of Maritime Resources

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EXECUTIVE SUMMARY

Dredged material management is a serious challenge throughout the State of New Jersey. Placement options for dredged material from State owned navigation channels and private marinas are limited. Limited disposal options are delaying much needed State and private dredging projects and increasing costs associated with dredging. Rising costs of dredging projects may soon force the State of New Jersey and private marinas to choose between the costs of dredging and the effects of shoaling on their operations.

Beneficial use of dredged material could substantially reduce problems associated with dredged material placement. This report describes several potential uses for dredged material, and presents examples of pilot studies that have investigated the feasibility of the beneficial use of dredged material. Two substantial barriers to beneficial use of the dredged material originating from State channels and marinas were identified. The first is the variable supply and consistency of dredged material. The establishment of one or more regional staging / processing facilities (RPFs) was identified as a potential solution to this obstacle. RPFs would provide a central location for processing and handling, and offer material with specific characteristics in larger quantities. The second barrier to beneficial use is the lack of demand for dredged material. At this stage, potential users of dredged material have no reason to consider it for their projects. Legislation and regulatory action promoting or requiring the use of dredged material in projects and tax-based incentives were identified as potential solutions to this problem.

To further examine the issues, a case study analysis was performed to determine the costs and benefits associated with State and private dredged material management in New Jersey. Four locations were chosen to represent New Jersey's diverse marine environments. The four locations selected are: Cape May Harbor, Cape May, NJ; Dredge Harbor in Delran Township, NJ; the upper Metedeconk River in Brick Township, NJ; and the upper Manasquan River in Brick Township, NJ. Baseline conditions and two to three alternative strategies were evaluated for each location. The alternative strategies focused on potential beneficial use applications in an attempt to examine their feasibility. The costs and benefits of each strategy were assessed and projected over a 50 year planning period. A cost-benefit analysis was performed to examine the economic benefits of dredging and to evaluate the cost effectiveness of each dredged material management strategy.

Significant findings of these analyses include:

- The costs associated with the current strategies for the placement of dredged material are expected to rise significantly, ranging from $21 to $59 per cubic yard of dredged material at the four case study locations.
- The case studies demonstrated that the maritime industries in the large harbors provide sufficient economic benefits to justify continuation of dredging and dredged material management, even with increasing costs.
- The increasing costs of dredged material management cause significant hardship to small marina owners because the costs of dredged material management can outweigh the resulting economic benefits. Small marinas that can not afford to dredge will lose revenue from decreased slip rental fees, and may eventually be forced to close their businesses.
- Long term dredged material management strategies must be developed to avoid delays in dredging projects.
- Beneficial use of dredged material can regenerate the capacity of existing confined disposal facilities (CDFs) and provide a source of revenue.
- Because the dredged material is located in shoreline CDFs, the use of this material for construction projects in the center of the state is unlikely without added incentives.
- For beneficial uses such as fill and topsoil, the most significant cost is transportation. The results of analyses conducted for this study suggest that contractors pay for fill less often than they receive it for free.
- Potential solutions vary from location to location and in accordance with project specifics. In the end, a flexible dredged material management strategy that considers the wide variation in dredged material characteristics as well as the wide variation in projects and project sponsors may be the best solution.

The following recommendations to promote beneficial use applications were developed as a result of the analyses:

- Although using dredged material can appear more expensive than the use of virgin materials, the cost of using virgin material is often artificially low because the environmental impacts at the borrow site are not fully considered and the benefits to the State of using dredged material are not quantified. Statewide emphasis on the beneficial use of dredged material, and long-term material management strategies should be continued.
- One potential limitation to the use of dredged material by industry is that companies rely on a steady source of materials with consistent properties, but dredging projects are typically sporadic, and they do not produce consistent material types. Concentrating dredged material in large stockpiles or utilizing existing stockpiles (CDFs) may help to facilitate this process.
- The development of Regional Staging / Processing Facilities (RPFs) for dredged material may help to overcome current obstacles to beneficial use applications due to their potential to serve multiple end users. The feasibility of constructing and operating these facilities warrants further investigation.
- The permitting process for dredging and the beneficial use of dredged material should be streamlined.
- NJDOT/OMR should continue facilitation of the beneficial use of dredged material through their on-line Dredged Material Management System (DMMS), demonstration project funding, and public outreach efforts. Partnerships should be formed between potential end-users of dredged material and private marinas to increase the likelihood of creating a market for dredged material.
- Waste materials such as biosolids from wastewater treatment plants or paper and mulch materials can be blended with dredged material to create a usable product. Coordination between the county authorities that regulate these waste streams and the State may allow the creation of an interconnected large-scale solution to waste disposal for these materials in New Jersey.
- Brownfields sites and construction projects that will require large amounts of fill material should be identified and matched to dredged material stockpiles in CDFs or RPFs.
- Legislation should be enacted to provide incentives for use of dredged material in lieu of virgin material.

- Tidelands regulations should be reviewed and fees for private use of dredged material should be eliminated for material dredged for navigational purposes.

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AUD	Acceptable Use Determination
BMP	Best Management Practice
BTMUA	Brick Township Municipal Utilities Authority
CAFRA	Coastal Area Facility Review Act
CDF	Confined Disposal Facility
CEDT	Clean Earth Dredging Technologies, Inc
cf	Cubic Foot
COAST	New York / New Jersey Clean Ocean Shore Trust
CWA	Clean Water Act
cy	Cubic Yard
CZMP	Coastal Zone Management Program
DGW	Discharge to Ground Water
DM	Dredged Material
DSW	Discharge to Surface Water
LJ3	Lightning Jacks #3
MHW	Mean High Water
NEPA	National Environmental Policy Review Act
NJDEP	New Jersey Department of Environmental Protection
NJDEP/BEC	New Jersey Department of Environmental Protection Bureau of Engineering and Construction
NJDEP/ODST	New Jersey Department of Environmental Protection Office of Dredging and Sediment Technology
NJDOT/OMR	New Jersey Department of Transportation Office of Maritime Resources
NJPDES	New Jersey Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
OTC	The Burlington County Resource Recovery Operational Training Center
PADEP	Pennsylvania Department of Environmental Protection
PCDM	Palmyra Cove Dredged Material

POAK	Port of Oakland
RPF	Regional Dredged Material Staging/Processing Facility
SPDES	State Pollutant Discharge Elimination System
SWMA	New Jersey Solid Waste Management Act
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPCA	New Jersey Water Pollution Control Act
WQC	Water Quality Certificate

CHAPTER 1

INTRODUCTION

A unique feature of New Jersey is that over 80% of its border abuts navigable waterways. These waterways, including the Delaware River, Delaware Bay, the Atlantic Ocean, and the Hudson – Raritan Estuary, are a significant resource and contribute substantially to the State's economy. Historically, the people of New Jersey have facilitated access to these waterbodies and improved near shore navigation by dredging shallow areas. Continued access to coastal water resources requires that these dredged channels be maintained.

The future management of dredged materials is a serious challenge faced by the State of New Jersey and its residents. New Jersey is charged with maintaining acceptable depths in State owned navigation channels and marina operators are responsible for dredging their channels and slips. Increased regulations and costs associated with testing and handling of materials to be dredged have limited dredged material management options that were formerly available. In-water disposal of dredged material has become less favorable due to concerns about contaminant bioavailability. Therefore, upland placement is the most common option for dredged material management. However, upland placement options are also restricted.

Dewatering of dredged material usually requires a large expanse of undeveloped waterfront property. Existing placement sites exist, but they are currently at or near capacity. The development of new sites is problematic because coastal New Jersey has few undeveloped parcels adjacent to navigation channels. Remaining vacant parcels are highly valued for their real estate development potential, making them cost prohibitive. These factors contribute to limitations placed on dredged management options and these limitations have resulted in the delay of much needed State and private dredging projects. As a result, the State and many marina operators will need to find alternative management strategies for future dredging projects.

New Jersey's navigational channels and marinas are located throughout the State and there are a variety of conditions unique to their relative locations. Sediment and waterbody types, shoreline development, channel ownership, and levels of tourism activity are just a few of these conditions. A case study analysis was determined to be the most effective approach to quantify the costs of dredged material management strategies while also considering these variable conditions. Four case study locations were selected for the analysis, each representing a different geographic region. The four case study locations are:

- Cape May Harbor, Cape May, NJ
- Dredge Harbor, Delran Township, NJ
- Metedeconk River on the Upper Barnegat Bay, Brick Township, NJ
- Upper Manasquan River, Brick Township, NJ

The purpose of the analyses presented in this report is to determine the costs and benefits of different dredged material management strategies for each of the four case studies. Effective dredged material management plans developed for each case study can be used as a template to develop management strategies for other areas of New Jersey.

The findings of the analysis are presented in this report and have been organized as follows:

- Chapter 1: Introduction
- Chapter 2: Beneficial Use Applications
- Chapter 3: Case Study Analyses
- Chapter 4: Recommendations

The remainder of this chapter provides background on dredging responsibilities, the predominant dredging techniques currently used in New Jersey, and the regulatory programs with which dredging projects must comply.

1.1 DREDGING IN NEW JERSEY

In areas where water depth remains constant over time, the rate of erosion (scouring) is equal to the rate of deposition (shoaling). However, local hydrodynamic processes (e.g. shape of waterbody or bottom contours) can cause scouring of sediments in some areas and shoaling in others. The amount of sediment transported by rivers, streams, and longshore currents and the resulting sedimentation is primarily dependent upon rates of water movement. When movement slows, sediment particles settle out. Sediments tend to settle and build up, creating shoaling areas in many bays and harbors throughout coastal New Jersey. Since New Jersey's navigable waterways (channels) and marinas are located primarily on coastal bays and tidally influenced rivers, they are susceptible to shoaling. Maintaining desired depths in navigational channels and/or marina slips requires periodic dredging.

The United States Army Corps of Engineers (USACE) is responsible for the maintenance of the Intercoastal Waterway and most of the major inlets in the State. New Jersey's Department of Environmental Protection, Bureau of Engineering and Construction (NJDEP/BEC) is responsible for maintaining approximately 130 State navigational channels. The USACE and NJDEP/BEC regularly issue dredging contracts to maintain these waterways.

Private marina owners are responsible for maintaining access from their facilities to State or Federal channels. Marina operators either own their own dredging equipment or hire contractors to complete the process. In some cases, if NJDEP/BEC has a dredging project in an adjacent channel, marinas are allowed to bundle their dredging projects with State projects, which decreases their mobilization costs and facilitates the dredging process. State contractors dredge the marina during the State dredging project and the marina pays the same rate (per volume dredged) as the State.

Dredging of New Jersey's navigational channels and marinas is typically performed with hydraulic pipeline dredges, which pump a mixture of dredged material and water from the channel bottom to a dewatering site. Bottom material is broken loose with a cutterhead, a mechanical device on the suction end of the dredge that has rotating blades. The dredged material and water are sucked into the intake pipe of the dredge and forced out the discharge pipeline directly to the dewatering or disposal site. The amount of water pumped with the dredged material is controlled to ensure the efficient removal of sediment. This dredging method allows for continuous operation and is often cost-efficient. However, the dredged material that is produced often requires long periods of dewatering time before it is sufficiently dry for upland transport or beneficial use applications. The need for dewatering space and time has controlled the dredged material management strategies that are in place today and it also constrains future dredged material management options that can be considered.

1.2 DREDGED MATERIAL MANAGEMENT

Currently, the predominant method of dredged material management consists of pumping the mixture of dredged material and water directly into established confined disposal facilities (CDFs). In CDFs, dredged material is placed behind dikes, which contain and isolate it from the surrounding environment. Large CDFs are usually divided into several smaller areas, called cells. The water slows as it moves between the cells causing the dredged material to settle out. Clarified water is discharged through a weir structure at the downstream end of the CDF. Generally, direct pumping of dredged material to a CDF is the least expensive method of transport. However, when a CDF is far removed from the dredging site or a hydraulic dredge is not used for the dredging, barges or hopper dredges may transport dredged material to the CDF where it is off-loaded. A conceptual drawing of a CDF is shown in Figure 1.1.

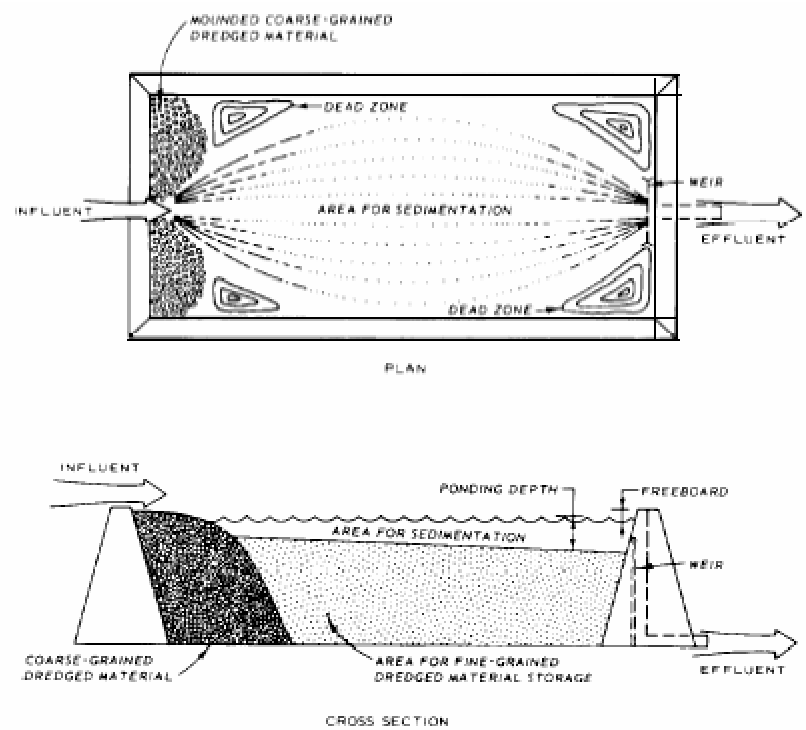

Figure 1.1. Conceptual Drawing of a Confined Disposal Facility (CDF) for Dredged Material.

New Jersey has existing upland, shoreline and island CDFs. Upland CDFs are above the high water line and out of wetland areas. Shoreline CDFs are constructed in protected open shallow water on the shoreline. Island CDFs are constructed offshore, but in relatively shallow water. The capacity of many New Jersey CDFs has been depleted, and due to a combination of economic and environmental factors, there are few coastal areas where new CDFs can be constructed. At this time, several State and private dredging projects are stalled due to the lack of available capacity in CDFs (NJDEP/BEC pers. comm.). Figure 1.2 is a photograph of Nummy Island, an island CDF located in Stone Harbor, NJ.

Figure1.2. Nummy Island CDF in Stone Harbor, New Jersey

1.3 DREDGING REGULATIONS AND PERMITTING REQUIREMENTS

Dredging projects in the State of New Jersey require permits from the State and Federal governments, issued by the New Jersey Department of Environmental Protection (NJDEP) and the U.S. Army Corps of Engineers (USACE), respectively. NJDEP's Office of Dredging and Sediment Technology (NJDEP/ODST) has primary responsibility for regulating dredging activities and for the management of dredged material in New Jersey waters. For more information about the role and regulatory authority of NJDEP/ODST and USACE see Appendix A.

Dredging in New Jersey can also fall under the jurisdiction of NJDEP's Land Use Regulation Program when they fall within the purview of the Waterfront Development Law or the Coastal Area Facility Review Act (CAFRA). The Waterfront Development Law deals with a variety of different types of work (e.g. piers, bulkheads) along tidally influenced waterways throughout the State, whereas CAFRA deals with waterfront activities in the southern part of the State. Typically, actions requiring dredging as well as permits issued under the authority of either of these laws would be jointly reviewed by NJDEP's Land Use Regulation Program and NJDEP/ODST.

The permitting procedures for completing a dredging project can be cumbersome for a marina operator. In most cases, a dredging project requires sediment testing and the acquisition of several permits for the dredging, discharge of dredged material into waterways and for the disposal or beneficial use of the dredged material. The level of sediment testing and the number of permits required varies from project to project. Marina operators typically hire consultants to navigate through the permitting process.

1.4 NJDEP BUREAU OF TIDELANDS MANAGEMENT

Tidelands or riparian lands consist of lands that now or were formerly located below the mean high tide line of a natural waterway. In New Jersey, the State owns all tidelands, and all of the State maintained channels and most of the State's marinas are located on these waters. The ownership of tidelands by the State of New Jersey extends to ownership of the material removed from tidelands during dredging or mining operations.

NJDEP Bureau of Tidelands Management gives authority to the Tidelands Commission to charge fees for the granting, leasing or licensing of tidelands. More information on these transactions and the Tidelands Commission is provided in Appendix A. In addition to the conveyance fees, the Tidelands Commission charges for materials dredged from tidelands. The Tidelands Commission currently charges $0.45 per cubic yard (in situ) for material dredged in riparian lands if the dredged material is placed anywhere other than the Newark Bay CDF. Once the fee has been paid, there are no additional responsibilities to the Tidelands Commission. However, the Commission has very wide latitude regarding fee structures. They have the authority to alter the fee on a case by case basis in consideration of the relative State benefit of any project. They may also charge based on a different quantity measurement basis. For example, the current license agreement with Amboy Aggregates to perform maintenance dredging and beneficial use is based on wet cubic yards in the barge. In contrast, the license to excavate material for the purpose of beneficial use from the Palmyra Cove CDF in Burlington County, NJ is based on changes to topographic surveys, thus representing dried in situ volume measurement.

The Tidelands Commission has agreements with the USACE that the State of New Jersey would provide State owned sites for dredged material from State waters and no fee would be incurred. However, if the material is permanently removed from the lands of the State (i.e. sent to a private concern or out of state for beneficial use), the Commission would charge a fee as they see fit.

Fees charged by the Tidelands Commission further increase the cost of dredging. It is noteworthy that these fees are not used to benefit New Jersey's State channel dredging program. Money collected from the sale or rental of tidelands is deposited into a trust fund for State education and is also used as a guarantee against bonds sold by local school boards.

CHAPTER 2

BENEFICIAL USE APPLICATIONS AND MANAGEMENT STRATEGIES FOR DREDGED MATERIAL

The objective of this chapter is to identify potential beneficial use applications appropriate for non-contaminated (clean) dredged materials originating from New Jersey's State channels and private marinas. Obstacles to the implementation of beneficial use applications are defined and both long and short-term strategies for dredged material placement are explored.

The ideal beneficial use application has:

- the ability to handle large volumes of dredged material
- a recognized environmental benefit
- compliance with regulatory, legal and permitting standards
- likelihood of stakeholder acceptance
- the potential for profitability

2.1 POTENTIAL BENEFICIAL USE APPLICATIONS

The following comprehensive list presents a diverse range of proposed uses of dredged material. Some of these applications require at a minimum, dewatering and some level of screening and processing. In some cases the dredged material is mixed with cement, stabilizers, or other additives to result in a product with specific properties or characteristics.

- Structural fill/asphalt

Coarse-grained dredged material can be used as raw material for asphalt, as fill material, or to improve the physical properties of soils for construction of buildings, roads and bridge abutments. Dredged materials can be used to fill old mining holes or obsolete canals.

- Lightweight aggregate

Dredged material can be used to create clay-like pellets. The dredged material is dewatered, mixed with shale fines, extruded into pellets and fired in a kiln. The product can be used as raw material for the manufacture of lightweight concrete, reducing the need for extractive mining operations.

- Ceramics/bricks

Dredged material with a high percentage of clay or dredged material mixed with clay can be used to create ceramic tiles for indoor and outdoor use. Dredged material with a high percentage of clay can also be mixed with cement and stabilizer to create cement-like bricks. For both bricks and ceramic tiles, the dredged material must be fired in a kiln. In Germany, building blocks from dredged material have been successfully manufactured for export. Coarse-grained dredged material is suitable for concrete aggregates and other building materials.

- Glass

Thermal/plasma vitrification of dredged material, including fine-grained silt and clay, can be used to produce a glass-like product. This product can be used as road fill material, undergo further processing to produce glass tiles, or be pulverized and used as part of a blended cement product.

- Topsoil/Improvement of soil structure

With specific additions for nutrients and pH balance, such as leaf compost and lime, high quality topsoil can be easily created from dredged material. Dredged material that is a mixture of sand, silt, clay and organic material can be used to improve sandy or gravelly soil.

- Embankments or berms

Dredged material consisting of rock, gravel and sand, or consolidated clay can be mixed with other soils and stabilizers (if needed) and used in transportation projects for erosion control, roadbed or highway sound barriers. Offshore underwater berms can be created from some types of dredged material and used to modify wave effects on the shoreline and to trap large storm waves.

- Flood control

Dredged material can be used in levee construction for flood control projects in low-lying areas subject to severe flooding from coastal storms. A variety of particle sizes are acceptable, except for exceptionally fine-grained or organic sediment. Examples of USACE flood control projects in New Jersey can be found along Green Brook and the South River, as well as in Union Beach and Port Monmouth.

- Beach nourishment

Dredged material consisting predominantly of sand (>90%) can be used to replenish eroded beaches, provided that the material has the appropriate grain size and color to be consistent with the beach sands.

- Landfill or Brownfields capping

Due to its generally low level of permeability, dredged material can act as a seal to prevent migration of existing contaminants at a site. For this application, the dredged material is incorporated into a physical matrix to create the final product. There are several examples of recent successes using this approach, including construction of the Jersey Gardens Mall on the old Elizabeth Landfill by OENJ Cherokee and the capping of the U.S. Fish and Wildlife Service Harbison-Walker Brownfields Site in Cape May, NJ. This approach has been recently permitted for landfills in the Hackensack Meadowlands as part of the ENCAP site. Redevelopment opportunities for reclaimed land can bring substantial economic benefits to local communities. Dredged material can also be used for capping and closure of landfills. Processed dredged material will be used as an alternative grading material to assist in the closure of Fresh Kills Landfill in New York. Dredged material can also be used as daily cover for active landfills.

- Strip mine reclamation or quarry filling

Dredged material, either alone or mixed with cement as a stabilizer, can fill large excavation sites that are in need of restoration. As an example, abandoned mined lands can be reclaimed by making use of large volumes of stabilized dredged material. The Bark Camp Mine Restoration Project in Pennsylvania demonstrates the successful application of this approach.

- Wetland creation or aquatic restoration

Depending upon its characteristics, dredged material can be used to create shallow intertidal areas. Examples include habitat for sport and commercial fishery enhancement, gravel riffle beds for endangered or threatened species, or flats for oyster reef restoration. For example, a successful gravel bed construction project was completed in Mound City, IL. Dredged material is commonly used for reef construction when it consists largely of rock. Rock material dredged from navigation channels has been used for reef creation off of the coasts of New Jersey and New York.

- Island creation

Dredged material can be used to create in-water islands for waterbird nesting habitat. This could be especially beneficial in areas where development has destroyed important flyways. Evia Island in Galveston Bay in Texas is a 6-acre island that was created using dredged material from the Houston Ship Channel. Placement was completed in the summer of 2000 and nesting was observed as early as spring of 2001. Aquaculture

Confined disposal facilities can be used for aquaculture operations between dredging cycles. This approach has been used to develop a shrimp hatchery in Galveston, Texas

2.2 BENEFICIAL USE DEMONSTRATION PROJECTS

A number of projects in New Jersey demonstrate beneficial uses of dredged material. In northern New Jersey, contaminated dredged material has been successfully processed to sequester contaminants and create structural fill material. This approach has been used to reclaim a mine in Pennsylvania, provide fill for golf course construction in Bayonne, and for development of a mall in Elizabeth. In southern New Jersey, material stored in a confined disposal facility (CDF) has been utilized for reclamation of a brownfield site and creation of a vegetated rolling dune field for wildlife habitat. One of the more comprehensive examinations of the diverse uses for dredged material is taking place at the Palmyra Cove Demonstration Project in Burlington County, New Jersey. For specific examples, including an in-depth look at the Palmyra Cove Demonstration Project, see Appendix B.

The Palmyra Cove Demonstration Project and other site specific demonstration projects reveal that dredged material can be put to a positive use and can provide benefits over the use of virgin materials. Beyond the immediate economic benefit of relieving the backlog of stalled dredging projects, beneficial use of Palmyra dredged materials can also reduce the economic cost of natural resource impacts associated with the extraction of virgin materials.

There is clearly a demand for building materials within the State and dredged material has the versatility, depending upon the sources, to satisfy a full range of material demands. The knowledge gained from an array of on-going demonstration projects can be used to build the road map towards a sustainable system of dredging and dredged material use within the State of New Jersey.

2.3 IDENTIFIED BARRIERS AND POTENTIAL SOLUTIONS TO BENEFICIAL USE APPLICATIONS

There are several primary barriers to the implementation of technologically feasible dredged material management solutions. One problem for contractors, processors and others involved in handling dredged material is the sporadic nature of the supply. Dredging occurs infrequently, on an as-need basis, and therefore produces an intermittent supply of material. In addition, the volume and type of material generated can be highly variable depending on the location and extent of the dredging project. For most beneficial use alternatives to be viable, dredged material must be consistently available in large volumes at prices competitive with current raw material alternatives (including transportation costs).

One solution to this obstacle is the creation of regional dredged material staging/processing facilities (RPFs), which would collect all dredged material generated within a specified geographical range. This approach may reduce overall costs and facilitate beneficial use options by providing a central location for processing and handling. Contractors may have an incentive to purchase materials from such a facility because it will provide a dependable source of material, in contrast to the uncertainty associated with locating and/or purchasing virgin material from borrow pits or other sources. A RPF may also be able to supply raw materials for a number of end uses. For example, the dredged material used to make ceramics must consist of fine grained sediment (those passing the 200 sieve). In other applications, such as beach replenishment, only the coarser grained material (sands) are desired. A RPF could screen and separate the material according to grain size, thus targeting the individual market demands by providing the required material for each end use.

