ISSUES AND CONFLICTS RELATED TO THE BENEFICIAL REUSE OF CONTAMINATED DREDGED MATERIAL IN CALIFORNIA, USA

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ABSTRACT

State and federal policies promote the reuse of dredged material to the extent practicable. However, the current regulatory structure addresses only the disposal or reuse of clean material in an unconfined aquatic environment and provides little or no direction on alternative disposal or reuse options. Under the current system, dredged material is classified as either suitable for unconfined aquatic disposal (SUAD) or not suitable for unconfined aquatic disposal (NUAD). Depending on the concentration of the contaminants, NUAD material can be suitable for an array of beneficial uses as long as the materials are managed appropriately. Unfortunately, the regulatory and permitting scheme presently in place offers no effective mechanism for evaluating materials for confined aquatic disposal and upland disposal or reuse. Further, dredged material, once determined to be NUAD, is often stigmatized in the public eye.

Even with these difficulties, several projects in California have demonstrated the beneficial reuse of NUAD material. The Ports of Oakland, San Francisco and Los Angeles have successfully used NUAD material to create habitat, construct public facilities, and cover landfills. These projects have incorporated material from both maintenance and new work dredging projects. In addition, private businesses and state funded programs have begun trying to identify a broader range of reuse options for NUAD material. The authors compare and contrast five completed or proposed reuse projects and examine the regulatory hurdles encountered, the overall success of each project, political considerations, cost and the resolution of technical issues.

KEYWORDS

Aquatic; California; contaminated; disposal; dredging; habitat; landfill; port.

INTRODUCTION

In California, dredging and the disposal of dredged material are regulated under a multitude of state laws, federal laws and an international treaty. In some cases, the provisions of federal and state laws overlap and contradict each other, complicating the permitting process for dredging projects. Most of the existing laws are based on an underlying presumption that dredged material will be disposed of in an unconfined aquatic environment. Thus, the laws are designed to assure that dredging and disposal operations result in the least possible adverse impact on the aquatic environment. There are no laws that directly address the disposal of dredged material in a confined aquatic disposal site or on land. The terrestrial disposal of dredged material is regulated under a set of state and federal laws that were designed to address solid waste, hazardous waste and contaminated soil and groundwater remediation, not dredged material disposal. The following is a brief discussion of the most significant laws that apply to dredging and the disposal of dredged material in the aquatic and terrestrial environments.

International Treaty

On August 30, 1975, the United States and other participating nations ratified an international agreement on ocean disposal of dredged material developed by the *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters (26 UST 2403: TIAS 8165), also known as the London Dumping Convention (LDC)*. The United States has incorporated the criteria of the LDC into its Marine Protection, Research and Sanctuaries Act

(MPRSA) of 1972.

Federal Laws Governing Unconfined Aquatic Disposal

The Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972 (commonly referred to as the Ocean Dumping Act) (33 U.S.C. 1401 et seq.) regulates the transportation of dredged material for ocean disposal. MPRSA requires that all dredged material proposed for ocean disposal be evaluated in compliance with the U.S. Environmental Protection Agency's (USEPA's) *Ocean Dumping Regulations (Title 40, C.F.R. Parts 220-228)*. Under Section 103 of the MPRSA, the U.S. Army Corps of Engineers (USACOE) issues permits for ocean disposal of dredged materials. Section 102 of the MPRSA authorizes the USEPA to designate ocean dredged material disposal sites. The USEPA recently designated an ocean disposal site approximately 50 nautical miles west of San Francisco (the SF-DODS site).

The Clean Water Act (CWA) of 1972 (33 U.S.C. 1252 et seq.) governs the discharge of dredged or fill material into all waters of the United States, including adjacent wetlands. Section 404(b)(1) of the CWA give the USACOE the authority to issue permits for the disposal of dredged material into inland waterways, wetlands and territorial seas. Section 401 of the CWA requires the USACOE to obtain a water quality certification or waiver from the State Water Resources Control Board and Regional Water Quality Control Boards (SWRCB and RWQCBs) prior to issuing a Section 404(b)(1) permit.

The Rivers and Harbors Act (RHA) of 1899, Section 10, allows the USACOE to regulate obstructions to navigation within navigable waters of the United States. Generally, all dredging projects require a Section 10 permit. Normally, the USACOE includes both the requirements of Section 10 (RHA) and Section 404(b)(1) CWA in one permit document.

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 1251 et seq.) requires federal agencies to fully analyze the environmental consequences of federal projects or federal decisions and incorporate those consequences into the decision-making process. The NEPA requires the federal lead agency, which is the USACOE for most dredging projects, to prepare an Environmental Impact Statement (EIS), in which it analyzes the environmental consequences of a reasonable range of alternatives to the proposed project. The federal lead agency must solicit and respond to public comments on the EIS.

