Building and maintaining our underwater highways

This booklet is presented courtesy of:

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Washington, D.C. 20314-1000

Cover photo: Port of Oakland

Second Edition

Historically, water transportation was the key to exploration of uncharted territories. As settlement progressed, roads, railways, and eventually airways were added to become our modern, global transportation system. The man-made or maintained parts of this system are our nation's transportation infrastructure: roads, railroads, airports, locks, dams, ports, and navigation channels.

The water transportation system, operating since the early 1800s, has played a major role in the growth of the United States' economy. Today this system serves as the pillar to one of the most extensive and economically significant waterborne commerce operations in the world.

Economic Theory of Adam Smith, Water Transportation, and the Potential to Grow

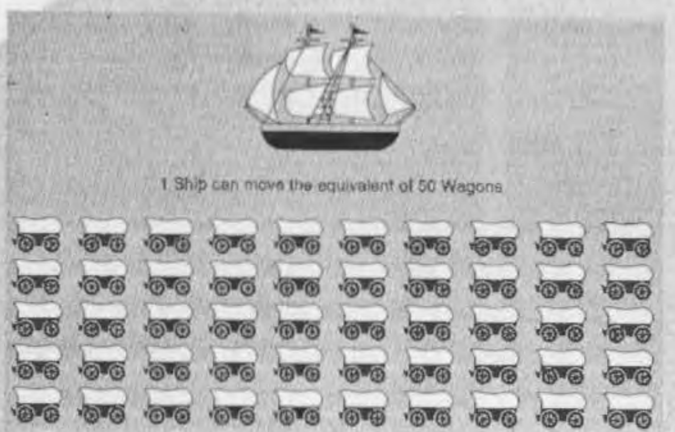
The classical economist Adam Smith recognized the efficiency of water transportation in 1776, when he published his revolutionary book, *An Inquiry into the Nature and Causes of the Wealth of Nations.* Smith championed water over ground transportation when he analyzed why some nations are better off than others.

Smith stated:

"A broad wheeled wagon, attended by two men and drawn by eight horses, in about six weeks time carries and brings back between London and Edinburgh near four ton weight of goods. In about the same time, a ship navigated by six to eight men, and sailing between the ports of London and Leith, frequently carries and brings back two hundred ton weight of goods.

"Six or eight men, therefore, by the help of water-carriage, can carry and bring back in the same time the same quantity of goods between London and Edinburgh as fifty broad-wheeled wagons, attended by a hundred men, drawn by four hundred horses."

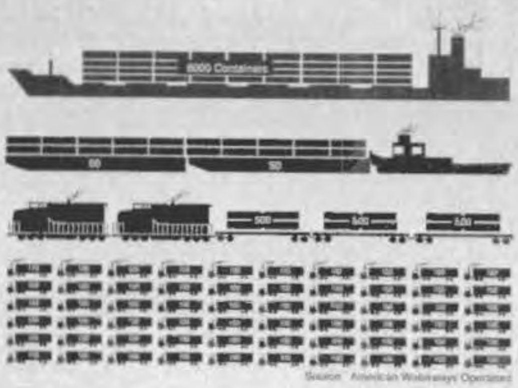
As a result of this comparison, Adam Smith came to a simple but important conclusion: "*Countries are only wealthy when they have growth potential.*" This unprecedented concept was echoed in our Constitution, which empowered the United States government to form economic incentives. These incentives stimulated commerce, building the basis for the nation's economic development.



Modern Economics of Shipping

Today, wagons and 200-ton cargo ships are of times past, but we can look at modern vessels and compare their capacity efficiencies. Modern technology allows the building and operation of ever larger vessels. Worldwide automation, standardization, and advanced technology applications have made water transportation safer and ever more efficient.

Approximately 95 percent of all United States international trade moves through our ports. Our now global economy must allow for fast and efficient transportation of goods meeting consumer needs and providing the means for import and export opportunities. As world populations increase, demand for goods will also increase, requiring further expansion of our water transportation system. As global economic forces exert pressure, we must build bigger and more efficient ships, and navigation channels must be deepened and widened. The designing, building, and maintaining of these channels can be compared to building an underwater highway. The huge vessels of the future entering and exiting our harbors will need underwater super highways.

