DREDGING AND DISPOSAL ALTERNATIVES AND TECHNIQUES

PREPARED FOR

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT

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SECTION I. INTRODUCTION

Thomas & Hutton Engineering Co. has been requested by the South Carolina Department of Health and Environmental Control's Office of Ocean and Coastal Resource Management to provide a brief overview of the latest dredging methods and dredged material disposal techniques being utilized throughout the marina industry. The purpose of this report is to introduce the options available for the handling and disposal or reuse of the dredged material. The report will also address the methodology, advantages, and costs associated with each option.

One of the most important parameters in the operation of recreational marina facilities is the maintaining of sufficient water depth for the berthing and maneuvering of boats. Adequate depth determines the size and number of boats the facility can accommodate. The greatest challenge marina managers face today concerning maintenance of the their water depth and dredging rest in the determination of where to dispose of dredged sediments.

Marinas in the Low Country are especially susceptible to increased siltation rates. This is primarily due to the heavy concentration of sand and silt particles in the rivers, creeks, and streams resulting from the large tide ranges in the coastal area. Earlier practices usually involved the use of hydraulic dredging equipment whereby sediments were pumped via pipeline to an upland area typically adjacent to the marina. The material once dried and consolidated usually became foundation material for marina expansion projects such as building construction and other landside development. Due to the reducing availability of land adjacent to the marina facilities and the development of environmental laws have led to restrictions on how and where to dispose of dredged materials. In addition, restrictions being imposed by the Federal Government on use of their large confined upland disposal facilities by private enterprises, have necessitated the need to consider alternatives to dredged material disposal.

Critical to the determination of dredged material disposal alternatives is compliance with the State's criteria for maintaining water quality. The Water Quality standards provide for restoring and maintaining the physical, chemical, and biological integrity of the State's waters, protection and propagation of fish, shellfish, and wildlife, prevention of increased turbidity, and take into consideration the use of the State's waters for public water supply, recreation, agricultural, and navigational purposes. Adherence to these standards is essential in the selection of any material disposal technique.

SECTION II.
DREDGING OPERATIONS

In order to fully address the disposal options available it is necessary to develop a preliminary understanding of the various dredging techniques and equipment being employed today. There are three primary types of dredging equipment presently being used for dredging of marina facilities: mechanical, hydraulic and hydro-pneumatic. The difference between these types of operations is the mechanisms and methods by which the sediments are excavated, collected and conveyed. In the case of mechanical dredges the material is physically excavated from the bottom by clamshell or dragline equipment located on a barge. Hydraulic dredges utilize a cutterhead and pump system to suspend and suction the sediments into a slurry state conveying the material via pipeline for discharge. Hydro-dynamic dredging re-suspends sediment into the water column. The natural movement of the water column by tidal and current flow is relied on to move the dredged material downstream to larger water bodies. No excavation or mechanical conveyance system is required.

Mechanical dredges generally transport the excavated material by use of scow barges although some smaller dredge plants pump the excavated material with a conveyer or a pump capable of transporting the material landside. In the case of scow barges the material is taken either to an approved designated ocean disposal site and released for re-deposition to the ocean floor or to unloading facilities where the material is removed by excavation equipment such as dozers for placement in a landfill facility. Hydraulic dredges transport the excavated material via floating and/or submerged pipelines attached to the discharge end of the pump equipment. Booster pumps are positioned along the pipeline to maintain the required flow rate of the material for extremely vast distances between the dredge equipment and the disposal site.

Specific mechanical dredges include: Clam Shell Bucket, Orange Peel, Bucket ladder, Dipper, Backhoe/Trackhoe, and Dragline dredges. They are named by the mechanism used to capture the material for disposal. Mechanical dredges are similar to land excavation equipment positioned on barges. They literally excavate material up from the water bottom and discharge the material into either a scow barge or deposit it landside. Mechanical dredges can be imprecise in their positioning and cannot operate very close to piers, bulkheads, and beneath floating docks. Mechanical dredges excavate material at near insitu density meaning very little dredge water is captured. In the cases where the sediments contain contaminants specially sealed buckets are utilized to minimize the re-suspension of the material.

