CONTAMINATED SEDIMENTS

IN THE MARINE ENVIRONMENT

Toxic chemicals have been discharged to coastal areas from a variety of sources for decades. These chemicals include trace metals and organic contaminants, such as polychlorinated biphenyls (PCBs), pesticides, and polycyclic aromatic hydrocarbons (PAHs). In many cases, sediments become the long-term repository of contaminants. In fact, in numerous examples around the world, sediments reflect the industrial and waste disposal history of coastal communities.

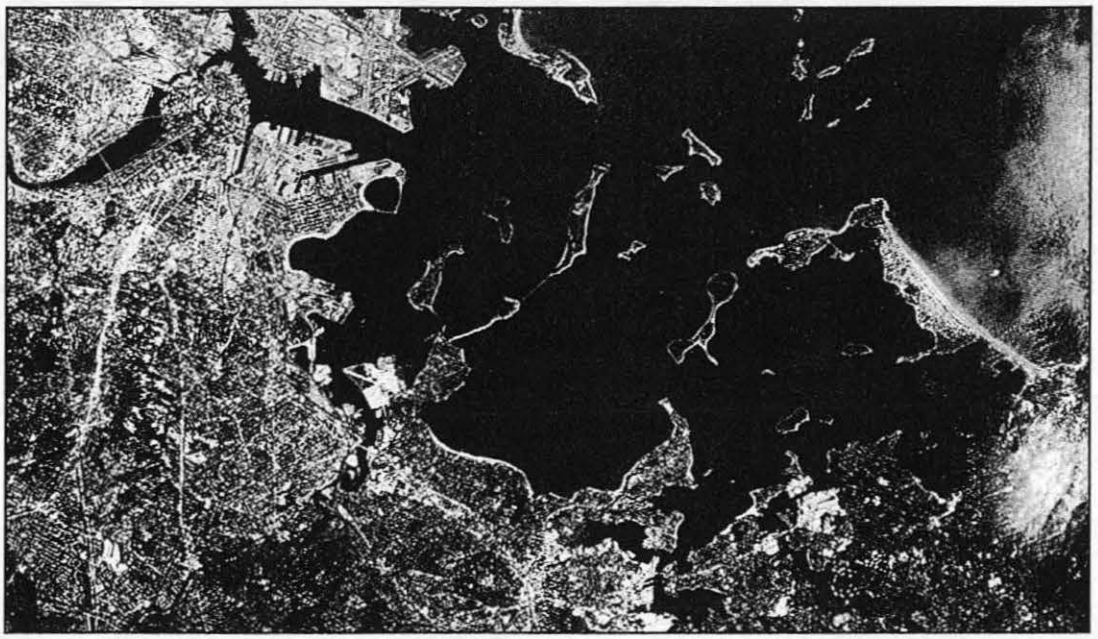
Boston, Mass.

Problem:
Reduced utility of navigational channels for shipping

Environmental Indicator:
High contaminant levels in sediments

Management Solution:
Formation of deep borrow pits, covered with uncontaminated sediments; clean sediments removed in creation of borrow pits to be disposed offshore

Photo courtesy of WHOI Sea Grant.



By **JUDITH E. McDOWELL, WHOI Sea Grant**

When contaminated sediments are found in coastal harbors or critical habitats for fishery or wildlife populations, it may be necessary to remove them through dredging. According to the National Research Council (NRC), approximately 14 million to 28 million cubic yards of contaminated sediments are managed annually in the United States. This represents an estimated five to 10 percent of all sediments dredged annually. Management of contaminated sediments through dredging may be necessary for many reasons, including:

- Remediation of hot spots of chemical contamination that pose risks to human health and ecosystems;
- Maintenance of navigational channels and new port construction; and
- Compliance with water quality and sediment quality standards to protect critical habitats.

At present, there are over 100 Superfund sites in the marine environment that will require removal or remediation of contaminated sediments in the next decade. In addition to the ecological concerns posed by contaminated sediments and their removal, there are significant economic and political concerns.