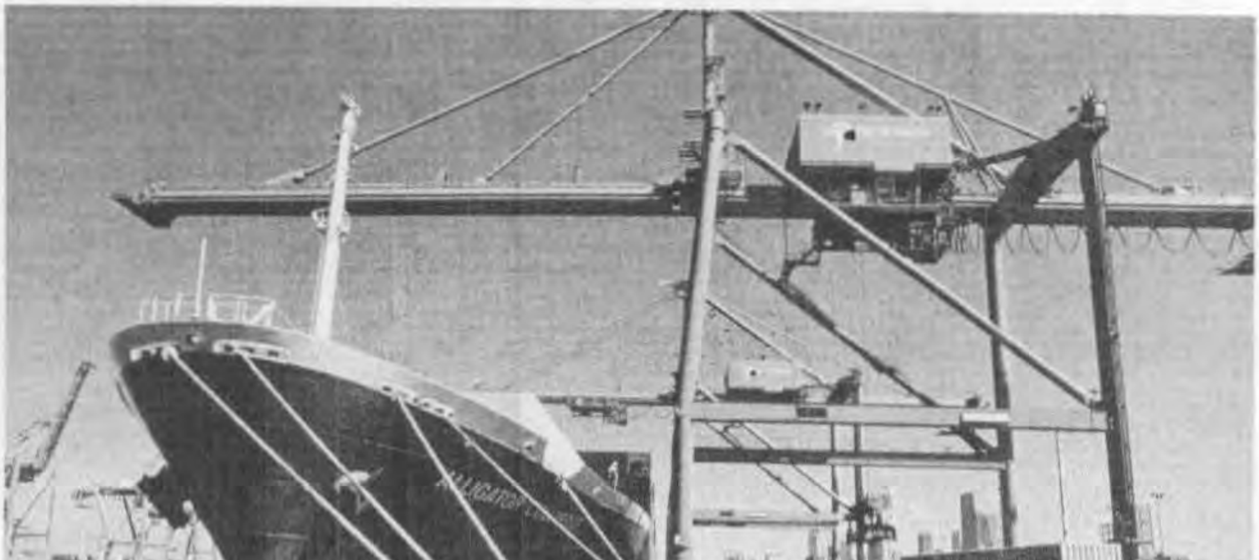


Efficiency in Size

Evolution of ships: From the time of the two-masted schooner to today's super container giants, seagoing vessels not only have increased carrying capacity but are also wider, longer, and faster and require deeper channels. Improving "productivity" of shipping means more cargo moved faster, safer, and more efficiently while consuming less energy and producing less pollution.

Evolution of shipping: From moving goods in barrels, baskets, and sea chests to the container-ship concept implemented in the 1960s was a long process. Containerization operates under the premise that durable and nondurable goods can be safely and economically shipped worldwide in standardized 20-ft-long containers (called twenty-foot equivalent units - TEUs). These containers are *intermodal*, can be stowed efficiently on container ships, and can be placed easily on railroad cars, in aircraft cargo holds, or on semitrailer trucks for door-to-door delivery. Other shipping methods include break/bulk, super colliers, and tankers.

Over time, container ship design evolved into a standard limited to a size able to pass through the Panama Canal. Today's container ships, however, can be more than 1,000 ft long, carry up to 6,000 TEUs, and require at least 45-ft channel depth. Ships of the future will be bigger yet and will need navigation channels at least 50 ft deep. Other nations in Europe and Asia are improving shipping channels to accommodate vessels with 60-ft drafts and deeper.



dredg′ing (drejing) vt. To enlarge or clean out (a river channel, harbor, etc.) with a dredge.

With their increased size, ships need improved navigation channels to enter and leave ports efficiently, quickly, and safely. Few rivers or harbors are naturally deep. Without dredging, New York harbor would be impassable to passenger liners and cargo ships. Periodic maintenance dredging as well as occasional enlarging and deepening of navigation channels is essential to

accommodate commercial and recreational vessels. Consumer product prices stay low when ships can transport their goods directly into the port.

Evolution of shipping channels closely parallels settlement of the United States. Congressionally authorized navigation improvement projects date to 1789 when Congress approved appropriations for lighthouse construction.

Construction of **new** navigation channels involves removal of materials previously undisturbed. **Maintenance dredging** operations involve the repetitive removal of naturally recurring deposited bottom sediment such as sand, silt, and clays in an existing navigation channel.

More than 400 ports and 25,000 miles of navigation channels are dredged throughout the United States to keep traffic operating efficiently.

Dredging Makes Sense

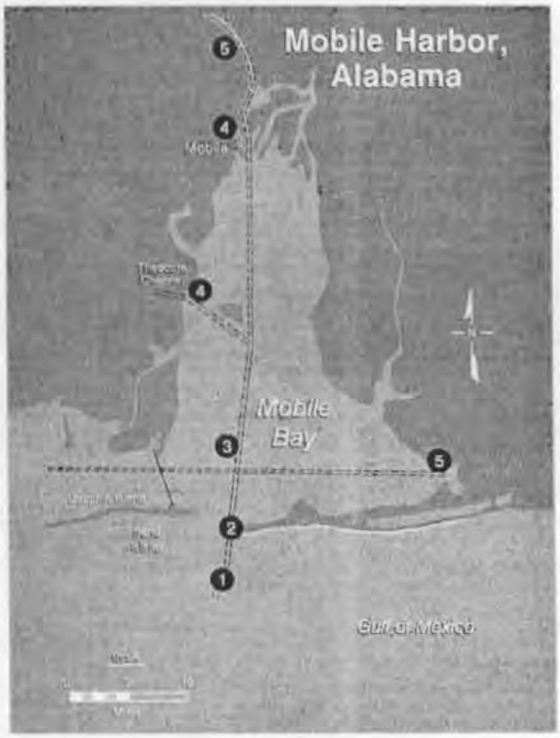
Billions of cubic yards of material are removed from sites around the globe annually in an effort to keep the big ships and their cargo moving. Thus, maintenance of navigation channels helps the world economy by promoting efficient trade. Our forefathers recognized this and passed the General Survey Act of 1824, which established the U.S. Army Corps of Engineers' role as the Federal water resource agency with the primary mission for constructing and maintaining a safe, reliable, and economically efficient navigation system.