The Coastal Zone Management Act (CZMA) of 1972 and Subsequent 1990 Amendments (16 U.S.C. 1456 et seq.) provides Congressional authorization and funding for individual coastal states to develop and implement their own coastal management programs. California has established two separate state programs under the CZMA, one that includes San Francisco Bay and certain of its tributaries, and one that incorporates the remainder of the California coast. These two state programs are discussed below.

The Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.) protects special status species by disallowing federal actions that would jeopardize a protected species or its habitat. The ESA has been controversial because it gives two federal agencies, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, the power to stop a project if an endangered species or its habitat is jeopardized. Several special status species of animals, plants and fish have been identified in dredging and disposal areas in California (LTMS, April, 1996).

State Laws Governing Unconfined Aquatic Disposal

The Porter-Cologne Water Quality Control Act (Porter-Cologne Act) of 1966 (Cal. Water Code Section 13000 et seq.; Cal. Code of Reg., Title 23, Chapter 3, Chapter 15) is California's basic water quality control law. The SWRCB administers the Porter-Cologne Act at the state level, but delegates much of the responsibility for implementing the law to a series of regional boards, the RWQCBs. As discussed above in the federal CWA section, the SWRCB and the RWQCBs are responsible for granting or waiving state water quality certification for federally sponsored or permitted projects before the USACOE issues a Section 404(b)(1) permit. In addition, the Porter-Cologne Act provides the SWRCB and the RWQCBs with independent authority to regulate discharges of pollutants

into state waters.

The California Coastal Act (CCA) of 1976 (Cal. Pub. Res. Code Section 30000-30900 (originally added by Initiative Measure of November 7, 1972, as Cal. Pub. Res. Code 27000-27650)) was enacted under the federal CZMA, as discussed above. The CCA, which is administered by the California Coastal Commission (CCC), regulates development within the State's waters and along all of the California coast except San Francisco Bay. The CCC reviews and permits dredging and disposal projects located within its jurisdiction.

The McAteer-Petris Act of 1965 (Cal. Gov. Code Section 1, Title 7.2), like the CCA, was enacted under the federal CZMA. The McAteer-Petris Act, which is administered by the San Francisco Bay Conservation and Development Commission (BCDC), regulates development within and along the shores of San Francisco Bay and certain of its tributaries. BCDC reviews and permits dredging and disposal projects located within its jurisdiction.

California has enacted its own versions of both the federal ESA and the federal NEPA. *The California Environmental Quality Act (CEQA) of 1973 (Pub. Res. Code 21000-21177)* contains provisions similar to those contained in NEPA. The *California Endangered Species Act (CESA) of 1984 (Fish and Game Code Section 2050 et seq.)* provides for the protection of rare and endangered species within California. The CESA is administered by the California Department of Fish and Game. For dredging and dredged material disposal projects, either the BCDC or the CCC is responsible for assuring CEQA compliance, depending on the geographic location of the project.

Federal Laws Governing Terrestrial Disposal

The Resource Conservation and Recovery Act (RCRA) of 1976 (42 U.S.C. Section 6901 et seq.) is the federal statute that defines solid and hazardous wastes and controls their handling and disposal. The RCRA was amended significantly in 1984 by the Hazardous and Solid Waste Amendments (HSWA). The RCRA is administered on the federal level by the USEPA, but in California the responsibility for the administration of most of the RCRA has been delegated to the State. The upland disposal of dredged material, whether the material is judged to be hazardous or non-hazardous, is governed by the RCRA and the its state counterpart, the Hazardous Waste Control Law, which is described below.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)(commonly known as the "Superfund") (42 U.S.C. Section 9601 et seq.) is the federal statute that establishes a comprehensive system for responding to releases of hazardous substances. The CERCLA was amended significantly in 1986 by the Superfund Amendments and Reauthorization Act (SARA) of 1986. The CERCLA is administered by the USEPA. Historically, dredging activities generally have not fallen under the jurisdiction of the CERCLA unless the project involves the remediation of sediments from a hazardous waste site as defined in the CERCLA's implementing regulations.

The Toxic Substances Control Act (TSCA) of 1976 (15 U.S.C. Section 2601 et seq.) is a federal law that contains specific prohibitions on the manufacture, use, distribution and disposal of polychlorinated biphenyls (PCBs). Dredged material that contains high levels of PCBs may fall under the jurisdiction of the TSCA. The TSCA is administered by the USEPA.

State Laws Governing Terrestrial Disposal

The Hazardous Waste Control Law (HWCL) of 1982 (Cal. Health and Safety Code Section 25100-25250.25) establishes a comprehensive scheme for regulating hazardous waste in California. It is interesting to note that for some constituents, the HWCL establishes lower thresholds for the identification of hazardous wastes than do the federal laws, the RCRA and the CERCLA. The HWCL is administered by the State Department of Toxic Substances Control (DTSC).

