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TOXICOLOGICAL ASSESSMENT AND DREDGED MATERIAL MANAGEMENT IN PORTS AND HARBORS

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INTRODUCTION

Seaports, their associated infrastructure (e.g., industrial parks, shipyards, and railroad and truck terminals) and attendant service industries are hubs of commercial activities and economic growth in a number of coastal communities. They move domestic and international freight, transport billions of barrels of crude oil and refined products, carry millions of people on cruise ships and ferries, and support a wide variety of recreational use of coastal waters. It is estimated that the overall contribution of port-related commerce to the nation's Gross Domestic Product (GDP) is over $700 billion (it was about 7 percent of the total GDP in the year 2002). This contribution is in the form of direct or induced jobs, personal income, sales and taxation. The five largest U.S. ports, in terms of total value of waterborne foreign trade, contribute nearly 50 percent of total for all ports in the United States (Table 1). The total value of this trade in the year 2002 was $764 billion. However, in terms of total tonnage, i.e., domestic and foreign, Port of South Louisiana predominates.

Table 1. Total value of waterborne foreign trade, imports and exports, in millions of dollars, at major U.S. ports in 2002 (data from U.S. Maritime Administration, Waterborne Databank, 2002).

PORT	**VALUE**
Los Angeles, CA	114,861
Long Beach, CA	94,766
New York, NY	94,637
Houston, TX	45,108
Seattle, WA	24,695

Many harbors on the East Coast are situated in spacious, estuarine areas that are quite shallow. For example, different sub-basins of the New York-New Jersey Harbor System have mean depths of between 6m and 7m that cannot accommodate large, deep-draft freighters, container ships and tankers. Therefore shipping lanes, as deep as 15m, have to be excavated and maintained due to substantial riverine flow and heavy deposition of sediment that is typical of such estuaries. Historic bathymetric charts of Newark Bay indicate water depth of about 1m in the vicinity of Port Elizabeth and Port Newark. These ports now include channels and berthing areas that are dredged to maintain 2 to 15m depths. In the Long Beach Harbor, the maximum depth in the main channel is more than 23m.

CONTAMINATION

Concomitant with concentrated economic activity in seaports are population growth, larger industrial infrastructure, and competition for space and amenities that often result in resource use conflicts and deterioration of coastal environmental quality. Most ports are highly contaminated in comparison with the ambient environment, not just because of port operations and associated industries but also due to activities, emissions and effluents from the surrounding metropolitan and suburban areas. With larger container vessels being placed in service nearly every year, the offloading and transportation of freight by trucks has heightened concerns about air pollution being generated by port-related operations. Large container ships now exceed 8,000 TEU (twenty-foot equivalent units) capacities, requiring dozens of trucks, several truck lanes and time-intensive operations. This often results in snarled traffic and idling of trucks and other vehicles, thus adding to air pollution. The spatial extent and severity of contamination is not well documented for most ports. Figure 1 shows data from Baltimore Harbor, comparing concentration of certain toxic chemicals in relation to a region outside the harbor and to values of "effects-based" guidelines, i.e., ER-L.

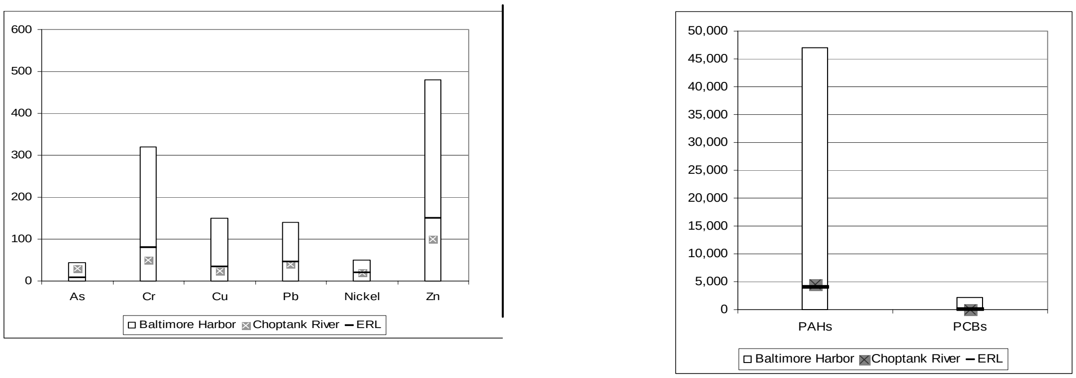


Figure 1. Concentrations of toxic chemicals in Baltimore Harbor, six year averages (left panel) and high values of PAHs and PCBs (right panel) in comparison with data off Choptank River (main stem of Chesapeake Bay) and ER-L values.

However, concentration of the potentially toxic chemicals is not a direct measure of toxicity; a suite of toxicity test area generally employed to determine the nature, severity and spatial extent of sediment toxicity. In a study of sediment toxicity in Newark Bay in 1993, it was found that sediments from nearly the entire bay (85 percent of the surveyed area) were toxic based on the amphipod mortality test (Long et al. 1996). More recent data showed a lesser spatial extent of toxicity, i.e., 46 percent of the surveyed area (Adams, et al 1998). In the Southern California coastal bays and harbors 58 percent of the studied area was found to be toxic; in comparison, none of the open shelf sampling site showed significant toxicity (Long, et al 1996; Bay 1996)

SEDIMENT QUALITY CRITERIA, ADVISORY LEVELS OR GUIDELINES

The total amount of sediment dredged from the nation's waterways each year is very large, with estimates exceeding 300 million cubic meters. This is necessary to maintain and improve waterways and maritime navigation. About 15 percent of the total dredged material is dumped in coastal and estuarine waters (Millemann 1999). In addition, an estimated one-eighth to one-quarter of all Superfund sites are submerged sediment beds (UHI 2000). Over the years, criteria for defining "clean sediment" for possible beneficial re-use of dredged material or defining restoration targets for contaminated sediment *in situ* have remained difficult to attain scientifically and interim measures are controversial in terms of their acceptability (Box 1).