Harbor Projects

From Snagboat to Self-Propelled Hopper Dredge

Early efforts to keep waterways navigable included manual labor and the use of draft animals for power. With the arrival of steam engines and other mechanical devices, the increasing need for wider and deeper channels soon spawned the development of dredges—ships that were equipped to keep navigation channels open, regardless of difficulty encountered when removing materials. The variety of materials and the need for a variety of placement methods resulted in the many types of dredges that are in use today.

Channels are kept deep and wide enough through dredging for safe movement of ships from deep ocean waters to the more than 200 deep-water harbors where imports are unloaded and exports loaded. Dredging, performed primarily by the Corps of Engineers at navigation channels and by Port Authorities at harbors, takes place in five major areas, and the materials removed differ in consistency and placement options.



❶ Main approaches (approach channel in ocean); dredged material is composed primarily of sand.

❷ Bar channels (sandbars at inlets); dredged material is composed primarily of coarse-grained sand.

❸ Entrance channels (to harbors); dredged material is composed primarily of sand to fine-grained silt and clay.

❹ Berthing areas (harbors/ports); dredged material is composed primarily of silt and some sand.

❺ Inland waterways (intracoastal waterways and river channels); dredged material is composed primarily of silt and sand.

Clearing and Snagging

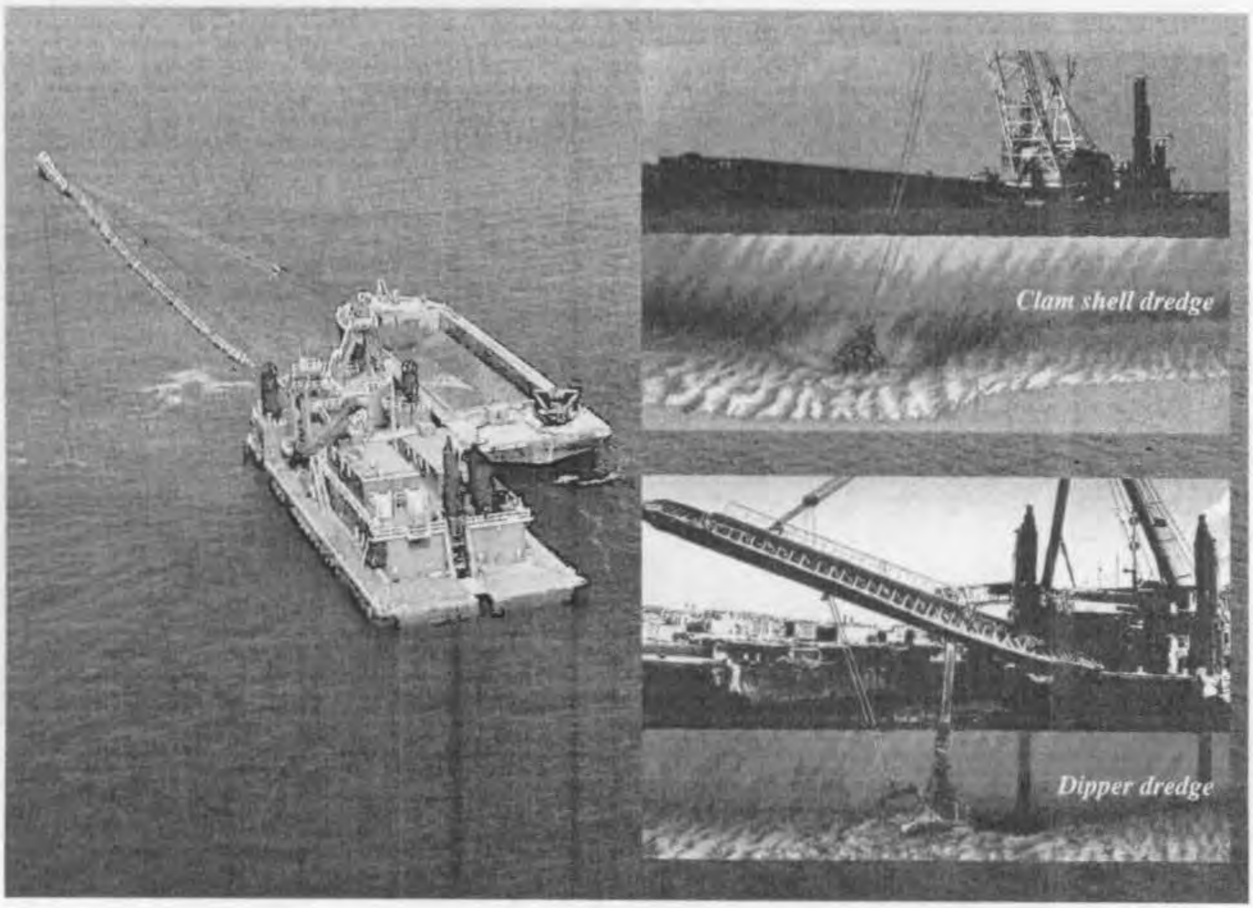
Snagboats are used to break up logjams and to clear debris, sunken vessels, and dilapidated piers that are or might become hazardous to navigation.


