THE OSLO HARBOUR REMEDIATION PROJECT

Oslo Fjord Clean Up

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Oslo Fjord Clean Up

Background to the project

The clean-up project is part of an integrated plan of remediation measures for marine areas within the Oslo Fjord. The project is also a step in a concerted national effort to remediate contaminated sediments. The Oslo project is timed to support the ongoing construction of an immersed tunnel in parts of the port.

The study underlying the clean-up of the Oslo Fjord, conducted over a ten year period, is a collaborative effort by professional entities in the City of Oslo administration, the Port of Oslo Authority, Norwegian research institutes and others. Analyses have shown unacceptable levels of environmental toxins.

Aim of the project

The aim of remediation of the contaminated seabed is two-fold:

1. to remove contaminated material from the harbour basin, thereby preventing the resuspension and dispersal of environmental toxins in the inner Oslo Fjord.

2. to improve navigation depth in the interests of safe vessel traffic, and to carry out urban renewal measures.

Who is responsible for the clean-up and who is financing the project?

While the "polluter pays principle" underlies all environmental remediation in Norway, this cannot be enforced in the Oslo Fjord since the polluters (manufacturing industries formerly situated along the coastline) no longer exist.

However, various road and urban development projects in the port area have presented financing opportunities. The clean-up now under way is a cost-sharing collaboration between the City of Oslo, the Port of Oslo Authority, the Norwegian Public Roads Administration and developers in the port area. The Norwegian Pollution Control Authority (NPCA) has also made funds available. All in all about NOK 130 million will be spent on cleaning up the port, in addition to remediation of marinas, bathing areas and rivers.

The remediation project, named "Oslo Fjord Clean Up", got under way in 2005.

Participants in the remediation process are:

- The Port of Oslo, tasked with achieving a clean Oslo Fjord
- The Norwegian Pollution Control Authority (NPCA), which has set the premises for dredging operations and the requirements to be met
- Secora, by contract with the Port of Oslo, responsible for dredging and disposal
- The Norwegian Geotechnical Institute, by contract with the Port of Oslo, tasked with monitoring, dredging and disposal operations to ensure compliance with NPCA directives

What kinds of substances are involved?

The seabed in the port area contains polychlorinated biphenyls (PCBs), tri-butyl-tin compounds (TBTs), polyaromatic hydrocarbons (PAHs), mercury (Hg), lead (Pb) and cadmium (Cd). Moreover, large quantities of untreated sewage and surface water were released from the end of the 1800s until purification plants were installed and upgraded in recent times. Although not acutely toxic, these substances can be taken up into the food chain and stored in the body's fatty tissue and liver. Combined with other environmental toxins to which we are exposed, they may be harmful in the longer term. However, the contaminated seabed is not defined as hazardous waste. Its content of hazardous environmental toxins such as PCBs and mercury amounts to a few parts per thousand. More than 90 per cent consists of sand, silt and clay, 5-10 per cent organic matter (leaves and dead algae), heavy metals and organic environmental toxins.

What solutions are available?

Various solutions

Various measures are taken to improve the state of contaminated sediments. There are currently two main remediation methods:

1.
Capping the contaminated sediments with clean material to form a new, clean seabed above them.

2.
Removal of the contaminated sediments from the seabed by dredging and placing them in an approved disposal facility.

Capping

This method involves covering the polluted sediments with clean material to render environmental toxins unavailable to marine organisms. The types of material needed depend on the extent to which the seabed is exposed to resuspension, currents and dispersal.

Dredging

Contaminated sediments can be removed from the seabed by dredging. Mechanical or hydraulic dredging methods will normally be employed.

An example of mechanical dredging is grab dredging where the sediments are scooped up by a grab bucket.

An example of hydraulic dredging is suction dredging where the contaminated sediments are removed from the seabed by a centrifugal pump.

Neither mechanical nor hydraulic dredging are perfect methods. While the small quantities of water accompanying the collected sediments in mechanical dredging are a major aid to subsequent disposal, this method may stir up and disperse particles and capacity is relatively small.

Hydraulic dredging has higher capacity and causes little resuspension and dispersal of material. However, large quantities of water may be taken up which may substantially increase the costs of disposal. The method is also sensitive to waste on the sea bed.

Disposal

Mechanical dredging requires a plan for disposal of the dredged material. A relevant method is to establish a disposal facility. Several types of disposal facility exist.

Disposal on land

The sediments are taken up on land and placed in an approved disposal facility, for example in a subterranean cavity or landfill.