Beneficial uses of dredged material that are expected to be most competitive are those that require little processing, such as construction fill and materials for brownfields reclamation and site remediation. For dredged material with the correct geotechnical properties, beach nourishment could be accomplished with minimal processing. Manufacturing topsoil may be a viable option for loamy materials dredged from waters with low salinity. High quality topsoil can be produced by mixing the dredged material with other waste streams, such as biosolids, leaf compost or wood chips. Lower quality topsoil can be produced with less processing.

Regardless of the end use, processing will most likely require dewatering, debris screening, trommel screening for grain size control, and attenuation of reactive components such as organic matter or hydrogen sulfide. Storage of raw dredged material will be necessary until an end use is identified and processing occurs. A full discussion of dredged material processing and equipment requirements, site considerations and the permitting requirements for RPFs is provided in Appendix B.

Public opposition to the beneficial use of dredged material has, in the past, been a deterrent due to perceived risks of environmental contamination and exposure related health hazards. A potential solution to this issue is continued outreach and public relations to publicize the fact that materials originating from New Jersey's State channels are relatively clean.

One potential method to promote the beneficial use of dredged material is legislative and regulatory action to require or promote the beneficial use of clean dredged material originating from New Jersey. As an example, legislation requiring the NJDOT to incorporate dredged material in a percentage of their projects would create an ongoing demand for this material, while ensuring environmental protection. In addition to its most common use as fill, dredged material can potentially be used in earthen noise barriers along highways, for embankment stabilization, or for green highway islands and shoulders. Several years ago, Senator Torricelli of New Jersey introduced bill S.537 which would have required the use of dredged material in Federally funded transportation projects. This bill did not garner sufficient support.

In August 2003 an act concerning the beneficial use of dredged materials was passed by the New Jersey Senate (S235). This act states that the NJDOT and the NJDEP and any other State department or agency shall consider the beneficial use of dredged material in any State-funded project. This includes, but is not limited to, road construction projects and publicly funded remediation projects. This legislation provides a foundation for beneficial use of the material generated from all State channel dredging projects. If the legislation further required NJDOT to incorporate dredged material in a percentage of their projects, it would create an ongoing demand for this material.

There may be other methods to encourage or direct the beneficial use of dredged material. Creating incentives for voluntary participation may be economically viable and may encourage private sector involvement. Examples include tax-based incentives and elimination of Tidelands Commission fees. With these incentives dredged material could become more cost-competitive with other raw materials.

The State of New Jersey has already taken a significant step toward promoting beneficial uses of dredged material by creating a regulatory framework governing dredging and dredged material placement. The creation of this regulatory program has created a greater level of certainty regarding upland applications for this material. Greater certainty encourages more entrepreneurship and alternate beneficial uses. This first step can be used as an effective springboard for future utilization of dredged material. Other steps that can be taken to further promote beneficial use include streamlining the permitting process for dredging and beneficial use applications, and ensuring that the regulatory program has adequate staffing and resources to assist and help encourage beneficial use applications.

Moving forward, the NJDOT/OMR is building the "DMMS" system. The Dredged Material Management System (DMMS) is GIS-based and under construction in partnership with the NJDOT's Bureau of Information Management and Technology Planning. New Jersey is the only known state in the nation to build and utilize such an innovative system, a potential nationwide model for small quantity dredged material management solutions.

Eventually, utilizing available information from I BOAT NJ projects and other sources, the NJDOT/OMR plans to compile public and private dredging needs in order to be able to easily match quantities of dredged material with opportunities for dredged material use. Planning efforts will also allow NJDOT/OMR to be better equipped to assist localities and municipalities with their specific planning efforts for dredged material, including regional siting of dredged material management facilities.

The effort is evolutionary and currently focuses on five layers of information: 1. Federal, state and private material management areas; 2. NJDOT capital construction projects with a fill requirement; 3. New Jersey marinas; 4. State navigation channels; and 5. Beneficial use opportunities.

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Overall goals for the DMMS include the ability to:

- Match dredged material generators/existing material with those who need with dredged material
- Track and document available chemical and geotechnical characteristics of material being managed and/or placed into CDFs
- Make logical and cost-efficient decisions for dredged material management
- Assist localities with logical and cost-efficient dredged material management decision-making
- Develop regional dredged material management facilities
- Coordinate information gathered from relevant projects such as those funded by I BOAT NJ
- Simplify the dredging permit process

CHAPTER 3

CASE STUDY ANALYSES

A case study approach was selected to investigate dredged material management strategies and to develop economic information applicable to dredging in New Jersey's diverse marine environments. This approach utilizes actual site information from representative areas to develop an understanding of site specific dredged material management economics that can be applied to other areas of the State. Costs and benefits associated with State and private dredged material management approaches over an extended time period are examined assuming that current conditions remain unchanged. The economics of alternate strategies are also evaluated and compared.

Case study locations were selected using a number of criteria, including geographic location and proximity to State and private dredging projects. Four case studies were selected by the New Jersey Department of Transportation's Office of Maritime Resources (NJDOT/OMR), with assistance from the New Jersey Department of Environmental Protection's Bureau of Engineering and Construction (NJDEP/BEC). Although the dredged material management challenges vary among case studies, a common theme among them is the limited or diminished capacity of existing dredged material placement locations. The following sections describe the case studies in detail and provide an economic analysis of alternative management strategies for dredged material. The locations of the case studies are presented in Figure 3.1.

3.1 CASE STUDY SELECTIONS

1. Cape May Harbor

Cape May Harbor is located on the southern tip of the State. The land use of the region is largely defined by its maritime tourism-based economy. The health of this economy depends on the maintenance of the Harbor's navigation channels. Historic dredged material placement areas have nearly reached capacity or have been slated for more lucrative types of development. The development of new dredged material placement locations would require purchase of valuable waterfront real estate which is quickly becoming unavailable. Cape May Harbor was selected as a case study to represent a scenario that includes a large harbor (approximately 2,144 boat slips) that requires dredging by the State, private marinas, party/charter boats and commercial fishing and fish processing operations.

2. Dredge Harbor in Delran Township

Dredge Harbor in Delran Township, NJ is a man-made waterbody connected to the Delaware River by a privately maintained navigation channel. The Harbor has approximately 1,300 boat slips. Dredge Harbor was selected to represent marinas on the Delaware River that maintain their navigation channels without State assistance.

3. Upper Barnegat Bay

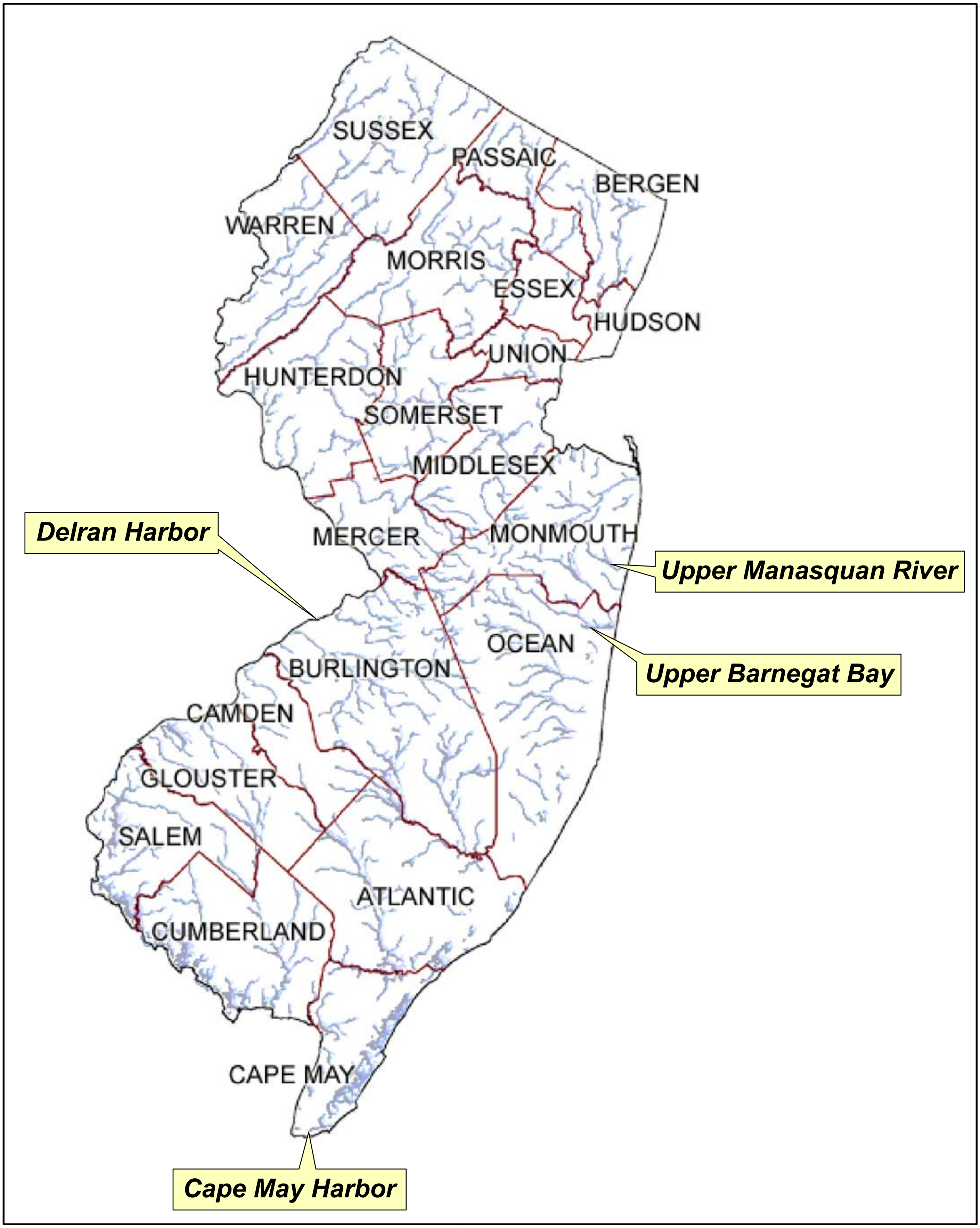
Sails Aweigh is a small marina with approximately 30 slips located in Brick Township, NJ. The marina is responsible for maintaining its slips and the access channel that connects it to the State navigation channel on the upper Barnegat Bay. Sails Aweigh was selected to represent the dredged material management issues faced by small business owners in coastal New Jersey.

4. Upper Manasquan River

Lightning Jacks #3 marina on the upper Manasquan River in Brick Township, NJ is a mid-size marina (200 slips) located on a shallow waterbody with a channel maintained by the State. Unlike most New Jersey marinas, Lightning Jacks #3 has an on-site Confined Disposal Facility (CDF) to manage dredged material from its slips and access channel. The proprietor of Lightning Jacks #3 maintains the capacity of its CDF by processing dredged material into topsoil and selling as landscaping material. Lightning Jacks #3 was selected to represent self-sustaining material management strategies that can be achieved by small business operators. In addition, this case study reflects challenges faced by marinas that are dependent on State dredging of the nearest navigation channel.

These four case studies exemplify the diverse challenges faced by business owners who depend on the preservation of water access for the continued growth and well being of their businesses.

Figure 3.1. Case Study Locations



New Jersey Department of Transportation **Office of Maritime Resources** **Lawler, Matusky & Skelly Engineers LLP** One Blue Hill Plaza • Pearl River, New York 10965 ENVIRONMENTAL ENGINEERING & SCIENCE CONSULTANTS	**Case Study Locations**	**Figure 3.1**

3.2 CASE STUDY ANALYSIS METHODOLOGY

The following sections describe the methodologies employed to collect estimates of dredging requirements, select alternate management strategies for dredged material, and perform economic analyses to compare the costs and benefits associated with each strategy.

3.2.1 Future dredging requirements

The initial step in understanding the magnitude of the issue is an estimation of the future dredging volumes required to maintain private marinas and State navigation channels. Truly accurate estimates of sedimentation rates and associated dredging needs can be developed using complicated mathematical models. However, this detailed approach is beyond the scope of this study, and general estimates of dredged material volumes are sufficient for the examination of alternate management strategies. Therefore, for this analysis, estimates of future dredging needs have been developed using the dredging history of the marinas and State maintained navigation channels. Average volumes of material dredged (wet measure) over the last ten years were used to develop an average annual volume of dredged material. It is assumed that this quantity will reflect the average amount of material that will be dredged during subsequent decades. It is also assumed that the rate of maintenance dredging will remain approximately the same over the next 50 years, with some years having more or less dredging.

3.2.2 State Channel Dredging Program and Material Management

NJDOT/OMR is the State agency responsible for funding the dredging of State navigation channels within New Jersey, and NJDEP/BEC is responsible for contracting the dredging projects. Background information about State dredging projects and dredged material management strategies at each of the case study locations (with the exception of Dredge Harbor which is maintained by local marinas) was obtained through telephone and person-to-person interviews with NJDEP/BEC. The types of material that need to be dredged, expected levels of contamination, and the obstacles to dredging and dredged material management in each of the regions were discussed. NJDEP/BEC provided navigation charts highlighting the location of State and Federal dredging projects. In addition, NJDEP/BEC accompanied the project team to Cape May for a site visit.

3.2.3 Private Dredging and Material Management

Several methodologies were employed to gather background information about the marinas located within the geographic limits of the four case studies. The project team interviewed marina operators in person and by telephone to obtain additional information about their dredging requirements, slip rental rates and capacity, dredging history, historical dredged material management strategies, current difficulties encountered when planning dredging projects, and employment history. This data was used to supplement information collected during a NJDOT/OMR Boating Access and Service Provider Survey conducted previously.

At each case study location, the project team also visited the town and/or county Chamber of Commerce to solicit information about other maritime businesses (e.g. charter boats) that rely upon channel maintenance for their operations.

3.2.4 Selection of Alternative Management Strategies

Using information collected from the NJDEP/BEC, private marinas, dredged material management demonstration projects and literature reviews, alternative dredged material management strategies were developed for each case study location. The alternatives were selected based on their viability at each case study site, with beneficial use of dredged material as the core objective.

3.2.5 Economic Analyses

An analysis of the costs and benefits associated with dredged material management strategies was performed for the current or baseline condition and two or three alternative scenarios. The baseline condition is defined as a continuation of existing material management strategies with no development of alternative placement or beneficial use strategies. Under the baseline condition scenario, it is assumed that the private material will be placed in a landfill after existing placement options have reached capacity.

Costs

The cost for each baseline condition and alternative dredged material management strategy was assessed on a present value basis and projected over a 50 year planning period. The current FY05 Federal discount rate for water resource planning of 5.375% was used to convert to present value (2005) dollars. In general, since the cost of the actual dredging activity was consistent for all alternative strategies, the cost of dredging was not assessed. Only the costs of loading, transport, unloading, dewatering, processing and placement were considered. Furthermore, it is believed that the costs of dredged material management will greatly exceed the costs of dredging.

Dredged material transport, dewatering, processing, and placement are components of material management strategies that can remain nearly constant for more than one alternative. When possible, generalized unit costs (per cubic yard of material) were developed for these components. Also, because these component costs are uncertain and depend upon several external factors (e.g. the labor market), they are presented as three values: "low range", "expected", and "high range". The methods used to develop these unit costs are fully explained in Appendix C.

Using the range of costs developed for each alternative scenario, a Monte Carlo simulation was performed to determine both the expected cost of each alternative and the associated level of uncertainty. The simulations were performed using the @RISK add-in to an Excel spreadsheet (Palisade Corp, 2004). All uncertain costs were modeled using triangular distributions with a minimum, most likely, and maximum value. These distribution values correspond to the low range, expected and high range cost scenarios. The @RISK add-in simulates random values from the distributions and keeps track of the results. After completing the simulation @RISK summarizes the output distributions, providing the probability of the cost values that may be encountered.

Another variable that needs to be considered is the fact that dredged material quantities can vary substantially in any one year. The State may not dredge at all in some years and private marinas will not dredge in most years. The use of a Monte Carlo simulation allowed the variability in dredged material volumes to be considered. The quantity of dredged material was modeled using a lognormal distribution.

Economic Analysis

Two of the most important types of economic analysis are economic impact analysis and cost-benefit analysis. Both estimate the benefits associated with a proposed economic scenario. Economic impact analysis attempts to quantify the effects of a chosen alternative or policy change on the economy of a region. Changes to sales, income, jobs and tax revenues are typically calculated using an input-output model of a region's economy. On the other hand, unlike economic impact analysis, cost-benefit analysis is concerned with changes in social welfare. Cost-benefit analysis examines the efficiency of an alternative or policy change and attempts to assess and quantify how the action will result in benefits to society. Cost-benefit analysis can also consider non-market values, such as the value of a recreational resource like a waterway (RTI International, 2004).

Cost-Benefit analysis

To examine the benefits of alternative dredged material management strategies, a simple cost-benefit analysis was performed. Economic benefits accrue to both the consumers (boaters) and producers (marinas). The total benefit, or value, is the sum of what consumers are willing to pay above what they are currently paying and the sum of what producers are willing to sell below the current price. This is known as the sum of the consumer and producer surplus.

Consumer surplus is the value of a recreation activity beyond what must be paid to enjoy it (Rosenberger and Loomis 2000). For example, a recreational boater might be willing to pay $2,000/year to rent a boat slip but is currently only paying $1,000/year. The difference, $1,000/year, is their consumer surplus or net willingness to pay. The total economic value (to the boater) is $2,000/year, the cost to participate ($1,000/year) plus the net willingness to pay (another $1,000/year).

Producer surplus is the difference in the price that producers charge for a good and the price at which they would be willing to supply it. In our example, the producers are the marinas. Marina owners may charge $3,000/year to rent a slip but would be willing to rent it for $1,000/year. The producer surplus is $2,000/year. The economic value (to the marina) is the price they are charging for the slip ($3,000/year) minus the cost that they are willing to supply it for ($1,000/year). To the marina, the economic value and the producer surplus are equal because they represent the amount gained from renting the slip at a particular price.

The net economic value is the sum of both consumer and producer surplus. This concept is illustrated graphically in Figure 3.2.

Consumer surplus can be estimated using benefit transfer methods. Benefit transfer methods use unit values derived in other studies with site specific user data. For example, the California Boating Needs Assessment used a contingent valuation survey to indicate the value of compensation for loss of access to a boater's primary waterway. The study indicated that in order to avoid this loss of access, boaters were willing to pay $29.36 per person per day of boating (NewPoint Group 2002). This is an average consumer surplus, the amount that the boaters were willing to pay over their current boating expenses. By multiplying this user day value by the number of recreational boating days (LMS 2004), the number of people on each boat and the number of slips in each of the case study locations, an annual value of dredging in each region can be estimated:

(29.36/person/day)(30days/year)(3persons/boat)(# slips) = annual consumer surplus (in dollars)

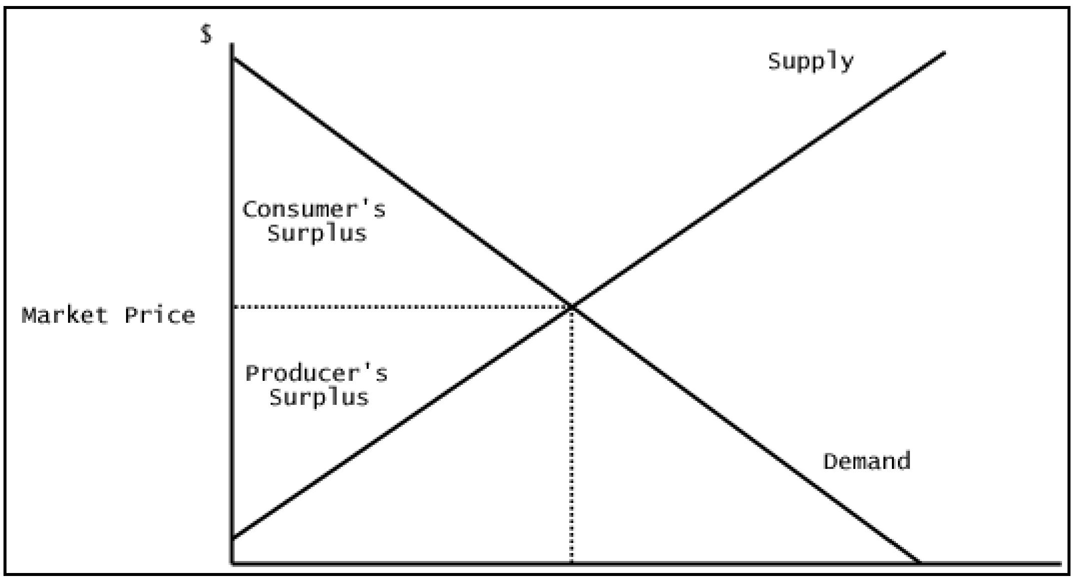


Figure 3.2. Graphic Representation of Net Economic Value

The economic value of dredging also includes other factors such as changes to property values, jobs, and taxes as well as direct and indirect effects of boater related spending in the local economy. Several recent studies have found that boating expenditures result in significant additional positive economic impacts to the local economy. For example, results of Recreational Boating in Maryland, An Economic Impact Study indicated that for each $1.00 of recreational boating expenditure there was an additional $0.97 of additional economic activity. Similar results were reported in the California Boating Needs Economic Assessment ($0.56 of value added to the gross State product for every $1.00 of boating related expenditures) and in a study of recreational boating in Michigan ($0.76 in sales and $0.22 income produced for each $1.00 of boater spending) (RMRC 2002). These studies point out the direct, indirect and induced effects of the marine trade industry throughout the local economy.

Providers of boating access and services also place a high value on access to waterways. Results from the New Jersey Recreational Boating Survey indicated that dredging related concerns far outweigh any other issues. Costs associated with dredging, permitting, placement of dredged material, availability of placement locations and restrictions in the timing for dredging were all important issues facing New Jersey marina owners/operators.

If revenues from slip rentals decrease due to shoaling, the producer surplus of the marina will decrease. Therefore, producer surplus, assuming full access to slips, can be equated to the economic value of dredging to marina owners. The benefit transfer method can be used to estimate producer surplus. According to Dun and Bradstreet (1987), the average return-on-sales for the marina industry is 3.3%. The average return-on-sales for the marina industry can be multiplied by the total revenue for the marinas at each of the case study locations to approximate producer surplus:

(0.033)(Total annual marina revenue) = Total annual producer surplus (in dollars)

For each case study, the total economic value of dredging was calculated as the sum of consumer and producer surplus over the 50 year planning period. This was compared to the cost of dredged material management over the same period to determine the cost – benefit relationship for each dredged material management strategy at a particular case study site.

The following sections describe the results of the case study economic analyses.

3.3 CAPE MAY HARBOR

3.3.1 Case Study Description

Cape May is a vibrant boating town located at the southernmost tip of New Jersey (Figures 3.3a and 3.3b). A number of private, Federal and State channels and facilities require dredging to maintain access to recreational, commercial and industrial maritime businesses. The geographic reach of this case study is the shoreline of Cape May Harbor and the ancillary channels maintained by the State of New Jersey. The location of the Federal and State navigation channels, private marinas, and CDFs are depicted on Figures 3.4 and 3.5. Materials from USACE dredging projects are placed in two CDFs, “Corps

Site C" and "Corps Site D". Materials from U.S. Coast Guard (USCG) dredging projects are placed in an on-site facility. NJDEP/BEC maintains four State channels in Cape May County and each channel has been dredged in the past ten years. Material from these projects was temporarily stored in the USACE-owned Corps Site C. The NJDEP/BEC maintains the Middle Thorofare Commercial Lagoon. Dredged materials are placed on the "Mogck Property", a privately owned parcel located at the end of the lagoon.

The State of New Jersey has permission to dewater dredged material from State channels in the USACE-owned site, but is required to remove the same volume of dry material. Recently, the NJDOT/OMR funded the NJDEP/BEC to contract the removal of material from Corps Site C to utilize it to remediate the U.S. Fish and Wildlife Service Harbison-Walker Site (USFWS HWS), a Brownfields site in the southern Cape May County wildlife management area (Figures 3.4 and 3.5).

Thirteen privately owned marinas and the Cape May Ferry are located in the Cape May Harbor study area (Table 3.1). Two marinas (Bree Zee Lee Marina and Utsch's Marina) have on-site disposal facilities, but others have no material placement sites and rely on the State to identify available placement options. In the past, some of the marinas were allowed to place material into USACE placement sites, and the owner of Bree Zee Lee Marina allowed other facilities to place material in their CDF for $2/cy. Neither of these options is currently available.

In addition to the marinas that rely on dredging to maintain their operations, seventeen charter boats operate out of Cape May Harbor, commercial fishing businesses, and three large fish processing plants located on the Middle Thorofare Commercial Lagoon channel rely upon regular dredging to maintain channel access for their operations.

The total estimated average annual dredging volume for Cape May Harbor is 75,000 cy. This includes 15,000 cy per year for State channels and 60,000 cy per year for marinas.

3.3.2 Economic Analysis – Cape May

The following sections discuss the baseline condition and alternative management scenarios for the dredged materials from State navigation channels and private marinas in the Cape May Harbor region.

Table 3.1 Privately owned Cape May Marinas and their location, number of slips, number of employees and the presence/absence of an on-site CDF.

Marina	No. of Slips	No. of Employees	Address	Has CDF?
Bree Zee Lee Marina	1,000	6 FT 4 PT	970 Ocean Dr.	Yes
Canyon Club Resort Marina	247	35 FT*	900 Ocean Dr.	No
Cape May Marina	142	9 FT 2 PT	1263 Lafayette St.	No
Corinthian Yacht Club of Cape May	NA	4 FT 14 PT	Delaware Ave. (next to USCG)	No
Harbor View Marina	197	3 FT	954 Ocean Dr.	No
Hinch Marina	110	3 FT*	989 Ocean Dr.	Yes
Miss Chris Marina	11	1 FT 3 PT	3 Monarch Ct.	No
Rosemans Boat Yard	20	2 FT 1 PT	Roseman Rd.	No
Seven Evans Marina	3	4 FT 4 PT	1484 Washington St.	No
South Jersey Marina	50	20 FT 10 PT	1231 Route 109	No
Utch's Marina	350	20 FT	1121 Rt. 109	No
Windmill Marina	14	1 FT 1 PT	1264 Wilson Dr.	No
Totals	**2,144**	**108 FT; 39 PT**		

Notes:

For the number of employees, FT = full time and PT = part time.