Along the U.S. coastline, numerous contaminated harbors and other habitats are in need of dredging or remediation. Some of the most contaminated sediments in these areas have been identified through routine monitoring programs such as the National Oceanic and Atmospheric Administration's (NOAA) National Status and Trends Program or through local site characterization programs. Not surprisingly, many of the most contaminated sites are adjacent to urban coastal areas, such as Boston, New York, San Diego, Los Angeles, San Francisco, and Seattle. Deciding upon management and remediation approaches requires consideration of several factors and may often involve tradeoffs: maintaining safe navigation, ensuring continued economic viability of ports, and providing for environmentally acceptable disposal methods for dredged material.

The Regulatory Picture: Whose Responsibility?

Regulatory responsibility for managing contaminated sediments falls to three federal agencies: the Environmental Protection Agency (EPA), the Army Corps of Engineers (ACE), and NOAA. Jurisdiction is covered by at least six federal statutes: Comprehensive Environmental Response, Cleanup and Liability Act (CERCLA), commonly known as Superfund; Resource Conservation and Recovery Act (RCRA); Clean Water Act (CWA); Rivers and Harbors Act of 1899; Marine Protection and Sanctuaries Act, commonly known as the Ocean Dumping Act; and the Coastal Zone Management Act.

These statutes are implemented to ensure environmental cleanup (EPA), natural resource protection (NOAA), and maintenance of navigation (ACE). State and local agencies may also be involved in regulatory and management decisions, adding additional layers to the overall assessment and management of contaminated sediments.

What Works Where

The complexity of technical, political, and regulatory challenges makes management of contaminated sediments a very difficult problem. Two major studies conducted and published by the NRC summarize many of the key aspects in site characterization, assessment, and management of contaminated sediments. The first volume,

New Bedford, Mass.

Problem:
Extensive contamination from PCBs in sediments and living resources throughout the Acushnet River Estuary

Environmental Indicator:
PCB levels in harvestable resources and sediments

Management Solution:
Two-phase dredging: (1) removal of hot spots, (2) removal of intermediary levels of contamination to minimize availability and uptake by living organisms

Photo courtesy of WHOI Sea Grant.

Table courtesy of WHOI Sea Grant.

Summary of federal and state jurisdiction over remediation and management of contaminated sediments.

Regulatory Statute	*Government Agency*	*Objective*
Comprehensive Environmental Response, Cleanup and Liability Act (CERCLA)	U.S. Environmental Protection Agency U.S. Army Corps of Engineers	Environmental cleanup, Superfund Remediation, dredging
Resource Conservation and Recovery Act (RCRA)	U.S. Environmental Protection Agency U.S. Army Corps of Engineers	Environmental cleanup, Superfund Remediation, dredging Land-based disposal
Clean Water Act (CWA)	U.S. Environmental Protection Agency U.S. Army Corps of Engineers National Oceanic and Atmospheric Administration	Environmental cleanup Navigational dredging Research and monitoring Aquatic disposal
Rivers and Harbors Act of 1899 (RHA)	U.S. Army Corps of Engineers	Navigational dredging Aquatic disposal
Marine Protection, Research and Sanctuaries Act (MPRSA)	U.S. Environmental Protection Agency National Oceanic and Atmospheric Administration	Dredged materials disposal Research and monitoring Aquatic disposal
Coastal Zone Management Act (CZMA)	State Coastal Zone Management Programs	Water quality and sediment quality issues Coastal Zone Consistency Review

Table courtesy of WHOI Sea Grant.

Examples of other urban harbors with contaminated sediments and proposed management solutions.

Location	*Environmental Indicator*	*Management Solution*
Hart/Miller Islands, Baltimore, Md.	High contaminant levels in sediments	Diked Containment Disposal Facility
James River, Norfolk, Va.	Kepone contamination in fisheries	Natural Recovery
Marathon Battery, New York City	Heavy metal contamination in wetland Superfund site	Dredging, treatment, and offsite disposal
Port of Tacoma, Wash.	High contaminant levels in sediments	Dredging and near-shore containment
Waukegan, Ill.	PCB contamination Superfund site	Dredging and treatment before containment

Contaminated Marine Sediments: Assessment and Remediation, was published in 1989 and describes case histories of contaminated sediments and the scientific needs for management decisions. The second volume, *Contaminated Sediments in Ports and Waterways: Cleanup Strategies and Technologies,* was published in 1997 and focuses on the decision-making process and the regulatory environment.