The provisions of the State's Porter-Cologne Act, described above, also apply to terrestrial disposal operations. The RWQCBs implement the provisions of the Porter-Cologne Act through the issuance of Waste Discharge Requirements (WDRs). WDRs, which set conditions for the discharge of wastes, are based upon the water quality

objectives set forth in the Basin Plans that the RWQCBs have developed for each region. Each Basin Plan sets narrative and numerical objectives that must be attained or maintained to protect the beneficial uses of the State's waters, including groundwater (Lyons, M. J., April, 1997). Basin Plan requirements differ from region to region, which has resulted in some inconsistencies in the State's water pollution control policies. For example, the San Francisco Bay RWQCB and the Los Angeles RWQCB view the potential impacts of terrestrial disposal of dredged materials very differently. The San Francisco Bay RWQCB promotes the beneficial reuse of NUAD dredged material for liner and daily cover at landfills, while the Los Angeles RWQCB discourages the use of all dredged material in landfills, citing concerns about potential salinity impacts to groundwater.

Operations and Authority

All of the large ports in California are non-operating ports. Non-operating ports lease space to shipping lines, stevedoring services and other tenants who operate the terminals. The ports are essentially landlords. The terms of the lease agreements between each port authority and its tenants can vary greatly. For example, the Port of Oakland's leasing policy allows for a range of uses and financing options, from temporary or short-term use to long-term, tenant-financed terminal development projects. Some ports require tenants to reimburse them for the cost of maintenance dredging, while others may subsidize the cost of maintenance dredging to varying degrees. The responsibility for financing new work dredging projects is determined on a case-by-case basis, but typically the tenant pays for modifications to the berths and the port (along with the federal government) takes responsibility for modifications to navigable channels. Since they are the property owners, all ports in California manage dredging projects and are responsible for regulatory compliance and permitting.

State Tidelands Trust

The public trust is a paramount public property right held in trust by the State for the benefit of the public. The public trust doctrine applies to lands that are, or once were, part of the public domain (Jones, 1989). The purpose of the public trust is to assure that the lands to which it pertains are kept for trust uses, which include water-borne commerce, navigation, fisheries, wildlife habitat, recreation and open space (BCDC, 1969). The land and water areas held by ports in California are, with few exceptions, subject to the public trust. Many port lands are composed of former open water areas that were filled to create upland, and the former tidelands remain subject to the public trust after they are filled, hence the term "tidelands trust." The State Lands Commission is responsible for managing the public trust. The enactment of the McAteer-Petris Act and the CCA can be viewed as an exercise of the California Legislature's authority over public trust lands (BCDC, 1969). In California, the existence of the public trust on port lands limits the uses to which ports can put these lands, and prevents ports from transferring the lands out of public ownership. The extent to which a state subject to the public trust doctrine can alienate trust lands is a question of state law and therefore differs from state to state (Jones, 1989).

Municipal Entities

Ports in California function either as part of the municipality in which they are located or as related but autonomous municipal entities. Non-autonomous ports are overseen and managed by municipal governments (mayors and city councils). Autonomously operated ports answer to the port executive management and a board of port directors, appointed by the mayor. Often municipalities use ports as revenue sources to support non-port-related activities. Ports that operate under the authority of the tidelands trust are bound by law to use all revenue generated by the port for maritime-related activities.

DETERMINING SUITABILITY OF DREDGED MATERIAL FOR DISPOSAL OR REUSE

The Current Sediment Testing Program

As previously described, the requirements for dredged material testing and management are determined based on the proposed disposal location. Material proposed for ocean disposal is regulated under Section 404(b)(1) of the

CWA and Sections 102 and 103 of the MPRSA. The requirements for sediment testing for ocean disposal can be found in the joint Environmental Protection Agency (USEPA)/U.S. Army Corps of Engineers (USACOE) ocean disposal testing manual, titled *Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual*, also known as the Green Book (USEPA and USACOE, 1991). The requirements for sediment testing for disposal at aquatic sites within San Francisco Bay are set forth in an interim guidance document known as *USACOE Public Notice 93-2* (PN 93-2) (USEPA, USACOE, BCDC, and San Francisco RWQCB, February, 1993). It is important to note that testing conducted under the Green Book and PN 93-2 is used to determine suitability for aquatic disposal only.

Both the Green Book and PN 93-2 evaluate the risk of adverse impacts from disposal of sediments directly on biological receptors using bioassay tests with appropriately sensitive organisms. The tests compare organism survival rates in the sediments to be dredged to survival rates in sediments from a reference site, hence the terms "effects-based" and "reference-based" testing. The system is "tiered" in the sense that higher tiers of testing, which involve more detailed tests and greater expense, are required only when a lower tier did not provide adequate information on which to base a decision (LTMS, April, 1996). There are four tiers which include various levels of sediment chemistry, toxicity testing, bioaccumulation evaluations and special studies.