Information was not provided for the Snug Harbor Marina and it is not included in the table.

* - From Dun & Bradstreet

Photo 1. Boats at a marina in Cape May

Photo 2. Cape May Canal

Photo 3. Cape May shoreline with boats

Photo 4. Wetland near Cape May Harbor

Figure 3.3a. Photographs of Cape May Harbor

Photo 5. Boats in Cape May Harbor

Photo 6. Cape May Harbor and pier

Photo 7. Cape May shoreline

Photo 8. Sailboats in Cape May Harbor

Figure 3.3b. Photographs of Cape May Harbor

Map source: USGS 7.5-min. quadrangle series, Cape May, NJ, 1954, photorevised 1972, and Wildwood, NJ, 1955, photorevised 1977.

0 2000 ft
~SCALE
1 in. = 2000 ft

Federal channel
State channel

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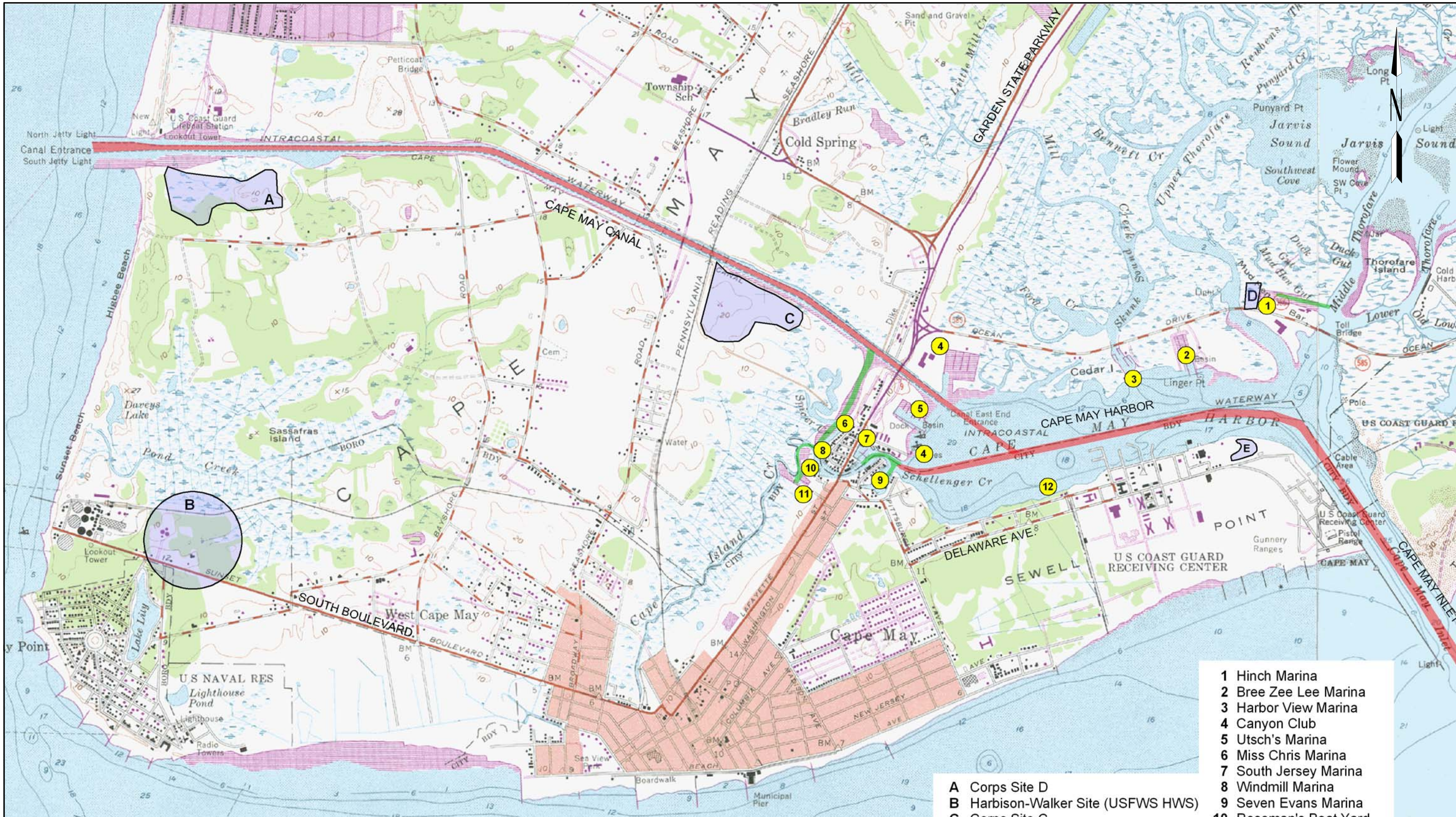
Location of Cape May Harbor CDFs, Navigation Channels, and Marinas

Cape May Harbor, Cape May, NJ Aerial Photo

Figure 3.4



1 Hinch Marina
2 Bree Zee Lee Marina
3 Harbor View Marina
4 Canyon Club
5 Utsch's Marina
6 Miss Chris Marina
7 South Jersey Marina
8 Windmill Marina
9 Seven Evans Marina
10 Roseman's Boat Yard
11 Cape May Marina
12 Corinthian Yacht Club

A Corps Site D
B Harbison-Walker Site (USFWS HWS)
C Corps Site C
D Mogck Property - private land used by NJDEP/BOEC
E USCG CDF

Federal channel
State channel

0 2000 ft
~SCALE
1 in. = 2000 ft

Map source: USGS 7.5-min. quadrangle series, Cape May, NJ, 1954, photorevised 1972, and Wildwood, NJ, 1955, photorevised 1977.

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Geographic Reach of the Cape May Harbor Case Study

Cape May Harbor, Cape May, NJ USGS Map

Figure 3.5

Baseline Conditions

- State Dredged Material Management Strategy

Currently, the State dredges and places material at the Corps Site C. Once dewatered, the dredged material is transported 4.5 miles via truck to the USFWS HWS. The current Brownfields site will be able to accept material for approximately 10 years. The future cost projection for the baseline scenario assumes that other placement sites will be located and dredged material can be placed (at no cost) in the following 40 years. This scenario will represent the minimum possible costs projected into the future. However, if the sites are further away from Cape May Harbor, transportation costs will make them more expensive to utilize.

The scenario with the lowest cost would use placement sites located a similar distance away as the USFWS HWS. The cost of removing, transporting and placing dredged material at the USFWS HWS was recently bid at $10/cy. The low range cost scenario for this analysis is based on this assumption. The expected cost scenario assumes that the new placement sites would be 10 miles away from the Corps Site C and the high range cost scenario assumes that they would be 100 miles away. In addition to the transportation costs, ranges in loading and placement costs were estimated based on engineering judgment. The component unit costs and the total unit cost for the low range, expected and high range cost scenarios are shown in Table 5.2.

- Private Dredged Material Management Strategy

Bree Zee Lee Marina and Utsch's Marina utilize their own CDFs for dewatering. The only alternative available to the other marinas is to dredge, dewater and send the material to a landfill. Once the capacities of the Bree Zee Lee and Utsch's CDFs are met, they will be forced to move their materials to a landfill also. Based on marina interviews, and assuming that dewatered dredged material has approximately half the volume of recently dredged (wet) material, the CDFs at Bree Zee Lee and Utsch's Marinas have capacity for approximately another ten years.

Assuming that landfill placement is the only option, the private dredged material management cost for the continuation of baseline conditions includes the purchase and installation of geotextile tubes for dewatering, loading the material for truck transport, and a 25-mile truck haul to the Cape May County Landfill. Landfill fees depend upon the waste classification. The high range cost scenario for landfill disposal assumes municipal solid waste classification. All scenarios assume that no land will need to be purchased and that the marinas have land available for onsite geotextile tube dewatering.

The range in estimated private costs for low range, expected and high range cost scenarios are presented in Table 3.2. The total expected present value cost for continuation of baseline conditions including both State and private projects, over the 50 year planning period, is $74.9 million (Table 3.3).

Baseline dredged material management strategies and the alternative strategies presented in the following sections assume that for the first ten years, Bree Zee Lee and Utsch's marinas will use their CDFs at current cost levels. (Bree Zee Lee Marina estimated a placement cost of $2/cy). Since Bree Zee Lee and Utsch's account for approximately 30% of the private dredging volume, the average private unit cost over the first ten years for the Cape May Marinas will be a weighted average of the lower Bree Zee Lee/Utsch's cost and the higher costs for the other marinas. Following the tenth year, the dredged material management costs for Bree Zee Lee Marina and Utsch's Marina is assumed to be the same as for the other marinas.

Alternative 1- Beneficial Use in State and Federal Projects

This alternative considers the potential use of dredged material in State and Federal construction projects. In this case, both State and private dredged material would be pumped directly to either a USACE CDF or a newly constructed CDF adjacent to Cape May Harbor. The capacity of the CDFs would be regenerated by periodically removing dredged material for use in construction. A significant portion of the estimated cost for this alternative is the loading and transporting of dewatered material from a CDF to construction projects.

This approach would be facilitated by legislation to encourage consideration of dredged material for use in construction projects, and to provide incentives so that dredged material becomes the preferred material. Without this legislation, dredged material cannot compete economically against virgin raw materials.

The expected cost scenario for this alternative was developed assuming that dredged material would be used in State sponsored Federal flood control projects. Under this scenario, the cost for removal and transport of the material from an existing CDF is based on the distance to mid-state where the Union Beach, Port Monmouth, South River or

Green Brook flood control projects are located. Over time, new construction projects would need to be identified for dredged material use. The low range cost estimate assumes barge transport, which will ultimately depend on adequate water depths and routes to the beneficial use sites. The high range cost estimate was made by increasing the expected cost by 50%. The cost increase could be due to increased diesel fuel prices or to longer barging distances.

A summary of the dredged material management strategy components and the unit costs for Alternative 1 are presented in Table 3.2. The total expected cost of this alternative over the 50 year planning period is $49.6 million (Table 3.3).

Alternative 2 – Regional Processing Facility

This alternative considers the construction of a regional staging/processing facility (RPF) to process State and private dredged material. Dredged material would be placed directly to barges, the barges would be pushed to the new RPF, and the dredged material would be pumped from the barges into an upland CDF for dewatering. After dewatering, the material would be processed with a trommel screen to grade it for further use.

The construction of a RPF would allow the State to eliminate use of USACE CDFs. Brownfields placement would remain an option, but it would not be a necessity. Processing at the RPF would also add value to the dredged material through dewatering and screening. However, the siting of a RPF is a significant undertaking and delays associated with the planning, permitting and construction of such a facility could further delay dredging projects.

The costs of Alternative 2 include transport via barge, unloading, dewatering in an upland CDF, and the capital and operational cost of the RPF. The location of the RPF in relation to Cape May Harbor will have a great impact on transportation and overall costs. The low range cost assumes the RPF is located within 5 miles of Cape May Harbor, the expected cost assumes it is within 20 miles and the high range cost assumes it is within 100 miles. The revenue from the sale of the material is expected to reduce total costs by $6/cy (based on current price for sandy fill material at the Burlington County Landfill).

To estimate costs to private marinas, it is assumed that the State channel dredging projects and dredged material would be bundled with the dredging projects from Cape May Harbor marinas. The dredged materials would be barged to the RPF. It is also assumed that Bree Zee Lee and Utsch's Marina will continue to use their CDFs for 10 years, after which they would begin to synchronize their dredging projects with the State, and their dredged material would then be barged to the new RPF.

A summary of the Alternative 2 dredged material strategy components and unit costs are shown in Table 3.2. The total expected cost of this alternative scenario projected over the 50 year planning period is $43.1 million (Table 3.3).

Alternative 3- Regional Processing Facility at an Existing Cape May CDF

This alternative examines the potential to construct a RPF within or directly adjacent to an existing CDF. Corps Site C and Corps Site D are the most likely candidates. The potential for hauling material out of the CDFs for transport by truck is limited due to the lack of transportation infrastructure. Trucks can be used to haul the material short distances, but they are not permitted on the Garden State Parkway, the largest roadway in Cape May County. However, dredged material could be pumped directly to the CDF/RPF, dewatered, processed and barged out.

One or more offloading areas would need to be constructed in another part of the State, where the processed material could be loaded onto trucks, weighed and hauled to its end use location. Since the RPF would be located at an existing CDF, the facility would likely be easier to permit and construct and face less opposition than an off-site RPF. Except for screening and loading operations, the land use would remain the same and the existing CDF would still be used for dewatering. However, there are potential obstacles since an offloading facility may need to be developed in another part of the State. It may be possible to find a site with existing infrastructure to handle offloading materials, but for this analysis, this possibility was not considered.

With this scenario there is no land cost associated with the RPF since it is situated at an existing CDF. There is also no cost associated with dewatering since it is performed in the existing CDF. Transportation costs would be as little as half of the costs considered under Alternative 2, since the volume of the dry material is expected to be one-half of the volume of material pumped directly into the barge. However, there is an extra cost associated with constructing an offloading area where materials are unloaded from a barge to a staging area and from the staging area into trucks. In addition to the offloading equipment, this staging area would include a dock, scale house and associated facilities for sale of the processed material. In Alternative 2, these facilities were located at the RPF.

A summary of the dredged material management components and the unit costs for Alternative 3 is shown in Table 3.2. The total expected cost of this alternative projected over the 50 year planning period is $45.4 million (Table 3.3).

3.3.3 Economic Value of Dredging

The recreational boating and fishing industry in Cape May contributes substantially to local and State economies by providing jobs, attracting tourism, and providing tax revenues. The industry consists of marinas, boat manufacturers, new and used boat dealers, boat repair yards, party and charter boat businesses, fishing supply stores and marine parts and accessory dealers. More than 5% of the residents of Cape May County are boat owners, the largest percentage of any New Jersey County (LMS 2004). The 5,431 registered boaters in Cape May County spend approximately $24 million dollars annually. The New Jersey Boater Survey recently completed by the NJDOT/OMR indicated that boaters spend approximately $2,625 each year on trip-related purchases such as bait, groceries and launching fees, and approximately $1,810 on annual expenditures (e.g. insurance, equipment, slip fees, etc.). Cape May is also visited by many out of county boaters who contribute to the regional economy.

In addition to boater expenditures, there are thirteen private marinas and seventeen party/charter boats in Cape May Harbor that contribute to the local economy. Twelve of the thirteen private marinas, excluding the Snug Harbor Marina, provide a total of 2,144 slips and employ 108 full time and 39 part time workers. The marinas reported annual revenue of almost $4 million. A review of Dun & Bradstreet data for these same marinas showed the actual figure may be as great as $10 million (possibly due to revenue from boat sales). Similarly, the seventeen party/charter boats contribute approximately $5 million of annual revenue and employ 54 people. Other waterfront businesses such as commercial fishing, seafood processors, restaurants, hotels and marine supply stores also contribute significantly to the Cape May Harbor economy.

Economic Evaluation of Decision to Dredge

The benefit transfer method discussed at the beginning of this chapter was used to gauge the value of boater access to the waterway (the value of dredging). Using this method, the annual value of dredging in Cape May Harbor to the boaters (consumer surplus) is estimated as $5.7 million. This is equivalent to a present value of $98.3 million over a 50 year planning period.

The producer surplus can be approximated by summing the value of dredging for marinas, fish processing plants and party/charter boat owners. The economic value of dredging for each industry was calculated by multiplying the estimated revenue by the estimated return-on-sales. The estimated annual revenue was then converted into a present value over the 50 year planning period.

The estimated revenue for the marinas, fish processing plants and charter boat owners in Cape May Harbor is estimated at $10 million, $40 million and $5 million respectively. The estimated return on-sales for the three industries is 3.3%, 4.3% and 4.8% respectively (D&B Key business ratios and Almanac of Business and Industrial Financial Indicators). Therefore the estimated annual return-on-sales for these three industries in Cape May Harbor is $330,000 for the marinas, $1,720,000 for the fish processors and $240,000 for the charter boat owners for a total of $2,290,000 annually. This is equivalent to a present value of $39.5 million over a 50 year planning period.

The total economic value of dredging can be calculated as the sum of consumer and producer surplus ($98.3 million + $39.5 million) or $137.8 million over the 50 year planning period. It should be noted that this value may overestimate producer surplus since return-on-sales are only dependent on dredging if lack of dredging reduces profit or forces closure. Conversely, it is recognized that there are other industries in Cape May Harbor that have not been included in this analysis and therefore the value may be low.

The economic value of dredging can be compared with the cost of dredged material management to determine economic viability. The cost of dredged material management has been shown to range from $43.1 million to $74.9 million (depending on the dredged material management alternative considered) over the 50 year planning period. A comparison of the economic value of dredging against the cost of dredged material management clearly demonstrates that there is economic justification to support the development of dredged material management strategies. The actual cost of dredging needs to be added to this analysis to gain a full picture of the economic benefits. However, the level of benefits in excess of the dredged material management costs is significant and would appear to support future dredging.

Economic Evaluation of Alternative Dredged Material Management Strategies

To determine the benefits of the three previously described dredged material management alternatives, the cost of each strategy can be compared with the economic value derived from dredging. The difference between the value and the cost is the benefit of that alternative. The benefits of the alternative dredged material management strategies are summarized in Table 3.3. The alternative strategy with the greatest benefit includes constructing a RPF. However, given the large uncertainty in the costs, it is recommended that further site specific analysis be undertaken prior to recommending a long term dredged material management strategy for Cape May Harbor.

Table 3.2. Summary of unit costs ($/cubic yard) for dredged material management strategies for materials from Cape May Harbor.

Management Component	Baseline (State) To No Cost Placement	Baseline (Private) To Landfill	Alternative 1 To State and Federal Projects	Alternative 2 New RPF	Alternative 3 New RPF at USACE CDF
Total (low, high) ($/cy)	**$21 per cy** (10, 40)	**$41 per cy** (27, 94) **$58 [4] per cy** (38, 133)	**$43 per cy** (21, 64)	**$37 per cy** (18, 56)	**$38 per cy** (22, 57)

Notes:

The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario. Alternatives 1-3 include both State and private dredging projects.

[1] Assumes USACE will continue to allow State use of CDFs for "Baseline State" scenario

[2] Use of barges is assumed in the low range estimate, unloading the barges is required

[3] Cost of offloading facility with dock, scales, etc. is included

[4] The second estimate is after an initial 10 year period when two private marinas can use their own CDFs. After 10 years, their CDFs will be at capacity and they will have to landfill their material, increasing overall costs.

Table 3.3. Summary of the expected costs and benefits in millions of dollars for the baseline and alternative dredged material management strategies for Cape May.

Management Strategy	Description	Expected Cost $ million	Expected Benefit $ million
Baseline	*State*: to CDF to Brownfield *Private*: to Landfill	**74.9** (33.5, 154.4)	**62.9** (-16.6, 104.3)
1	CDF to State and Federal Projects	**49.6** (24.2, 94.8)	**88.2** (43.0,113.6)
2	RPF	**43.1** (21.1, 84.4)	**94.7** (53.4,116.7)
3	RPF in existing CDF	**45.4** (22.0, 88.1)	**92.4** (49.7, 115.8)

Notes:
Expected Cost = present value cost over 50 year management period, where i=5.375%. The present value cost was determined by multiplying unit costs by the volume of dredged material and a present value factor in each year. These costs were then summed over a 50 year period. Expected Benefit = economic value of dredging over the 50 year planning period ($137.8 million) – Expected cost, where i=5.375%. Values in parentheses are 90% confidence intervals. The Expected Costs do not include the cost of dredging. Alternatives 1 - 3 include both State and private dredging projects.

3.4 DREDGE HARBOR IN DELRAN TOWNSHIP

3.4.1 Case Study Description

Dredge Harbor in Delran Township was created in the 1920s and 1930s by mining sand and gravel from the banks of the Delaware River to a depth of minus 20 feet at low tide. In the 1940s and 1950s, maritime businesses started to dominate the local economy. Currently, four marinas and one boat builder are located on Dredge Harbor (Table 3.4). Representative photographs of Dredge Harbor are presented in Figures 3.6a and 3.6b, and the geographic reach of this case study and the location of the navigation channel and the maritime businesses are presented in Figures 3.7 and 3.8.

There are no State or Federal channels in Dredge Harbor. The marinas perform their own maintenance dredging of marina facilities and the channel that allows access to the Delaware River from the harbor. Under baseline conditions, dredged material is placed on Amico Island, located just south of the confluence of Rancocas Creek and the Delaware River. The island was created from dredged material and has recently been converted into a county park. Only a 6 acre portion of the island is currently used for dredged material placement. The four marinas located in Dredge Harbor have a cooperative lease agreement with Burlington County to use Amico Island for disposal of their dredged material. The $5,000 ten-year lease will expire in 2007 and there is no guarantee that it will be renewed. The estimated average annual dredging volume for channels and marinas in Dredge Harbor is 33,000 cy.

Table 3.4. Maritime businesses in Dredge Harbor and their location, number of slips, number of employees, and the presence/absence of an on-site CDF.

Maritime Business	No. of Slips	No. of Employees	Address	Has CDF?
Dredge Harbor Marina	300	16 FT; 2 PT	67 St. Mihiel Dr., Riverside, NJ	No
Riverside Marina	200	18 FT; 2 PT	74 Norman Ave Ste 1, Riverside, NJ	No
G. Winters Sailing and Yacht Center	275	15 FT; 12 PT	8 Reserve Ave, Riverside, NJ	No
Clarks Landing Marina/Marine Max	350	10 FT; 2 PT	63 St. Mihiel Drive, Delran, NJ	No
Independence Cherubini Marine Co., LLC [1]	0	24 FT[1]	51 Norman Ave. Riverside, NJ	No
Totals	**1,125**	**83 FT;18 PT**		

Notes:
For employees, FT=Full-time and PT=part-time.
[1] Independence Cherubini Marine Co., LLC is a boat builder and not dependent on access from the main Dredge Harbor channel

3.4.2 Economic Analysis – Dredge Harbor

The following sections describe the baseline condition and alternative dredged material management strategies for the materials originating in the marina slips and access channels in Dredge Harbor.

Photo 1. Dredge Harbor Marina and Small Island and Amico Island.

Photo 2. Winters Marina.

Photo 3. Winters Marina.

Figure 3.6a. Photographs of Dredge Harbor

Photo 4. Amico Island from Riverside looking East

Photo 5. CDF on Amico Island

Photo 6. Clarks Landing Slips

Figure 3.6b. Photographs of Dredge Harbor

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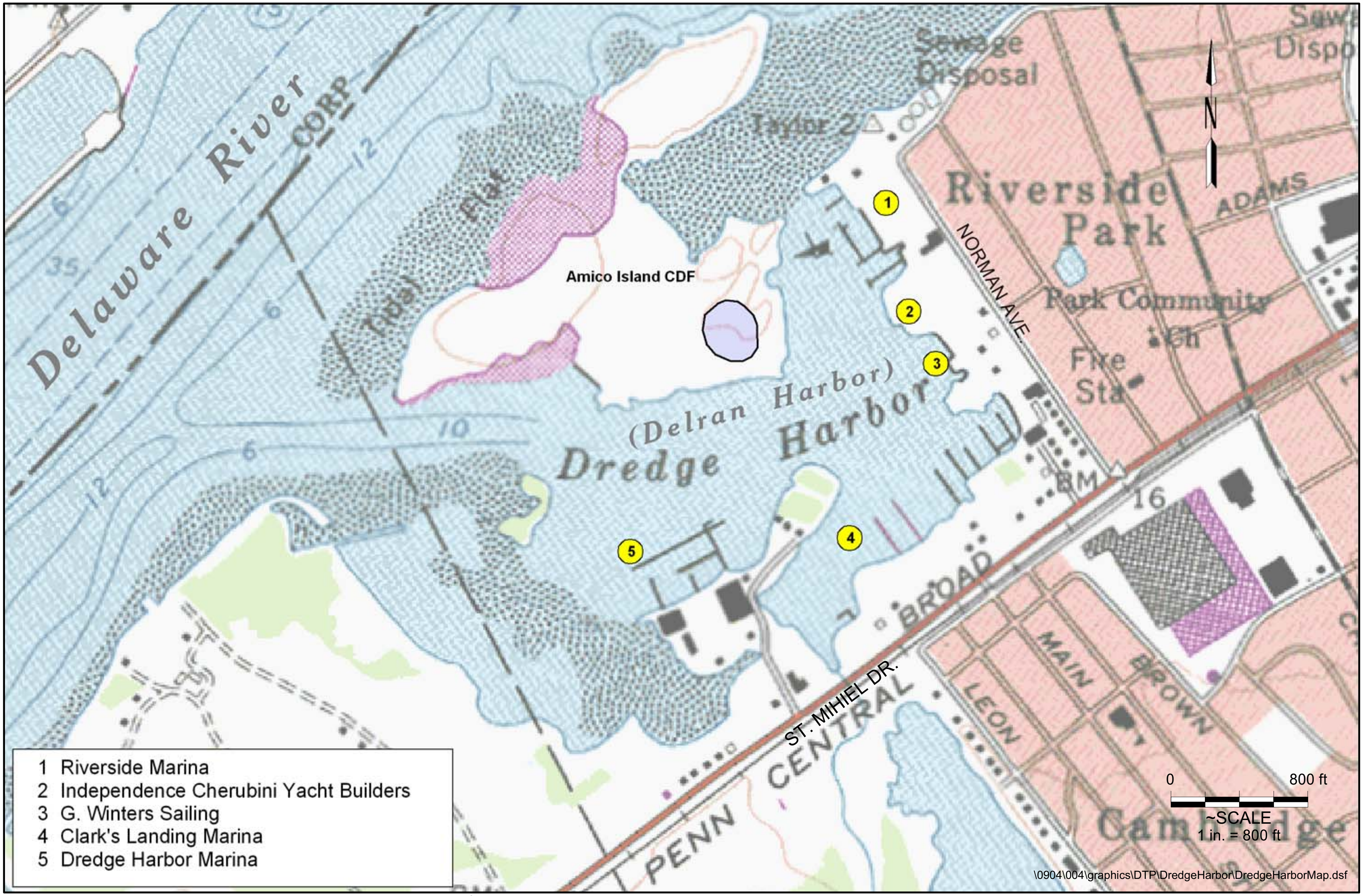
CASE STUDY MARINA LOCATIONS
Dredge Harbor, Delran Township, NJ
Aerial Photo

Figure 3.7



1 Riverside Marina
2 Independence Cherubini Yacht Builders
3 G. Winters Sailing
4 Clark's Landing Marina
5 Dredge Harbor Marina

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CASE STUDY MARINA LOCATIONS
Dredge Harbor, Delran Township, NJ
USGS Map

Figure 3.8

Baseline Conditions

Over the last ten years the cost of dredged material placement has been very low; the dredging, testing and placement cost has averaged approximately $10/cy. The portion of this cost associated with placement on Amico Island was calculated using the cost of the lease and the estimated annual dredging volume with a resulting placement cost of less than $0.02/cy. However, it has been estimated that there is only 10,000 cy of remaining capacity at Amico Island and the baseline condition cannot continue unless the island's capacity is regenerated. If the current approach to dredging is continued into the future, the dredged material management strategy will need to include both the removal of dewatered dredged material from Amico Island and transportation to the Burlington County Landfill (approximately 15 miles) or another nearby landfill. There is the possibility that Burlington County will not want to continue the lease for the Amico Island CDF, or a new lease could include a substantial cost increase.

