Dredge Spoils Management for Sustainable Support of U.S. Coast Guard Missions

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The onsite confined dredge sediment disposal facility at the United States Coast Guard Training Center in Cape May, NJ is almost at full capacity. In order to maintain operational readiness and success of Coast Guard missions, the sediment build-up in navigable waterways must continually be removed and disposed off or stored in an environmentally friendly manner. The dredge management process at this facility is discussed in this paper as part of a feasibility investigation to assess viable alternatives for sustainable dredging and sediment disposal. Three alternatives to ensure proper dredge management for continued and sustainable dredge spoil disposal were investigated. Each alternative was evaluated based on several considerations including up-front cost, overall costs, storage capacity, environmental impacts and effects on Coast Guard operations. Based upon analysis of the site conditions, Coast Guard interests, and the future of dredge management capabilities, vertical expansion of the confined disposal facility was found to be the most cost effective and practical immediate short-term option.

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Introduction
The use of navigable waterways is critical to the nation’s economy and Coast Guard missions. The maritime coverage of the United States Coast Guard is vast; spanning from Atlantic shores to Caribbean beaches, Pacific Coastlines, Alaskan and Hawaiian seas. Within these geographical locations, a variety of missions are carried out that include search and rescue, drug and migrant interdiction, aids to navigation, safety and security, and environmental protection. The homeports of Coast Guard vessels and cutters are located in safe harbors, up rivers, inside bays and through navigation channels. Coast Guard missions cannot be completed if the cutters and patrol boats are unable to leave the dock due to an absence of navigable waterways. Maintaining navigable ports and waterways is critical to operational readiness and success of Coast Guard missions. Sediment build-up in the waterways is routinely removed by the process of dredging to ensure that channels and harbors remain true to charted depths, are safe for navigation, and retain nearly constant bathymetry. These ongoing processes consistently require analysis and reanalysis of sustainable options for dredging and sediment disposal. The Environmental Protection Agency (EPA) collaborates with the United States Army Corps of Engineers (USACE), state officials and local agencies to set and regulate acceptable dredging processes. Specialized vessels carry out dredging operations through a variety of methods-including but not limited to pipeline dredging, ladder dredging, clamshell bucket dredging, and many more. There are many options for the disposal of dredged material ranging from engineered facilities, product processing and offshore dumping.

This paper focuses on the present and future of the dredge management processes at the Coast Guard Training Center (TRACEN) in Cape May, New Jersey. The development of alternative solutions for the rapidly filling Confined Disposal Facility at TRACEN Cape May is adversely impacted by the potential for naturally occurring contaminants that exist in the area. New Jersey’s technical manual for dredging (NJDEP, 1997), provides guidance for the approval process for dredge projects in New Jersey. Furthermore, New Jersey Department of Environmental Protection (NJDEP) encourages the reuse, rather than disposal, of dredged material whenever possible. Details of a feasibility study to investigate alternative solutions to the problem of limited on-site dredge disposal capability facing the TRACEN Cape May are discussed.

Site Description
The New Jersey Shoreline is divided into three geographic regions based on the benthic environments characteristic to each region shown in Figure 1. Region 1 ranges from Sandy Hook north to the New York/New Jersey Harbor. This region is defined by shallow estuary type waterways. Region 2 spans from Sandy Hook and southward to the Cape May canal. This region is the Atlantic coastline and is defined by the natural harbor and canal system that compose the Intracoastal Waterway (ICW). Region 3 ranges from the Cape May Canal inland through the Delaware River to
This region is defined as a commercial corridor (Maher, et. al., 2013).