Snagboat

Mechanical Dredges

Several types of mechanical dredges are used. **Dipper dredges** and **clam shell dredges** are the two most common. Mechanical dredges are rugged and capable of removing hard-packed materials or debris. They can be worked in tight areas and are efficient when large barges are used for long-haul disposal.

Mechanical dredges have difficulty retaining loose, fine materials in buckets, do not dredge continuously like pipeline dredges, and may need added controls when handling contaminated sediments. Mechanical dredges place the material into barges for transport to the placement location.

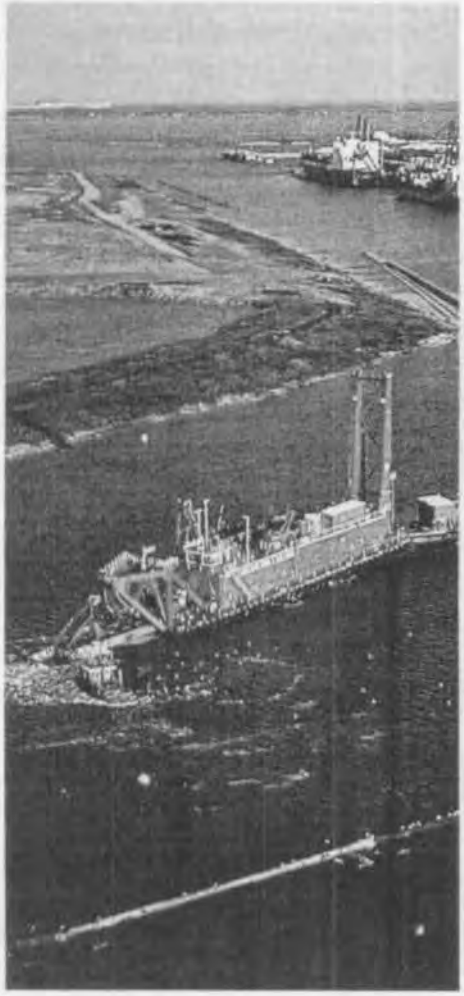

Clam shell dredge

Dipper dredge

Hydraulic Dredges

The two primary types of hydraulic dredges are the **cutterhead pipeline dredge** and the **self-propelled hopper dredge**.

Advantages of cutterhead pipeline dredges include their ability to excavate most materials, to pump directly to a disposal site,

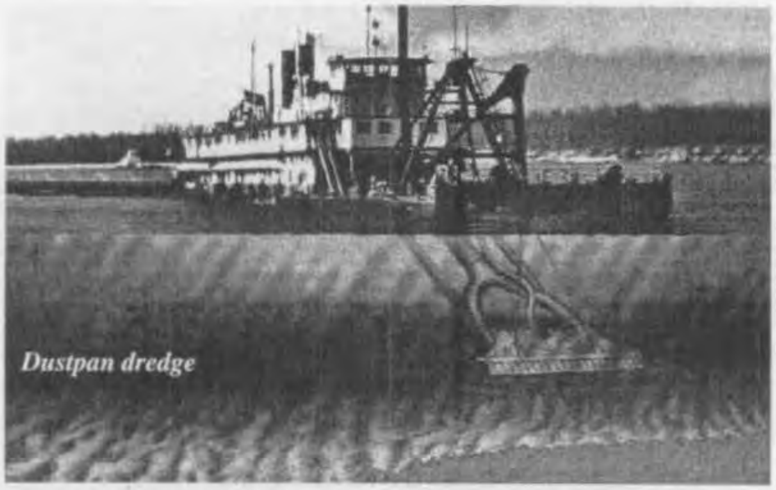


Cutterhead pipeline dredge

Self-propelled hopper dredge

to dredge almost continuously, and to dredge some types of rock without blasting. However, cutterhead pipeline dredges have limited capability in rough weather; have difficulty with coarse sand in swift currents; and, for the most part, are not self-propelled. In addition, the necessary pipeline can be an obstruction to navigation and, when handling debris in sediment, the removal efficiency is diminished.