The primary types of hydraulic dredge equipment in use today include: plain suction, cutterhead, horizontal auger, dust pan, and matchbox. As with the mechanical dredge equipment they are named for the procedure used to facilitate the excavation and movement of the sediment through the system. The basic process of the hydraulic dredge is the use of centrifugal pumps to suction the material entrained with water at the excavation point discharging the slurry of water and solids via a pipeline or other form of conveyance system. The ratio of water to solids typically ranges 10:1 – 3:1.

Hydrodynamic dredging, or sometimes referred to as silt suspension, is a method whereby the sediment is placed into suspension in the water column without the physical removal of the material from the water body. Once the material is placed in suspension the natural movement of the water column by tidal and current flow moves the dredged material from the site. No further handling of the material takes place. Agitation dredging is a form of hydrodynamic dredging where mechanical stirring and/or hydraulic washing re-suspends the sediment. Hydrodynamic dredging is also accomplished by dragging of a heavy fixed device along the water bottom to displace the upper sediments. Another form of hydrodynamic dredging is the use of water injection where low pressure water jets are lowered into the sediment to fluidize the sediment. This fluidized sediment is denser than the surrounding water and flows into deeper areas by gravity. Water Injection Dredging relies on the gravity flow of the fluidized sediment rather than the movement of the water column to relocate the dredged sediments.

SECTION III.
DISPOSAL METHODS

Historically most recreational marina facilities have performed maintenance dredging by means of hydraulic with upland disposal, mechanical clamshell with disposal into upland landfills, or a form of agitation or silt suspension of the sediments. In most situations the properties of the dredged material, operational costs, as well as the availability of beneficial use projects or disposal sites have dictated the best method. Over the past several years various methods have become more readily available to recreational marinas to offset the increased environmental concerns and the lack of available on-site adjacent upland disposal areas. The latest techniques for the disposal of dredged material generally consist of:

- Ocean Disposal
- Placement of Sediment in Geo-tubes
- Habitat Development
- Silt Suspension
- Shoreline Stabilization and Erosion Control
- Beach Renourishment
- Land Creation
- Wetlands Enhancement & Restoration
- Upland Confined Disposal

Ocean Disposal

Use of Dredged Material Disposal Sites, (ODMDS) are sites approved by the US Environmental Protection Area for the offshore disposal of dredged material. Only uncontaminated materials may be disposed of at ODMDS. Use of ODMDS is a permitted by the USACOE with EPA review and concurrence. Suitability of a material for placement in an ODMDS is determined in accordance with the "Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual" (EPA and CE, 1991). Typically, these disposal sites are at fairly significant depths. Dumping of the dredged materials into the water results in a turbidity plume as some of the fine material will remain in suspension in the water column. ODMDS are not typically close enough to the site of dredging excavation for hydraulic dredge pipelines to discharge directly requiring the use of scow barges or hopper dredges to transport the material to the approved site. This procedure results in a slower production rate of dredging along with a significant cost increase due to the increased marine equipment required to perform the dredging and provide the transportation to and from the disposal sites offshore. In addition, permit conditions with this form of disposal usually require extensive monitoring at the disposal site to confirm the accurate placement procedure and methodology is in compliance with the site requirements.

Advantages:

- Use of Ocean Disposal Sites can sometimes be attractive in that the material is permanently removed from the marina location with no impact to adjacent land use or navigational concerns.

Disadvantages:

- In most cases use of Ocean Disposal methods will require the use of larger dredging companies with suitable resources to provide the amount equipment and licensing requirements to undertake the near shore and offshore operation. Smaller recreational marina facilities are somewhat restricted in their ability to accommodate larger dredging vessels due to the close proximity of the floating dock systems.
- The material to be discharged into an Ocean Disposal Site must be free of contaminants to avoid placement of an additional capping layer on top.
- Production rate for the dredging operation is much slower than other methods due to the capacity available in the hopper or scow barges that transport the material to the offshore site.