Fig. 1 New Jersey Geographical Dredging Regions  
(Source: Maher, et. al., 2013)

The Coast Guard Training Center (TRACEN) at Cape May is located in the New Jersey Benthic Characteristic Region 2. This region is unique in that the primary purpose of the waterways and large network of channels is for recreational use. The dredged material from this region typically ranges from sand to silty-clay (Maher et. al., 2013). Dredging has been conducted at TRACEN, Cape May since 1965; it is required to conduct a cyclical dredging every 3-5 years to keep the basin operational. Currently, a pipeline dredging system is used to remove sediments from the basin and transport them to an on-site Confined Disposal Facility (CDF). The dredge spoils or sediments settle out from highly saturated slurry within the CDF, and the effluent (mostly water) is discharged back into the water basin. The CDF, shown in Figure 2, is currently located on the eastern edge of the TRACEN, Cape May peninsula. It is currently enclosed between a road along its western wall and the Cape May inlet along the eastern wall (CG Facilities Engineering, 2012). The amount of dredging is expected to increase in the coming years to accommodate a greater number of larger Coast Guard vessels in the basin. The current disposal procedure of dredged spoils into the CDF presents a multi-faceted problem: the CDF is near its volumetric capacity to continue future operations, and the high likelihood of naturally contaminated dredge sediment limits the reuse option of the spoils to a “like-on-like” disposal, on-site storage, or costly remediation.

**Pipeline Dredging**

Dredging is done using hydraulic pipelines. In this process, an appropriately equipped vessel enters the basin at the specified dredging location, a pipe is placed down into the sediment and hydraulic methods (pressure) are used to pull the sediment up out of the basin. Since this pressurized process relies on constant flow in the pipeline, the dredged material is mixed to a very watery consistency with about 70% water and 30% sediments. It is also very important to note that for pipeline dredging to occur, an area for disposal must exist in the vicinity of the basin. This disposal facility must be equipped with methods for separating the sediment from the water. Unlike other methods of dredging, such as hopper dredges, clamshell, and bucket dredges, pipeline dredging does not involve sediment storage on board the vessel (U.S. epa.gov website). The CDF has an inflow pipe (see Figure 3) that transports the water-sediment mixture from the dredging vessel; and an outflow at the opposite end of the facility. In theory, the outflow discharges relatively “clean” water back into the waterway, leaving mostly sediment and very little water in the facility to evaporate. Dikes or berms are built as baffles into the facility, forcing the dredged material to have a longer path to travel from the inflow to the outflow. This gives the sediment or solids a longer time to settle out, while the water continues to move towards the outflow. The outflow has a weir structure that can be opened or closed to prevent large amounts of soil from leaving the facility, while allowing the water to exit through the outflow pipe. The effluent discharged back into the waterway must meet certain NJDEP environmental requirements to minimize...
pollution of the water basin. Furthermore, if the soil in the CDF is found to be contaminated (i.e. exceeding NJDEP limits), it cannot be displaced or moved to any other location without testing/treatment to meet the required standards for reuse or disposal.

Within the past 50 years, dredging and the subsequent use of the Confined Disposal Facility has occurred at various cycles: specifically, every few years since 1993. The facility has been expanded at least twice throughout its lifetime. The most recent expansion of the CDF was completed in 2012, in which the height of the dike was raised by 6 feet. Additional scope of the 2012 expansion included the relocation of 600 ft of dike walls, construction of internal finger baffles, extension of the discharge pipe and modification of the discharge weir. A summary of known historical dredging cycles are presented in Table 1.

### Table 1. Summary of dredging cycles & activities

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
<th>Dredge Volume (CY)</th>
<th>Cost ($)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>Initial construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>Expansion</td>
<td>Not available</td>
<td></td>
<td>Expanded to ½ current footprint</td>
</tr>
<tr>
<td>1993</td>
<td>Routine Dredging</td>
<td>144,750</td>
<td></td>
<td>No volume information available</td>
</tr>
<tr>
<td>1995</td>
<td>Routine Dredging</td>
<td>77,000</td>
<td>414,415</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>Routine Dredging</td>
<td>53,000</td>
<td>369,000</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Routine Dredging</td>
<td>60,000</td>
<td>300,000</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>Routine Dredging</td>
<td>56,000</td>
<td>639,100</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>Dredge</td>
<td>91,000</td>
<td>775,821</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>Expansion</td>
<td>490,600</td>
<td></td>
<td>6ft vertical expansion, expanded footprint</td>
</tr>
<tr>
<td>2014</td>
<td>Routine Dredging</td>
<td>82,774</td>
<td>1,522,010</td>
<td>Significant cost increase from 2010</td>
</tr>
</tbody>
</table>

**Identification & Selection of Alternatives**

The main objective of the project was to investigate suitable alternatives to ensure proper dredge management practices to maintain Coast Guard operations. The scope involved investigating three key alternatives, namely:

- **Option A: Vertical Expansion**-vertically expanding the CDF by repurposing the dredge material from within the facility as construction material.
- **Option B: Empty CDF**-Emptying the material currently in the CDF to provide capacity for new material.
- **Option C: Direct Offsite Disposal & Discontinue CDF use**- Implement a new process of immediate disposal of the dredge spoils directly from the basin to an off-site disposal facility.

