WHAT IS ENVIRONMENTAL DREDGING?
Use of the term “environmental” or “remediation” dredging has evolved in recent years to describe dredging performed specifically for the removal of sediment contaminated at levels that can endanger marine life and human life. Environmental dredging is executed for the specific purpose of removing hazardous wastes that are detrimental to ecosystems and it is conducted in a way to minimise the spread of contaminants to the surrounding waters during dredging.

Environmental dredging techniques aim to achieve a high concentration of dredged sediment with the lowest possible turbidity. They try to optimise the precision with which operations are done, for instance, to remove accurate thin layers so that the least possible quantities of contaminated material are dredged and therefore less material requires disposal, since secure disposal of contaminated material can be a challenge. To do this, special ‘environmental dredgers’ have been developed. These are often modifications of cutter suction hoppers, backhoes and grabs. Other adaptations are the so-called “green valve” system developed for trailing suction hoppers, which reduces turbidity caused by overflow during the dredging process.

HOW DOES ENVIRONMENTAL DREDGING DIFFER FROM NAVIGATIONAL DREDGING?
Since all dredging projects have an environmental component and almost all must undergo environmental impact assessments and adhere to strict environmental standards, what is the difference between normal a “navigational” dredging project and a specifically environmental dredging project?

Navigational dredging meets the demands created by increased maritime trade worldwide as well as for the energy industries. The ongoing increase in ship size requires that many of the world’s rivers and canals, the aquatic highways, need to be enlarged or deepened. It also includes capital dredging projects to build new harbours and expand old ones, as well as maintenance dredging to remove sediment as efficiently and economically as possible. Environmental dredging on the other hand is specifically aimed at cleaning up hazardous sediments.

WHAT CHARACTERISES ENVIRONMENTAL DREDGING?
Environmental dredging projects are generally smaller in scale than navigational or capital dredging, but because of their long-lasting environmental implications, environmental dredging projects are of special importance. A capital dredging project may have an environmental component, but more often environmental dredging projects are specific initiatives designed to remove contaminated sediments with the goal of improving water quality and restoring the health of aquatic ecosystems.

Cleaning water bodies where industrial wastes deposited in a pre-environmentally conscious era or other contamination occurs directly aims to protect human health and ensure significant sustainable development. For instance, Sweden’s most important environmental asset is its countless lakes and woods. Nevertheless, the wood and timber industry – and the paper industry in particular – have severely contaminated the lake beds with unmonitored discharges and dumping. The same is true of the paper industry in northern Wisconsin (USA) on the Fox River.

WHAT ARE THE KEY COMPONENTS IN DREDGING CONTAMINATED SEDIMENTS?
Removal of contaminated sediments from the waterbed is complex and demanding. Some of the key components to be evaluated when considering dredging as a clean-up method include sediment removal, transport, staging, treatment (pretreatment, treatment of water and sediment, if necessary), and disposal (liquids and solids). More complex projects may include most or all of these components.

Efficient coordination of each component typically is very
important for a cost-effective cleanup. In general, fewer sediment re-handling steps lead to lower implementation risks and lower costs. To do this requires dedicated equipment which can dredge in a way that recognises the added hazard of working with contaminated sediments. To that end, shipbuilders and the major dredging companies have invested in research to adapt regular dredging vessels. They have also created dedicated technologies to address these hazards.

**WHAT IS PRECISION DREDGING?**
Environmental dredgers have optimised their precision so that they can accurately dredge thin layers. Environmental dredging aims to remove accurate thin layers so that there is less dredged material to be disposed of, especially if the dredged material is contaminated. Special environmental dredgers, such as augers and scoop heads, are equipped with advanced technological positioning and monitoring systems. These increase the ability to dredge with a high degree of precision.

This precision however means that the production level is often lower than with a normal dredging process because the goal is to work with high accuracy and to minimise turbidity. On the other hand, the increase in dredging accuracy permits a decrease of overdredging. This is an essential development as less overdredging means less material to be dredged and treated. From an environmental perspective this means a decrease of suspended sediments. From a financial perspective it results in lower costs, which can lead to reduced tender prices.