These detailed volumes make it clear that local environmental and economic concerns must be addressed when managing contaminated sediments in the United States. The solution for one locale is not necessarily the ideal solution for every locale.

New York Harbor

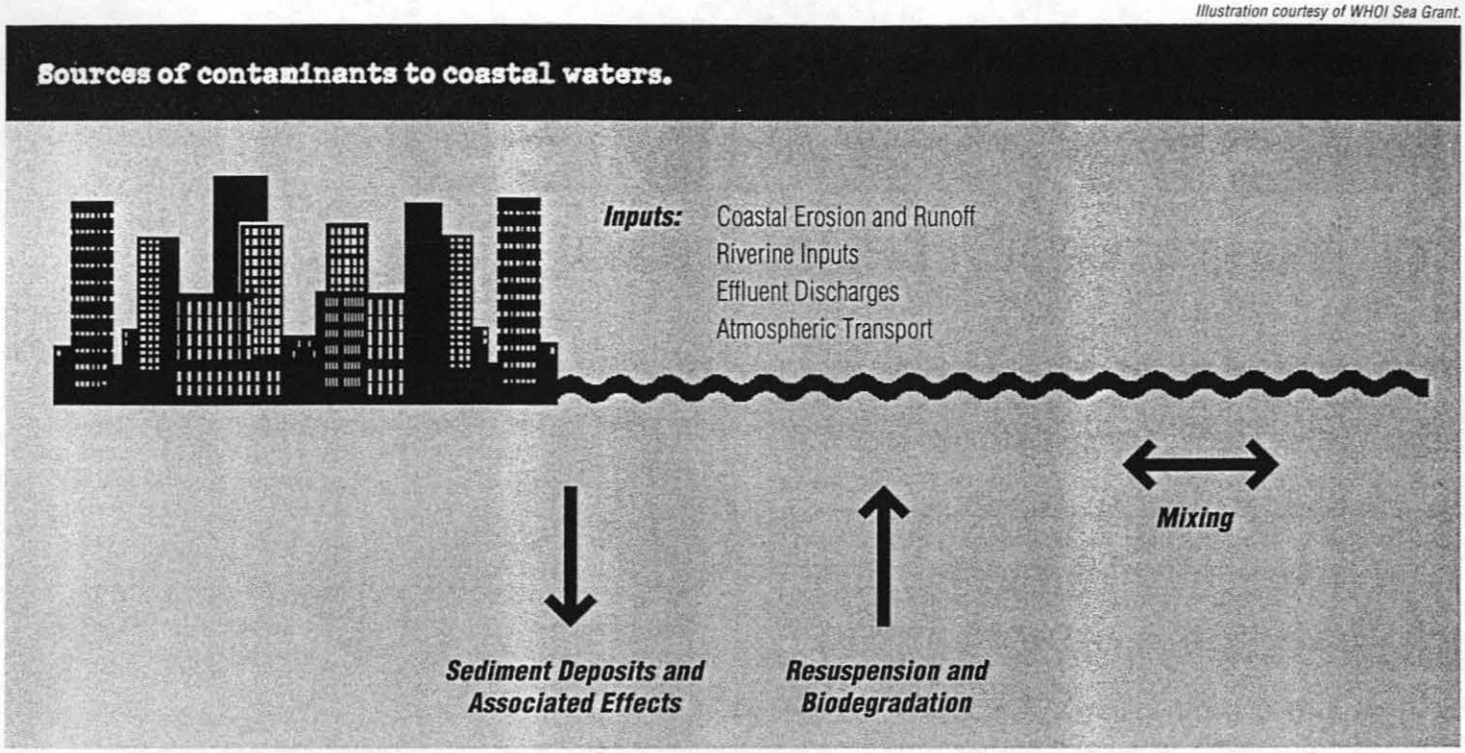
■ The governors of New York and New Jersey committed $130 million from the Port Authority of New York and New Jersey for dredging to allow deep draft ships to continue to use New York harbor. This decision assures that 170,000 jobs and $20 billion in annual economic activity will remain in New York and New Jersey rather than moving to competing ports. While the economic benefits of this decision are clear, the environmental costs are not. Dredging has not occurred for four years due to discord in the environmental community over management options for disposal of the contaminated sediments. Environmental groups oppose the use of an offshore disposal site and are calling for a cessation of that site and for development of new options—options that might include the use of dredged materials in highway projects, the restoration of shorelines, or other remediation processes.