In addition to the federal requirements, the State can set regulations governing dredged material testing and disposal within state waters. In California, the Porter-Cologne Act authorizes the SWRCB and the RWQCBs to set testing standards for dredging projects. The federal government has developed, but not finalized, "standardized" testing protocols for projects that require Section 401 CWA certification from the state for use by those states that have not accepted responsibility for the testing program. In addition, the federal protocols, commonly known as the Gold Book, set a minimum standard for state testing programs. The Gold Book is closely modeled on the Green Book, with several modifications. Material is determined to be either SUAD or NUAD as a result of these tests. Additional testing is usually required for upland disposal or reuse.

Lack of Regulatory Guidance in Reuse Projects

Although the government supports dredged material reuse in the broad sense, neither the federal government nor the state government has established regulations to promote dredged material reuse. As a result, different regions in California have established different reuse goals for dredged sediment. In southern California, regulators encourage beach replenishment, whereas in northern California, regulators encourage tidal wetland restoration (LTMS, April, 1996). There are no clear testing guidelines or quality criteria for the reuse of dredged material in these "encouraged" projects. Because SUAD material must meet the stringent testing requirements discussed above, most regulatory agencies agree that SUAD material is suitable for a variety of alternative uses, including habitat creation and beach replenishment.

In contrast, material that has been classified as NUAD through the Section 404(b)(1) CWA testing guidelines is rarely recommended for uses beyond landfill construction. Because NUAD material typically exhibits very low levels of contamination, it usually presents a very low risk to human health and the environment (LTMS, April, 1996). The material potentially could be used in many other ways. Unfortunately, the existing sediment testing programs are designed to determine only whether material is suitable for unconfined aquatic disposal, and do not address the broader issue of the risks associated with the reuse of NUAD material. Once material is classified as NUAD, a project proponent must look to the laws that apply to solid waste disposal, hazardous waste disposal and groundwater remediation.

NUAD material proposed for reuse is often subject to extensive testing and engineering design requirements, adding cost and complication to reuse projects involving NUAD material. Such conservative decision-making is driven by the following factors:

1. Agency mandates to protect the public;
2. The degree of uncertainty present in the science of toxicology;
3. Lack of supporting laws and regulations;
4. Lack of local experience with the proposed reuse, and;

5. Public perception.

The classification of dredged material as NUAD often inflames public concerns over reuse projects. Project proponents are then obligated to address the fears of both the general public and those of the regulatory agencies, which can result in added costs and delays.

ENVIRONMENTAL RISKS AND THE REUSE OF NUAD MATERIAL

NUAD material may be suitable for reuse in areas with limited exposure or in areas of low environmental sensitivity. Unfortunately, the existing regulatory framework offers little guidance on evaluating the environmental risks associated with such uses. Currently in California, only the "interim" guidance document published by the San Francisco Bay RWQCB (Carlin and Wolfenden, 1992) addresses this issue. This guidance relates only to the reuse of dredged material for tidal wetlands creation. Based on bulk sediment chemistry only, the interim guidance separates dredged material into "cover material," which can be placed on the top three feet of the created wetlands, and "non-cover" material," which must be placed three feet below the surface of the created wetland. While the RWQCB guidance document represents a positive step because it promotes the reuse of dredged material, its approach is simplistic in that it does not address the engineering of the wetlands site, the leachability of contaminants or the water regime (fresh, salt or brackish wetland), all of which can affect the ultimate availability of contaminants.

There have been other attempts to formalize risk-based sediment screening criteria (SSC) within the United States, but few states have adopted SSC. The USEPA proposed a nation-wide SSC for a few hydrocarbons (polycyclic aromatic hydrocarbons or PAHs) and published the SSC as draft guidelines. The draft guidelines proved controversial, and the USEPA has withdrawn them. In the Puget Sound area of Washington, USA, regional agencies have developed SSC based on a database of chemical concentrations and biological effects. Although the Washington SSC are used to determine suitability for aquatic disposal or the need for additional testing, the Washington SSC are also used to determine suitability for reuses.

Local agencies, academics, consultants and federal agencies have all attempted to produce SSC. The most noteworthy of these are the criteria known as the "Effects Range Low (ERLs) and Effects Range Median (ERMs), developed by the National Oceanographic and Atmospheric Administration (NOAA) (Long and Morgan, 1990). The ERLs and ERMs are generally accepted as useful only as a screening tool to determine a conservative threshold below which no biological effects would be expected. The numbers were generated as a basis for comparison for a national survey of sediment quality (Hoffman, Anderson and Knezovich, 1994). The ERLs and ERMs were not intended to be used as a screening criteria, but some regulators, desperate for an "off-the-shelf" approach to suitability determinations, have used ERMs and ERLs to determine suitability of dredged material for reuse or disposal. Although a project sponsor can dispute the application of the ERLs and ERMs using high resolution testing, such a dispute can delay projects and add cost.