A vital step before a final decision on the implementation of any of the options is to complete a sampling plan that addresses three major components of
the dredge material: (1) physical soil properties, (2) chemical composition, and (3) contaminant analysis. The sampling plan should be conducted in accordance to the NJDEP Dredge manual (NJDEP, 1997). Each alternative is discussed below in general terms while awaiting the completion of the sampling plan. Each option considers the two possibilities of the dredge material being uncontaminated or contaminated above acceptable limit. The final selection will be primarily based on the results of the required NJDEP sampling plan. The routine dredging is considered a common activity and the associated costs will be incurred for each option.

**Option A: Vertical Expansion of CDF**

This option includes the vertical expansion of the CDF by raising the height approximately 5 feet on the outer dike walls and the interior baffles. The design process explored various options of vertical expansion of the CDF and a stability analysis of the slopes. The dike walls are designed so that the increased base width expands towards the interior of the facility without increasing the CDF’s footprint as recommended by the U.S. Army Corps of Engineers (USACE, 1987) and shown in Figure 4. The footprint must remain the same due to obstacles located around the CDF: a road on the west side, and a waterway on the east. The already settled and drained dredge sediments in the CDF will be used for the vertical expansion of the dike walls. This option will result in increased capacity from both increasing the height and from reusing the dredge material in the construction.

The flow chart shown in Figure 5 is designed to aid in the decision making process after the sampling plan is completed.

![Flow chart](image)

**Fig. 5: Decision flowchart for Option A**

Depending on the results of the sampling plan, the following two scenarios are possible:

- **Contaminated dredge material**-In such a case, materials from the CDF can be used in a “like-on-like” situation to expand the volume of the CDF by raising the height 5 feet (1.5 m). The like-on-like and 75th percentile requirements are specific to the state of New Jersey. NJDEP’s like-on-like requirement states that no new contaminants may be placed in an “Area of Concern” (AOC) other than those already determined to be present (NJDEP, 2011). The 75th percentile standard requires that the disposed donor material have lower contamination levels than the receiving site in order not to increase the overall contaminant level of the receiving AOC. Therefore, contaminated soils may be recycled for use in areas that have similar contaminants as well as higher contaminate levels. If the maximum contaminant level for each donor contaminant is less than the 75th percentile of the receiving material, the alternative fill is acceptable and placement is permissible (NJDEP, 2011).
• **Uncontaminated dredge material**—Similarly, the uncontaminated material can be used to raise the height of the CDF. However, given the fact that vertical expansion of the CDF cannot continue indefinitely, it might be more practical (not necessarily cheaper) to directly dispose of the dredge spoils and discontinue the use of on-site storage if the dredge is uncontaminated. Direct offsite disposal will ensure the continued long-term dredging of the waterways and dredge disposal well into the future.

The expansion will provide an additional 207,000 yd$^3$ (158,263 m$^3$) of capacity as well as repurpose 70,000 yd$^3$ (53,519 m$^3$) of soil currently in the CDF. This reuse and expansion will result in an overall increase in capacity of 277,000 yd$^3$ (211,782 m$^3$). An additional service life of approximately 12 years will be gained at the current dredging cycle frequency. The estimated capitalized cost for this option is $6 million. This includes the construction cost, dredging cost (for approximately 250,000 yd$^3$) and maintenance cost over 12 years. The unit costs are based on historical Coast Guard costs. Based on the site limitation on horizontal expansion and the results of the stability analysis, the CDF can only be expanded vertically one more time. Vertical expansion is therefore a short-term solution that will no longer be viable after 12 more years of service. The 12 year additional service life gained from a vertical expansion is used as baseline for comparing the other alternatives.