Boston Harbor

■ In Boston Harbor, sediments are highly contaminated with trace metals and PAHs, reflecting a long history of transportation and industrial activity. Continued navigation in the harbor and requirements of modern vessels for deeper ports require that much of the harbor be dredged.

Reaching final approval for Boston Harbor dredging plans took three decades. The 1997 NRC report describes the complexity of that screening process, which involved all stakeholders and considered 312 land-based inland and coastal sites, 21 landfills, and 21 aquatic sites. Four final management options were identified as acceptable: the Massachusetts Bay Disposal site, the Boston Lightship site, two near-shore borrow pits, and one contained aquatic disposal site. The final selection involves removal of contaminated sediments to allow dredging of highly

Illustration courtesy of WHOI Sea Grant.



contaminated sediments, formation of very deep pits, replacement of the contaminated sediment and, finally, placement of clean sand as a sediment cover. Uncontaminated sediments that are removed to form the deep pits will be disposed at the Massachusetts Bay Disposal site. This solution is a good example of meeting both economic and environmental objectives in the management of contaminated sediments.

MIT Sea Grant has supported an interdisciplinary group of scientists, engineers, and managers to address the complex issues related to capping of contaminated sediments, specifically addressing the Boston Harbor Navigation Improvement Project (BHNIP). Investigators from MIT, the University of Massachusetts–Boston, and Harvard University's School of Public Health are focusing their studies on the physical, chemical, and biological processes that occur when contaminated sediments are capped by coarser sediments. A technical steering committee composed of other scientists and engineers and state and federal agency personnel provides advice on current and future research efforts.

New Bedford Harbor

■ For sites where contaminated sediments pose direct threats to ecological systems—and potentially to human health—the problem of managing contaminated sediments is magnified, as disposal options are not readily available or acceptable. The New Bedford Harbor Superfund site is an 18,000-acre urban tidal estuary where PCB contamination has resulted in fishery closures and the classification of one portion of the harbor and estuary (a six-mile section extending from the upper Acushnet River to Buzzards Bay) as "extremely contaminated."

During Phase I of the New Bedford Harbor cleanup process, 14,000 cubic yards of sediment were dredged from the five-acre "hot spot" (the most contaminated area of the estuary). This initial cleanup phase was completed in September 1995. The EPA had originally proposed to incinerate the dredged materials, but local and congressional opposition to incineration intervened. While alternative technologies are explored, the dredged materials are being held in a confined disposal facility, or CDF—a lined and covered holding pond. An EPA feasibility study on alternative treatment technologies was issued in December 1997.

Phase II dredging involves removal of 450,000 cubic yards of PCB-contaminated sediment that is spread over approximately 170 acres of the harbor. A major component of this phase is development of a long-term monitoring and maintenance program for the CDFs in addition to assessment of improvements in the harbor ecosystem following completion of sediment removal.

WHOI Sea Grant supported many of the early investigations of the characterization of the New Bedford Harbor Superfund site, including the spatial mapping of contaminated sediments, the uptake and effects of contaminants in marine organisms, and the physical transport of contaminated sediments from the "hot spot" to Buzzards Bay. These investigations led to the development of a comprehensive analysis of the Superfund site and were critical in the final resolution of remediation plans for the harbor. Research is continuing in a wide array of topics relevant to the New Bedford Harbor site, including the food chain transfer of contaminants and the long-term consequences of contaminant exposure.

Clearly, managing contaminated sediments requires a complex interaction of scientific, economic, and political information to ensure protection of human health and sensitive ecosystems without sacrifice of the economic viability of coastal ports. Continuing efforts are needed in the development of predictive models that integrate analytical approaches for identifying contaminant distribution and effects in coastal environments with management approaches for reducing the input and impact of contaminants in the environment.

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