Review of the Potential Effects of Thin-layer Placement of Dredged Sediment in Mobile Bay

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Introduction

In response to recent public concerns about disposal of dredged material in Mobile Bay, Thompson Engineering, Inc. has compiled information regarding the U.S. Army Corps of Engineers, Mobile District's sediment management program for Harbor expansion and maintenance, including in-Bay placement of dredged material. This report provides information on past and future disposal of dredged material in the Bay, a brief review of the water column effects of sediment resuspension due to dredging and open-water disposal, and the potential effects of disposal-related disturbance on the estuarine benthic ecosystem.

History of Open Water Placement of Dredged Material in Mobile Bay

From the late 19th century until the 1980s, sediment dredged from the Mobile Bay Channel was placed in open waters of Mobile Bay. The dredged material was typically mounded on the bay bottom next the channel, in some areas to heights above the waterline. The dredge spoil mounds modified bay circulation patterns, exacerbated episodic low dissolved oxygen events, and reduced estuarine mixing (May, 1973; Schroeder and Lysinger, 1979; Osterman and Smith, 2012). The Water Resources Development Act (WRDA) of 1986 authorization for the Mobile Harbor Project required all dredged material be disposed of in open-water in the Gulf of Mexico, removing sediments discharged naturally into the bay system. The 1994 and 1996 WRDA authorizations subsequently included language allowing a thin-layer placement (TLP) option of suitable material in open water within the bay, near the channel.

In May 2019, USACE, Mobile District prepared the Mobile Harbor Integrated General Reevaluation Report with Supplemental Environmental Impact Statement (GRR/SEIS), which was approved with a Record of Decision (ROD) signed in September 2019. Among the dredged material management alternatives evaluated in the GRR/SEIS, the plan included open water placement along the Mobile Bay Channel and at relic shell mining areas northeast of Gaillard Island. These areas were evaluated in an effort to determine if capacity exists for future maintenance dredging events. The analysis determined that adequate capacity exists to support the in-water placement of material dredged during maintenance from the Bay Channel over the next 20 years.

The USACE estimates maintenance dredging to generate ~5.5 million cubic yards (mcy) of sediment annually, which would be placed at the Mobile Offshore Dredged Material Disposal Site (ODMDS), open bay thin-layer disposal areas, the Sand Island Beneficial Use Area (SIBUA), Blakely Island, and Gaillard Island. The National Marine Fisheries Service, Habitat Conservation Division (NMFS) was involved as a cooperating agency early in the assessment of beneficial use in Mobile Harbor. NMFS agreed with USACE's determination in the GRR/SEIS that the harbor maintenance actions are designed in such a way as to not have an adverse effect on essential fish habitat (EFH) or federally managed fishery species in Mobile Bay and surrounding waters.

At the time of the 2019 Final GRR/SEIS and ROD, some of the channel maintenance portion of the dredged material was already being placed in the open water areas of the bay. The Mobile Harbor Interagency Working Group (IWG) collaborated from 2012 to 2014 on sediment management and beneficial use of dredged sediments. Agencies participating in the IWG included the following:

- Alabama State Port Authority
- U.S. Army Corps of Engineers, Mobile District
- U.S. Army Corps of Engineers, Engineer Research and Development Center
- Alabama Dept. of Environmental Management
- Alabama Dept. of Conservation and Natural Resources, State Lands Division
- ADCNR, Marine Resources Division

- Geological Survey of Alabama
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service, Habitat Conservation Division

The IWG considered TLP through a series of meetings in 2012, and subsequently TLP was approved for management of dredged material for emergencies. The IWG had concerns regarding material behavior upon placement, so monitoring and modeling programs were established to evaluate short- and long-term dispersion and impacts of in-bay thin layer placement. A program to monitor the reestablishment of benthic organisms in the placement areas was also implemented (USACE, 2014, Parson et al., 2015). A large pipeline dredge was used to clear the upper bay channel, removing approximately 9 mcy of material which was discharged to the historic open water placement areas in a thin-layer not greater than 12 inches. The material was placed using a spill barge outfitted with continuous GPS tracking system and a diffuser or baffle plate to spread the material. The spill barge utilizes a system of winches, which constantly move the barge in a sweeping pattern to prevent material from exceeding the thin-layer tolerance (USACE, 2014).