Box 1. Setting sediment clean-up targets

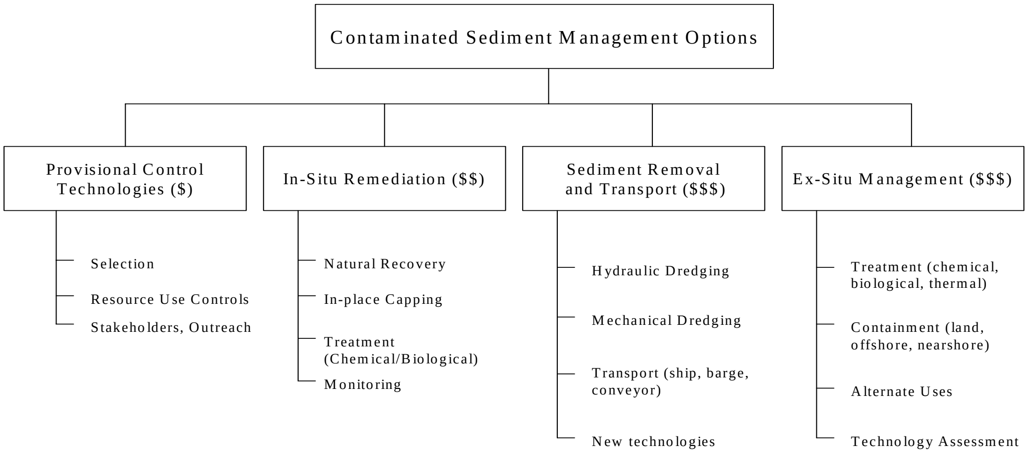
What level of PCBs would be acceptable to maintain indigenous biological population and ecosystems, and to conserve the "fishable and swimmable" attributes of coastal waters and estuaries?
Such a question can only be answered in a broad societal context:

- PCB concentration in sediment: up to 24,000 ppb in some harbors
- Natural background level (pre-1930): zero
- ERL Value: 23 ppb
- ERM Value: 180 ppb
- Clean-up target: 300 ppb ($$$)
- Revised clean-up target: 450 ppb ($$)

CONTAMINATED SEDIMENT MANAGEMENT OPTIONS

Considerable progress has been made during the past decade in developing options for managing contaminated sediment, including new ways of sequestering or manufacturing consumer products (Figure 2). To a large extent, this could be traced to funding and other incentives offered under the Water Resources Development Act of 1992. Dredged material has been used quite often as a fill material (for dykes, wharfs, parking lots, etc.), and for beach nourishment and reclamation purposes. However, many of the *ex situ* treatments or manufacturing technologies are viewed as neither cost effective nor practical (NRC 1997). Provisional control technologies, which could be described as euphemism for doing the minimum, remain a prevalent option.

Clearly, there is a need to examine the regulatory framework, realities in terms of stakeholders' interests, and contaminated sediment disposal and re-use technologies in a holistic manner and with site-specific considerations. In terms of harbors and ports, aspects of concentrated human activities and commerce should be viewed as parts of the regional ecosystems that need to be managed more efficiently. The concept of "commerce managed areas," as distinct from conservation managed areas and exemplified by the Marine Protected Areas, may offer a new approach to sustainable coastal development, including a new set of corrective or rehabilitative measures for highly urbanized estuaries, including those dominated by ports (Weinstein and Reed 2005).



(Modified from NRC, 1997)

Figure 2. Contaminated sediment management options and their relative costs (modified from NRC, 1997)

LITERATURE CITED

Adams, D.A., J.S. O’Connor, and S.B. Weisberg. 1998. *Sediment Quality of the NY/NJ Harbor System.* U.S. Environmental Protection Agency, Washington, DC. Report EPA/902-R-98-001.

Bay, S.M. 1996. *Sediment Toxicity on the Mainland Shelf of the Southern California Bight in 1994.* Southern California Coastal Water Research Project, Long Beach, CA. SCCWRP Annual Report. Pages 128 to 135.

Long, E.R., A. Robertson, D.A. Wolfe, J. Hameedi, and G.M. Sloane. 1996. “Estimates of the Spatial Extent of Sediment Toxicity in Major U.S. Estuaries.” *Environmental Science and Technology*. Volume 30. Pages 3585 to 3592.

Millemann, B.A. 1999. *Muddy Water: The Toxic Wasteland Below America’s Oceans, Coastal, River and Lakes.* Joint publication by A Coastal Alliance, Clean Ocean Action, and American Littoral Society, Washington, DC. 152 pages.

NRC (National Research Council). 1997. *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies*. National Academy Press, Washington, DC. 295 pages.

UHI (Urban Harbors Institute). 2000. *Green Ports: Environmental Management and Technology at U.S. Ports*. University of Massachusetts, Boston, MA. 66 pages.

Weinstein, M.P., and D.J. Reed. 2005. “Sustainable Coastal Development: The Dual Mandate and a Recommendation for “Commerce Managed Areas.” *Restoration Ecology*. Volume 13. Pages 174-182

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