Costs:

Cost for the dredging and disposal into an Ocean Disposal Site typically ranges in the $30-40.00 per cubic yard excluding mobilization and permitting fees. Dependent on the proximity of the site to the nearest approved offshore disposal area the mobilization costs can exceed $100,000.00. In most cases the recreational marinas in the Low Country do not incur significant siltation or volume of material to be excavated to warrant selection of this method.

Water Quality Issues:

Concerns relating to water quality generally are focused at the dredging site with the specific excavation site and conveyance of the material to the transport barge equipment to minimize turbidity in the stream and impacts to marine life and habitat.

Placement of Material in Geo-tubes

Geo-tubes are high strength woven geotextiles designed to resist pressures from dredge pumping operations while fully containing the sediments. The bags are connected to the discharge end of a hydraulic dredge and filled with the sediment/water slurry. The geotextiles contain special filtering properties that provide for the rapid dewatering of the material. The water draining from the container can be held within a containment basin or allowed to flow back into the waterway. This dewatering system provides for the quick consolidation of the material allowing the removal of the sludge sediments for transportation to a landfill or relocation of the entire geotextile container to be used as shoreline protection, erosion control, breakwaters, jetties, groins, and berms where by the container can be covered with soil and vegetative grasses planted. Typically the containers are 30 feet in length and 30 inches in diameter with sealed ends.

Advantages:

- the containers can be used to capture contaminated soils for easy transport as a sludge to an approved landfill
- This method is suitable when upland disposal space is limited
- Once filled the containers can be transported and utilized in several beneficial projects such as shoreline stabilization and protection, berms, etc.
- Ideal for use with a small dredging operation in regards to the handling of smaller pump discharge rates.
- Generally the success of the geotextile is not dependent on the properties of the material being dredged however dewatering and consolidation rates make be impacted.

Disadvantages:

- Issue of handling the effluent water must be addressed in terms of containment or treatment
- Dependent on the amount of dredging required sufficient space for the placement of the containers must be provided with provisions made for the dewatering process.
- Geotextile containers tend to be very costly in the purchase of the material

Costs:

The material cost for supplying the geotextile container is generally $25.00 per cubic yard of material to be dredged making it cost prohibitive to many marina facilities.

Water Quality:

Water Quality in regards to the return of the effluent to the waterway and the resulting turbidity are a concern. Sufficient containment of the effluent once outside of the geotextile container to allow for settling of any solids must be considered.

Habitat Development

The appropriate placement of materials dredged from marina facilities can provide fishery and various wildlife habitat. Many upland wildlife habitats are the result of dredged containment areas that are no longer being used or have had long periods of maintenance dredging material placement there. The non-use allows native vegetation to grow providing food and cover for nesting periods and small animals. Many nesting islands have been created as a result of the placement of dredged sediments.

Placement of the dredged material can occur either by mechanical placement or by means of jet spraying of the sediments in thin layers over existing marsh or shoreline vegetation. In most cases placement of the material can be easily manipulated to develop the most preferred characteristics of the habitat desired. Generally maintenance dredged material in this area typically consists of silt/soft clay/sand mixtures making the sediments ideal for habitat use.

Advantages:

- This disposal method can be relatively inexpensive if the suitable proposed habitat developable area is in close proximity to the marina facility.
- Containment of the dredged water is not required.
- No maintenance of the disposal area is necessary.

Disadvantages:

- Significant coordination and cooperation with the regulatory agencies is required to ensure the proper application of the dredged material will accomplish the desired habitat without adversely impacting fragile existing biological, ecological, benthic habitats.
- This method becomes difficult if no suitable sites for development are within close proximity to the marina being dredged.
- Material being dredged must be uncontaminated and suitable for placement in existing marsh and shore areas.