**Option B: Empty CDF & Continue Use**
The second option of mass disposal of sediment from the CDF includes excavating the material from within the facility, transporting the material to an off-site facility, and disposing of the dredge material currently in the CDF. This option will have high upfront costs, but the emptied facility will gain a large volumetric capacity. Emptying the facility would provide a capacity of approximately 250,000 yd$^3$ (191,139 m$^3$). Depending on the results of the sampling plan, the following options are possible:

• **Contaminated dredge material**—If the results of the sampling plan reveals that the soil in the CDF is contaminated above acceptable levels, the soil should be removed for decontamination or disposal. The possibility of using the soil on a “like-on-like” program would be investigated. The decontamination and disposal cost of this option is highly dependant on the contamination level of the material and could not be factored into the overall cost at this time. The estimated capitalized cost for this emptying the CDF (excavation and transportation costs and dredging) is approximately $43 million over a 12 year-service life.

• **Uncontaminated dredge material**—If the soil in the CDF is not contaminated, it can be disposed of, removed or sold for reuse. The cost would vary depending on the soil properties and construction demand. However, the cost would be generally less expensive than if the spoils were contaminated. Estimated capitalized cost for emptying, dredging and continued use is approximately $15.5 million over a 12 year-service life.

The estimated costs include the associated costs for emptying the facility twice; initially, at year 0, and 10 years later, when it is estimated that the CDF would be filled to capacity again.

**Option C: Direct Offsite Disposal-Discontinue Use of CDF**
The third option is discontinuation of the use of the CDF (either permanently or temporarily) and disposing of the dredge spoils directly from the basin to an off-site disposal facility. This option would not alter the volumetric capacity of the CDF. However, removing the dredge for direct disposal would require changing the dredging method from the pipeline method to an alternate mechanical method in order to increase the sediment to water ratio. Barges would be required if disposal is via water. Over a twelve-year time period, which corresponds to the approximate length of time required to fill the capacity gained from the CDF expansion (Option A), the estimated capitalized costs were determined to be $38 million for contaminated material and $10.5 million for uncontaminated material. These costs include an average dredging cost and transportation to the off-site disposal facility. It can be anticipated that additional cost (such as dewatering requirements, etc.) might be associated with this option that would result in slightly higher overall cost. Different methods may significantly affect the cost, including use of mechanical dredging to lower water content, and transport of the dredged materials via barge. It was difficult to obtain an accurate estimate of the costs associated with a change in dredging method and/or barge transportation without contract documents. Therefore, an estimated average value based on historical Coast Guard contract documents were used to estimate the associated cost for comparison of the options.

Based on analysis and careful consideration of factors such as, immediate costs, life cycle costs, volumetric gain, maintenance history, budgetary constraints and environmental impacts of the project, vertical expansion of the CDF (Option A) was found to be the best option at this time. It should be noted that the expansion only provides TRACEN, Cape May with a projected 12 years
of dredge operation storage after which Options B or C may be considered as viable options at the end of that timeframe.

Conclusions
This feasibility study explored potential solutions to the problem of inadequate dredge disposal capacity at the Coast Guard’s TRACEN, Cape May on-site Confined Disposal Facility (CDF), and the associated costs and impacts of the three potential solutions. The three alternatives presented include vertical expansion of the CDF, emptying the CDF, and cyclical direct dredge disposal with discontinued use of the CDF. Notwithstanding the possibility of contaminants, each solution would introduce minimal risk to the environment and allow for sustainable reuse or disposal in accordance with EPA and NJDEP regulations. Based on site limitations, budget and other constraints, vertical expansion proved to be the most cost effective and practical short-term solution with an associated 12 years of extended use. However, vertical expansion is only a short-term solution to the long-term challenge of continuous dredging cycles to maintain navigable waterways for Coast Guard assets. After the additional service life of the vertical expansion, a more long-term solution will be required. It is anticipated that within this timeframe, new technologies and more effective methods of dredging, decontamination and disposal methods might become available to make the option of direct disposal economically viable for the Coast Guard.

References


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