Self-propelled hopper dredges can operate in rough water and move quickly to a jobsite under their own power. The dredging operation does not interfere with other traffic. Work progresses quickly and is economical for long haul distances. Hopper dredges are limited to work in deep waters, but they cannot dredge continuously. Excavation is less precise than with other dredges, and this

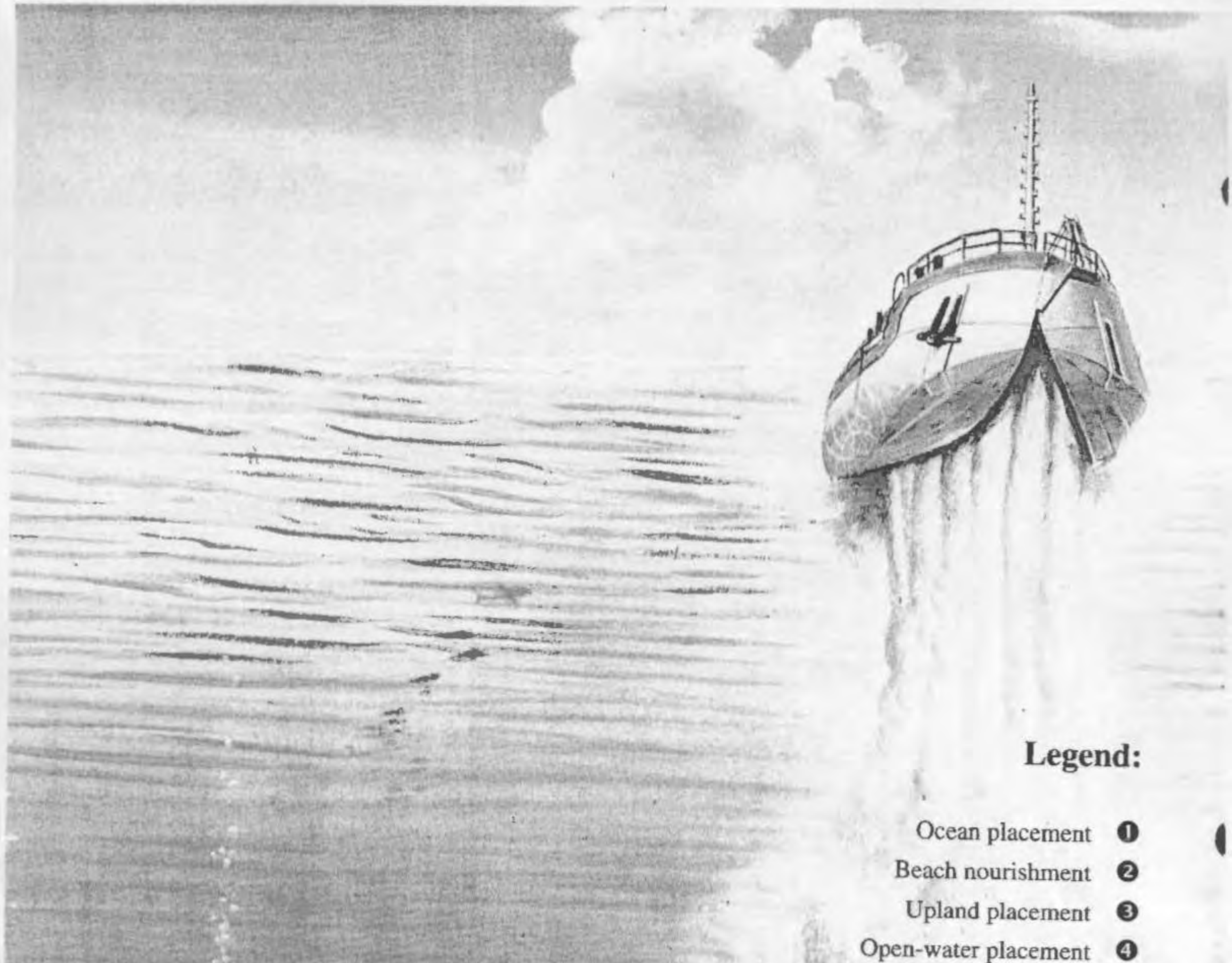


Dustpan dredge

Sidecaster dredge

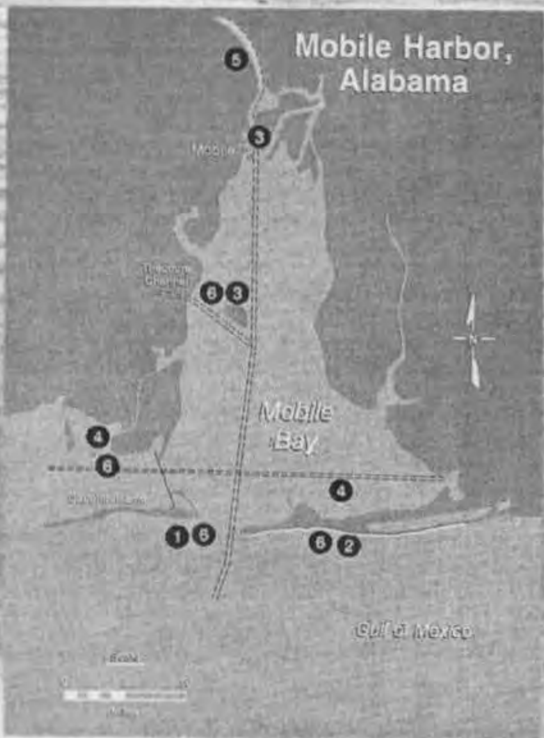
dredge type has difficulty dredging steep banks and consolidated materials.