Costs:

Costs of utilizing this method of disposal vary widely in range dependent on the amount of dredged material and its properties. Development of habitats by means of mechanical placement can range from $6-15 per cubic yard excluding mobilization. Hydraulic means of placement such as jet spraying can cost up to $20 per cubic yard.

Water Quality:

Although habitat development is consistent with water quality standards short-term impacts such as increased turbidity in the water and temporary impacts to the protection and propagation of shellfish, fish, and other marine life may occur. Environmental assessments as to these impacts must be considered.

Silt Suspension

Silt Suspension is a method whereby the sediments to be dredged are placed in suspension by underwater water jets or by means of agitation. Once the material is in a suspended state the natural movement of the water body due to tidal and current flow transports the material away from the site. Agitation of the material can be accomplished by the dragging of a heavy device behind a boat along the bottom causing the upper layer of sediments to be displaced.

Advantages:

- A defined specific disposal area is utilized
- Subsequent dredging events can be easily performed

- Disruption of the marina operations is minimal

Disadvantages:

- If heavy siltation has occurred requiring a substantial effort to remove large depths of sediment the silt suspension method can be ineffective and inefficient
- Cost of installation and maintenance of the water jet system for small marinas may be prohibitive
- Environmental impacts to the benthic life are a concern.
- This method is typically short lasting requiring frequent re-dredging to maintain the required water depth
- Impacts to adjacent properties due to increased shoaling from the re-distributed sediments can be detrimental.

Costs:

Purchase and installation of underwater jet silt suspension system typically cost $100,000 per unit not including routine maintenance costs. If the marina layout is complex and fragmented numerous units would be required. Agitation dredging typically cost $2-3 per cubic yard per event not including the performance of verification surveys.

Water Quality:

Adverse impacts to the benthic and marine life are concerns as well as short term turbidity resulting from the re-suspension of the sediments.

Shoreline Stabilization and Erosion Control:

Use of dredged material for shoreline stabilization and erosion control typically consists of the placement of dewatered sediments along eroded embankments and shorelines to replace lost material. In addition, as indicated earlier sediments placed in geotextile containers called geo-tubes can also be used to create protective berms. Use of dredged material for erosion control is generally limited to sediments containing primarily coarse grained sands.

Advantages:

- Use of the material for stabilization and erosion control can provide a much needed source to prevent damaging erosion and the minimize the threat of property loss due to storm erosion.

Disadvantages:

- Manipulation of the material to provide a stable embankment for erosion control requires significant labor and equipment increasing the dredging cost
- Material must be contaminant-free and granular in nature.
- Marina facility being dredged must be in close proximity to the proposed site to avoid high transportation costs.
- Environmental concerns regarding the filling of eroded shorelines and eroded waterfront property must be considered.

Costs:

The cost of utilizing dredged sediments for shoreline and erosion control varies dependent on the extent of the eroded areas and proximity to the marina being dredged. Typically, disposal operations for this use entail mechanical dredging equipment which could cost in the range of $20-30 per cubic yard

Beach Nourishment:

The practice of utilizing dredged sediments for beach renourishment has been in use for many years. Typically the dredge site is either near shore or in very close proximity to the beach site and after extensive testing of the sediments has been performed to determine the sand grain size compatibility with the native beach soils. Renourishment usually is performed by hydraulic dredges working in site specific borrow areas offshore however navigational channel deepening and maintenance work in federally controlled channels have utilized nearby beaches for disposal of the dredged sediments in lieu of expensive offshore ocean disposal. In most cases beach renourishment as a means of disposal for maintenance dredging of small marina facilities is not common due to the properties of the sediments being dredged and the extreme distance from the marina to the beach area

Advantages:

- Provided the sediments being dredged are compatible with the native beach sands at the site, beach renourishment provides an excellent benefit to the public allowing for less frequent costly specific renourishment projects.