The cost scenarios assessed for baseline conditions are primarily dependent on landfill tipping fees and the classification of the dredged material. The low range cost is based on the material meeting New Jersey residential direct contact soil cleanup criteria (RDCSCC) site standards and the landfill using it as daily cover. The expected cost is based on the material meeting ID27 criteria for soil. The high range cost is based on classification of the material as contaminated waste that does not meet the ID27 criteria.

The baseline condition dredged material management strategy components and their unit costs are shown in Table 3.5. The total expected present value cost projected over the next 50 years will be $29.0 million (Table 3.6).

Alternative 1 – Off-site Topsoil Manufacturing

This alternative examines the potential use of dredged material to create a marketable topsoil product. This alternative assumes that processing would occur at the Operational Training Center (OTC) at the Burlington County Landfill. A long-term contract could be signed whereby the marinas in Dredge Harbor will send their materials to the OTC. The agreement would likely specify a maximum and minimum volume that would be sent to the OTC, and the marinas would be responsible for on-site dewatering with geotextile tubes and transport of the dredged material to the OTC. Material testing would also be required to make sure that it is suitable for use in a topsoil blend.

With this alternative dredged materials will be used beneficially, but the marinas will not directly benefit economically from this use. Based on past projects, a tipping fee of

$10/cy would be charged at OTC. The marinas would also need to contract for the 15-mile truck transport to the OTC. Transport costs alone are expected to be $17/cy.

There may also be obstacles to dredged material dewatering. During the off-season marinas could dewater dredged material in their parking lots, but in some cases space constraints may make this option unfeasible. A possible solution would be to remove dewatered material from the Amico Island CDF and transport the material to the OTC, thus renewing capacity at the CDF for newly dredged material. However, removal of only the dewatering costs would not change the total cost significantly, $30/cy compared to $37/cy including on-site dewatering.

A summary of the dredged material management strategies for Alternative 1 and their unit costs are presented in Table 3.5. The total expected present value cost projected over the next 50 years is $22.5 million (Table 3.6).

Alternative 2 – On-site Topsoil Manufacturing

This alternative is similar to Alternative 1 with the exception that the marinas would band together to manufacture topsoil themselves. Marinas would dewater, blend and process the materials on Amico Island and sell the topsoil to public or private vendors. If a partnership with a local landscaping company could be established, it would increase the likelihood of a successful enterprise. The manufacture of topsoil for landscaping requires very little processing, and is less expensive than the production of other products. However, topsoil appears to be in abundant supply in New Jersey. Therefore, a partnership with the end-user would likely be required or the marinas could undertake additional processing to improve the quality of the product. Developing top grade bagged topsoil could increase the marketability of the product and command a higher price. The OTC currently sells a topsoil product for $14/cy.

Equipment such as a trommel screen and a large front end loader would be required for processing. The fuel and rental costs for both pieces of equipment would be approximately $30,000 per month. In terms of dredged material, this is approximately $10.91/cy ($30,000/month*12month/year / 33,000cy/year).

Depending on the topsoil mix, costs of blending materials may also have a significant impact on the total topsoil production costs. If the marina operators were to produce a S-21 topsoil similar to that produced by the OTC at the Burlington County Landfill, 33,000 cy of dredged material plus the required blending materials would produce 198,000 cy of topsoil. The S-21 topsoil blend consists of 3 parts Pleistocene clay, 2 parts leaf compost and 1 part dredged material. Four pounds of lime are also added for each cy of S-21 topsoil mix. Prices for blending materials were estimated at $5.25/cy for the Pleistocene clay, $18/cy for the leaf compost and $0.11 per pound for the lime. Based on these prices, the blending materials would cost $9.06 to produce one cubic yard of the S-21 topsoil blend ($6/cy for 1/3 cy of leaf compost, $2.63/cy for ½ cy of clay and $0.43/cy for 4 lbs of lime) or $54.33 for each cubic yard of dredged material used ($36.00/cy for 2 cy leaf compost, $15.75/cy for 3 cy of clay and $2.58/cy for 24 lbs of lime). The total equipment and blending material costs would be approximately $65.24/cy of dredged material ($10.91+$54.33). These costs are highly uncertain and dependent on local suppliers and demand.

Assuming that two full time people would be required for this operation and that the annual payroll would be $100,000/person for labor (wages plus benefits), the cost of the final product would increase by $6.06/cy (2 persons * $100,000/person year / 33,000 cy/year). Anticipated site improvements at Amico Island would also be required and would include fencing, trailer, lighting and roadways. In addition, approximately 6 acres of additional area would be required for processing operations. It is estimated that these site improvements and land purchase/lease would cost an additional $5 million or approximately $5.48/cy of DM, when annualized over the life of the project and applied to the anticipated production rate.

In summary, total expected processing costs including equipment, blending materials, labor, site improvements and land are $76.78/cy of dredged material (65.24+6.06+5.48).

The advantages to the marinas include possible cost savings and control over the processing of their materials. Marinas would save the cost of transport to the OTC and benefit from the revenue generated by the sale of the topsoil product. However, the marinas may not want to be in the business of processing and selling topsoil. They may not have the personnel required for such operations nor be inclined to hire additional personnel. Due to potential aesthetic, noise and liability concerns, Burlington County might not want the processing operation on their parklands or be willing to dedicate more land to such a facility. Finally, the marinas would have to incur initial costs for site improvements and processing equipment and continuing costs for blending materials and extra labor. Each obstacle introduces uncertainty into the viability of this alternative.

A summary of the dredged material management components for Alternative 2 and their unit costs are shown in Table 3.5. The total expected present value cost for Alternative 2 projected over the next 50 years is $3.8 million (Table 3.6). The expected cost assumes that $14/cy in revenue can be obtained for 198,000 cy of the topsoil blend produced annually. In terms of the 33,000 cy of dredged material, the expected revenue is $84/cy.

Alternative 3 – Brownfields Remediation

Under this alternative, the dredged material would be dewatered at the marinas with geotextile tubes. The marinas would contract to have the dried dredged material trucked (or barged) to a Brownfield site.

This alternative is dependent on the assumptions that the marinas have space available for dewatering and that there are plentiful nearby Brownfield sites in need of material. If sites are not available then dredging might be delayed. In addition, if sites are located far from the marinas, significant transportation costs would be incurred.

A summary of the dredged material management components for Alternative 3 and their unit costs are shown in Table 3.5. The total expected present value cost for Alternative 3 projected over the next 50 years is $19.2 million (Table 3.6).

3.4.3 Economic Impacts of Alternative Dredged Material Management Strategies – Dredge Harbor

Recreational boating contributes substantially to the Burlington County and State economies by providing jobs, attracting tourism, and providing tax revenues. More than 2% of the residents of Burlington County are boat owners—this is approximately the median value of all New Jersey Counties (LMS 2004). Using the annual boating expenditures reported by the New Jersey Boater Survey, Burlington County's 9,022 registered boaters spend approximately $16.3 million annually on expenses such as slip rentals, boat storage, taxes, and equipment. As much as an additional $23.8 million is spent on trip related expenditures such as overnight lodging, bait and groceries.

The four marinas in Dredge Harbor rely on the navigation channel for access to their facilities from the Delaware River. The marinas reported annual revenue of over $2 million and a review of Dun & Bradstreet data for these same marinas showed approximately $7 million of revenue. These marinas employ 59 full time and 18 part time workers. Other waterfront businesses such as restaurants, hotels and marine supply stores also contribute to the local economy.

Economic Evaluation of Decision to Dredge

Using the benefit transfer method, the value of dredging in Dredge Harbor was estimated to be $3.0 million. This is equivalent to a present value of $51.7 million over a 50 year planning period. The economic value of dredging also includes other factors not included in this estimate such as changes to property values, jobs, taxes as well as direct and indirect effects of boater related spending in the local economy. In this respect, the economic value of dredging may be underestimated.

Using 3.3% return-on-sales for the marina industry (Dun & Bradstreet 1987), the benefit transfer method yields an estimated total annual producer surplus of $231,000 for the Dredge Harbor marinas. This is equivalent to a present value of $4.0 million over the 50 year planning period. This value may overestimate producer surplus since return-on-sales are only dependent on dredging if marina profit is reduced by lack of dredging or if marinas are forced to close due to lack of dredging.

The economic value of dredging can be compared with dredging cost to determine the economic viability of dredging. The total value of dredging can be calculated as the sum of consumer and producer surplus ($51.7million + $4.0 million), or $55.7 million over the 50 year planning period. This can be compared to the cost of dredging and dredged material management over the same period. The cost of dredged material management has been shown to range from $3.8 million to $29.0 million (depending on the baseline or selected alternative) over the 50 year planning period. Based on the Dredge Harbor historical cost of dredging of $10/cy, the cost of dredging over the next 50 years is $5.7 million. Therefore, total dredging and dredged material management costs range from $9.5 million to $34.7 million. The benefit of $55.7 million well exceeds the costs of dredging and dredged material management, making it clear that it is economically viable to continue under the baseline condition or under one of the alternative dredged material management strategies.

Economic Evaluation of Alternative Dredged Material Management Strategies

Any one of the three alternative dredged material management strategies appear to be more cost efficient than the current or baseline strategy, and they provide a beneficial use for the dredged material. The lowest cost strategy consists of production of a topsoil blend on Amico Island. However, given the large uncertainty in the costs it is recommended that further site specific analysis be undertaken prior to recommending this as a long term dredged material management strategy for Dredge Harbor.

To determine the benefits of the three dredged material management alternatives previously described, the cost of each strategy can be compared with the economic value of boating made possible through dredging. The difference between the value and the cost is the benefit of that alternative. Since the economic value has been previously calculated as $55.7 million over the 50 year planning period, the benefit is $55.7 million minus the cost of the alternative. The benefits of the three alternatives are summarized in Table 3.6.

Table 3.5. Summary of unit costs ($/cy) for baseline and alternative dredged material management strategies for Dredge Harbor.

Management Component	Baseline Amico Island To Landfill	Alternative 1 Off-Site Topsoil	Alternative 2 On-Site Topsoil	Alternative 3 Brownfields Site
Total (low, high) ($/cy)	**$40 per cy** (29, 85)	**$37 per cy** (32, 50)	**-$4 per cy** (-7, 31)	**$31 per cy** (17, 53)

Notes:
The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario.
[1] Includes the tipping fee at the Burlington County Landfill
[2] Includes the tipping fee at the Burlington County Landfill OTC
[3] Assumes that the end-user will be responsible for transport costs
[4] Unloading dried dredged material from the CDF on Amico Island to the on-site processing facility

Table 3.6. Summary of the expected costs and benefits in millions of dollars for the Dredge Harbor baseline and alternative material management strategies.

Management Strategy	Description	Expected Cost $ million	Expected Benefit $ million
Baseline	Amico Island to landfill	**29.0** (11.5, 63.6)	**26.7** (-7.9, 44.2)
1	Topsoil processing at OTC	**22.5** (9.0, 48.7)	**33.2** (7.0, 46.7)
2	Topsoil processing at Amico Island	**3.8** (0.6, 10.3)	**51.9** (45.4, 55.1)
3	Brownfield placement	**19.2** (7.6, 41.0)	**36.5** (14.7, 48.1)

Notes:
Expected Cost = present value cost over 50 year management period, where i=5.375%. The present value cost was determined by multiplying unit costs by the volume of dredged material and a present value factor in each year. These costs were then summed over a 50 year period. Expected Benefit = economic value of dredging over the 50 year planning period ($55.7 million) – Expected Cost, where i=5.375%. Values in parentheses are 90% confidence intervals. The expected costs do not include the cost of dredging.

3.5 UPPER BARNEGAT BAY

3.5.1 Case Study Description

The Metedeconk River is located on upper Barnegat Bay in Brick Township, New Jersey. The land use along the southern fork of the Metedeconk River is characterized by single family homes with private docks. Sails Aweigh Marina and the American Legion Post are the only two marinas on the upper Metedeconk River. Representative photographs of the upper Barnegat Bay are presented in Figure 3.9, and the location of Sails Aweigh Marina is presented in Figures 3.10 and 3.11.

The owners of the American Legion Post do not recall ever having dredged and they do not anticipate dredging in the near future. Sails Aweigh has not dredged in at least 35 years. However, this marina has lost 15 of its 45 slips in the last 10 years due to sedimentation. There are two storm drains adjacent to the marinas, and Sails Aweigh first noticed the sedimentation around the time the second drain was installed. In the past, Sails Aweigh sold deep draft sailboats to customers in New Jersey and Pennsylvania, but this operation has been discontinued. The business currently relies on revenues from the manufacture of marine parts and accessories, and to a lesser extent, slip rentals. The current revenue from slip rentals is approximately $40,000 per year, but revenue was $70,000 per year prior to sedimentation.

Photo 1. American Legion

Photo 2. Metedeconk

Photo 3. Sails Aweigh Empty Slips

Figure 3.9. Photographs of Upper Barnegat

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CASE STUDY MARINA LOCATIONS
Metedeconk River, Brick Township, NJ
Aerial Photo

Figure 3.10

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CASE STUDY MARINA LOCATIONS
Metedeconk River, Brick Township, NJ
USGS Map

Figure 3.11

The State channel appears to have sufficient depth and does not restrict access to the marinas. There are reports that party boats up to 70 feet long navigate the upper Metedeconk. There is also no local knowledge of the State ever dredging this reach of the Metedeconk, and local opinion is that the channel is naturally deep. Charts of the area do indicate artificial deepening, and the State anticipates that the channel will become depth-restricted soon. However, the NJDEP/BEC currently has no convenient site to dewater material. If lack of a dredged material placement site delays dredging, the channel will eventually become un-navigable and access to Sails Aweigh and the American Legion marinas will be blocked.

Sails Aweigh was recently given a preliminary estimate of $100,000 for dredging the slips and access channel and disposing of the material. No bathymetric survey was performed to estimate the volume of the material to be dredged. A rough calculation based on the current and preferred slip depths produced an estimate of 15,000 cy of accumulation over the past 10 years. The total estimated average annual dredging volume for the Sails Aweigh Marina is 1,500 cy.

3.5.2 Economic Analysis – Upper Barnegat Bay

The following sections evaluate the baseline conditions and two dredged material management strategies for the upper Metedeconk River on the upper Barnegat Bay.

Baseline Conditions

Sails Aweigh Marina does not currently dredge, and has not dredged in the past 35 years. Recent sedimentation problems have resulted in a loss of slips and revenue. If the current conditions persist, Sails Aweigh Marina will lose more of its slips and the associated revenue, and will likely be forced to close. In addition, without dredging the State Channel, the upper Metedeconk may eventually become un-navigable.

Alternative 1 – Regional Processing Facility

A regional processing facility (RPF) could be constructed for processing of dredged material. Both State and private dredged materials would be dredged directly to barges and the barges would be pushed to the new RPF. At the RPF, the dredged material could be pumped from the barges into an upland CDF, dewatered, and processed with a trommel screen to grade it for further use.

The construction of an RPF would also allow the State to perform other local dredging projects that have been stalled due to a lack of placement options. However, delays associated with the planning, permitting and construction of an RPF may delay a solution to the current problem at the Sails Aweigh marina and result in the closure of the marina due to the lack of an immediate viable solution.

The costs of this alternative scenario include transport via barge, unloading, dewatering in an upland CDF, and the capital and operational cost of the RPF. The location of the RPF in relation to the Sails Aweigh Marina will have a great impact on transportation and overall costs. For this analysis, the low range cost assumes a RPF located within 5 miles of Sails Aweigh, the expected cost assumes the RPF is located within 20 miles and the high range cost assumes the RPF is located within 100 miles. The revenue from the sale of the material is expected to reduce total costs by $6/cy (based on current price for sandy fill material at the Burlington County Landfill).

A summary of the dredged material strategy components and unit costs for Alternative 1 are shown in Table 3.7. The total expected cost of this alternative scenario projected over the 50 year planning period is $1.0 million (Table 3.8). With an annual revenue of $40,000 the Sails Aweigh Marina cannot afford to pay an average of $55,500/year (1,500 cy/year * $37/cy) for dredged material management.

Alternative 2

Sails Aweigh Marina could dewater on-site using geotextile tubes and haul the material to the Brick Township Landfill, approximately 10 miles away. The dewatered dredged material would be used as daily cover at the landfill.

This scenario would cost far less than Alternative 1. However, the Sails Aweigh Marina likely does not have the resources to conduct the dewatering and transport operations and contracting these functions may be too expensive given their low revenue.

A summary of the material management components and unit costs for Alternative 2 are presented in Table 3.7. The total expected present value cost for Alternative 2 projected over the next 50 years is $0.6 million (Table 3.8). With an annual revenue of $40,000 it is unlikely that the Sails Aweigh Marina can afford to pay $37,500/year (1,500 cy/year * $25/cy) for dredged material management.

3.5.3 Economic Impacts of Alternative Dredged Material Management Scenarios

Recreational boating is an important part of the Ocean County economy. Approximately 4.5% of the residents are boat owners, the second largest percentage of all New Jersey

Counties (LMS 2004). These 22,760 registered boaters spend approximately $41.1 million annually on expenses such as slip rentals, boat storage, taxes, and equipment. Trip-related expenditures could contribute as much as $60.1 million annually to the regional economy. Ocean County is visited by many out of county and out of State boaters who also contribute to the regional economy.

There are approximately 16,000 boat slips in Ocean County and approximately 3,200 in Brick Township (Ocean County Planning Department, December 2004). There are several competing marinas on the north fork of the Metedeconk River. Therefore, it is unlikely that Sails Aweigh Marina can simply raise their slip fees to cover their increased dredging costs.

Economic Evaluation of Decision to Dredge

Using the benefit transfer method, the value of dredging in Upper Barnegat was estimated to be $79,300. This is equivalent to a present value of $1,367,000 over a 50 year planning period. The economic value of dredging also includes other factors not included in this estimate such as changes to property values, jobs, taxes as well as direct and indirect effects of boater related spending in the local economy. In this respect, the economic value of dredging may be underestimated.

The average return-on-sales for the marina industry (3.3%, Dun & Bradstreet 1987) can be multiplied by the annual slip revenue for Sails Aweigh to arrive at an approximation of the producer surplus, or economic value of water access to the marina owners. Sails Aweigh is a small business with low costs. If their profit margin on sales is estimated at 10% of their revenue, annual profits on slip rentals would be $4,000. Therefore the total annual producer surplus for Sails Aweigh Marina is estimated to be $4,000. This is equivalent to a present value of $69,000 over the 50 year planning period.

The economic value can be compared with the dredged material management cost to determine the economic viability of dredging. The total value of dredging can be calculated as the sum of consumer and producer surplus ($1,367,000 + $69,000) or $1.4 million over the 50 year planning period. The cost of dredged material management has been shown to range from $0.6 million to $1.0 million over the 50 year planning period. For this specific location, the costs of dredged material management are clearly less than the benefits, and therefore it is not economically cost effective to dredge.

However, neither the baseline dredged material management strategy nor the two alternative scenarios provide solutions for the Sails Aweigh Marina. Sails Aweigh is faced with the real costs of dredged material management which are only offset by its small profit. Without outside financial and/or technical assistance, it is unlikely that they will be able to stay in business. Possible solutions to reducing sediments at their source could reduce regular dredging needs and associated costs. With source reduction and a one time dredging project, Sails Aweigh might be able to retain their water access and associated revenue and profits.

Table 3.7. Summary of unit costs ($/cubic yard) for dredged material management strategies for materials from Sails Aweigh Marina.

Management Component	Alternative 1 New RPF	Alternative 2 To Landfill
Total (low, high) ($/cy)	**$37 per cy** (18, 56)	**$25 per cy** (22, 28)

Notes:
The expected unit cost, with the low and high range costs in parentheses (low, high) is presented for each component of each alternative. All costs for Alternative 1 are based on a RPF designed to process 75,000 cy/year.
[1] Includes tipping fee

Table 3.8. Summary of the expected costs and benefits in millions of dollars for the two alternative dredged material management strategies for Sails Aweigh Marina.

Management Strategy	Description	Expected Cost $ million	Expected Benefit $ million
Baseline	Cease Operations	-	-
1	To RPF	**1.0** (0.4, 2.0)	**0.4** (-0.6, 1.0)
2	To Brick Township Landfill	**0.6** (0.3, 1.4)	**0.8** (0.0, 1.1)

Notes:
Expected Cost = present value cost over 50 year period, where i = 5.375%. The present value cost was determined by multiplying unit costs by the volume of dredged material and a present value factor in each year. These costs were then summed over a 50 year period. Expected Benefit = economic value of dredging over the 50 year planning period ($1.4 million) – Expected Cost, where i=5.375%. Expected costs do not include the cost of dredging.

3.6 UPPER MANASQUAN RIVER

3.6.1 Case Study Description

The upper Manasquan River is a naturally shallow tidal river in Brick Township, NJ. The shoreline consists primarily of residential development and tidal wetlands. Channel depths restrict access to the upper reach of the river, especially during low tide. Historically, NJDEP/BEC pumped materials from maintenance dredging directly to Gull Island, a man-made dredged material island in the center of the river, but the capacity of Gull Island became depleted. At the time of printing of this document, the island CDF was rebuilt to expand the capacity for current dredging projects.

Lightning Jacks #3 (LJ3) is the only marina located at the shallow end of the State navigational channel. LJ3 has an on-site CDF for their dredging projects. The existing capacity of the CDF is limited, but the proprietor is attempting to expand and renew the capacity by manufacturing topsoil from the dewatered material. Representative photographs of the Upper Manasquan River and the LJ3 facility are presented in Figures 3.12. The location of the channel and the LJ3 facility are presented in Figures 3.13 and 3.14.

It is estimated that the annual dredging requirement for the State navigation channel on the upper Manasquan River is 12,000 cy.. Prior to the rehabilitation of the Gull Island CDF, there were no available options for dewatering dredged material from the State channel because the Gull Island CDF had reached its capacity and there were no viable locations for the development of a new CDF. The proprietor of LJ3 expressed an interest in undertaking the State channel dredging project and using their on-site CDF for dewatering. However, their CDF does not have the capacity required to contain materials from a State channel dredging project. In addition, the NJDEP/BEC is required to bid dredging projects out to contractors; sole sourcing a dredging project to LJ3 would not fulfill this requirement.

The estimated annual dredging volume for the LJ3 marina is 2,500 cy. The dredged material from the LJ3 CDF is currently being used by Sunkist Landscaping Company to make topsoil. LJ3 recently excavated 20 tandem loads of material from the CDF in July 2002, mixed the material with sand and provided it to Sunkist. Under their agreement, LJ3 was responsible for processing costs ($10 to $12 per cy) and Sunkist was responsible for transportation costs. Sunkist sold the processed topsoil material for approximately $22 per cy. Lightning Jacks #3 expects to expand their role in the beneficial use operations by bagging and selling the topsoil from their facility. If permitted, LJ3 will expand their CDF and create cells within it to allow dewatering in one cell and excavation from another. This will promote a steady stream of material to process and sell. LJ3 has also investigated the possibility of purchasing equipment to bag the soil on the premises.

3.6.2 Economic Analysis

The following sections discuss the baseline condition and two alternative management strategies for the State and private dredged materials originating from the upper Manasquan River in Brick Township, NJ.

Baseline Conditions

As described above, State and private dredged materials are managed differently. Baseline management strategies are discussed for each source in the following sections.