Specialty dredges such as the **dustpan dredge** and **sidecaster dredge** are used to remove loosely compacted coarse-grained material at rapid shoaling sites or in areas where the sediment is needed adjacent to the navigation channel.


Legend:
Ocean placement ❶
Beach nourishment ❷
Upland placement ❸
Open-water placement ❹
Within banks placement ❺
Beneficial uses ❻

Moving Dredged Material Is a Full-Time Job

To maintain navigable waterways, approximately 400 million cubic yards of material are dredged in the United States every year. Of this amount, about 60 million cubic yards are placed in ocean waters at more than 100 Environmental Protection Agency approved sites. The other 340 million cubic yards are dredged in coastal and inland waters and placed in a variety of locations, including uplands, beach sites, wetlands construction sites, and riverine sandbars, to name a few.



Ocean Placement

Typically, in ocean placement, a hopper dredge or towed barge is filled with dredged material, sails to a designated area of the ocean, opens its hull, and allows the sediment to drift to the bottom. Dredged material meeting the evaluation criteria is placed in ocean sites. This material usually comes from inlet, bar, and main approach navigation channels.

Beach Nourishment

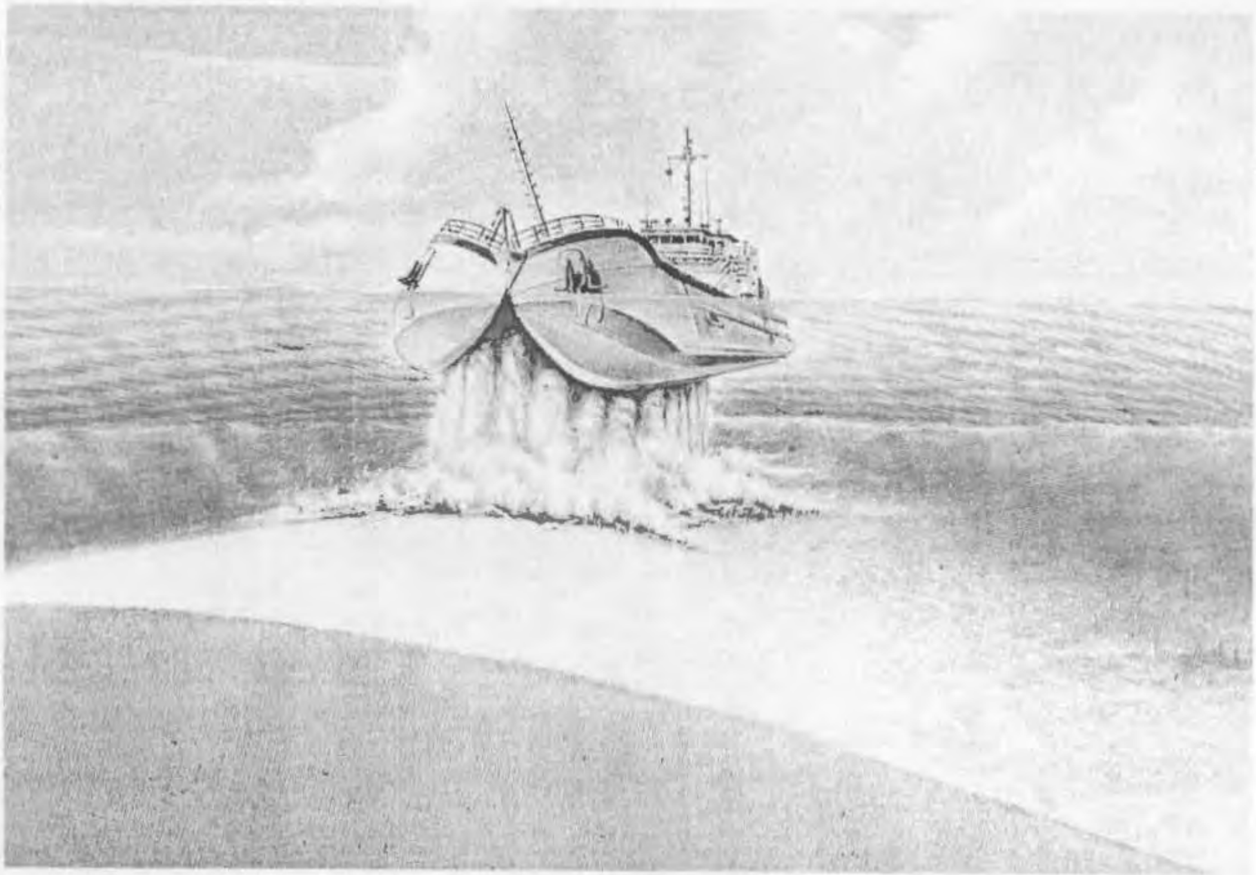
Beach nourishment is the placement of the material on or near the beach, usually to renourish an eroding beach. In some cases, suitable material is placed just offshore on an eroding beach, and natural drift processes may carry the material onto the beach over a long period of time. Beach nourishment is typically done with pipeline and hopper dredges. The material usually comes from inlet, bar, and approach navigation channels.