Disadvantages:

- Extensive testing of the dredged sediments and compatibility analysis of both the sediment and native beach are required
- Larger dredging operations are required to facilitate the manipulation of the discharged material into dune formations and beach templates.
- Scheduling of the dredging work must be coordinated with beach use and weather.

Cost:

The cost of the placement of dredged sediments onto a beach in a manner to be considered renourishment can range from $5-10 per cubic yard dependent on the proximity of the marina to the beach not including mobilization costs. Testing of the sediments can range from $10,000 to $50,000 based on the type and quantity of material.

Water Quality:

Water Quality issues are related to the excavation site in regards to turbidity and the impact to benthic organisms in the surf zone and turtle and bird nesting areas on the beach site.

Land Creation:

The use of dredged material to create additional upland consists of filling, raising, and protecting an area that is periodically or permanently submerged. The suitability of the sediment will depend primarily on the intended use of the land being created. Placement of the material for this use is typically restricted to mechanical equipment to reduce the dredged water containment requirements. Sediments generated from maintenance dredging generally are limited to use in recreational areas such as parks where anticipated loads will be minimal.

Maintenance material is typically unsuited for commercial or industrial development where heavy loads may occur. Due to the need for dewatering and consolidation of the material, projects involving these sediments as land creation must be considered in the long range planning stage for the development. The creation of open space on the water by this method of disposal near urban areas makes them valuable assets for redevelopment. The poor foundation provided by the typical fine grained dredged materials is well suited to the lightweight structures common to parks and recreation facilities. The public ownership of many CDF sites combined with the regulations relating to coastal zone management and flood control make reuse of dredged material sites as park and recreation areas one of the most viable long term options.

Advantages:

- Provides opportunity for additional development and expansion of marina's landside facilities
- Can provide additional land available for public enjoyment near the waterway

Disadvantages:

- Creation of land is limited to uncontaminated soils unless capped with clean material
- Proposed site must be near the marina being dredged to avoid high disposal costs
- Environmental concerns relating to filling of marsh and wetland areas typically found near marina facilities.
- If the material is poorly consolidated foundation costs for future development may be cost prohibitive

Costs:

The cost for creating additional land as a means of disposing of dredged sediments is primarily dependent on the properties of the material being dredged and the availability of areas suitable for the filling of low-lying properties. In general, the cost for this method of disposal could range between $3-10 per cubic yard not including mobilization and testing of the material.

Water Quality:

The primary factor in regards to Water Quality with use of dredged materials for land creation is the impacts to fish, shellfish and marine life in the low-lying areas as well as increased turbidity during the discharge of the material.

Wetland Restoration

Wetland Restoration has been a relatively common and technically feasible alternative to the use and placement of dredged material when proper sites and coordination with governmental and environmental agencies can be accomplished. Restoration of an existing wetland is generally preferred over the creation of a new wetland area since recovery of a degraded or damaged area enhances already existing soils and marine life versus the introduction of new vegetation and condition to create an entirely new site. Dredged material can be used in many ways to restore wetland. For example, the sediments can be jet sprayed in thin layers over deteriorated or marginal marsh and wetland areas as described under the Habitat Development discussion above up to an intertidal elevation. This provides much needed nutrients as well as raising the wetland elevation to a more preferred elevation conducive for growth. Dewatered dredge sludge can also be used to create wind and wave barriers to assist in protecting vegetation allowing for re-growth.

Advantages:

- Provides for the re-establishment of new vegetation in degraded wetland areas
- Eliminates need for upland containment areas
- Maintenance dredge material generally very conducive to uses in wetlands

Disadvantages:

- Wetland to be restored needs to be in close proximity to marina dredge site to be cost effective
- Can cause short-term impacts to wetland marine and benthic life
- Cannot be considered if sediments are contaminated
- Elevations of newly placed dredged material may adversely alter hydrologic characteristics needed for wetlands to be viable

Cost:

Cost for this form of dredge disposal can range from $3-5 per cubic yard excluding mobilization and dependent on close proximity to dredge site.