Photo 1. Lightning Jacks #3 Dredge Equipment

Photo 2. Lightning Jacks #3 CDF

Photo 3. Upper Manasquan

Figure 3.12. Photographs of Upper Manasquan

New Jersey Department of Transportation
Office of Maritime Resources
LMS Lawler, Matusky & Skelly Engineers LLP
One Blue Hill Plaza • Pearl River, New York 10965
ENVIRONMENTAL ENGINEERING & SCIENCE CONSULTANTS

CASE STUDY MARINA LOCATIONS
Manasquan River, Brick Township, NJ
Aerial Photo

Figure 3.13

New Jersey Department of Transportation
Office of Maritime Resources

Lawler, Matusky & Skelly Engineers LLP
One Blue Hill Plaza • Pearl River, New York 10965
ENVIRONMENTAL ENGINEERING & SCIENCE CONSULTANTS

CASE STUDY MARINA LOCATIONS
Manasquan River, Brick Township, NJ
USGS Map

Figure 3.14

- State Dredged Material Management Strategy

Prior to the recent rehabilitation of the Gull Island CDF, the CDF could not accept any dredged material. The NJDEP/BEC had considered the LJ3 offer to dredge the channel and place materials in their CDF, but physical constraints of the LJ3 CDF and legal issues preclude this as an option. The LJ3 CDF capacity is not sufficient to hold materials from a complete State channel dredging project, and CDF expansion will not be permitted because it would require substantial wetland disturbance. Consequently, with the exception of rehabilitating the Gull Island CDF, there were no current feasible dredged material management strategies for the State. At the time of this analysis, the capacity of the CDF was depleted, and the baseline condition is that there is no feasible option for the placement of dredged material.

- Private Dredged Material Management Strategy

The LJ3 marina has a feasible long-term dredged material management strategy. The current strategy of placing dredged material in their CDF, allowing it to dewater, and processing it and selling it as topsoil has been successful, and they have sufficient resources to continue.

The total processing costs entail labor, materials, equipment, fuel and the cost of blending materials. The LJ3 marina has sold their dredged material with screening only and mixed their dredged material with sand and leaf compost. The sources and costs of these blending materials play an important part in the profitability of their processing operation.

For this analysis it is assumed that the material produced by LJ3 will be 50% dredged material, 50% leaf compost, with 6 and 2/3 lbs. of lime added to each cy. The cost of lime is based on current retail price, and is approximately $ 0.73/cy of finished topsoil. The cost of leaf compost is assumed to be $18/cy, based on the cost of this material at the Cape May County Municipal Utilities Authority. Leaf compost could also be obtained for free through agreements with local municipalities that want to dispose of their leaves. The range in cost of leaf compost has been estimated as between $3 and $25/cy. The total estimated blending costs are $7/cy, $37/cy and $51/cy for the low, expected and high cost scenarios, respectively.

The LJ3 marina has one backhoe and one screening plant for processing their dredged material. They can process up to approximately 30 cy/day of dredged material. Currently, one employee operates the backhoe and screening plant. For this analysis, the

LJ3 marina operational costs are based on renting current equipment and hiring an employee for the sole purpose of processing dredged material The high and low range costs were estimated by increasing and decreasing this expected value by 50%. Based on a production rate of 30 cy/day of finished topsoil, the equipment, fuel and labor costs for the low, expected and high range scenarios per cubic yard of dredged material are $33/cy, $66/cy and $99/cy, respectively.   In addition, the cost for the blending materials are estimated at $7/cy, $37/cy and $51/cy for the low cost, expected and high cost scenrios. The total estimated processing costs are therefore $40/cy, $103/cy and $150/cy respectively in terms of dredged material.

The topsoil product would be sold for $22/cy with low and high prices of $14/cy and $28/cy ($28/cy, $44/cy and $56/cy in terms of dredged material). The low price is based on the current price for topsoil material at the Burlington County OTC and the high price is based on the current retail price for topsoil. A summary of the unit costs for the baseline condition at the LJ3 marina is shown in Table 3.9.

For each of the following alternative strategies, it is assumed that the LJ3 marina will continue to process and sell its own dredged materials. It also is assumed that the LJ3 CDF and processing facility will not be able to accommodate the needs of the State, and that the State will need to develop other options for dredged materials from the State channel.

Alternative 1

This alternative investigates the future regeneration of the Gull Island CDF capacity by removing the material and transporting it off-site for use in large Federal flood control projects or New Jersey Department of Transportation projects. A regenerated Gull Island CDF could then be used for subsequent dredging projects. Under this alternative analysis, it is assumed that the material would be transported by barge to the proposed Union Beach or Port Monmouth flood control project sites. The Gull Island materials would be loaded onto barges using large excavators or cranes with clamshells, towed from Manasquan Inlet to Raritan Bay, offloaded using cranes with clamshell buckets, and placed near the project site or directly into trucks for transport.

A corollary benefit to this approach is that the State would not need to purchase virgin materials for their projects. In addition, with legislative changes the State may realize cost savings on Federal projects from an in-kind material contribution.

The estimated cost for Alternative 1 includes the costs of loading and transporting the dewatered material from the Gull Island CDF to State or Federal projects. The expected cost is based on barging the material to the Union Beach, Port Monmouth, South River or Green Brook flood control project areas. Transport by rail has the potential to reduce this cost but it is unlikely that the nearby passenger line could be utilized.

A summary of the dredged material management components and the unit costs for Alternative 1 are shown in Table 3.9. The total expected present value cost projected over the next 50 years is $9.2 million (Table 3.10).

Alternative 2

Under this alternative, the dredged material will be pumped to barges and transported to a Regional Processing Facility (RPF). At the RPF, the dredged material would be screened and mixed with leaf compost and lime to produce a high quality topsoil product. The proposed topsoil mix is the same as what is currently produced at the LJ3 marina consisting of 50% dredged material and 50% leaf compost with 6-2/3 lbs of lime added to every cy of topsoil mix.

The construction of a RPF would provide a dredged material management strategy to the State and facilitate the dredging of the navigation channel. An alternative dredged material management strategy would also be provided to LJ3. Processing at the RPF would satisfy the objective of providing a beneficial use of dredged material through the production of a desirable topsoil product. However, delays associated with the planning, permitting and construction of a RPF could delay dredging and exacerbate current problems.

The costs of Alternative 2 include transport via barge, unloading, dewatering using an upland CDF, and the capital and operational cost of the RPF. The location of the RPF in relation to the Upper Manasquan River will have a great impact on transportation and overall costs. The low range cost assumes a RPF located within 5 miles of the Upper Manasquan, the expected cost assumes the RPF is located within 20 miles, and the high range cost assumes the RPF is located within 100 miles. The cost of processing at the RPF was estimated based on a small RPF (96 cy/day capacity or 24,000 cy of dredged material per year) that would blend dredged material, leaf compost and lime. The revenue from the sale of the topsoil material is expected to reduce total costs by $14/cy to $28/cy depending on the quality of the material. The expected revenue used in this analysis is $22/cy ($44/cy in terms of dredged material) based on the price that the Sunkist Landscaping Company is currently receiving for their topsoil product.

A summary of the dredge material management components and unit costs of Alternative 2 is presented in Table 3.9. The total expected present value cost for Alternative 2 projected over the next 50 years is $9.9 million (Table 3.10). The expected cost assumes that $22/cy in revenue can be obtained for the topsoil blend.

3.6.3 Economic Impacts of Alternative Dredged Material Management Strategies – Upper Manasquan

As discussed in Section 3.5.3, boating is an important part of the Ocean County economy. Boaters spend approximately $41.2 million annually on expenses and trip-related expenditures and could contribute as much as $60.1 million annually to the regional economy. If the State is unable to dredge, access to the upper Manasquan River and LJ3 marina will become severely limited and eventually could become impossible.

The benefit transfer method was used to determine the value of dredging. A total of 200 boats were assumed on the upper Manasquan River based on the number of reported slips. Using this method, the value of dredging on the upper Manasquan River is estimated to be $9.1 million over a 50 year planning period. Due to the potential effects of dredging on property values, jobs, and taxes, as well as direct and indirect effects of boater related spending in the local economy, this value may be an underestimate.

In addition to the recreational boaters, marinas also place a high value on access to waterways. The benefit transfer method was also used to estimate the economic value to marina owners or producer surplus. The total revenue for the LJ3 marina was estimated at $300,000. Using the return-on-sales value of 3.3% for the marina industry (Dun and Bradstreet 1987), the total annual producer surplus for the Upper Manasquan River marinas is equivalent to a present value of $171,000 over the 50 year planning period. This value may overestimate producer surplus since return-on-sales are only dependent on dredging if marina profit is reduced by lack of dredging or if marinas are forced to close due to lack of dredging.

The economic value can be compared with the dredging and dredged material management cost to determine the economic viability of dredging. The total value of dredging, calculated as the sum of consumer and producer surplus, is approximately $9.3 million over the 50 year planning period. Based on the Upper Manasquan River historical cost of dredging of $5/cy, the cost of dredging over the next 50 years is $1.3 million. Total dredging and dredged material management costs therefore range from $10.5 million to $11.2 million (depending on the alternative) over the 50 year planning period. The lowest cost alternative strategy includes use of State material in USACE flood control projects or large NJDOT projects.

There is a high level of uncertainty associated with the benefit and cost estimates. If a free source of leaf compost was found and could be delivered to the RPF in an adequate supply, then Alternative 2 might become cost effective. Similarly, if land could be acquired at no fee for the RPF, then the facility would become more cost effective. On the other hand, if the marketable topsoil blend required the addition of sand or other amendments, the estimated costs could be higher. Additional site specific studies are necessary to choose the most cost-effective strategy.

Table 3.9. Summary of unit costs ($/cy) for the two alternative dredged material management strategies for the upper Manasquan River.

Management Component	Baseline (Private) LJ3 Marina On-site topsoil	Alternative 1 (State) To State and Federal Projects	Alternative 2 (State) New RPF
Total (low, high) ($/cy)	**$59 per cy** (-16, 122)	**$30 per cy** (21, 48)	**$35 per cy** (-15, 89)

Notes:
The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario. All costs for Alternative 2 are based on a RPF designed to process 24,000 cy/year.
[1] Includes loading costs.

Table 3.10. Summary of the expected costs and benefits in millions of dollars for two alternative material management strategies for the upper Manasquan River.

Management Strategy	Description	Expected Cost $ million	Expected Benefit $ million
1	To USACE or NJDOT Projects	**9.2** (4.4, 18.2)	**0.1** **(-9.8, 4.9)**
2	To RPF	**9.9** (4.5, 20.3)	**-0.6** **(-11.0, 4.7)**

Notes:
Expected Cost = present value cost over 50 year management period, where i=5.375%. The present value cost was determined by multiplying unit costs by the volume of dredged material and a present value factor in each year. These costs were then summed over a 50 year period. Expected Benefit = economic value of dredging over the 50 year planning period ($9.3 million) – Expected Cost, where i=5.375%. Values in parentheses are 90% confidence intervals. The expected costs do not include the cost of dredging.

3.7 CASE STUDY SUMMARY

The four case studies were selected to represent the current range of problems encountered with dredged material management in New Jersey. The studies included a large harbor with State and private dredged material management needs (Cape May Harbor); a smaller harbor with only private dredged material management needs (Dredge Harbor); a single small marina (Upper Barnegat Bay); and a mid-sized marina that has its own CDF for dredging projects but relies on State dredging of the channel in the river for access (Upper Manasquan River).

For each of the case studies several feasible dredged material management alternatives were proposed using beneficial use of dredged material as the core requirement. Costs and benefits were developed for each alternative dredged material management strategy in order to assess their economic feasibility. Since the costs and benefits are highly uncertain, a risk-based approach was used to assess both the mean or expected cost and the possible range in costs.

The analyses demonstrate that it is generally cost effective to implement dredging projects and new beneficial use dredged material management strategies. For the two larger harbors with many users, the benefits clearly exceed costs. Even if the costs of dredging were included in the analysis, the benefits would outweigh the costs. For the mid-sized single marina with its own CDF and for the small marina, the benefits of State channel dredging are nearly similar to the costs. If the costs of dredging were added to the Manasquan analysis, it is uncertain whether the economic benefits would outweigh the costs.

Although the overall costs of dredged material management are expected to increase sharply in the future, eventually costs will decrease as the processes evolve and there is increased coordination between those that perform dredging projects and potential users of the dredged material.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Historically, dredged material management was limited to either disposing of material offshore, or placing it in island, upland or shoreline CDFs. Costs associated with these placement options were minimal. However, the diminishing capacity of existing dredged material placement locations and increased regulations have resulted in substantially higher costs. The case study analyses presented herein have demonstrated that these costs are expected to increase as the capacity in existing placement sites is being exhausted, and the development of new dredged material placement sites is precluded by escalating shoreline property values. However, the case study analyses have also shown that the marine trades industry throughout New Jersey provides sufficient economic benefits to justify the cost of continued dredging and dredged material management.

The backlog of delayed dredging projects highlights the need for both immediate actions and long term planning. Dredged material management strategies that make beneficial use of this poorly understood resource appear to be the best option to address both short and long term needs. It is clear that dredged material can be utilized beneficially, but it is often more expensive to use than virgin material, since processing, screening and separation are usually required to transform dredged material into a usable product. Steps need to be taken to increase the incentives to use dredged material in lieu of material from virgin sources. The following section provides recommendations to promote the beneficial use of dredged material throughout the State.

4.1 RECOMMENDATIONS

The case study analyses have demonstrated that many obstacles to dredged material management can be overcome on a case-by-case basis. However, there should be a Statewide emphasis on the promotion of the beneficial use of dredged material since the costs associated with dredged material management are clearly outweighed by the economic benefits of waterway access. The case study analyses also demonstrate that the solutions to dredged material management are location specific. The location of dredging projects and the types of material being dredged will dictate the selection of the most appropriate beneficial use strategy.

Regional dredged material processing facilities warrant further examination due to their potential to serve multiple end users and to be a significant part of a Statewide dredged material management strategy. For regions where placement options are limited, concentrating the material into centrally located RPFs can create an economy of scale that will allow efficient processing of dredged material into an array of readily usable end products. For single marinas or clusters of marinas where the dredged material is loamy in texture, the development of topsoil and distribution to partners such as landscaping companies, NJDOT, construction companies or other end-users may be the solution to regenerating material placement capacity.

The State and Federal governments are responsible for maintaining waterway access by dredging and are therefore large producers of dredged material. These governmental bodies are also consumers of large volumes of similar materials used in land reclamation and construction projects. Identifying brownfields sites and construction projects that require substantial amounts of fill materials, and matching these projects to existing stockpiles of dredged material in CDFs can free capacity for future dredging projects in areas where dredging projects are stalled. Opportunities to use large volumes of dredged material in these projects should be evaluated. When bidding construction projects that require the purchase of fill materials, the use of dredged material should be included as part of the selection criteria.

Legislation providing incentives for the use of dredged material instead of virgin materials may be appropriate. When left to the contractor, the single most important factor in determining the source of construction fill materials tends to be the distance between the material source and the construction project. The cost to transport materials from the source site to the construction site is generally the most significant portion of the material cost. Therefore, virgin materials mined nearby tend to be less expensive than dredged material from more distant locations. However, the cost of using virgin material is often artificially low because the environmental impacts at the borrow site are not fully considered and the benefits to the State of using dredged material are not quantified. Overall, the use of dredged material in State construction projects may be the most economically viable strategy when considered on a Statewide basis. Using dredged material may increase the cost of individual State construction projects, but it will decrease the cost to the State overall by decreasing the cost of State dredging projects and alleviating the burden of trying to find other uses or placement sites for dredged material located in CDFs.

The addition of Tidelands fees to the costs associated with the beneficial use of dredged material is a further deterrent to any potential user. The Tidelands Council should reconsider the fees for material dredged for navigational purposes. Since the State will benefit significantly from the removal of dredged material from CDFs by private interests, the removal should be permitted at no charge. The benefits of removing the material and allowing marine trade to continue far outweigh any income that may be generated through Tidelands fees. A clear distinction should be made between sand that is mined as a resource that can generate substantial profits and material dredged from marinas and State channels. While Tidelands fees may be appropriate for sand miners, they currently discourage the beneficial use of dredged material unnecessarily.

The process for obtaining permits for small marina dredging projects should be streamlined. The costs associated with sediment testing, surveys and consulting services can prohibit marina operators from completing the dredging projects, or may result in marina operators ignoring regulations and clearing their channels and slips illegally (e.g. using boat propellers, back hoes, etc.). If the permitting process were made easier and less expensive, it would benefit the marina operators who currently comply with the regulations, and would increase the likelihood that more operators would comply.

In summary, no single action can be targeted as the solution to the management of dredging and dredged material in the State of New Jersey. Instead, there are a number of potential solutions that should be considered for inclusion in the State's dredged material management toolbox. As new beneficial uses become apparent and new dredged material management strategies arise, they should be continually added to the State's arsenal. The dredged management strategies presented in the case studies analyzed in this report can be added to this toolbox for use in locations where they are the most appropriate. Due to their potential to serve multiple end users and to be a significant part of a Statewide dredged material management strategy, RPFs warrant further examination. For regions where placement options are limited, and the dredged material requires substantial processing or screening to make it into a desirable product, concentrating the material into RPFs in centralized locations is a reasonable solution. This will allow for a steady source of materials suitable for more than one type of beneficial use application. For single marinas or clusters of marinas on freshwaters where the dredged material is loamy in texture, partnerships with landscaping companies or other end-users may be the solution to regenerating material placement capacity. Identifying Brownfields sites, and transportation or flood control projects that require substantial amounts of fill materials and matching these projects to existing stockpiles of dredged material in CDFs can free capacity for future dredging projects in areas where dredging projects are stalled.

In addition to evaluating potential beneficial use applications for dredged material, the potential use of sedimentation reduction strategies should be evaluated throughout the State. Techniques such as establishing vegetated buffer strips, placement of in-water structures to divert sediments from settling in channels, and in-water placement sediment traps could reduce the amount of maintenance dredging that needs to be performed, thereby reducing the volume of dredged material that requires upland placement.

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Appendix A

Agencies Involved in the Permitting and Regulation of Dredging Projects in New Jersey

A.1 New Jersey Department of Environmental Protection, Office of Dredging and Sediment Technology (NJDEP/ODST)

The role of NJDEP/ODST is to determine the impacts that could result from a proposed dredging and/or dredged material disposal activity, to regulate or manage the project to minimize potentially adverse impacts, and to develop programs to monitor for potential adverse impacts. The procedures developed and used by NJDEP/ODST are defined in their dredging manual, "The Management and Regulation of Dredging Activities and Dredged Material in New Jersey Tidal Waters". Permit applicants should consult this manual for specific procedures on applying for permits and complying with NJDEP/ODST requirements.

NJDEP/ODST's regulatory authority is derived primarily from 4 state and 2 federal statutes:

- Waterfront and Harbor Facilities Act of 1914 ("Waterfront Development Law") (N.J.S.A. 12:5-3 *et seq.*)
- Coastal Area Facility Review Act (CAFRA) (N.J.S.A. 13:19)
- Tidelands Act (N.J.S.A. 12:3-1 *et seq.* and 18:56-1 *et seq.*)
- New Jersey Water Pollution Control Act (N.J.S.A. 58:10A-1 *et seq.*)
- Clean Water Act of 1972 (33 U.S.C. 1344)
- Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*).

A.2 United States Army Corps of Engineers (USACE)

USACE's responsibilities in New Jersey are divided between the New York and Philadelphia Districts. The regulatory authority of the former includes areas on the Atlantic Coast north of the Manasquan Inlet and that of the latter includes the remainder of the state.

USACE's regulatory authority is derived primarily from 2 federal statutes:

- River and Harbors Act of 1899 (33 U.S.C. 401)
- Clean Water Act of 1972 (33 U.S.C. 1344).

In addition to these statutes, USACE has responsibilities under other federal statutes, such as the Coastal Zone Management Act, that govern its actions.

A.3 Tidelands Commission

The State of New Jersey claims ownership of all Tidelands, or those lands along the shore of the State that are now or formerly flowed by the tide extending from the mean high water mark to the seaward territorial jurisdiction of the State, under the authority of the General Riparian Act of 1869. The General Riparian Act updated and improved the Wharf Act of 1851, which provided the first formal mechanism for appropriation of tidelands, based upon the recommendations of the Riparian Commissioners who were appointed in 1864 to study the subject. The General Riparian Act originally included only waters in the New York Harbor area, but the State's authority was extended under a series of enactments between 1869 and 1891. By 1891, the Board of Riparian Commissioners had the authority to define the State's interest in tidelands throughout the State. In 1979, legislation was enacted to extend the authority to grant or lease tidelands "to the seaward territorial jurisdiction of the State" (L.1979, c.311).

The removal of material from waters that are considered tidelands is currently regulated by the NJDEP Bureau of Tidelands Management. Authority to administer these State lands is given to the Tidelands Resource Council (the current successor to the Riparian Commissioners), a regulatory body consisting of 12 members appointed by the Governor, whose authority comes from the General Riparian Act of 1869 (L.1869, c.383), as amended in 1979 (L.1979, c.311). The Tidelands Commission's mandate is to determine if an action or conveyance of tidelands is in the public interest. They make initial decisions to sell or lease tidelands, which then are acted on by the Commissioner of the New Jersey Department of Environmental Protection (NJDEP).

There are three basic forms of tidelands conveyance: a grant, a license, or a lease. A tidelands grant is a deed from the State of New Jersey for the sale of its tidelands. Tidelands grants are generally only issued for lands already filled in and no longer flowed by the tide. In general a grant gives the grantee "all right, title, and interest" within the conveyance, and the grant means that the State no longer owns the property and therefore has no right to collect tidelands fees. A tidelands license is a short term revocable rental document to use tidelands, generally for structures such as docks, mooring piles and other temporary structures, as well as dredging projects. Licenses have a specific term, usually seven years. A tidelands lease is a long term rental document to use tidelands, generally issued to marinas or homes over water. The term of a tidelands lease is generally twenty years. In 1997 legislation was enacted requiring all leases and licenses to have a minimum term of seven years (L. 1979, c.239).

The basis for the jurisdictional determination is the Tidelands Claim Line, based primarily on historical aerial photography, and to a lesser extent on coastal geodetic surveys, topographic maps, and other sources. The most recent source that shows the area in its natural state is used to establish the Tidelands Claim Line. Existing tidelands conveyances are usually recorded with the county clerk, but requesting a jurisdictional determination from the NJDEP Bureau of Tidelands Management is the preferred approach to determining jurisdiction of a specific site. If it has no claim, the State will issue a Statement of No Interest, a recordable document in which the State of New Jersey agrees that it has no tidelands ownership interest in a property.

The Tidelands Resource Council also requires licenses to dig, dredge or remove any material from the tidelands of the State, under the provisions of L. 1891, c. 123. The Council sets the terms and restrictions as to duration and compensation for the licenses, which are executed in the same manner as grants and leases of tidelands.

The Tidelands Resource Council is given wide latitude in the establishment of a fee structure. The Council was required to adopt rules and regulations dictating the fees imposed by the council by the "Administrative Procedure Act" of 1968 (P.L. 1968, c. 410), but was not required to publish as a rule or regulation any formula or method used to determine the fair market value of the license, lease or grant. The Council has not published any regulations setting forth the rules under which it operates, and it is not possible to obtain a clear understanding of their methods of operation. Legislation enacted in 1997 (N.J.S.A. 12:3-12.2) required the Council to publish an informational "Guide to the Tidelands" document that provides information about the history and purpose of the Tidelands Resource Council, as well as an explanation about the application of fees, and guidance to apply for leases, licenses or grants. To date, no such publication has become available to the public.

Appendix B

Palmyra Cove and Bark Camp Mine Beneficial Use Demonstration Projects

B.1 PALMYRA COVE DEMONSTRATION PROJECT

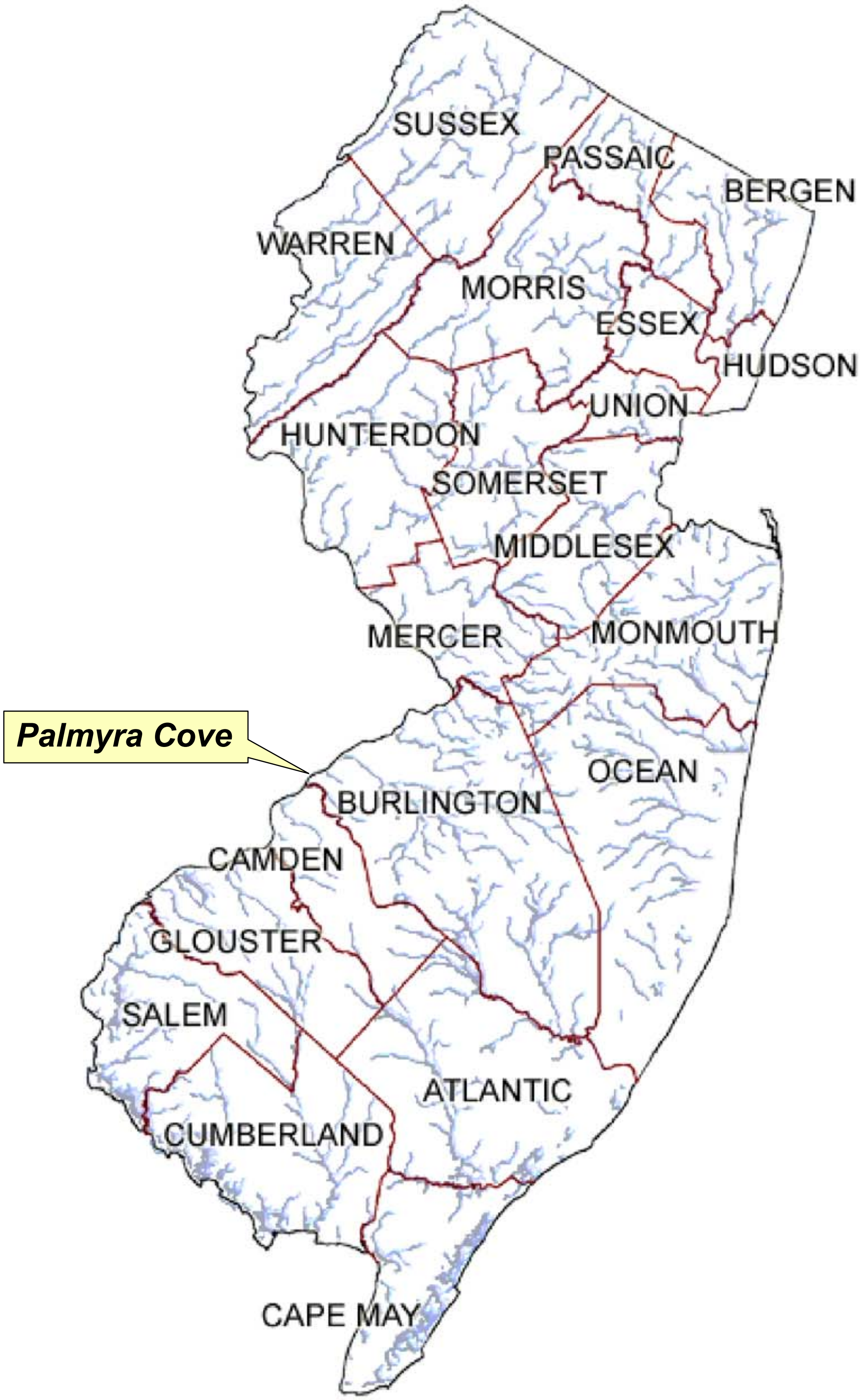
The Palmyra Cove Nature Park, which is located on the eastern shore of the Delaware River in Burlington County, was built on land created with dredged material in the 1940's. The location of the park is presented in Figure B.1. As the land was created, a 70-acre confined disposal facility (CDF) was constructed to dewater and contain material from dredging projects (Budoff 1999). Currently, the CDF is at or near capacity, but it expected to be used for dewatering and storing dredged materials from the USACE Delaware River Project. This will not be possible without removing existing materials.