**WHAT ARE LOW-IMPACT ENVIRONMENTAL DREDGERS?**
This new range of equipment increases precision, i.e., by reducing overdredging and minimising the suspension of bed material and thus has a lower impact than traditional dredgers. In some cases existing dredger types have been modified; in other cases completely new dredgers have been designed. These new or modified dredgers and technologies ensure that contaminants are not re-mobilised and/or released into the water column where they may detrimentally affect aquatic life. They are built to minimise turbulence and turbidity so as to cause less disturbance to marine flora and fauna.

In addition, the safety of the crew and surrounding populations is also a top priority. In many cases the dredged materials are brought via a closed system to a barge or to disposal areas. Examples include: encapsulated bucket lines for bucket chain dredgers; closed buckets for backhoes; closed clamshells for grab dredgers; auger dredgers, disc cutter, scoop dredger and sweep dredger, all of which are modifications of standard cutter dredgers. These dredgers also contain sophisticated automation and the ability to maximise the concentration of the sediments – which means controlling the excavation level as well as the layer thickness.

**WHAT IS AN ENVIRONMENTAL DISC CUTTER DREDGER?**
A disc cutter dredger is a cutter dredger equipped with a specially designed closed bottom plate and shields. It is stationary and is moved by spuds and/or anchors wires. The special cutter head rests horizontally and rotates its vertical blades slowly. The dredged sediments are discharged through pipelines. It is able to dredge strongly consolidated silt and sand in thin layers of 40 to 50 cm.

**WHAT IS A SCOOP DREDGE?**
A scoop dredge has a shrouded draghead and is designed to remove thick deposits of silt with a minimum of
re-suspension. It is a two-sided functional draghead mounted to allow dredging in two opposing swing directions. This scrapes the material from the water bottom into the suction head of the dredge. At the end of the swing, the blade is turned in the opposite direction, the dredge then walks forward as the draghead continues scraping in the opposite direction. It is because of this functional scraping that the draghead has been named the “scoop head”.

WHAT IS AN AUGER SUCTION DREDGER?

An auger suction dredger functions like a cutter suction dredger, but the cutting tool is a rotating Archimedean screw set at right angles to the suction pipe. The shroud on the auger dredge system creates a strong suction vacuum, with the ability to convey material to the pump faster, causing the augers to be productive with much less turbidity than conical (basket) type cutter heads. This makes them especially useful for environmental applications.

Auger dredgers are highly accurate, designed for efficient removal of layers of contaminated sand or silt. Special attention has been given to boosting the mixture concentration. The spill is minimised by the enclosed auger head, which is unusually wide. The high accuracy of the dredging process helps to keep the treatment costs of the contaminated sediment down. During the 1980s and 1990s auger dredgers were primarily used for sludge removal applications. Today, auger dredgers are used for a wider variety of applications including river maintenance and sand mining.

WHAT IS AN ENVIRONMENTAL CLAMSHELL OR GRAB?

An environmental clamshell bucket, also known as a visor bucket, has a precision cut that closes and is sealed horizontally. It is a mechanical means of dredging that reduces the amount of water that is taken with the sediment and it can also remove debris. Once the bucket is full, the shutter (visor) is closed and only then is the bucket hauled out of the water and the sediments discharged into a barge. This visor or shutter prevents sediments from spilling back into the water. A crucial element is the computer system that is used with high-accuracy motion sensors. With these the operator can accurately follow the removal of materials and monitor the accuracy of the dredging operation.

WHAT IS AN ENCAPSULATED BUCKET LADDER DREDGER?

An encapsulated bucket ladder dredger is a normal bucket ladder dredger that has had a special shield built over the ladder. This ensures that the entire dredging process remains sealed and does not expose the atmosphere or crewmembers or local residents to the contaminated sediments.

ARE THERE OTHER SPECIALISED ENVIRONMENTAL DREDGERS?