HUMAN HEALTH RISK IN RELATIONSHIP TO ENVIRONMENTAL RISK

Regulatory agencies commonly use risk assessments to evaluate the potential risks to human health and the environment from land-based contaminants in land-based remediation projects. Although it seems logical to extend this risk-based approach to the evaluation of dredged material disposal projects, risk assessments for dredging disposal project are uncommon, and present some unique challenges. First, dredging regulators may be unfamiliar with the assumptions and concepts underlying risk-based analysis. Second, as previously discussed, dredging disposal projects often engender considerable public controversy. Although contaminant levels in dredged material are usually orders of magnitude below regulatory action levels (for example, the Preliminary Remediation Goals or PRGs established by the USEPA) for the reuse of contaminated soil, dredged material often is nevertheless identified as presenting an unacceptable risk to the community (Smucker, 1995). Finally, it is difficult for the public to understand that, in some cases, contaminant concentrations that are toxic to marine organisms present no human health risks.

Despite these challenges, decisions about reuse should be based on the risk to human health and the environment. Most of the concern raised by the reuse of dredged material is based on cancer risk. California requires the agencies to protect the public from cancer risk exceeding $1x10^{-6}$. USEPA guidelines have set the range at $1x10^{-6}$ to $1x10^{-4}$ increased cancer risk. Despite the lack of consensus amongst regulators about what constitutes a cancer risk, the evaluation of carcinogenic compounds tends to drive the decision making process as it relates to potential human health effects. Non-carcinogenic compounds in dredged material rarely present human health concerns.

PUBLIC PERSPECTIVE

Even reuse projects that involve "clean" SUAD sediments can raise public concern. The current movement toward increased reliance on upland disposal and reuse is at least partly based on the public's view that even clean materials pose a human health or environmental risk. The public concern holds true for the entire state, from San Diego Bay to the Oregon border. In truth, these concerns and issues are national in scope.

In the popular media, dredging has been implicated in the decline of fish stocks, degradation of water quality and loading of contaminants in fish tissues. Despite the fact that current research does not support and in fact refutes some of these claims, such claims resurface again and again (LTMS, April, 1996). It is interesting to note that the disposal options endorsed by the public are often located away from populated areas (i.e. "Not in my backyard" or NIMBY). This scenario is especially prevalent in lower income areas, where people in some cases have borne a disproportionate burden of environmental impacts in general, often without a net benefit to their communities. Such communities are naturally skeptical of risk assessments provided by individuals who do not reside in their community. Therefore, the proponent of dredged material reuse bears the responsibility for providing adequate information to affected communities, and such communication is a vital and integral part of any NUAD reuse project.

PRACTICAL PROBLEMS WITH REUSE

Testing for Different Environments

At present, landfill disposal is often the only viable disposal alternative for NUAD material. Landfills charge a fee for disposal (or tipping fee) per ton of material disposed. Landfills in California are specifically designed to accept certain types of wastes. The type of waste the landfill can accept is based on the design of the landfill. Although liners are now required in all landfills in California to prevent groundwater contamination and collect leachate, this was not always the case.

Some older landfills are unlined and therefore can accept only contaminated dredged materials or soils with non-leachable contaminants (Class III). Other landfills were designed to accommodate waste designated as hazardous under California law, but not federal law (Class II). In general, California's definition of hazardous waste is more strict, and therefore more inclusive, than the federal definition. Finally, a few landfills in California are designed to accommodate all wastes including federally-designated hazardous wastes, the most highly contaminated class of waste (Class I). The tipping fee is dependent on the landfill's design, the extent of material management required, and the volume of material. The tipping fee alone (exclusive of transportation costs) for disposal can range from approximately $5.00 per ton in unlined landfills, to $60.00 per ton for lined landfills, to a high of $180.00 per ton in hazardous waste landfills (U.S. dollars).

Dredgers must address the following key questions when planning a landfill disposal project:

1. How contaminated is the material and what type of landfill will accept it?
2. How much room is available to dry the material?
3. Does the timing of the project allow for batch drying, or are active measures required?
4. How far must the material be trucked?

At present, landfill disposal is often the only viable disposal option for some material, despite its costs. However, if NUAD material can be used to meet a specific need in a specific project, the cost for reuse can drop substantially below the landfill disposal rates, making the reuse of NUAD material more cost-effective and potentially making the reuse of SUAD material an economically feasible alternative to aquatic disposal. Unfortunately, the timing of dredging projects often makes the reuse of NUAD material difficult.

Timing

Finding a reuse for NUAD material depends on the timing and practicality of the reuse. For example, some NUAD material may be suitable as base material for road construction. However, road construction projects typically involve years of advance planning and engineering design, and materials are specified far in advance of the start of construction. Since dredging projects usually require only six months to one year of advance planning, there is no guarantee that the dredged material available during the planning stages of a road construction project will be available at the start of construction. Such a reuse project would require a high level of coordination. Stockpiling dredged material for later use could help solve the timing problem, but most port areas lack sufficient space for stockpiling. For these reasons, dredged material is not often used in another party's construction project.