In an effort to regenerate capacity in the Palmyra Cove CDF, NJDOT/OMR and NJDEP have been working cooperatively with the Burlington County Bridge commission, Burlington County Resource Recovery Complex, and Rutgers University to demonstrate beneficial use applications for the stored dredged material. NJDOT/OMR and NJDEP conducted research on four specific beneficial use applications as part of the Palmyra Cove Demonstration Project. The project involved excavating dried dredged materials from the existing CDF and evaluating the feasibility of the beneficial use applications. Figure B.2 is a plan view of the park that shows the location of the demonstration project within the park.

The goals of the Palmyra Cove Demonstration Project included the following:

- Characterize (with both chemical and physical testing) and quantify the existing dredged material that is available in the CDF as a resource
- Define potential beneficial uses for the dredged material
- Evaluate the feasibility of these beneficial use alternatives
- Maintain Palmyra CDF capacity for future Federal dredging projects, by utilizing material on an ongoing basis to create space within the existing facility. Thus, the CDF acts as a dredged material holding facility until a placement option is implemented.

A complete review of the findings from the Palmyra Cove Demonstration Project was conducted as a preliminary step in identifying viable management strategies for the dredged material from the case study locations selected for the economic analysis.



New Jersey Department of Transportation
Office of Maritime Resources

LMS Lawler, Matusky & Skelly Engineers LLP
One Blue Hill Plaza • Pearl River, New York 10965
ENVIRONMENTAL ENGINEERING & SCIENCE CONSULTANTS

Location of Palmyra Cove

Figure B.1

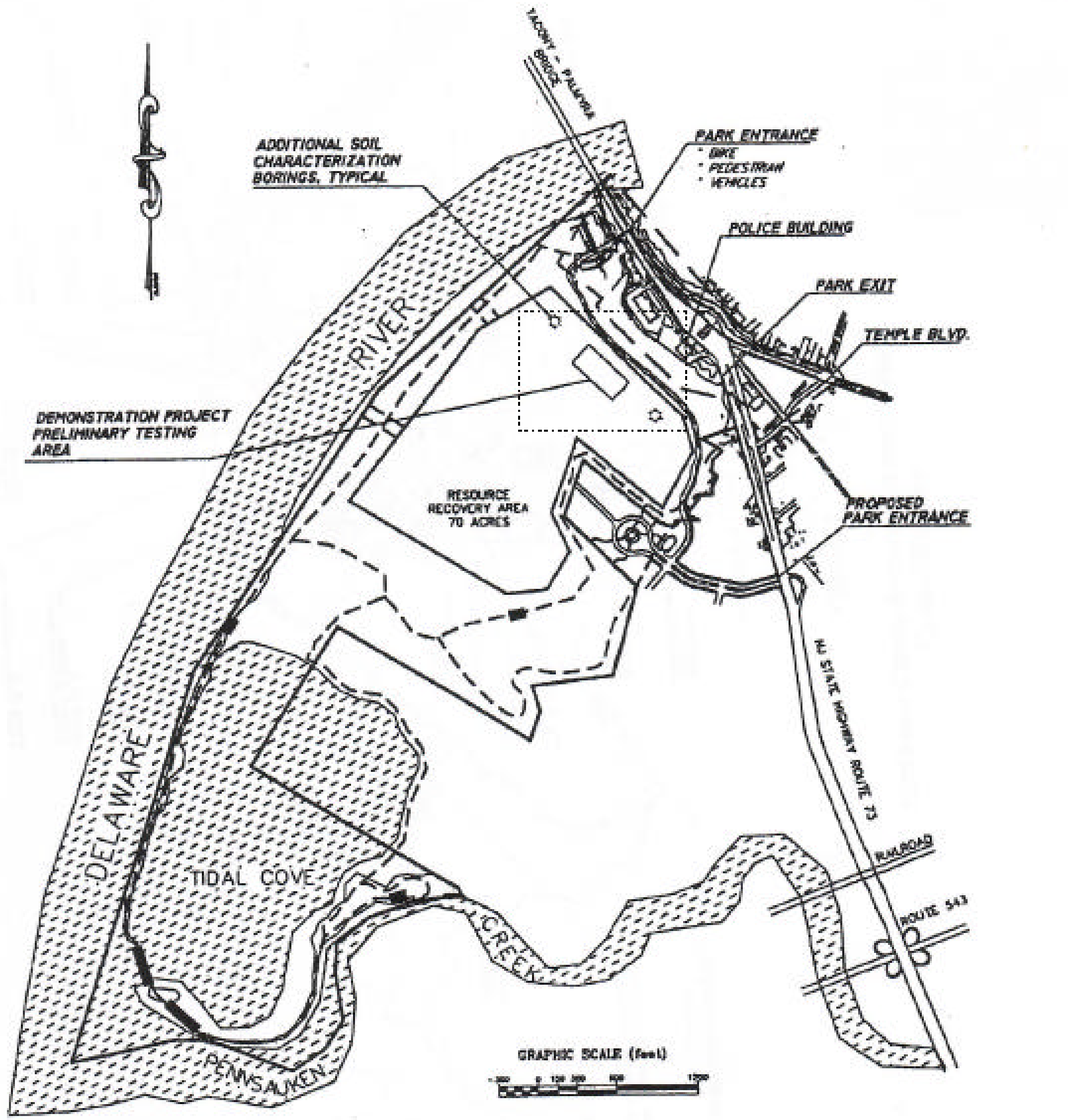


Figure B.2 - Palmyra Cove Nature Park and Demonstration Facility.

The first step the Palmyra Cove Demonstration Team used to determine feasible beneficial use applications for the Palmyra Cove Dredged Material (PCDM) was to characterize the grain size, moisture content and density of the material. In general, the material has a high sand content (between 80% and 90%). Soil/ sediment generally consists of a range of particle sizes, classified by diameter size into general categories, fines (clay and silt) are the smallest and sands and gravel are the largest. Clay particles have broken edges that carry negative charges and thus potentially act as binding sites for contaminants. NJDEP, recognizing that contamination has a greater affinity for these smaller particles, specifies that any dredged material with less than 10% fines (i.e., passing through a 200 sieve) is unlikely to be contaminated and is acceptable for unrestricted upland use without additional testing. This policy is stated in the "Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters" (NJDEP 1997).

Based on the physical properties of the materials, four general areas of beneficial use were identified during the Palmyra Cove Demonstration Project for developmental testing: ceramics, roadbed and other structural applications, topsoil and landfill applications .

Results of the Palmyra Cove Demonstration Project are documented in Quarterly Reports from the Palmyra Cove Demonstration Team's consultants. There is also a final report on the use of dredged material in ceramics applications. The Palmyra Cove Demonstration Project activities described in these reports are summarized in the following sections. In some cases, other applicable studies or projects support the findings of the Palmyra Cove Demonstration Project. When applicable, a summary description of these other activities is also provided to supplement the Palmyra Cove information.

Ceramics

Ceramics include construction materials such as bricks and tiles that are produced by forming clay materials into desired shapes and firing them in a kiln (vitrifying). Within the last five years, 250 million tons of virgin material have been used to make ceramics, of which 200 million tons were for brick production alone (Haber 2002). The typical raw materials for bricks cost approximately $25 per ton, and raw materials for tile cost approximately $50 per ton.

The physical properties of raw materials used in ceramics are more specific than requirements for other beneficial use alternatives examined during the Palmyra Cove demonstration. Grain size, color, and consistency of the materials are all important properties. However, considerable knowledge of blending raw materials for ceramics exists, making it possible to overcome any limitations in PCDM as a viable raw material source. For example, foundry sands can be mixed with PCDM fines to provide a blend that achieves the desired characteristics.

As a part of the demonstration, ceramics investigators attempted to make terra cotta and paver tiles, as well as standard floor tiles, which have the advantage of requiring high tonnage and therefore use more material (Q2, 2002). Investigators attempted to adjust the high plastic characteristics in the PCDM fines by blending the dredged materials with Woodbury Clay (Q4, 2001), but found that the high iron and sulfur contents in the clay could cause excessive bloating. Therefore, the Woodbury Clay should not be used for tile. However, the blend of materials could be used for brick compositions (Q2, 2002). The following optimal blends were identified:

- 40-60% dredged material for tile, Woodbury not preferred; and
- 50-80% dredged material for brick, with less than 50% Woodbury Clay

The PCDM could be converted to functional raw ceramic material for approximately $5 or $6 per ton. This material source is substantially more economical than the virgin materials currently used for ceramics. The PCDM would be especially attractive for bricks because it only requires the addition of limestone to make it viable and it is cheaper than the virgin material cost of $25 per ton.

One potential limitation to the use of dredged material from the economic analysis case studies for ceramic manufacture is that the manufacturing companies rely on a steady source of materials with consistent properties, but dredging projects are typically sporadic, and they do not produce consistent material types. However, concentrating dredged material in large stockpiles in regional staging/processing facilities may help to facilitate this process.

Roads and Structural Fill

Soils used for road bed construction originate from numerous sources. Depending on the specific application, the structural requirements for these materials can differ significantly. Most materials in the state, including PCDM from the Palmyra Cove CDF, qualify as Zone III borrow (NJDOT), which is a material commonly used in construction. This material generally costs about $8/ton loaded at the source. Therefore, if it is to be used in construction projects, dredged material needs to be competitive with this cost. An important consideration in any project is the location of the source materials, since the highest cost is trucking. Proximity to the placement site can serve to favor one source over another. Paul Hanczaryk (Oct. 1, 2001 meeting minutes, Q4, 2001) estimated that contractors are not willing to transport material a distance greater than approximately 15 miles.

Dr. Ali Maher of Rutgers University evaluated PCDM for geotechnical properties, including grain size, bearing strength, compaction and deformation characteristics, and moisture retention properties to determine adequacy for use on construction projects. Construction fill appears to be a viable application for fine-grained and mixed dredged material. However, a demand for the material needs to be identified before considering it as an alternative beneficial use application. A survey was mailed to twenty-four NJDOT approved contractors to identify their current sources of fill material and associated purchase and transportation costs, and gain information on the required handling of the material. An introductory paragraph explaining the questionnaire and the list of questions was faxed or mailed to the contractors. Non-responding contractors were also contacted by telephone in an attempt to increase survey response. Figure B.3 is a reproduction of the questionnaire.

Five contractors completed the survey and an additional two contractors briefly discussed their operations. For uses such as fill and topsoil, the most significant cost is transportation. The response to the survey and conversations with individual contractors suggests that contractors pay for fill less often than they receive it for free. Two of the contractors indicated that, more often than not, their construction jobs generate excess fill material. When it is necessary to purchase fill material, the contractors reported average costs between $2 and $7 per cubic yard. The distances contractors reported traveling to pick up fill material ranged between 4 and 20 miles. However, most of the contractors indicated that a third party delivers fill to the site more than 50% of the time.

Contractors indicated that most of their fill material comes from sources other than borrow sites. Sources included a quarry, other construction projects, and a recycling yard in Pennsylvania.

Three contractors reported that they are not required to excavate their own fill material because the service is provided at the borrow site. The contractors indicated that they were responsible for transporting the material from the borrow site most of the time. The results to the contractor survey are summarized in Table B.1.

The results of the survey demonstrate that the source of fill material and the responsibility for transporting material to a project site vary significantly from project to project. The one variable that appears to remain more constant is the distance that a contractor is willing to transport fill. The maximum reported distance was 20 miles. Distance to transport is clearly a significant factor due to the cost of trucking.

Questionnaire for Excavating and Landscaping Contractors in New Jersey

Material Sources

In an effort to identify cost-efficient strategies to manage dredged material throughout the State, New Jersey's Department of Transportation Office of Maritime Resources (OMR) is conducting an economic analysis of dredging issues in New Jersey. As part of this analysis, OMR is exploring ways to attract contractors to dredge material for use as fill or topsoil on projects throughout the state. As a pre-qualified contractor for NJDOT projects, your experience with acquiring material will assist OMR in the development of a plan for regional dredge material management facilities that will work for you.

Please take a moment to complete this brief survey and return via facsimile to LMS Engineers (Fax 845/735-7466).

1. What do you typically pay for fill material? ____________ $/cubic yard

2. How far do you typically travel from a jobsite for material? ____________ miles

For each question below, please estimate of the percentage of your projects for which the following activities occur.

3. How often do you pay for fill material? ____________% of the time

4. Do you use a third party or subcontractor to provide fill material? ____________% of the time

5. Do you amend, blend, screen or otherwise process fill material? ____________% of the time

6. Where do you acquire fill material? (list all that apply)

   From a NJDOT approved borrow site: ____________% of the time
   From a project-specific borrow site: ____________% of the time
   From another source (name): ____________% of the time

7. Do you excavate your own material from a borrow site? ____________% of the time

8. Does your borrow source excavate and load material for you? ____________% of the time

9. Do you provide your own transportation from borrow source? ____________% of the time

Additional comments:

THANK YOU FOR COMPLETING OUR SURVEY!

FIGURE B.3. QUESTIONNAIRE MAILED TO NJDOT APPROVED CONTRACTORS TO ASSESS THE POTENTIAL USE OF DREDGED MATERIAL AS CONSTRUCTION FILL

Table B.1. Average, minimum and maximum values reported for questions in the Contractor Survey

Question	Avg.	Min.	Max.
Typical cost of fill material ($/cubic yard)	$4.80	$2.00	$7.00
Distance traveled for fill material (mi.)	13	4	20
Purchase of fill is required (% of time)	51%	20%	100%
Third party provides fill (% of time)	62%	20%	100%
Fill is processed (% of time)	10%	0%	50%
Fill is from NJDOT borrow site (% of time)	24%	0%	70%
Fill is from project-specific borrow site (% of time)	16%	0%	30%
Fill is from another source (% of time)	60%	10%	100%
Excavation from borrow site by contractor (% of time)	41%	0%	90%
Excavation from borrow site is provided at site (% of time)	59%	10%	100%
Material transport provided by contractor	70%	0%	100%

The results of the contractor survey and the demonstration project suggest that the use of dredged material as construction fill would be largely dependent upon the distance between the construction project and the stored dredged material. Because the dredged material stockpiles are not distributed evenly throughout the state (i.e. they are located along shorelines), the use of this material for construction projects in the center of the state is unlikely without added incentives.

Topsoil

Nutrient-rich topsoil is often applied to residential, commercial and State-owned properties during landscaping operations. Topsoil can be manufactured by adding organic matter such as leaf litter to nutrient poor soils. Dredged material can be used for this application.

Dr. Daniel Gimenez from Rutgers University evaluated PCDM for hydraulic, organic, and thermal properties as they pertain to topsoil characteristics. He determined that

PCDM is probably not well suited for topsoil, due to its high sand content, poor moisture retention, and low nutrient levels (Q2, 2001). However, blending PCDM with nutrient-rich materials such as leaf compost or dewatered sewage biosolids can yield topsoil blends with the physical characteristics and nutrient concentrations necessary to support growth.

Bob Simkins of the Burlington County Resource Recovery Complex (RRC) headed the evaluation of topsoil applications by the Palmyra Cove demonstration team. Approximately 18,500 cy were removed and delivered to the RRC in April 2001 (Q2, 2001). Burlington County paid the Tidelands Resources Council $9,000 for the material on 3 July 2001 (Q3, 2001). This material was used by RRC primarily for regrading areas of its facility, but a portion of it was used for topsoil blending studies. Simkins identified potential additives from waste streams such as paper mill sludge, crushed glass, and leaf compost, and analyzed 32 blends of topsoil at pilot scale (App AJ, Q2, 2002). The topsoil was determined to be adequate for use on NJDOT projects (according to AASHTO standards) (Q2, 2002). The Burlington County Resource Recovery Operational Training Center (OTC) used 2,900 cy to make topsoil using the OTC trommel rotating screen and lime in May and June 2002 (Q2, 2002). OTC utilized PCDM to replace material at OTC facilities in March 2002 and found good workability (Q1, 2002).

In general, the topsoil business is very competitive, with numerous sources of material available, often free of charge. Topsoil for large projects is often obtained from local supplies, usually within 10-15 miles of a project site. This is consistent with the Palmyra Cove survey results for fill material, which estimated that a source must be within 15 miles to be competitive.

The ready availability of earthen material that could be processed into topsoil is demonstrated by a recent project undertaken by Brick Township Municipal Utilities Authority (BTMUA). The BTMUA constructed a potable water reservoir on the upper Metedeconk River in 2003. As a result, large quantities of topsoil were excavated from the site and made available to the public. Rebecca Scott of LMS spoke with David Harpel of BTMUA on April 16, 2003, who indicated that the total amount of soil generated during the excavation was approximately 144,000 cubic yards. BTMUA performed approximately $50,000 in analytical tests to demonstrate that the material was not contaminated. They subsequently received a Letter of No Further Action from NJDEP approving use of the material as fill. The material could be used as topsoil, but did require further amendment at an estimated cost of $2.00 per cy. BTMUA attempted to give this material away at no cost. Due to a lack of demand BTMUA needed to pay to have much of the material removed. Following is a breakdown of how the BTMUA ultimately had the material removed from the site.

- Applied Landscape was paid $0.78 per cubic yard to remove approximately 30,000 cubic yards at as part of their contract for constructing the reservoir.
- Vogel Contracting took approximately 20,000 cubic yards free of charge.
- Local townships and the NJDOT took approximately 8,500 cubic yards free of charge.
- Muccio, Inc., a private Contractor was paid approximately $1.62 per cubic yard to remove much of the remaining material (87,000 cubic yards). Of this, 10,000 cubic yards were delivered to the Brick Township Department of Public Works who made it available to the public.

Mr. Harpel believed that more people would have taken the material if it was bagged and available in the spring or summer (at the peak of construction season), rather than in late November when it was released (R Scott [LMS], personal communication). However, this option would have also added costs for the BTMUA.

The creation of topsoil is a potential beneficial use of the loamy dredged material originating from the fresh waters of the Delaware River, lakes and tidal creeks where there is sufficient fresh water discharge. This application is suitable for the upper Manasquan River and the Dredge Harbor case studies. Manufacturing topsoil from the dredged material requires minimal processing to create a high quality product that can be sold to offset the costs of processing and/or transportation. Identifying a market for the topsoil will likely be the limiting factor to this alternative.

Capping Applications

Brownfields are former industrial sites that are currently abandoned due to concerns about contamination. The potential for redeveloping Brownfield sites exists if contaminated soils can be encapsulated or remediated. Many Brownfield sites can be reclaimed by capping (covering the surface) with a material that will both facilitate redevelopment and prevent water infiltration that could mobilize subsurface contaminants and cause leaching. Dredged material can be used as capping material for Brownfield sites, although some material must be processed or amended to make it suitable for this purpose.

Landfill applications for dredged material include using the material as daily cover and using the material to cap and close the landfill. The Palmyra Cove Demonstration Team evaluated the potential use of PCDM for use as landfill cover and determined that these applications are less desirable than other evaluated uses for a number of reasons.

Landfills typically receive tipping fees for receipt of materials used for capping and cover. Therefore, a net cost would be associated with this alternative. In addition, materials with high sand content would not be suitable for the purpose of capping landfills (or contaminated Brownfield sites) because the high permeability would allow infiltration and exacerbate groundwater leaching (April 11, 2001, NJDEP letter; Q2, 2001). However, daily landfill cover and structural subgrade applications may be feasible if the dredged material satisfies the geophysical criteria for landfill daily cover (less than 20% passing the 200 sieve; more than 40% passing the 40 sieve with no particles greater than 6 inches).

Due to the potential to use large quantities of dredged material, one landfill was investigated to more clearly assess the feasibility for this application. The Pennsauken Landfill, located in Pennsauken Township New Jersey, requires structural capping underneath the impermeable cap. This extra layer provides an opportunity for additional placement of dredged material. On July 9, 2001, Burlington County requested cost estimates for 70,000 cubic yards of capping material that they planned to use at the Pennsauken Landfill (Q3, 2001), and expressed interest in acquiring an additional 200,000 cubic yards. In response to this request, the Palmyra Cove Demonstration Team developed the costs for the proposed use. Estimated cost ranged from $1.20 per cy to $1.95 per cy and consisted of engineering, surveying, and site work ($0.75 to $1.50 per cy) and the $0.45 per cy fee that the Tidelands Commission requires the County to pay for the stored dredged material. The tipping fees for landfills' acceptance of dredged materials may need to be considered in final costs. The total cost for capping this landfill is still being evaluated, but other landfills have similar needs and a partnership is possible.

The results of the demonstration project suggest that brownfields remediation is a potential beneficial use of the fine-grained dredged material from the economic analysis case studies. The clean materials originating from the State channels and the marinas would not require processing prior to use for these applications, and dredged material is commonly used for capping applications. New Jersey has numerous brownfields sites that are in need of remediation. The materials stored in the USACE Corps Site D in Cape May, NJ have been used to help remediate the USFWS Harbison-Walker site, and the site requires more material for this use. Transportation of the material is the costliest component of this beneficial use, and locating brownfields sites near dredged material stockpiles would be the most efficient way to minimize costs.

Daily landfill cover is also a potential use for the dredged material from the economic analysis case studies, but tipping fees associated with this alternative make it a less attractive option. Landfills charge as much as $15 per cy to accept this material and these fees added to the transportation costs make this option very expensive.

B.2 BARK CAMP MINE RECLAMATION

An application related to capping applications is mine reclamation using dredged material. This option has been undergoing investigation by the NJDOT/OMR, New York / New Jersey Clean Ocean Shore Trust (COAST) and the Pennsylvania Department of Environmental Protection (PADEP). Pennsylvania has over 250,000 acres of unreclaimed mine lands and PADEP has designated over 5,600 abandoned mine features as human health hazards in need of remediation. Two major problems associated with these abandoned mines are acid mine drainage and fall hazards from exposed strip mine highwalls. Individual strip mine features have fill requirements estimated to be up to one billion cubic yards. It is estimated that the cost of reclaiming these lands will be 15 billion dollars (COAST/PADEP 2004).

NJDOT/OMR, COAST, PADEP and Clean Earth Dredging Technologies, Inc (CEDT), a Pennsylvania environmental contracting and recycling firm, formerly known as Consolidated Technologies, Inc.(CTI), initiated the Bark Camp Demonstration Project in 1995 (COAST/PADEP 2004). This project investigated the feasibility of using the materials dredged from NY/NJ Harbor and products of coal combustion to fill abandoned coal mines to reclaim the land. The Bark Camp Demonstration Project was conducted at the Bark Camp Mine Reclamation Laboratory in Clearfield County, PA. Bark Camp is an abandoned coal mining complex that includes abandoned surface and underground mines, preparation facilities and operating equipment. The mine site totals approximately 1,200 acres and is located in the Moshannon State Forest. The State of Pennsylvania has taken responsibility for the reclamation of this site.

A pilot project involving dredging of the City of Perth Amboy Municipal Marina and placement of the dredged materials in Bark Camp took place in 1998. CEDT (then CTI) was contracted by the New Jersey Department of Commerce and Economic Development (Division of Purchase and Property, Purchase Bureau) and NJDOT/OMR to perform this work. Dredging commenced on May 15, 1998 and pre-amended material was delivered to Bark Camp on May 28, 1998 and was processed and placed the same day. The final placement of amended dredged material from Perth Amboy Marina occurred on September 9, 1998 (CTI 1998).

Barges containing the dredged material were transported to CTI’s portside facility in Elizabeth, NJ. The barges were moored at the facility in order to allow the sediment to dewater prior to offloading. The material was screened to remove large debris, which was disposed of in an approved facility. The dredged material was amended with coal fly ash to bind free water and provide stabilization. The amended material was transported using 110 ton gondola rail cars. Upon arrival at the processing area of the mine site, the material was blended with additives (coal ash and lime kiln dust) according to a pre-determined mix, transported to the highwall area, spread, and compacted (CTI 1998).

The site was monitored for two years before additional material from the NY/NJ Harbor was placed in the mine. The one difference in the process was the addition of municipal waste incinerator ash (MWIA) to the alkaline activated ash and dredged material in 2001. A total of 435,000 cubic yards of dredged materials were amended and placed in the abandoned mine between 1998 and 2002 at an overall cost of $45 per cubic yard of material (COAST/PADEP 2004).

Each step of the process was regulated by permits and approvals. Dredged materials and all additives had to meet specific bulk chemistry and leachate testing standards to gain approval for use. All admixture elements were also required to meet regulatory standards (CTI 1998, COAST/PADEP 2004).