Water Quality:

Issues relating to Water Quality for this method of disposal center on the impacts to wetland marine and benthic life during the placement of the material.

Upland Confined Disposal:

Upland Confined Disposal Facilities are upland areas isolated by either earthen berms or structural walls. This method is the most widely used procedure for the handling of dredged sediments. The material can be placed in the disposal area by either hydraulic or mechanical dredging. The perimeter dike configuration and height is determined by the significant amounts of water discharged along with the material excavated. The dike system provides a settling basin allowing for the consolidation of the material with the resulting effluent returned back to the receiving stream via weir structures strategically positioned in the containment berm. In most cases the location of the upland disposal areas are situated along rivers and waterways making them accessible to dredging operations. Other than specific on-site disposal sites at marina facilities most upland disposal areas are owned by either large industrial facilities or governmental agencies such as the Department of Transportation or the U. S. Army Corps of Engineers. In recent years due to the increased amount of dredging being performed both privately and through the Corps for navigation purposes many of the disposal areas have reached their capacity to accept additional dredged sediments without expansion of the interior volume of the containment area. Development of new upland disposal facilities require significant investment in land acquisition along prime waterfront sites making them generally cost prohibitive to create for dredged sediment containment.

Advantages:

- Use of an upland facility, particularly an on-site facility, provides for easily accessible disposal and monitoring and the ability to plan for future maintenance dredging operations.

- Provided the material is suitable for dike building expansion, placement of the material in this system can be beneficial in the long term maintenance of the facility
- Upland facilities are typically utilized be nesting birds and animals creating a natural habitat

Disadvantages:

- Many private dredging projects are restricted from using government controlled upland disposal sites in order to preserve their capacity for large scale federal and state dredging operations
- On-site private disposal sites require valuable property adjacent to the water and are unsightly for residential developments nearby.
- Monitoring of the effluent discharge must be programmed into the dredging budgets

Costs:

Cost for disposal into an upland facility is largely dependent on the ownership of the site. If owned by the marina the costs are negligible relative to the actual dredging costs. If permission can be obtained to use other upland sites owned by others, the hydraulic dredging work with discharge into these sites can range from $4 to $6 per cubic yard excluding mobilization. Mechanical Dredging would range from $10 to $20 per cubic yard.

Water Quality:

Issues on water quality would center on the proper control of the effluent discharge back into the receiving stream and monitoring of turbidity.

Disposal of Contaminated Soils:

Some dredged materials may be unsuitable for open disposal due to the presence of potential contaminant effects on benthic organisms. In may cases, if contaminants in the sediments are determined to be present, the disposal of the material is limited to either direct placement into an approved landfill suitable for handling the material or open water disposal along with a capping material of clean sand. In an open water disposal capping would be performed by the controlled accurate placement of the contaminated material followed by a cap of clean isolating material. Disposal in this manner requires the use of appropriate equipment and placement techniques so that the exposure of the material being capped prior to placement of the covering deposit is minimized. The density and rate of application of the covering material must be controlled to avoid displacement and/or mixing of the previously placed contaminant material. Compatibility between the equipment and placement technique for the contaminated and covering materials and the accuracy and control of the equipment during placement are essential for the success of the operation.

SECTION IV
SUMMARY

As dredging needs continue to increase for the State's coastal marinas, available upland confined disposal sites continue to reach their maximum containment capacity. The search for technologically efficient and cost effective solutions to the sediment disposal has become a management and permitting challenge for marina facilities and regulatory agencies. Consideration of beneficial uses of dredged material as well as environmental concerns, operational constraints, and cost all factor into the decision making process in determining the best method and application for solving the maintenance dredging needs on the coast.

In recent years the use of dredged materials for habitat development, wetland restoration, land creation, beach renourishment and many others have become attractive alternatives to the more previously utilized upland disposal areas. Many marina owners will need to individually assess the viability of these alternatives based on their facility's location, dredged quantities, frequency required and budgetary constraints and the specific properties of the material in order to develop a management strategy for their maintenance programs.