Disposal at sea

The contaminated sediments are placed on the seabed and are covered with clean sediments to prevent the dispersal of environmental toxins (relevant when the sediments cannot be covered in situ). If the sediments are placed in deep water, the solution is known as deep-water disposal. Where sediments are placed in shallow water, the term is shallow-water disposal.

Shore disposal

Shore disposal areas can be established where there is a need both to reclaim land and to dispose of sediments. The disposal area is first walled in, after which the sediments are placed inside the wall.

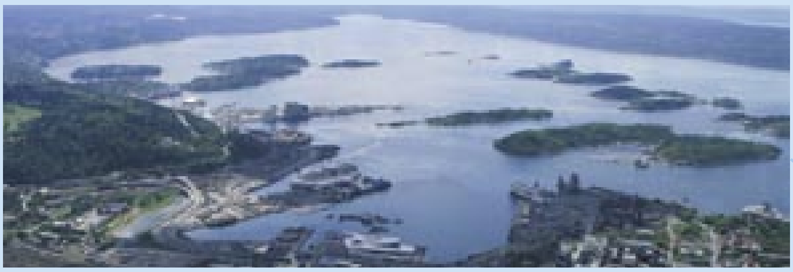
Which solution did we choose?

Both capping and dredging were selected in the Oslo Fjord Clean Up Project. Some of the contaminated sediments will be capped; the remainder will be dredged and stored in a disposal facility.

Capping
The contaminated sediments will be capped using clean clay recovered from the tunnel construction project.

Dredging
The sediments will be dredged using a specially designed closed grab to minimise resuspension.

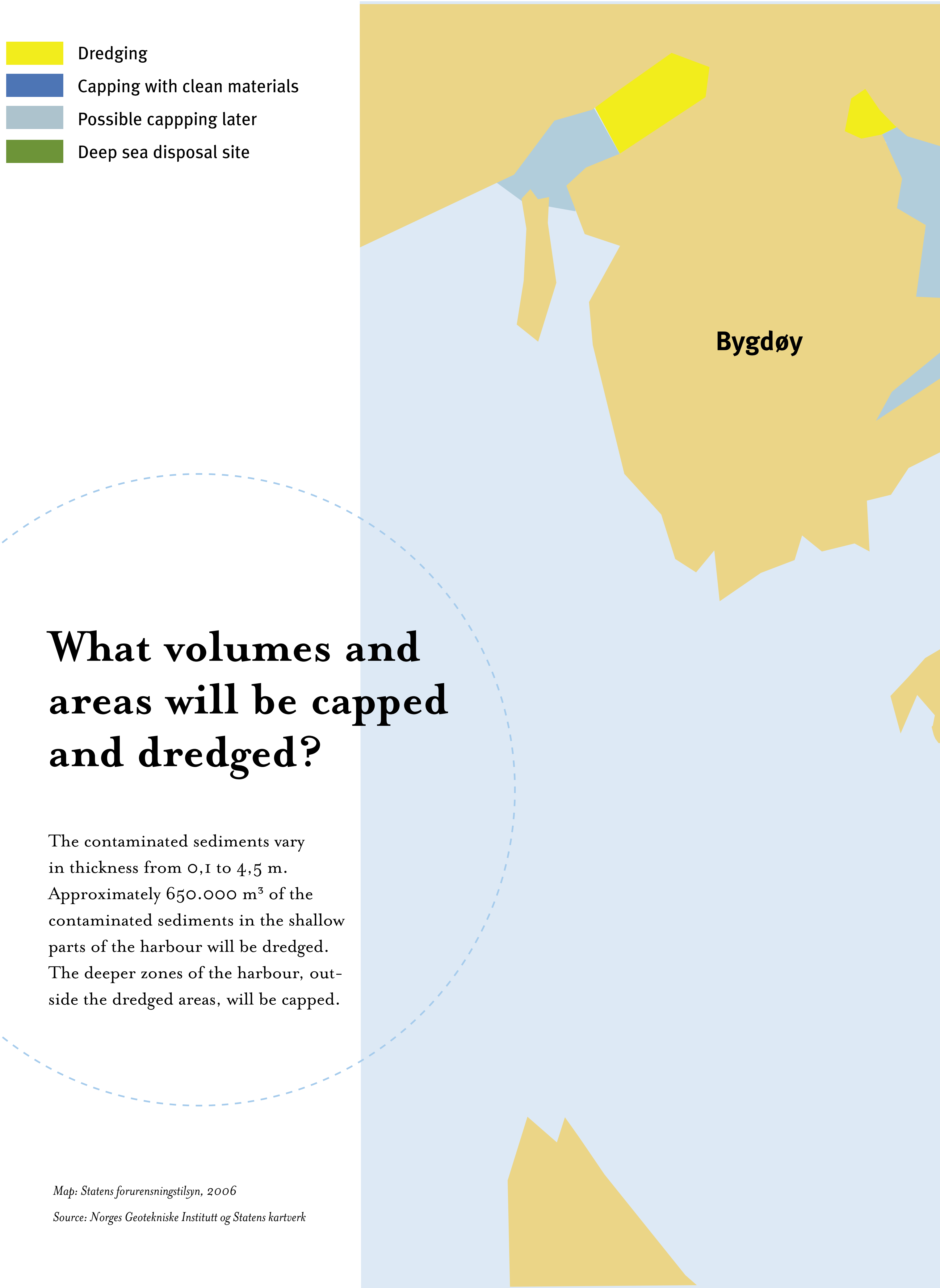
Disposal
The sediments will be stored in a deep-water deposit site located near the head of the Oslo Fjord.