Analysis of sediments before dredging and during processing showed that trace contaminants remained within permitted levels in the fill material prior to placement in the former mine. Groundwater and surface water monitoring is being conducted over five years to identify impacts after placement. Substances of public health concern, including PCBs, pesticides, volatile and semi-volatile organic compounds, dioxins and furans, have not been detected in any water samples collected during the monitoring. Similarly, metal concentrations in the former mine remained at pre-project background levels and have not been impacted by the amended dredged material used as fill (COAST/PADEP 2004).

This demonstration project successfully reclaimed the land without environmental consequences, and placed nearly one-half million cubic yards of dredged material over a period of four years. Although the costs associated with the placement were high, this was the result of the distance between the dredging project and the mine, and the required multi-step handling of the material. (COAST/PADEP 2004).

This beneficial use application could have enormous potential if the transportation and handling costs can be minimized. Although New Jersey State channel and marina dredging projects typically yield relatively small volumes of material, if material from several projects was stockpiled in a regional staging/processing facility with rail transportation, this may be a viable alternative.

ADDITIONAL REFERENCES:

Consolidated Technologies, Inc. 1998. Pilot Project for Dredging of the City of Perth Amboy Municipal Marina, Middlesex County, NJ and the Beneficial Re-use of Dredged Sediments for Mine Reclamation at the Bark Camp Mine Reclamation Facility, Huston Township, Clearfield County, PA. Summary Report prepared for the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation and Bureau of Land Recycling and Waste Management and the New Jersey Department of Commerce and Economic Development, Office of Maritime Resources.

Appendix C

Considerations for Siting a Regional Staging / Processing Facility for Dredged Material

The establishment of Regional Staging/Processing Facilities (RPFs) for dredged material may be a viable option in areas in New Jersey where waterfront property is unavailable for material placement. When siting an RPF for dredged material, the location of the facility, regulatory requirements, required on-site equipment and potential beneficial use applications for the material are all important considerations to be evaluated during the early phase of the planning process. The following sections provide information on these considerations.

C.1 LOCATION

The development of a RPF needs to address multiple factors that could impact the likelihood of success. In general, construction requirements of a RPF will need to consider or incorporate the following factors:

- Direct waterfront access for receiving dredged materials and access for trucks and/or rail for the transport of processed end products.
- A bulkheaded dock area for receiving barges. Ideal locations will have these facilities in place at the desired depth and berthing dimensions.
- Facility yard space for multiple material staging areas, to accommodate other needed or available raw materials in addition to dredged material
- Processing equipment such as dewatering equipment, screens, and tumblers
- A truck loading area with a weigh station or a railroad spur
- Administration, maintenance, gate, and other ancillary buildings
- Miscellaneous civil site work such as utility connections, site improvements, service roads, and lighting

Relevant information to consider regarding the siting of a RPF includes: the characteristics of raw dredged material, need for processed dredged material storage, proposed end product characteristics, projected volume requirements, water access and availability, land transportation options and associated costs, existing and potential sites, and environmental constraints. Optimizing the capacity of a facility to serve multiple functions and provide multiple revenue streams must be explored.

Identifying a location to build a facility with the aforementioned requirements would constitute a major undertaking. In addition to pure logistical considerations, other factors may play important roles in the decision-making, such as identification of potential users and end-users, permitting restrictions, proximity to residential and other sensitive areas, and real estate values.

A feasibility study would be necessary to evaluate potential sites (including existing CDFs) for environmental, engineering, and economic features. The goal of the feasibility study would be to develop a list of potential sites for consideration, then to reduce the list to those with the greatest potential to support an RPF. The final selection would be based on evaluating the demand and reuse options, legal liability, insurance requirements, environmental site assessment, and economic analysis. This process could be headed by a steering committee composed of representatives from interested agencies, environmental groups, and business and port interests. A similar feasibility study for the Port of Oakland (1999) had an overall budget of $750,000.

C.2 REGULATORY REQUIREMENTS

Construction and subsequent operation of a RPF at a waterfront site in New Jersey would require authorizations from various levels of government. The required authorizations are likely to overlap in nature and extent. To minimize delays and redundancy in meeting governmental requests for information and to avoid conflicts of interest between agencies, early coordination with the fullest range of Federal and State agencies is recommended.

- Federal Authorization

Any proposed RPF is likely to be sited in a coastal region in tidal waters and the highest level of required governmental authorization would be at the Federal level. Agencies that will be involved in the regulatory process at this level and their main governing laws are noted in Table C.1.

Although all of these organizations will be involved in the regulatory process, the USACE would be the lead Federal agency responsible for issuing permits to construct a RPF. Depending on the proposed location in New Jersey, either the New York or Philadelphia Districts of USACE would be involved. The New York District handles regulatory affairs in the portions of New Jersey north of the Manasquan River watershed and east of the Delaware River watershed, and the Philadelphia District handles the remainder of the state.

The USACE issues permits for construction activities in navigable waters of the United States, which are defined (in part) as water bodies subject to the ebb and flood of tides and water bodies that have been or can be used for interstate commerce. Almost all coastal waterways qualify as navigable waters of the United States. The authority under which USACE issues permits derives from Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Construction of bulkheads, piers or wharves, installation of pilings, or dredging of the waterway to allow use by deeper draft vessels, are among the types of activities regulated by USACE.

Table C.1. Federal authorizations and responsible agencies

Agency	Authorization
U.S. Army Corps of Engineers	• Section 10 of the Rivers and Harbors Act • Section 404 of the Clean Water Act
U.S. Environmental Protection Agency	• Section 404 of the Clean Water Act
U.S. Fish and Wildlife Service	• Fish and Wildlife Coordination Act • Section 7 of the Endangered Species Act
NOAA Fisheries (formerly National Marine Fisheries Service)	• Fish and Wildlife Coordination Act • Section 7 of the Endangered Species Act • Magnuson-Stevens Fishery Conservation and Management Act
U.S. Coast Guard	• Section 9 of the Rivers and Harbors Act

USACE also regulates the discharge of dredged or fill material in waters of the United States, including navigable waters, under authority derived from Section 404 of the Clean Water Act of 1972 (33 U.S.C. 1344). Discharges of dredged or fill material may be placed into authorized disposal facilities or relayed to construction activities authorized by a Section 10 permit. USACE defines any of the following as discharges pursuant to Section 404: decanted water from barges used to allow settling of dredged material, barge overflow, transfer of dredged material into subaqueous disposal facilities, and return flow of water removed by dewatering dredged material, even if dewatering occurs at authorized disposal sites. Therefore, if dewatering activities with return flow were to occur at the RPF, a permit from USACE would be required.

The USACE also operates under other authorities, e.g. Section 103 of the Marine Mammal Protection, Research and Sanctuaries Act of 1972 (16 U.S.C. 1413), and statutes that relate to their consultation and coordination with other Federal and State agencies. These authorities are noted, as necessary, in the following discussion.

Historically, potential impact(s) to navigation was USACE's prime consideration regarding permit issuance. In the last 3 to 4 decades, the emphasis of USACE's review has shifted to include a full Public Interest Review that incorporates environmental as well as navigational issues. To facilitate its review, USACE consults with other Federal and State agencies, as well as elected officials and the general public.

Consultations with other agencies are held under authority of a variety of Federal legislative enactments. Typically, the USACE will consult with the USEPA, NOAA Fisheries (formerly the National Marine Fisheries Service), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Coast Guard. These consultations are held under various authorities including the Clean Water Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, and the Magnuson-Stevens Sustainable Fisheries Act. Thus, any proposed RPF will be subject to the scrutiny of a variety of Federal resource agencies. The agencies will comment on potential impacts of the project on resources within their purview.

- State Authorization

In addition to Federal agencies, the USACE will also consult with various State agencies. In New Jersey, the primary resource and regulatory agency will be the NJDEP, including various units within it. The USACE's interaction with the NJDEP involves more than consultation. Requirements for certain State certifications and/or concurrences need to be granted prior to a permit decision being made by the USACE. These certifications and concurrences are discussed in the following section on State authorization. The USACE will also interact with the New Jersey's Office of Historic Preservation on issues of cultural resources, i.e. historic properties and archeological sites that may be affected by proposed work associated with construction of a RPF. Potential impacts to such resources must be addressed prior to issuance of a permit by the USACE.

The NJDEP will exercise primary State responsibility related to construction and operation of any RPF under a variety of State and Federal statutory authorities. Federal statutes pertain to State issuance of certifications and concurrences required prior to issuance of Federal permits. Under these statutes, New Jersey has been given authority to develop and enact programs mandated by the Federal government. The relevant statutes (State and Federal) under which NJDEP or other state agencies will act are listed in Table C.2.

Table C.2. State laws that may govern the establishment of an RPF.

Law/Regulation
Waterfront Development Law
Coastal Area Facility Review Act (CAFRA)
Section 307 of the Coastal Zone Management Act
Section 401 of the Clean Water Act
New Jersey Water Pollution Control Act of 1977
Wetlands Act of 1970
Freshwater Wetlands Protection Act
Soil Erosion and Sediment Control Act
General Riparian Act of 1869 (Tidelands Management)
Section 106 of the National Historic Preservation Act
Green Acres Program (N.J.A.C. 7:36)

The primary authority under which the State will regulate any RPF is the Waterfront Development Law (N.J.S.A. 12:4-3). This statute addresses all development at or below the mean high water (MHW) line in tidal waters of New Jersey as well as most development up to 500 feet from MHW in the Coastal Zone, but outside of the area regulated under the Coastal Area Facility Review Act (CAFRA; N.J.S.A. 13:19-1 *et seq.*). Waterfront development activities would include the types of actions expected to be associated with development of any RPF, such as piers, wharves, pilings, placement or removal of subaqueous materials (filling or dredging), and building construction.

CAFRA regulates all development on beaches and dunes, and the first house or other development within 150 feet of the waterline, beach, or dune. The CAFRA area extends along the shoreline east from Cheesequake Creek in Middlesex County along the Atlantic Ocean coastline and Delaware Bay and up the Delaware River to Pennsville, Salem County, NJ. Therefore, there is overlapping jurisdiction with the Waterfront Development Law in some areas.

Activities regulated under the Waterfront Development Act and/or CAFRA would occur within the coastal zone and would also be subject to Section 307 of the Coastal Zone Management Act (16 U.S.C. 1451 *et seq.*). This mandates that any project requiring a Federal permit be consistent with the state's Federally approved Coastal Zone Management Program (CZMP). Applicant's for permits certify that their project is consistent with the State CZMP. The certification and supporting documentation are reviewed by NJDEP and a consistency concurrence determination is made. The consistency determination by the State is usually incorporated into the Waterfront Development or CAFRA permit.

Another Federal statute under which New Jersey exercises authority is Section 401 of the Clean Water Act. Projects requiring Federal permits for the discharge of dredged or fill material also require a Water Quality Certification (WQC) issued by the State to ensure that the activity is consistent with applicable New Jersey Water Quality Standards and management policies. As with the CZMP consistency concurrence, the WQC is usually incorporated in the Waterfront Development or CAFRA permit.

If the development or operation of a RPF involves a discharge to surface waters, then a New Jersey Pollutant Discharge Elimination System (NJPDES) Discharge to Surface Water (DSW) permit is required. This type of discharge might include return flow through a permeable barrier or filter or water decanted from barges after dredged material has been allowed to settle for 24 hours or longer. Similarly, if there will be a discharge to groundwater, then a NJPDES Discharge to Ground Water (DGW) permit is required. DSW and DGW permits are issued under authority of the New Jersey Water Pollution Control Act of 1977 (N.J.S.A. 58:10A-1 *et seq.*).

In addition to NJPDES permits, discharges of stormwater require development of plans for compliance with local and regional stormwater management plans. This will include installation of Best Management Practices (BMPs) to address water quality, quantity and groundwater recharge issues. These BMPs will be required as part of any NJDEP permit defined as a major development under NJAC 7:8.

Wetlands are among the natural resources associated with shorelines that may be affected by development of RPFs. Wetlands are protected by the Federal Clean Water Act, as well as by State statues. The Wetlands Act of 1970 (N.J.S.A. 13:9A-1 *et seq.*) protects coastal wetlands, which are defined as extending from the head of tide at Trenton, NJ south along the Delaware River to Delaware Bay and then up the east coast to the mouth of the Raritan River. A permit is required for any activities related to development (e.g. piers, construction of impoundments, installation of utilities), including excavation or discharge of fill in mapped tidal wetlands.

Similarly, activities in freshwater wetlands are regulated under the Freshwater Wetlands Protection Act (N.J.S.A. 13:9B-1 *et seq.*). These wetlands are often associated with rivers. The potential exists for a RPF to be located above the head of tide on a river considered navigable by USACE. Although New Jersey assumed authority for implementation and enforcement of the Section 404 program for freshwater wetlands in the early 1990s, USACE retained regulatory authority over wetlands located within 1,000 feet of the ordinary high water line. Hence, activities having an impact on freshwater wetlands could be regulated by both State and Federal statutes. Activities regulated under the Freshwater Wetlands Protection Act are similar to those regulated by the Wetlands Act of 1970.

In addition to permits issued under the authorities noted above, there are additional State requirements that may or may not be applicable to a particular RPF. One of these is a Tidelands Conveyance (Appendix A), issued by the Tidelands Resource Council under authority of the General Riparian Act of 1869 (N.J.S.A. 12:3). If the proposed facility is not located on or does not make use of state-owned riparian land, then a Tidelands Conveyance is not required.

- Local Authorization

There are also State statutes whose implementation and enforcement is the responsibility of regional or county authorities. An example that relates to dredged material management is sediment and erosion control. Activities related to these concerns are regulated by the Soil Erosion and Sediment Control Act (N.J.S.A. 4:24-1 *et seq.*). A Soil Erosion and Sediment Control Certification approval from the local soil conservation district is required for projects that involve the disturbance of more than 5,000 square feet of land surface area. Certain activities, e.g. demolition of structures, also require this certification. Typically, the approval requires implementation of BMPs to control soil erosion, sedimentation, nonpoint source pollution, and manage stormwater during construction and other land disturbance. As a RPF would likely involve storage of dredged material on-site for some period of time, instituting approved BMPs would probably be required.

Finally, local authorities (city, town, etc.) will require adherence to local statutes and ordinances. These may relate to issues such as zoning, noise or traffic. Permits may be required for certain activities, such as construction.

- Permitting Considerations and Costs

Due to the involvement of a number of Federal agencies and various divisions of NJDEP, it is imperative that the potential RPF operator has a clear understanding of the regulatory processes involved in the "start up" of the facility and its subsequent operation. This understanding will streamline the process and assist in avoidance of potential pitfalls and unwarranted delays. A potential RPF operator should initiate consultation with federal and state agencies at the earliest possible time. Once a potential site has been selected and initial requirements for construction determined, a joint pre-application meeting with all concerned agencies should be scheduled to determine their exact requirements and establish lines of communication for exchange of information with all concerned parties.

To minimize regulatory concern, initial site selection should focus on areas that have been previously utilized for waterfront activities and that have existing facilities or structures compatible with the proposed use. For example, a site with bulkheads, adequate wharf space, upland access, and sufficient water depths for safe mooring of loaded barges is preferable to a site with existing piers that would initially require dredging to achieve the necessary water depths. Constructing a new facility involves much greater environmental impacts to upland resources and the aquatic environment than using an existing facility. Therefore, new facility construction will result in more extensive review by agencies to ensure that there are no feasible alternatives that will result in fewer impacts. In addition, utilization of existing facilities will minimize or obviate the need for providing mitigation for new construction impacts. Moreover, it is difficult or impossible to obtain authorization(s) to undertake certain activities. As an example, new dredging is not authorized by the New Jersey Coastal Zone Management Plan. Therefore, locating a potential RPF in an area that does not have sufficient water depth and has never been dredged, may preclude permit issuance.

During the preliminary phase of siting an RPF, preliminary coordination with NJDEP Natural Resources Program, USFWS, and NOAA Fisheries should be undertaken to determine if there is any evidence that the potential site(s) are known to be habitat for endangered, threatened, or protected species. Similarly, preliminary inquiries should be made to the New Jersey Office of Historic Preservation to determine if there are archeological and/or historic resources on or adjacent to the site. The status of the property with regard to NJDEP's Green Acres Program should also be investigated.

The responses to such preliminary inquiries, whether positive or negative, will prove useful in assessing the potential viability of a project or a project area. They can be viewed as a decision making tool that should be utilized as early as possible by potential RPF operators.

Table C.3 lists components of completing the permitting requirements for siting a regional processing facility on a waterfront site with sufficient depths to support barge transport to and from the facility. Completing the permitting requirements would cost approximately $170,000, assuming the following:

- The action would not trigger the need for an Environmental Impacts Statement (EIS) to satisfy requirements of the National Environmental Protection Act (NEPA) (this is unlikely as most large projects can not be authorized without an EIS being prepared). The costs associated with a NEPA EIS vary greatly, but could be as much as $2,000,000.
- The action would not require filling of wetlands and no compensatory wetland mitigation would be required
- No known threatened or endangered species are known to use the project site
- There are no historic/archaeological concerns
- The action would only need approvals from one municipality (building permits, curb cuts, and roadwork)

Table C.3. Components of permitting requirements for constructing a regional staging / processing facility for dredged material in coastal New Jersey.

Regulation/Requirement
USACE Section 404 of the Clean Water Act-Individual Permit
USACE Section 307 of the Coastal Zone Management Act – CZM Concurrence (issued by NJDEP)
USACE Section 401 of the Clean Water Act – Water Quality Certification (issued by NJDEP)
USEPA Section 404 of the Clean Water Act – consultation during Public Notice comment period
USFWS Fish and Wildlife Coordination Act – initial Threatened and Endangered Species consultations
National Historic Preservation Act of 1966 - consultation pursuant to Section 106 (conducted by NJDEP State Historical Preservation Office)
NOAA Fisheries –Endangered Species and Fish and Wildlife Coordination Act consultations and Essential Fish Habitat consultation
USCG Consultation during Public Notice comment period
NJDEP Land Use Regulation Coastal Program – Permits associated with Waterfront Development Law; Coastal Area Facility Review Act; and/or Riparian Lands Act Wetlands Act of 1970;

Table C.3 (cont'd). Components of permitting requirements for constructing a regional staging / processing facility for dredged material in coastal New Jersey.

Regulation/Requirement
NJDEP Division of Water Quality – NJPDES Surface Water Quality Permit (including the development of Best Management Practices pursuant to N.J.A.C. 7:8)
Federal Coastal Zone Management Act – Section 307 – (Reviewed by NJDEP under N.J.A.C. 7:7E)
Municipal approvals
Coordination/Consultation meetings with State and Federal agencies
Agency Review/Application Fees
Total Estimated Cost - $170,000

C.3 PROCESSING EQUIPMENT

The level of processing to be performed at the facility will dictate the equipment that will be needed on-site. If material is transported to the RPF wet, dewatering will be the first stage in processing. Screening to remove debris and grain size separation should also be performed on-site at the facility to make the material more attractive to potential users. The following sections describe basic processing equipment requirements for an RPF.

- Dewatering Technologies

Dewatering is a critical stage in dredged material processing that reduces the moisture content in dredged material. Dewatering reduces the cost of shipping and disposal, simplifies material handling, and is usually necessary prior to any beneficial use. Dewatering can be accomplished through evaporation and infiltration or accelerated by mechanical or chemical means. The level of dewatering necessary depends on the end use or intermediate processes for which the material is intended. It also depends on space constraints, typical dewatering by evaporation requires a relatively large area in comparison to a mechanical alternative, and the cost of real estate can be weighed against the cost of operating a mechanical process over an appropriate life cycle. Regardless of the process used to facilitate dewatering, the resulting supernatant may contain unacceptable levels of solids or contaminants, which may prohibit discharge to surface waters without treatment under the Clean Water Act (CWA) Section 404, State water quality certification and compliance with coastal zone regulations.

Geotextile tubes

Geotextile tube technology utilizes permeable geosynthetic fabrics to dewater dredged material slurry and contain the dewatered material for placement or beneficial use. An example of geotextile tubes is Geotubes®, manufactured by TC Mirafi of Pendergrass, Georgia. For marine applications, Geotubes® are constructed of 15-foot wide, 16-ounce GT500 polypropylene strips of material stitched together circumferentially to create a tube of any desired length. They come with a series of ports along one side of the tube for pumping material in and for allowing water and air to escape. They are offered in three sizes: 30 ft, 45 ft, and 60 ft circumferences. Table C.4 summarizes the details of each.

Table C.4. Costs for Geotubes® of different dimensions.

Circumference (ft)	Dry Capacity (cy/lf)	Cross-section (width x ht, ft)	Price ($/lf)
30	1.5	9 x 6	$14.35
45	3.5	18 x 6	$21.50
60	5.0	27 x 6	$29.00

The 45 and 60 foot diameter Geotubes® are the most practical for marine dewatering applications. The main criteria for sizing are the volume of the project and space considerations. Geotextile tubes require a fairly large temporary space, although not in comparison to other means of dewatering. Prior to implementation, a series of “bag tests” are conducted, in which a sample of the dredged material slurry is placed through a 5 ft long by 1 ft diameter tube and the performance is measured. Flocculants can be added to accelerate dewatering and improve the clarity of the filtrate. There is no restriction on the disposal of empty used geotextile tubes in landfills, and based on the purchase price, disposal costs are negligible.

Mechanical Dewatering

Mechanical dewatering machines can substantially accelerate the dewatering process. Mechanical dewatering machines include belt filter presses, centrifuges and hydrocyclones. A typical mechanical dewatering process includes polymer addition, sedimentation and dewatering using a belt filter press. Debris must be separated from the sediments by screening and vibration prior to dewatering. The slurry is pumped to an agitated storage tank where particles are kept in suspension. Polymers are added to enhance flocculation, settling and dewatering. After polymers are added to the slurry, the slurry is pumped to a circular tank called a thickener, where sedimentation occurs. The clear water then overflows back to the waterbody. The precipitated sediment at the bottom of the thickener is kept moving via a rotating rake shaft that draws the solids to the belt presses. The belt filter press uses gravity and pressure to separate the water and solids. Conveyors collect the material and feed it to stacking conveyers. From there, the material can be picked up by front end loaders and transported by truck or barge (Phoenix Process Equipment, 2004).

A mobile dewatering machine could be useful in instances when another dewatering site is not located in close proximity. Some mobile dewatering systems can be taken down and stored between dredging projects. The capacity of mobile mechanical dewatering systems vary and are dependant on the project timeframe (i.e. days/weeks/months), how many hours of operation per day (e.g., 20 hours) and the physical characteristics of the sediment (e.g., sediment size, specific gravity, %organic matter, etc.). Costs and time requirements for mobile mechanical dewatering systems are high when compared to other dewatering processes. A possible scenario was providedby Phoenix Process Equipment Co. for dewatering 100,000 cubic yards in a relatively small area. The process would be completed over six months with work occurring 16 to 20 hours per day and operations would require an approximately 100ft x 150ft. Costs, including equipment (belts, polymers, thickener, pumps, controls, etc.), installation and field piping, could total 1.75 to 2.00 million dollars ($17.50 to $20.00/cy).

One success story using mechanical dewatering of dredged material involved the direct feed of sediment slurry to a continuously operating rotary press on the St. Lawrence River in Canada (EC, 1995). The rotary press reduced the volume of approximately 5,000 cubic meters of dredged material by 5 to 10 times and the dryness level went from 15 percent to 72 percent of total particulate matter during dewatering.

On-Water Dewatering Options

A system of barges can be used to dewater dredged material on the water. Up to four barges could rotate through the dredging process: one barge accepts the dredged material at the dredge location, one barge collects the dewatering supernatant from the offloading barge and returns it to the dredge location (then replaces the dredge barge), one barge is offloaded for further processing of the dredged material (such as screening debris), and a final barge could be made available to deliver finished material, if necessary. This approach would reduce the amount of space necessary for dewatering and the permitting and cost considerations associated with supernatant discharge. For example, typical scows used in New York / New Jersey Harbor are 3,000 cy in capacity, approximately 250 ft long and 55 ft wide. One potential problem with this is option is vessel traffic congestion on water. A single scow may have sufficient capacity to haul the dredged material from a single marina project, but several barges would be required for typical State channel dredging projects.

All dewatering methods have drawbacks and many other factors should be used to determine which method is appropriate for a particular area. Dewatering in CDFs is time-consuming and requires substantial physical space to accommodate the volumes of dredged material generated during hydraulic dredging. This method may be impractical in areas where real estate is expensive, or when there is a high demand for the dredged material. Active methods, such as dewatering machines and geotextile tubes, utilize expensive equipment. These costs should be weighed against real estate costs to determine whether they are prohibitive. Dewatering machines also take considerable time to complete the process. Wet materials are pumped directly into the machine's storage tank. The capacity limits the amount of material that could be dredged in a day and this method could potentially prolong dredging projects. These machines are likely only appropriate for smaller private dredging projects. On-water dewatering systems require less land and can potentially decrease permitting requirements, but would be impractical in areas where vessel traffic is a major concern.

- Screening Equipment

Depending on the project location, type of material being dredged, and type of dredging process used, large quantities of debris may be included with the dredged material. This debris must be removed prior to processing which can be accomplished on land using coarse screening equipment.

Once the material is cleaned of debris and relatively dry, it may be passed through a trommel screen to separate the material by grain size. A trommel screen is a circular rotary screen. Materials smaller than the screen opening pass through and larger grain sizes continue along the length for collection at another point. The screen opening depends on the particle size desired, with a number of standard sizes that correlate to particles such as clay, silt, fine sand, coarse sand, and gravel. NJDEP previously issued Acceptable Use Determinations (AUDs), based on the absence (or minimal presence) of fine-grained material, defined as less than 10% by mass of the material passing a standard number 200 sieve. Due to this specified criteria, a 200 sieve screen is recommended as the primary screening for the dredged material. In certain cases, a second trommel screen may be used to further refine the grain size for end uses such as beach nourishment or ceramics.