The monitoring and modeling efforts for the 2012 TLP event were conducted by the USACE Engineer Research and Development Center. Adverse results of the TLP were not found and potential effects on EFH associated with dredging and material placement activities were determined to be temporary in nature. TLP in open water was determined to be an environmentally acceptable option for the management of maintenance dredged material from the Mobile Bay navigation channel. This method allows sufficient time for benthic recovery and permits the bottom elevations to return to that of the adjacent bottom as the placed sediment is remobilized within the Bay's natural sediment transport system. Upon the results of the monitoring and modeling efforts long-term in-bay thin layer placement was approved in 2014. That year, 1 mcy of dredged material was placed in a thin layer in-bay.

Effects of Sediment Resuspension in the Open Water Environment

Water quality is temporarily affected by suspended solids and turbidity caused by dredging and open-water disposal. Dredging and side-casting the sediments increases suspended solids and turbidity over the bottom. Turbidity may undergo dispersion in a plume that drifts with water currents, until suspended sediments from dredging settle. The extent of suspension/dispersion depends on the type of dredging equipment, techniques for operating the equipment, sediment composition, and sediment transport processes influenced by prevailing hydrodynamic regime. Biological responses to turbidity depend on all of these physical factors coupled with the types of organisms and their distributions in space and time.

Much attention has been given to turbidity effects from dredging in estuaries, embayments, and enclosed waters (e.g., Peddicord and McFarland, 1978; Stern and Stickle, 1978; LaSalle et al., 1991; Wilber and Clarke, 2001). Turbidity from dredging can elicit a variety of benthic responses primarily because attributes of the physical environment are affected (Wilber and Clarke, 2001). Large quantities of bottom material placed in suspension decrease light penetration and change the proportion of wavelengths of light reaching the bottom, leading to decreases in photosynthesis and primary productivity of benthic algae and submerged grasses. Turbidity can affect food availability for benthic organisms, by interfering with food gathering processes of filter feeders through inundation with nonnutritive particles. Turbidity also may inhibit feeding by organisms that forage by sight. Other biological responses to turbidity include reduced hatching success, slowed growth, abnormal development, tissue abrasion, and increased mortality (Wilber and Clarke, 2001). In general, egg and larval stages are more sensitive to turbidity effects than older life stages.

Suspension and dispersion of sediments may cause changes in sediment and water chemistry as nutrients and other substances are released from the substratum and dissolved during dredging. Dredging may produce localized hypoxia or anoxia in the water column due to increased oxygen consumption caused by suspended sediments (LaSalle et al., 1991). Adverse environmental effects of temporary increases in turbidity and suspended sediments are typically brief and minor, particularly within the context of natural increases in suspended solids. Wind-induced waves and storms have a significant impact on resuspension and redistribution of sediments and shoreline changes in Mobile Bay (Schroeder et al. 1998, Byrnes et al. 2013), and natural communities are adapted to such conditions. During open water TLP of channel maintenance sediments, adherence to ADEM water quality standards would minimize potential adverse effects on water quality.

Community Dynamics of Estuarine Benthos and Response to Benthic Disturbance

Side-cast dredged sediments has potential to bury benthic macroinvertebrates in the placement area, alter local bathymetry, and potentially change surficial sediment characteristics, which may influence benthic recolonization. Open water placement of dredged material can physically damage benthic organisms, resulting in burial, stress, sublethal injury, or death. Richardson et al. (1977) and Bingham (1978) found that the effects of dredged material disposal on benthos probably were related to direct burial of benthos and changes in sediment characteristics, rather than increased turbidity from disposal operations or introduction of pollutants or organic matter. Deposition of sediment can bury and suffocate benthic fauna, although some organisms are able to migrate vertically to the new substratum surface (Mauer et al., 1978; Maurer et al., 1986). Any organism in the direct path of the disposal material will be subject to burial, and the effects will depend on the nature of the disposal material, its rate of accumulation, and the burrowing capabilities of the individual species. Various benthic organisms that inhabit soft sediments are not affected equally by sediment deposition and overburden (Canter et al., 1977; Richardson et al., 1977). Many animals adapt by burrowing, closing valves, or developing a tolerance to sediment stress.