Upland Placement

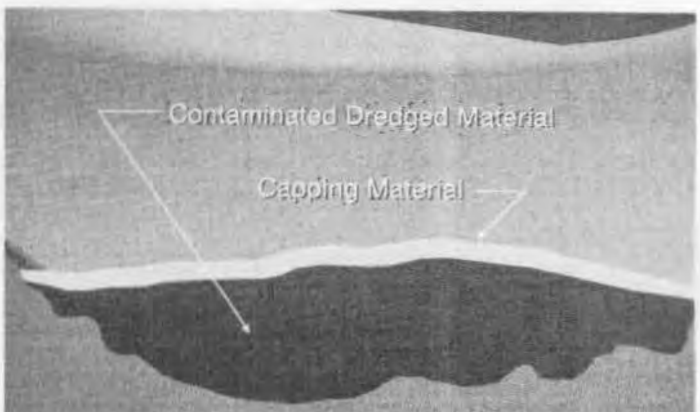
Upland placement isolates the material from the environment by placing it in diked areas where the material is contained. Upland placement usually occurs by pipeline dredge, but in special circumstances dredged material is pumped or mechanically rehandled directly from barges or hopper dredges. In some cases, this is the most economical method for managing the material. However, urbanization threatens the availability of suitable sites.

Open-Water Placement

Open-water placement refers to dredged material placement in near-coastal and inland waters and might also include capping, which is a specially engineered method to contain contaminated sediments.

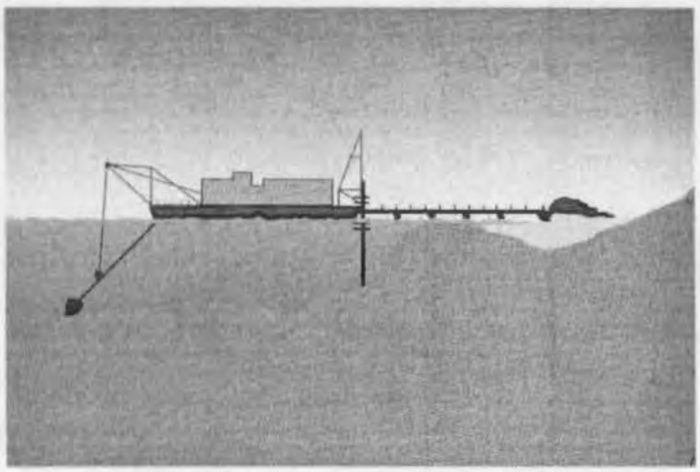


The contaminated dredged material is placed on a level bottom or in deep pits or bottom depressions and capped in a precisely engineered manner to ensure that the cap stays in place and the contaminated material remains isolated from the environment.



Within-Banks Placement

The within-banks placement method generally occurs on river systems where the sands are placed on eroded banks or downstream of the shoals along the shoreline. Sometimes these sands are used for construction aggregate or other commercial purposes. Material placed within banks is usually coarse-grained sand that has accreted into rapidly shoaling navigation channels.



Dredging Can Benefit the Environment

About 95 percent of dredged material is not contaminated and is a resource that, placed in proper locations, can be put to productive use. Our search for opportunities to beneficially use dredged material includes wetlands construction, borrow pit reclamation, landfill cover, construction aggregate, beach nourishment, and wildlife and endangered species habitat.

The Corps of Engineers and the Environmental Protection Agency use scientific procedures for identifying and assessing contaminated sediments at dredging projects. These procedures have been published in technical manuals to ensure that dredged material will be managed in an environmentally responsible manner.

Landscaping with manufactured soil from dredged material

When contaminated sediments are identified in material that must be dredged for navigation, proper safeguards are undertaken to isolate the contaminants from the environment.

Where the dredged material is highly contaminated and traditional disposal is not suitable, one of a number of special remediation technologies might be considered. Activities such as physical separation (hydrocycloning or attrition scrubbers) and incineration can be used to remove contaminants from the dredged material. However, these techniques are very expensive, have limited application, and create management problems of their own.