Important criteria for selecting dredging equipment

It should:

- cause minimal seabed resuspension
- permit accurate dredging resulting in minimal contaminated volume for disposal
- produce pumpable matter for placement into the disposal facility
- have high capacity
- do the job quickly
- run quietly
- incur favourable costs
- cause little inconvenience to ship traffic in the period of operation
- enable removal of metal scrap from the dredged sediments
- permit archaeological monitoring



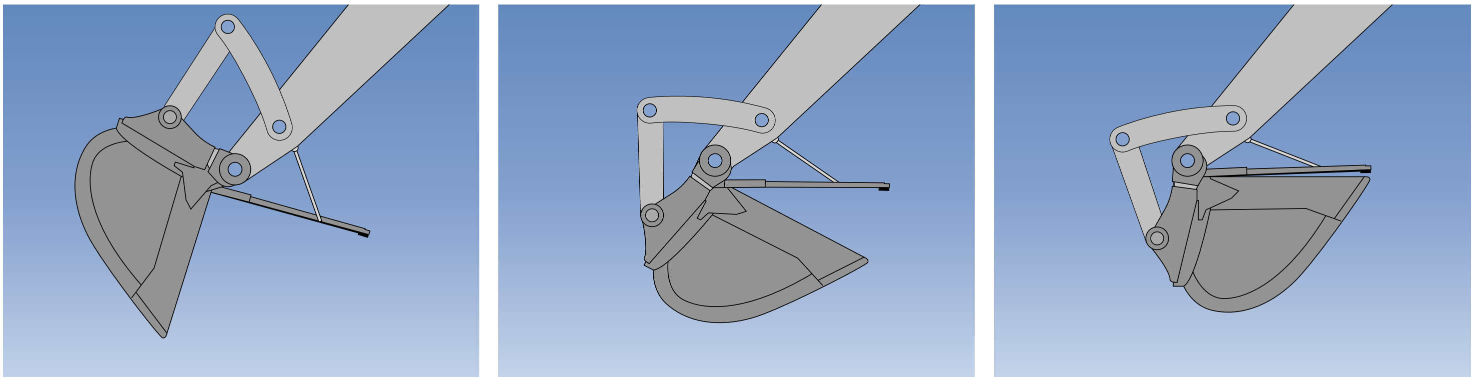
What volumes and areas will be capped and dredged?

The contaminated sediments vary in thickness from 0,1 to 4,5 m. Approximately 650.000 m³ of the contaminated sediments in the shallow parts of the harbour will be dredged. The deeper zones of the harbour, outside the dredged areas, will be capped.

Map: Statens forurensningstilsyn, 2006

Source: Norges Geotekniske Institutt og Statens kartverk


Rådhusplassen
Aker brygge
Filipstad
Bjørvika
Bispevika
Sørenga
Loelva
Hovedøya
Lindøya
Bleikøya
Sjursøya
Langøyene
Ulvøya
Malmøya
Malmøykalven



About the dredging

Secora's contract with the Port of Oslo for the dredging of 500,000 m^3 of contaminated sediments from the harbour basin in Oslo, along with transport and placement into the deep-water deposit site, has so far proceeded as planned.

The dredging vessel uses an excavator fitted with a specially designed grab which loads the materials directly onto a barge. The grab has a specially designed "lid" which closes when the bucket is raised to the surface, thereby reducing spillage and resuspension. The operator controls the grab using information fed into a system of maps showing the level of the present seabed and the thickness of the layer to be dredged. Sensors on the dredger combined with map presentation enable the operation to be carried out in real time. By this means the system records the progress made in the dredging area.


LEKTER
LEKTER
Arild W Solerød


Displacement operated pump.


Salt container.