Dredging projects that involve the construction of maritime terminal facilities have the highest probability of accommodating the reuse of NUAD materials. In such a project, the advance planning required for dredged material reuse is incorporated into the overall project planning effort, which can raise the probability of success. However, even when the reuse of NUAD material is considered an integral part of the project, engineering issues can become stumbling blocks.

Engineering

Dredged material, which is composed of a mix of sand, clay and silt in varying percentages, acts as a sink for contaminants. Through physical bonding, chemical bonding and co-precipitation, the clays and silts hold contaminants, particularly organic contaminants, to a greater degree than does sand. Material high in silts and clays is also the most difficult material to use in construction projects. California is seismically active. Clays and silts deform easily, making construction of load-bearing surfaces (such as a modern stacked-cargo container terminal) problematic. Clays and silts can be used for construction in seismic zones for load-bearing if the material is mixed with sands or other material to add strength. Such mixing can be costly, however.

Technological Solutions

There are two general classes of technological solutions available for NUAD materials. These consist of processes that improve the construction properties of the material and processes that reduce contaminants or contaminant availability. In some instances, both goals can be achieved using the same process.

Commonly used processes to improve engineering qualities of soil are now being adapted to the specific needs of dredging projects. For example, mixing of one or two percent Portland Cement and sodium silica can speed the drying process and improve the structural qualities of NUAD material that consist of greater than 90 percent silts and clays. This process may also bind soluble contaminants and reduce the environmental risk of reuse. Ports and regulatory agencies have begun to closely examine the use of Portland Cement, sodium silica, lime and other additives in dredged material

In general, the use of sediment remediation technologies has been limited to highly contaminated sediments. Most available remediation methods will effectively lower high concentrations of contaminants in dredged material. However, most of the material dredged in California contains only low levels of contaminants, and remediation to lower levels can be extremely time-consuming and costly. Since the agencies have set conservative contaminant thresholds for remediation projects in general, it would be difficult to decrease concentrations below levels of concern. The agencies are also reluctant to allow the reuse of treated materials.

Liability

The reuse of NUAD material presents liability issues. Although most NUAD material falls below the threshold levels for hazardous waste, dredgers can incur liability when disposing of material in landfills or reusing material. If the NUAD material is mixed with hazardous waste at the landfill or any site, state and federal laws hold that the mixture of a hazardous waste with a non-hazardous results in a hazardous waste for which any contributor to that mixture could be held liable. This is a serious issue for both the generator of the waste and the recipient of the waste and is a great disincentive in the development of dredged material reuse projects. In addition, the federal CERCLA incorporates by reference an array of lists of chemicals of concern, some of which contain no threshold limits. Thus, liability under the CERCLA may extend to material with trace amounts of one of these listed substances, even though contaminant concentrations do not exceed any of the commonly-used hazardous waste criteria.

SUCCESSFUL PROJECTS

Despite complicated and sometimes inconsistent regulatory guidance, public concern about contamination, engineering issues and liability concerns, several ports within California have successfully reused dredged materials. Each project is unique, and each demonstrates a slightly different approach to the problems associated with dredged material reuse.

FUTURE PROJECTS AND INITIATIVES

Port of Oakland Shallow Water Habitat

The Port of Oakland currently plans to deepen its channels and berths to -50 feet mean lower low water (MLLW) and construct six new modern container terminals ("The 50-Foot Deepening Project"). In order to accomplish this, the Port plans to dredge 20,000,000 cubic yards of material. The Port of Oakland hopes to reuse the entire volume. The Port of Oakland is coordinating its efforts with numerous agencies and environmental advocates to ensure that the entire project receives timely approvals. The proposed project includes the creation of 180 acres of shallow water habitat from existing deep dredged channels. These channels and berths are being granted to the Port of Oakland from the U.S. Navy as part of the national military base closure process.

The shallow water habitat enhancement project will require as much as 10,000,000 cubic yards of material to convert the -40 foot channels to -5 foot to -6 foot shallow water habitat. The Port of Oakland expects that most of the material that will be placed in the habitat area will be SUAD material, composed of clean sand obtained below the depth of previous dredging. Plans include reef structures, sand flats, mud flats and eel grass beds. The habitat will improve fishing and provide foraging habitat for California least terns and, perhaps, other scarce species and resources.

The Port of Oakland is also pursuing the idea of incorporating some NUAD material into the shallow water habitat project, thus creating a confined aquatic disposal (CAD) site. Several regulatory agencies have expressed concern about the establishment of a CAD site in this location. The Port of Oakland is also exploring the possibility of using NUAD material mixed with one percent Portland Cement and two percent sodium silica in the construction of the new container terminals.