Studies of dredged material disposal in open water have found that benthic recolonization usually begins soon after sediment placement (Diaz and Boesch, 1977; Van Dolah et al., 1984; Wilbur and Clarke, 1998). In Mobile Bay, alteration of bay bottom due to placement of dredged material excavated from navigation channels has been shown to result in only temporary loss of biological production, as the deposited sediments quickly become populated by a variety of benthic organisms (Clarke and Miller-Way, 1992). Investigations of open-water disposal have found that the opportunistic nature of local benthic macrofauna may buffer impacts of such operations (Diaz and Boesch, 1977; Van Dolah et al., 1984).

Community structure of subtidal sediments is controlled primarily by benthic disturbances and physical stresses (Probert, 1984; Thrush et al., 1996). Resiliency of invertebrate assemblages in subtidal sediments is due primarily to the life histories and behaviors inherent in the benthic populations (Newell et al., 1998; Posey and Alphin, 2002). Opportunistic benthic species are continually present in most estuarine environments (Diaz and Boesch, 1977; Holland, 1985; Dauer, 1993). Because of frequent perturbations, estuarine benthic invertebrates tend to be small bodied, short lived, and adapted for maximum rate of population increase with high fecundity, efficient dispersal mechanisms, dense settlement, and rapid growth rates (MacArthur, 1960; MacArthur and Wilson, 1967; Odum, 1969; Pianka, 1970; Grassle and Grassle, 1974). Rates of recolonization have been measured in studies of disturbed soft bottom habitats (Oliver et al., 1977; Van Dolah et al., 1984; Lewis et al., 2002) and in studies using defaunated sediment (McCall, 1977; Simon and Dauer, 1977; Rhoads et al., 1978; Santos and Simon, 1980). These studies showed that recolonization of sediments generally occurs very rapidly, and that infaunal community characteristics of recolonized sediments, such as abundance, diversity, and evenness, are often comparable to that of nearby non-impacted areas within a relatively short period of time.

Mobile Bay is a frequently perturbed system that supports populations of opportunistic species adapted to fluctuating salinity, muddy sediments, and episodic hypoxia and anoxia. The most likely initial colonizers of TLP sediments include polychaetes such as *Mediomastus* spp., *Nereis succinea*, *Paraprionospio pinnata*, and *Streblospio benedicti* (Grassle and Grassle, 1974; Boesch et al., 1976; Boesch, 1977; McCall, 1977; Dauer, 1993), which are among the numerical dominants in the project area (Dauphin Island Sea Lab, 1982;

Shaw et al., 1982; Ruth et al., 1994). Because most species possess a two-phase life cycle consisting of a sedentary benthic phase and a dispersive planktonic phase capable of moving away from the natal area, there are always potential colonists available in the local and regional species pool. Nonplanktonic immigrants from nearby habitats may also recolonize disturbed areas, and post-settlement dispersal is potentially important in the benthic recovery process (Van Dolah et al., 1984; Cummings et al., 1995; Whitlatch et al., 1998). In addition to larval recruitment, in-migration of post-settlement juvenile stages can have important effects on the population dynamics of disturbed areas (Whitlatch et al., 1998; Stocks, 2002). Because many estuarine infaunal populations are naturally resilient (Van Dolah et al., 1984; Holland, 1985), impacts of dredging and introduced dredged material in many cases may be short-lived or not apparent. The nature of benthic recolonization of TLP sediment will depend in large measure on hydrodynamic flow along the bay bottom, over scales of days to months.

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