C.4 CONSIDERATIONS FOR FINAL PRODUCTS

If the processing facility intends to manufacture a higher end commodity such as topsoil, additional steps and raw materials would be necessary. In addition to an inorganic or mineral matrix such as coarse grained dredged material, topsoil usually requires a certain amount of clay, organics, fibrous material, and potentially lime for pH stabilization. These materials may incorporate other waste streams, such as biosolids from wastewater treatment plants or paper and mulch materials from landfills. These waste management authorities are often at the county level in New Jersey and dredged material may be part of an interconnected large-scale solution to waste disposal in the State. Regardless, topsoil blend optimization may take up to a year of testing, and may be limited by the variability of incoming dredged material.

Besides the screening and blending operations, yard equipment would be necessary to move material. Reducing handling and transportation of dredged material is essential in order to keep costs down. Efficient use of space is necessary to reduce the amount of land required. Several strategies are recommended to optimize material movement, such as direct transfer of dredged material to final drying areas and locating the trommel screen adjacent to the drying area. However, the various separation processes would still produce piles of material that would need to be moved around the facility.

Ideas about other types of equipment that may be necessary for a RPF are based on information obtained from The Burlington County OTC facility. They use the following to manage their material: one 3 cy track backhoe, one 5 cy bulldozer, and one 6 cy bulldozer, several 18 cy dump trucks and one 65 cy "live-bottom" for processing dredged materials and other material into topsoil. Their equipment costs are approximately $12,000 per month in payments, excluding the trucks, which are owned outright.

Finally, finished material must be temporarily staged prior to delivery to the final placement site. The timing of dredging activities, processing, and placement may not be optimal. The total storage area required for any RPF will depend on balance between supply and demand and the cost/benefits of storage and placement opportunities. Large-scale placement operations usually do not exceed 10,000 cy per day, would limit the overall production of finished material. State dredging projects usually occur as a single, large event, resulting in about 10,000 cy per day of dredged material production. Private projects would likely occur sporadically during the late fall, following the recreational boating season and preceding winter flounder spawning. If a large-scale placement project coincides with a large dredging operation, no storage would be necessary. However, the lack of a placement site would require storage of the entire quantity of processed dredged material. In addition, the undesired material separated during processing would still require disposal. Removal of both finished products and waste materials could be accomplished by barge, truck, and/or rail, depending on distance and location of the site.

C.5 CHALLENGES

The principal challenge in developing beneficial uses for dredged material is the ongoing availability of placement sites and the demand for the finished material. The Port of Oakland (POAK) funded a study to identify a regional upland dredged material reuse/rehandling facility for the San Francisco Bay area in 1999. As part of this project, they performed a detailed survey of the construction and redevelopment community, the likely end users for any beneficial use product. The results of this survey showed that there was very little enthusiasm in the industrial and commercial communities to utilize dredged material as a resource. A common concern was that the material was contaminated, and those surveyed did not foresee a large user base for the material in either construction fill or general fill. The POAK report concluded that there is a need to educate the end user community regarding risks and benefits of dredged material reuse before it is likely to be accepted by the public. In addition, an incentive may be needed to encourage end users to consider dredged material. As discussed in Section 2.3, legislation requiring utilization of a percentage of dredged material in publicly funded projects could create this type of incentive.

The survey conducted for this study and described in Figure B.3, included surveying NJDOT earthwork and landscaping contractors. Results suggest a similar reluctance to using dredged material. Presently, contractors can be flexible with their material requirements, borrowing from previous or simultaneous construction projects. In addition, they prefer material located close to their final placement operation to reduce transportation costs. In Cape May Harbor, much of the fill material used in new shoreline construction derives from waste clam and oyster shells generated by the local seafood processing industry. Because market forces are currently insufficient to make dredged material a competitive alternative, government incentives may be necessary. Awarding bonus points to the bid score of State bidders using dredged material, or taxing the use of virgin material, could improve the competitiveness of dredged material. At a minimum, use of dredged material by the primary generators (i.e., the State, USACE) would be an important initial step in developing a user base.

Appendix D

Development of Costs Associated with Dredged Material Management

D.1 PROCESSING COSTS

Potential costs of RPFs are based on hypothetical waterfront facilities designed for dredged material dewatering, processing and distribution. For this study cost estimates for two different RPFs were performed. The first one was designed to handle 75,000 cy per year of dredged materials with minimal processing and the second one was designed to handle 24,000 cy per year of dredged materials with topsoil production.

Both facilities were designed for dewatering using an on-site upland CDF. Processing at both facilities includes primary debris screening and secondary Trommel screening, separating dredged material by particle size. For the smaller facility the dredged material is mixed with leaf compost and lime to produce a topsoil product. For the larger facility only screening and separation are performed. The larger facility is located on a 50 acre site while the smaller one is on a 20 acre site. Land costs for both facilities were assumed at 200,000 per acre.

Unit costs are lower at the larger facility due to economies of scale and less processing. Total expected dredged material processing net costs for the larger facility were estimated to be *$33/cy*. This cost includes the cost of the land, processing facility infrastructure and site work, labor and energy. Revenue generated from the sale of the fill material is assumed at $6/cy, based on the OTC's current price for sandy fill material. If clean fill materials become scarce, revenue from the sale of the processed dredged material could increase, decreasing the total processing cost. It is estimated that processing costs may differ by as much as 50% due to site specific factors and the market for the end use products. Due to this high uncertainty in costs, lower and upper bound cost estimates were made. The low estimate was *$17/cy* and the high estimate was *$49/cy*. These costs only include dewatering and processing at the RPF.

Total expected dredged material processing costs for the smaller facility were estimated to be $69/cy of dredged material. This cost includes the cost of the land, processing facility infrastructure and site work, amendments, labor and energy. Revenue generated from the sale of topsoil material is assumed at $22/cy ($44/cy in terms of dredged material), based on the price that Sunkist Landscaping is currently receiving for a similar product. Unit costs for this processing facility include the cost of amendments to produce the topsoil product. The topsoil product is composed of 50% leaf compost and 50% dredged material with 6-2/3 lbs of lime mixed in for each cy of topsoil mix. If topsoil becomes scarce, revenue from the sale of the processed dredged material could increase, decreasing the total processing cost. It is estimated that processing costs may differ by as much as 50% due to site specific factors and the market for the topsoil. Due to this high uncertainty in costs, lower and upper bound cost estimates were made. The low estimate was *$34/cy* and the high estimate was *$102/cy*. These costs include dewatering, processing and addition of amendments at the RPF.

D.2 DREDGED MATERIAL TRANSPORTATION

The first step in dredged material management is transporting the wet material from the dredging location to a dewatering location. Further transportation is sometimes required to take the dry material from the dewatering site to a processing or beneficially use site. Dredged material can be moved via pipeline, barge, truck, rail or conveyor.

Generalized unit costs (per cy of material) were developed for loading/unloading and dredged material transportation. These costs depend on site specific conditions. Since these costs are uncertain, low, expected and high unit cost scenarios were developed.

- Loading and unloading Costs

Different loading and unloading costs are associated with different transportation modes. For example, moving material by pipeline could avoid loading or unloading costs since the material would be pumped directly to its dewatering location. Truck transportation includes only a loading cost, since it is assumed that dump trucks will travel to their final destination and dump their load in the desired spot. For rail transport it is assumed that there will be loading and unloading costs, since rail spurs are assumed to be unavailable near the dredging, processing and dewatering sites. Barge transport only includes unloading since dredging directly into barges is assumed. Conveyor belt transport only includes loading onto the belt since the belt would transport the material to a truck or barge.

Loading and unloading costs depend on the composition and water content of the dredged material. For example, earthwork costs are least expensive for sand and gravel (Means Heavy Construction Cost data). Costs are slightly more for common earth (soil) and can be 50 to 70% greater for clay. Wet material increases excavation costs by 50 to 100%. To simplify the analysis and since material quantities and properties are uncertain, all loading and unloading costs for wet and dry dredged material were estimated as $3/cy (Means BCCD, 2003). Based on unknown material composition, moisture content and production rates, a level of uncertainty of 30% was set. The low cost estimate is therefore 30% less than the expected cost and the high cost estimate is 30% more than the expected. Loading and unloading unit costs were estimated as *$2/cy*, *$3/cy* and *$4/cy* for the low, expected and high cost scenarios respectively.

- Transportation Costs

Transporting dredged material from the point of dredging to its final location incurs a significant cost in any dredged material management strategy. Transportation costs depend on the mode of transportation and the distance traveled. For this study, transportation cost curves were developed based on published information (Sauder et al., 1978; Means BCCD, 2003) and personal interviews. The cost curves relate the cost of transport (per cy) to the distance that the material needs to be moved. Five different transportation methods were considered: pipeline, rail, barge, conveyor belt and truck. The transportation cost curves are shown in Figure D.1.

A range in transportation unit costs was developed by assuming different required transport distances. The low transportation cost would represent a short (5 mile) distance, the expected transportation cost would represent a medium (20 mile) distance and the high transportation cost would represent a long (100 mile) distance. These costs are summarized in Table D.1 for different transportation modes.

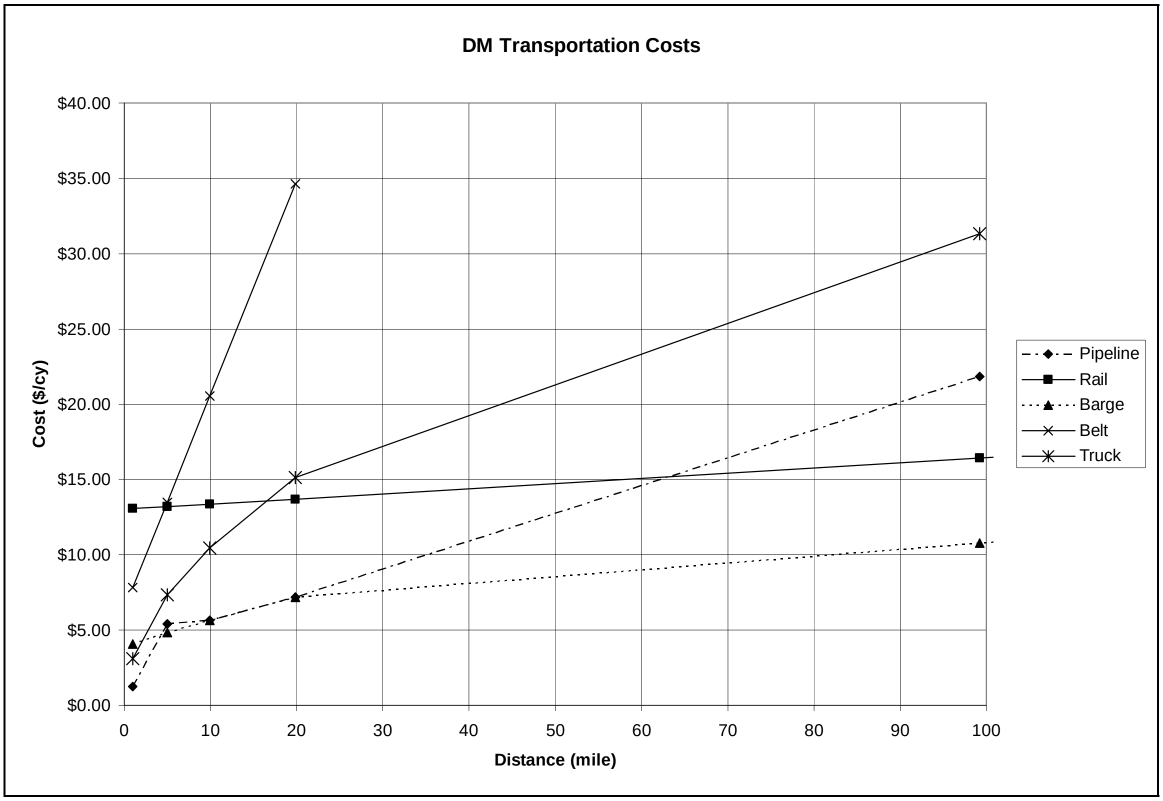


Figure D.1. Dredged material transportation costs per cubic yard of material.

Table D.1. Transportation Cost ($/cy)

Transportation Mode	Low Cost (5 mile distance)	Expected Cost (20 mile distance)	High Cost (100 mile distance)
Pipeline	5	7	22
Truck	7	15	31
Barge	5	7	11
Rail	13	14	16
Conveyor Belt	13	35	n/a

- Dewatering Costs

Dewatering can be performed in a number of ways including centrifuges, belt filter presses, CDFs, and geotextile tubes (Appendix C). For this analysis only CDFs and geotextile tubes are considered since it is thought that mechanical dewatering would not be cost-effective (Herbich, 2000).

The cost of dewatering depends on the physical properties of the dredged material. In general, materials with higher sand and gravel content can be dewatered more quickly and inexpensively than material with a high amount of clay and silt. Sand can be settled out in a settling tank or sand wheel. The remaining dredged material, containing silt and clay, is much harder to dewater and requires more time for gravity dewatering or energy for mechanical dewatering. The dredged material properties will be site-specific and may even vary within a single dredging project location. For this study, dewatering costs are not considered to be dependent on the dredged material composition.

The cost of dewatering also depends on the water content of the dredged materials. In general, hydraulically dredged materials have higher water content than mechanically dredged materials. Typical water content for dredged material is 50 to 80 percent (Salomons and Forstner, 1988). All known dredging projects conducted in the case study locations were performed with hydraulic dredges, so the cost of dewatering does not consider initial variations in water content.

The unit cost for dewatering with geotextile tubes is based on purchase and installation of 60 foot diameter Geotubes® and allowing evaporative drying of the material. It is assumed that the dredged material is pumped directly into the geotextile tubes via hydraulic dredging. The unit cost for dewatering using geotextile tubes is expected to be $7/cy. This cost could vary by 25% due to the aforementioned factors. The low, expected and high cost for dewatering with geotextile tubes are <u>*$5/cy*</u>, <u>*$7/cy*</u> and <u>*$9/cy*</u>, respectively

The unit cost for dewatering in a CDF can be estimated by the cost of removal of material currently in the CDF. It is assumed that there will be no new in water CDFs built and that existing CDFs will be utilized by regenerating their capacity. Material currently in the CDFs will be removed and used in other locations. The unit cost is largely dependent on the distance that the material must be transported and the mode of transportation. Assuming trucking is used to move the material out of the CDFs, the cost was approximated using the loading cost plus the transportation cost. For dewatered material the low, expected and high cost scenarios were estimated as follows:

$3/cy (loading)
+$7/cy (5 mile truck transport)
=$10/cy

$3/cy (loading)
+$15/cy (20 mile truck transport)
= $18/cy

$3/cy (loading)
+ $31/cy (100 mile truck transport)
= $34/cy

If barges are used to remove materials from the CDFs, then the low, expected and high cost estimates would be similarly derived but the barging would include both loading and unloading costs. In this case the low, expected and high cost estimates would be calculated as follows:

$3/cy (loading)
$3/cy (unloading)
+ $5/cy (5 mile barge transport)
= $11/cy

$3/cy (loading)
$3/cy (unloading)
+ $7/cy (20 mile barge transport)
= $13/cy

$3/cy (loading)
$3/cy (unloading)
+$11/cy (100 mile barge transport)
= $17/cy

If the CDF is located at the RPF site, then the cost includes the cost of constructing the upland CDF. However, there are no transportation costs included. In this case the costs include the additional land required at the RPF, sitework, excavation and construction of berms, construction of an underdrain system and liner. Based on two different size upland CDFs (for the 24,000cy/yr and 75,000 cy/yr RPFs) the costs range from $4 to $6/cy. This cost does not include any cost for loading or unloading dredged material. The low, expected and average cost scenarios for this case are estimated at $3/cy, $5/cy and $7/cy.

Dewatering costs are summarized in Table D.2.

Table D.2 Costs (per cy) for dewatering dredged material

Type of Dewatering	**Low Cost**	**Expected Cost**	**High Cost**
Geotextile tubes	5	7	9
CDF			
Existing facility-Removal by truck	10	18	34
Existing facility-Removal by barge	11	13	17
New facility at RPF	3	5	7

D. 3 DREDGED MATERIAL PLACEMENT

There will be costs associated with placing dredged material at a Brownfields site, landfill or other upland site. It is assumed that prior to placement, the material will require dewatering using either a CDF or geotextile tubes. The placement costs are discussed in the following section.

- Brownfields Placement

Costs associated with placement of dredged material at a brownfields site could include grading, or the construction of access roads. At a minimum, after the material is placed it must be spread and stabilized at a cost of approximately $1/cy. This cost could easily increase if site grading and access roads are needed at the brownfields site or if storm water management/water quality features are required. The low, expected and high cost estimates for placement at a Brownfields site are estimated at *$1/cy*, *$3/cy* and *$5/cy* respectively.

- Landfill Placement

If the dewatered dredged material is placed in a landfill, landfill fees must be included in the cost analysis. Landfill placement costs were based on current Cape May County Landfill placement cost data. Landfills charge by weight. Assuming that a cubic foot of dry dredged material weighs 120 lbs. or and one cubic yard weighs 1.62 tons/cy, it will cost $20/ton or $32/cy to dispose of dredged material certified as ID 27 material (non-hazardous industrial waste) at the landfill. It is assumed that the dredged material has already been dewatered and is dry enough not to cause problems with landfill operations. If the material can not be classified as ID 27 then a cost of $64/ton or $106/cy would be charged. A lower cost could be realized if the material were used as daily cover at a landfill. For example, the Brick, NJ Landfill currently charges $15/cy for material that is suitable for daily cover. For the landfill placement option the low, expected and high costs are *$15/cy*, *$32/cy* and *$106/cy* respectively

- Land Placement

If there were no nearby Brownfields or landfill sites to place the dewatered dredged material, land would have to be purchased for an upland CDF. If this site was far away from the dewatering site, then the transportation cost would be great. Assuming a maximum placement height of 30 feet (from the NJDEP/BOEC recent contract for removal of material from Corps CDF Site C) and a volume of 75,000 cy/year (the average annual dredging volume [1]) for 50 years, a total land area of about 85 acres is required. At $100,000 per acre (for an upland site), this is equal to an $8,500,000 land cost. Site clearing, grading, access roads, stormwater management, engineering and permitting would raise costs to $13.7 million. Including a new placement site would therefore increase placement costs by $11/cy [2] to *$12/cy*, *$14/cy* and *$16/cy* for the low, expected and high cost scenarios.

D. 4 TOTAL COSTS

Total costs ($/cy) for each dredged material management scenario were derived from the sum of each unit cost. The following tables (Tables D.3 - D.6) display unit costs and the resulting total costs for each management strategy for each case study location. Management strategies are presented as current conditions (baseline) and alternatives. The specific method for each component of the management strategy (i.e. dewatering, transport, processing, etc.) is presented for each alternative. For each method, unit costs and the range (low, high) are shown.

[1] Note that the reported dredging volume is in wet cubic yards and placement will occur following dewatering. This may be a conservative estimate.
[2] Cost of land annualized over a 50 year period at 5-3/8%, divided by number of work days per year and the annual volume of dredged material.

Table D.3. Detailed unit costs ($/cubic yard) for dredged material management strategies for materials from Cape May Harbor.

Management Component	Baseline (State) To No Cost Placement	Baseline (Private) To Landfill	Alternative 1 To State and Federal Projects	Alternative 2 New RPF	Alternative 3 New RPF at USACE CDF
Dewatering $/cy (low, high)	USACE CDF **0** [1] (0, 0)	Geotextile Tubes **7** (5, 9)	USACE CDF **0** (0, 0)	At RPF in CDF **0** (0, 0)	USACE CDF **0** (0, 0)
Loading $/cy (low, high)	Onto Truck **3** (2, 4)	Onto Truck **3** (2, 4)	Onto Truck/Barge **3** (2, 4)	N/A **0** (0, 0)	Onto Barge **3** (2, 4)
Transport $/cy (low, high)	To Brownfield **15** (7, 31)	To Landfill **16** (16, 16)	To Project Site **40** (16, 60)	To RPF **7** (5, 11)	To RPF **7** (5, 11)
Unloading $/cy (low, high)	N/A **0** (0, 0)	At Landfill **32** (15, 104)	At Project Site **0** [2] (3, 0)	At RPF **3** (2, 4)	At RPF **13** [3] (10, 16)
Processing $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0,0)	N/A **33** (17, 49)	N/A **21** (11, 32)
Placement $/cy (low, high)	At Brownfield **3** (1, 5)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0, 0)
Revenue $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0,0)	Sale of Material **-6** (-6, -6)	Sale of Material **-6** (-6, -6)
Total (low, high) ($/cy)	**$21 per cy** (10, 40)	**$41 per cy** (27, 94) **$58** [4] **per cy** (38, 133)	**$43 per cy** (21, 64)	**$37 per cy** (18, 56)	**$38 per cy** (22, 57)

Notes:

The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario. Alternatives 1-3 include both State and private dredging projects.

[1] Assumes USACE will continue to allow State use of CDFs for "Baseline State" scenario

[2] Use of barges is assumed in the low range estimate, unloading the barges is required

[3] Cost of offloading facility with dock, scales, etc. is included

[4] The second estimate is after an initial 10 year period when two private marinas can use their own CDFs. After 10 years, their CDFs will be at capacity and they will have to landfill their material, increasing overall costs.

Table D.4. Detailed unit costs ($/cy) for baseline and alternative dredged material management strategies for Dredge Harbor.

Management Component	**Baseline** **Amico Island To Landfill**	**Alternative 1** **Off-Site Topsoil**	**Alternative 2** **On-Site Topsoil**	**Alternative 3** **Brownfields Site**
Dewatering $/cy (low, high)	At Amico Island **0** (0,0)	Geotextile Tubes **7** (5, 9)	At Amico Island **0** (0, 0)	Geotextile Tubes **7** (5, 9)
Loading $/cy (low, high)	Onto Truck **3** (2,4)	Onto Truck **3** (2, 4)	N/A **0** (0, 0)	Onto Truck/Barge **3** (2, 4)
Transport $/cy (low, high)	To Landfill **17** (17, 17)	To OTC **17** (17, 17)	N/A **0** [3] (0, 0)	To Brownfield **15** (7, 31)
Unloading $/cy (low, high)	At Landfill **20** [1] (10, 64)	N/A **0** (0, 0)	To Process Area **3** [4] (2, 4)	At Brownfield **3** (2, 4)
Processing $/cy (low, high)	N/A **0** (0, 0)	At OTC **10** [2] (8, 20)	At Amico Island **77** (39, 115)	N/A **0** (0, 0)
Placement $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0, 0)	Brownfield **3** (1, 5)
Revenue $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)	Sale of Topsoil **-84** (-48, -84)	N/A **0** (0, 0)
Total (low, high) ($/cy)	**$40 per cy** (29, 85)	**$37 per cy** (32, 50)	**-$4 per cy** (-7, 31)	**$31 per cy** (17, 53)

Notes:

The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario.

[1] Includes the tipping fee at the Burlington County Landfill

[2] Includes the tipping fee at the Burlington County Landfill OTC

[3] Assumes that the end-user will be responsible for transport costs

[4] Unloading dried dredged material from the CDF on Amico Island to the on-site processing facility

Table D.5. Detailed unit costs ($/cubic yard) for dredged material management strategies for materials from Sails Aweigh Marina.

Management Component	Alternative 1 New RPF	Alternative 2 To Landfill
Dewatering $/cy (low, high)	At RPF in CDF **0** (0, 0)	Geotextile Tubes **7** (5, 9)
Loading $/cy (low, high)	Onto Barges **0** (0, 0)	Onto Truck **3** (2, 4)
Transport $/cy (low, high)	To RPF **7** (5, 11)	To Landfill **10** (10, 10)
Unloading $/cy (low, high)	At RPF **3** (2, 4)	At Landfill **5** [1] (5, 5)
Processing $/cy (low, high)	At RPF **33** (17, 49)	N/A **0** (0, 0)
Placement $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)
Revenue $/cy (low, high)	Sale of Material **-6** (-6, -6)	N/A **0** (0, 0)
Total (low, high) ($/cy)	**$37 per cy** (18, 56)	**$25 per cy** (22, 28)

Notes:

The expected unit cost, with the low and high range costs in parentheses (low, high) is presented for each component of each alternative. All costs for Alternative 1 are based on a RPF designed to process 75,000 cy/year.

[1] Includes tipping fee

Table D.6. Detailed unit costs ($/cy) for the two alternative dredged material management strategies for the upper Manasquan River.

Management Component	Baseline (Private) LJ3 Marina On-site topsoil	Alternative 1 (State) To State and Federal Projects	Alternative 2 (State) New RPF
Dewatering $/cy (low, high)	LJ3 CDF **0** (0, 0)	Gull Island **0** (0, 0)	At RPF in CDF **0** (0, 0)
Loading $/cy (low, high)	N/A **0** (0, 0)	Onto Barge **3** (2, 4)	N/A **0** (0, 0)
Transport $/cy (low, high)	N/A **0** (0, 0)	To Project Site **24** (17, 40)	Barge to RPF **7** (5, 11)
Unloading $/cy (low, high)	N/A **0** (0, 0)	At Project Site **3** (2, 4)	At RPF **3** (2, 4)
Processing $/cy (low, high)	At LJ3 **103** [1] (40, 150)	N/A **0** (0, 0)	At RPF **69** 34, 102)
Placement $/cy (low, high)	N/A **0** (0, 0)	N/A **0** (0, 0)	N/A **0** (0, 0)
Revenue $/cy (low, high)	Sale of Topsoil **-44** (-56, -28)	N/A **0** (0, 0)	Sale of Topsoil **-44** (-56, -28)
Total (low, high) ($/cy)	**$59 per cy** (-16, 122)	**$30 per cy** (21, 48)	**$35 per cy** (-15, 89)

Notes:

The expected unit cost, with the low and high range costs in parentheses (low, high), is presented for each component of each scenario. All costs for Alternative 2 are based on a RPF designed to process 24,000 cy/year.

[1] Includes loading costs.