The Port is working closely with regulatory agencies and the public to answer questions and obtain feedback on design issues raised by The 50-Foot Deepening Project. Using this open and proactive process, the Port hopes to clear all regulatory hurdles and break ground on The 50-Foot Deepening Project by 1999.

Regional Dredged Material Reuse and Rehandling Project

Most successful reuse projects involve using large quantities of dredged material for specialized projects. Dredgers

and regulators alike agree that there is also a need to identify reuse opportunities for smaller dredging projects, including maintenance dredging, dredging at marinas and dredging at small marine facilities. The dredging community, regulatory agencies and environmental groups have joined together in northern California to develop an economically viable dredged material rehandling facility for smaller projects. The regional Dredged Material Reuse and Rehandling Project is designed to study the feasibility of constructing a dredged material rehandling facility that would be available to all users in the San Francisco Bay region. The study, which has just begun and is scheduled to be completed within a year, will examine the feasibility of using fees generated from the disposal of NUAD material to subsidize the cost of developing the facility. Reuse options and business opportunities will be sought for both NUAD and SUAD material. The goal is to construct the facility within two years.

COMPLETED PROJECTS

Port of Los Angeles Shallow Water Habitat

In order to expand its maritime facilities, the Port of Los Angeles has embarked on the largest dredging and filling project in the USA. The "2020 Development Project," which will be constructed in phases, will result in the dredging of over 50 million cubic yards of material and the creation of over 600 acres of new land in Los Angeles Harbor (The Resources Agency, March, 1997). Construction of the project began in late 1994. As part of the environmental mitigation for the project, the Port of Los Angeles agreed to create a shallow water habitat to serve as a foraging area for a nearby colony of California least terns. Least terns are listed as endangered under both the federal and state ESAs.

The least tern mitigation project involves decreasing the water depth in the habitat area from the existing depth of -40 feet MLLW to -10 to -15 feet MLLW. Sand will be used to top the habitat to reflect light (to enhance tern foraging) and to promote the growth of eel grass. To decrease the water depth, many millions of cubic yards of sediment are required, a requirement that strained the ability of the project contractor to provide enough sediment for both the landfill and the habitat.

At the time that the least tern project was under development, over 450,000 cubic yards of dredged material in Los Angeles Harbor were determined to be unsuitable for unconfined ocean disposal. Based on the need identified in the least tern project, the Port of Los Angeles was able to obtain permits to construct the first CAD site in California for the least terns using this NUAD material. Despite the demonstrated environmental benefits of the project, which was well conceived and designed to conservative standards, some agencies and environmental groups opposed the project. The agencies with technical understanding of the issues related to CAD (USEPA, USACOE, and the Los Angles RWQCB) supported the project. Although one opposing state agency, the CCC, finally allowed the project to proceed, the CCC declared a moratorium on any further CAD sites in Los Angeles and San Diego until more information can be generated on this reuse practice.

The Port of Los Angeles agreed to place a minimum of 15 feet of clean sand and mud on the CAD Site/Shallow Water Habitat to encapsulate the contaminants (mostly low levels of PAHs, DDT and PCBs). Studies by the USACOE (Palermo, September, 1992) have indicated that as little as 8 inches of clay and sand would work well as a chemical barrier. In most areas, as little as 3 feet of sand would effectively prevent over 90 percent of the burrowing organisms from "bioturbating" the contaminants in a CAD site. There is at least one organism that can reach depths of 10 to 15 feet into the sands. Therefore, to be conservative, the Port agreed on a final cap thickness of 15 feet.

Once the Port of Los Angeles disposed of its NUAD material, the CAD site was found to have additional capacity, and Marina del Rey in Los Angeles County was able to use the excess capacity for its NUAD material. The Ballona Creek drains a large watershed in Los Angeles County directly into the mouth of Marina del Rey. This waterway carries a large volume of urban runoff that contains trash and pollutants. Los Angeles County, the USEPA and the Los Angeles RWQCB are working to improve the quality of the runoff. In the interim, there are annual problems with the dredging of the marina. As an experiment, the USACOE obtained permission to place an additional 200,000 cubic yards of NUAD material into the Port of Los Angeles CAD site. Since there was floatable trash in

the dredged material and since the CCC was concerned about the dispersal of the NUAD material from Marina del Rey, the material was dredged and placed into double lined geotextile tubes.

The Port of Los Angeles accomplished a great deal through this project. First, it obtained approval for the first CAD site in the State of California. Second, it constructed one of the first projects in the USA to use geotextile fabric tubes to contain NUAD material for aquatic disposal. Finally, it created a beneficial habitat for an endangered species with NUAD material.

Port of Oakland Charles P. Howard Terminal Expansion

Port development is largely dependent on opportunity. With massive marine terminal developments underway in Los Angeles, Long Beach and Seattle, the Port of Oakland finds it increasingly difficult to compete. When COSCO Maritime expressed an interest in expanding its operations at the Port of Oakland, the Port and its operator, Marine Terminals Corporation, were quick to react and guarantee a key expansion of 15 acres to support larger ships. Although 15 acres is not a large project, the project required dredging of some of the most contaminated material in the Port of Oakland.