Indeed, a few years ago a special-order cutter suction dredger called the Amoris was delivered to Antwerp to work at the SeReAnt contaminated silt treatment facility. The Amoris is an entirely electrically driven cutter suction dredger, including its dredge pumps, powered by a high voltage shore cable. The dredger is fitted out with a heavy duty swing ladder that swings by means of hydraulic cylinders instead of conventional wire winches. To ensure continuous and smooth dredging, the stationary dredger is provided with four spuds of which two are placed in spud carriages. The dredger is designed to work at a dredging depth of max -18 m. The silt is treated and dewatered, after which it is disposed of in a responsible way. The stationary cutter suction dredger, with its 450 mm discharge diameter, was designed to very specific customer requirements for the Antwerp harbour, where a large scale clean-up project of contaminated silt was started in early 2011. The fully automated dredger features, for instance, dredge pump capacity control, swing ladder control, and automated coupling to the shore-based treatment plant.

WHAT IS THE ‘GREEN VALVE’?

The ‘green valve’ system was developed for trailing suction hopper dredgers to help reduce turbidity caused by overflow during the dredging process. One of the first technological advances in the reduction of turbidity was the design of an overflow valve which discharged sediment under the vessel instead of at the water’s surface. However, water overflow consists of not only water, sediments and fines, but also air. And air rises. So, although the larger sediments were
discharged to the sea/riverbed, as the air rose from the underwater outlet to the water surface, it carried fines with it, spreading over a large area causing increased turbidity. With the invention of the ‘green valve’ a major breakthrough took place. The Green Valve reduces the air entrainment and therefore sediments and fines sink to the sea- or riverbed and reduce the turbidity. Less turbidity means less environmental impact.

WHAT ABOUT SILT SCREENS AND AIR BUBBLE SCREENS?
Another environmental measure is the use of silt screens and/or air bubble screens. These screens enclose the area being dredged and prevent sediment from drifting into the general water body. The turbidity is then limited to the area being dredged and disturbance of the aquatic environment is therefore kept to a minimum. The removal of the silt or bubble screen once the operation is completed requires careful attention.

WHAT DATA IS NEEDED FOR SUCCESSFUL ENVIRONMENTAL DREDGING?
As with all successful dredging projects, the characterisation of the dredged material prior to the start of the operation is crucial. A thorough site investigation which evaluates the physical, chemical and biological characteristics of the sediment is necessary to determine: potential dredging methods; use, disposal or treatment options; potential impacts; extent of biological and/or chemical testing; and monitoring needs. This is true for simple maintenance dredging but even more true for complex dredging of contaminated sediments where the risks are higher.

WHEN IS ENVIRONMENTAL DREDGING THE SOLUTION?
The need for the remediation of contaminated sediment is recognised throughout the world despite its costs. Stakeholders realise that for a truly sustainable world the contamination caused by residual chemicals and industrialisation must be addressed and that often remedial dredging is the only sufficient answer. Ongoing remediation projects can be found in Brazil, Australia, Israel, Sweden and other European countries as well as at many sites throughout North America in both the United States and Canada. In Canada alone over 600 aquatic sites are under assessment; 40 are in the remediation phase.

Cleaning up toxic chemicals in ports and harbours and rivers is a specific skill. Technologies including capping, monitored natural recovery, and dredging have advanced and continue to develop. In this way contaminated sediment management has differentiated itself from mainstream dredging. However, from a sustainability perspective, and despite the capacity of the dredging community to remediate contaminated sediments, the long-term solution and ultimate goal should always be given to control contamination at source. This basic premise is an environmental rule: Prevention is always worth a pound of cure.

WHAT ARE THE PROS AND CONS OF ENVIRONMENTAL DREDGING?
Environmental dredging can result in efficient and accurate removal of contaminated sediments. One given however is that operational and production rates for environmental dredging are lower than for navigational dredging. Another is that re-suspension, release and residual sediments are
controllable, but these issues must be addressed in the planning stages. Typically, as with other dredging equipment, the impact of noise, fuel emissions and exhaust must be considered. The safety of the crews is also always a concern but more so when working with contaminated sediments.

In general sustained production rates for environmental dredging are low, but their precision allows the removal of contaminated sediments without removing clean material. This precision is ultimately cost-efficient. Environmental dredgers serve a unique purpose in the stride towards sustainability. They provide the opportunity to clean up waterways – ports, access channels, lakes and rivers – that are crucial to long-term global well-being, both economically and socially.

FOR FURTHER READING AND INFORMATION


*Dredging the Environmental Facts (2005)*. PIANC, IADC, CEDA and UNEP. ISBN 90-75254-14-8