Beneficial Uses

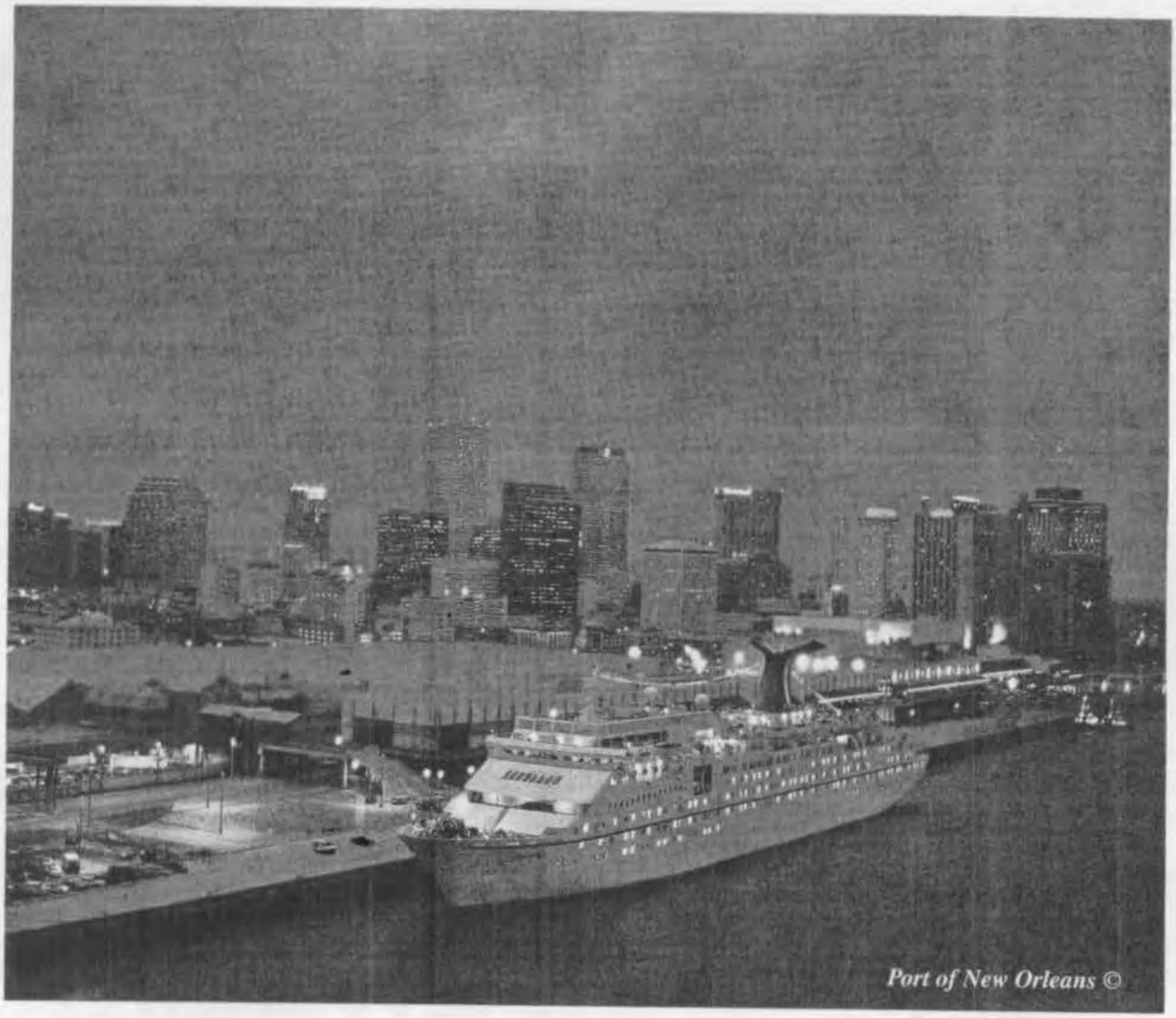
Placing dredged material in areas that benefit the environment is referred to as "beneficial uses." This method offers perhaps the greatest number of possibilities for placement. Suitable dredged material is placed as fill to create recreational areas, airports, or other projects. Constructing wetlands is a beneficial use that has evolved into a scientific process where habitat can be designed for specific plants and animals, including critical habitat for endangered species.

Where clean sand cannot be economically transported to renourish beaches, underwater berms can be constructed just offshore from the beach zone and the sands may be transported by natural forces to the beach. Agriculture and industry have also welcomed the beneficial use concept. Some disposal areas leased to farmers have been successfully converted to crop and pasture lands. Sites in or near cities have been used as industrial sites, parking lots, and airports.

London Convention

The Convention on Prevention of Marine Pollution by the Dumping of Wastes and Other Matter, more commonly referred to as the *London Convention*, was negotiated in London in November 1972 and came into force in August 1975. Member nations meet

annually to debate and resolve legal, policy, and technical issues regarding ocean dumping of all materials. The United States is a signatory member of the London Convention. Thus, regulatory criteria developed by the United States must, at a minimum, be equivalent to and contain all the basic constraints set forth in international regulations.



Port of New Orleans ©

Dredging Is for People

The importance of dredging cannot be underestimated. Our national defense and economic well-being depend on our successful participation in the global marketplace. Our military vessels depend on rapid access to land-based facilities. This participation and access is possible only if state-of-the-art shipping vessels can safely operate in our navigable waters.

Constructing and maintaining our underwater highways keeps these big ships moving.

The men and women of the U.S. Army Corps of Engineers work closely with port authorities and other stakeholders to keep our shipping channels open for the benefit of the people of the United States.

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Large photos, pages 3 and 4 . . . . Don Wilson

Special thanks to the American Association of Port Authorities (AAPA) and Dredging Contractors of America (DCA) for editorial and photo contributions.

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