As much as 160,000 cubic yards of material had to be removed to expand the berth and provide adequate footing for the fill. The Charles P. Howard Terminal was built on the site of a historic coal gasification plant. Large amounts of "lamp black" were stored and handled on the site. The sediments were contaminated with 60 to over 800 parts per million total PAHs.

All of the dredged NUAD material was originally proposed as fill for the expansion project. However, further engineering evaluations showed that the material would require extended drying time, jeopardizing the deadline for the project. Thus, the Port of Oakland decided not to use the NUAD material as fill. The volume of NUAD material was reduced by dredging only the extension of the berth and the footprint of the dike that would hold the fill. The NUAD material within the fill footprint was left in place. Since the NUAD material that remained consisted of a fine-grained fraction, wick drains were installed and the site sur-charged to speed consolidation. This reduced the volume of material requiring upland disposal from 160,000 cubic yards to 60,000 cubic yards.

Several other maintenance dredging and deepening projects took place while the Charles P. Howard Terminal was under development. The deepening material (approximately 100,000 cubic yards) was permitted for ocean disposal at the SF-DODS located approximately 50 miles offshore. Costs for disposal at the ocean site are in the range of $15 (U.S. dollars) per cubic yard. Since the deepening material was predominately sand, the Port of Oakland proposed to reuse the material as fill. This saved over $10 per cubic yard over the cost of ocean disposal.

During this period, approximately 5,000 cubic yards of fine-grained maintenance material was determined to be NUAD and required upland disposal. The Port of Oakland also needed to construct an upland rehandling facility to dispose of the NUAD material generated by the Charles P. Howard Terminal. The Port of Oakland designed and built a 10-acre rehandlling facility at an earthquake damaged break-bulk terminal for this purpose. The containment structure was constructed using geotextile tubes with an inner non-woven liner filled with the NUAD material from the maintenance project.

The Port of Oakland conducted appropriate testing for the NUAD material that was dried at the rehandling facility, and negotiated disposal with a landfill in the San Francisco Bay Area. The landfill required extensive testing because it had not previously accepted dredged material. However, through negotiations, testing requirements were greatly reduced from the landfill's original requirements. The testing showed that the contaminants were not soluble or biologically available. The agencies approved and the landfill accepted the entire 60,000 cubic yards for reuse as liner material for the landfill's expansion program. The Port of Oakland did not pay a disposal fee since the landfill accepted the material for reuse. However, transportation costs were high since no barge access was available and trucks were used.

The project was completed on schedule. The project demonstrated the reuse of NUAD material as liner material in landfills and as construction material for the development of the rehandling facility itself. The rehandling facility is

still permitted and is used to rehandle material from the Port of Oakland as needed.

Port of San Francisco Disposal at Redwood Sanitary Landfill

In 1991, the Port of San Francisco discovered that 12,000 cubic yards of its maintenance dredging materials were unsuitable for disposal in San Francisco Bay. The Port of San Francisco identified the Redwood Sanitary Landfill in Marin County, north of the Golden Gate Bridge, as the best place to dispose of the NUAD material. Redwood Sanitary Landfill requires a large amount of cover material which it normally must purchase, so the Port of San Francisco paid no "tipping fee" to the landfill for the disposal of the material. The Port of San Francisco paid only to transport the material to the landfill by barge. Barge transportation is much more cost-effective than trucking.

CHANGES NEEDED IN THE REGULATORY PROCESS

As we have illustrated, it is difficult to reuse dredged material in the terrestrial or contained aquatic environment under the system currently in place in California. Several changes to existing laws and policies are needed to promote beneficial reuse projects.

First, the state and federal government should strengthen their current policies by enacting laws that support the reuse of dredged material. Second, the State of California should produce uniform regulations that promote the reuse of dredged material where practicable. These regulations should include uniform testing guidelines for aquatic disposal and reuse projects. Third, if the federal and state government wish to designate reuse as a preferred method of dredged material disposal, then the government should subsidize the development of reuse and rehandling facilities and provide incentives for reuse projects. Such incentives could include the provision of a "fill credit banking system." Under a fill credit banking system, proponents of reuse projects would receive "credits" for reuse projects that could be used to offset the amount of environmental mitigation required for fill projects. At present, even relatively cost-effective reuse scenarios are more costly than unconfined aquatic disposal. Forcing maritime industry to pursue a dredge material reuse policy without providing subsidies will place California's maritime industry at a competitive disadvantage because the governments of many other nations assist with the management and disposal of dredged material. Finally, regulators and project proponents must establish close working relationships to help overcome some of the currently existing obstacles to dredged material reuse.

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