About the disposal facility

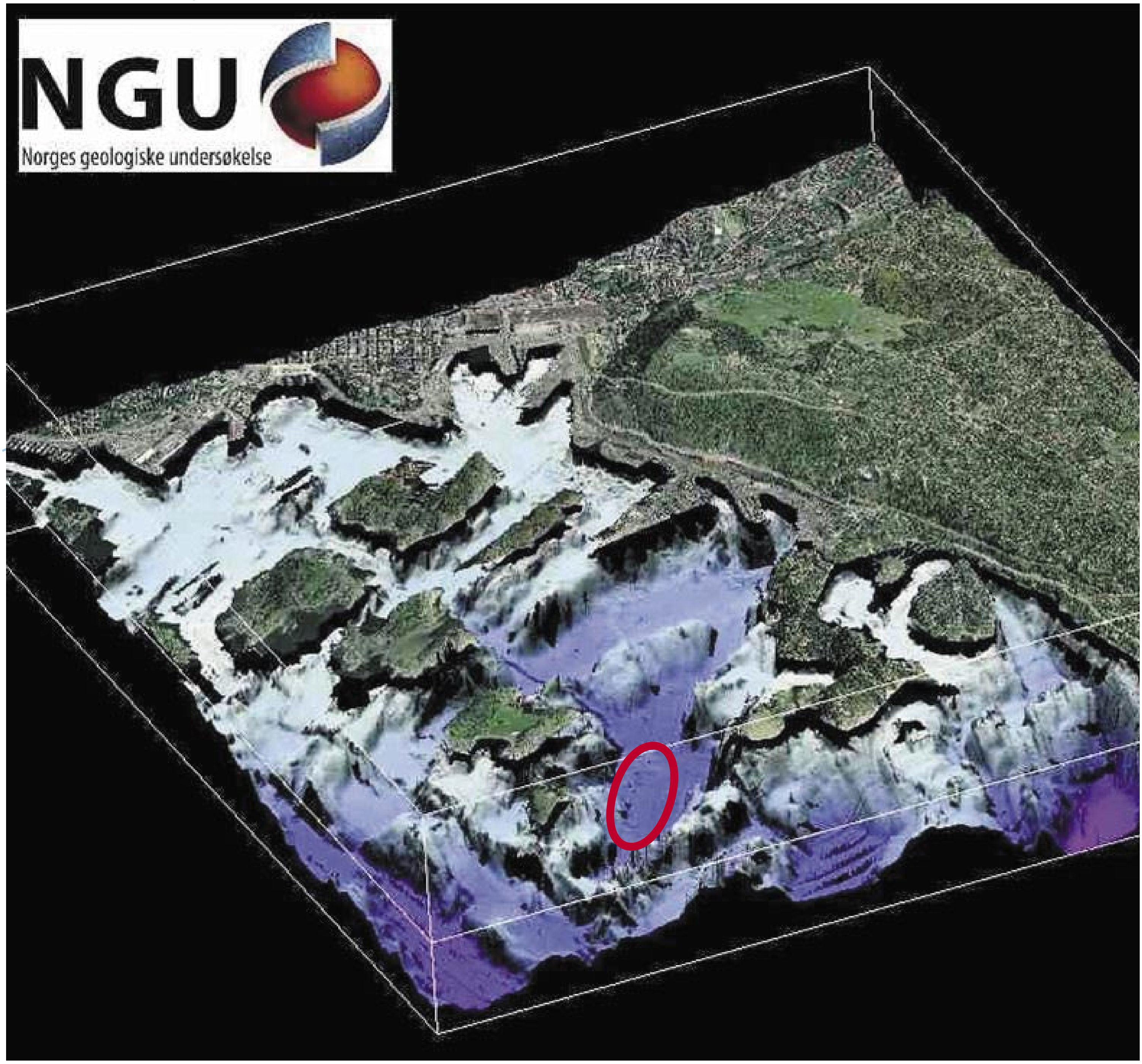
There were several reasons for selecting the location of the deep-water deposit site. The selected basin is at some depth, approaching 70 m, and is encircled by relatively shallow natural barriers that minimise the risk of dispersal beyond the facility. The seabed in the area was already heavily contaminated having previously been used as a dumping area for waste such as clay and ballast and scrapped ships/boats.

The transport distance from the dredging area is short, enabling good logistics. The disposal facility also has the capacity needed to receive the projected volume of dredged sediments.

The sediments are transported by barge to the deep-water deposit site and are transported into the facility by means of a permanently anchored dredged material placement unit. Two barges are used to achieve optimal work flow.
The unit features a displacement operated pump.

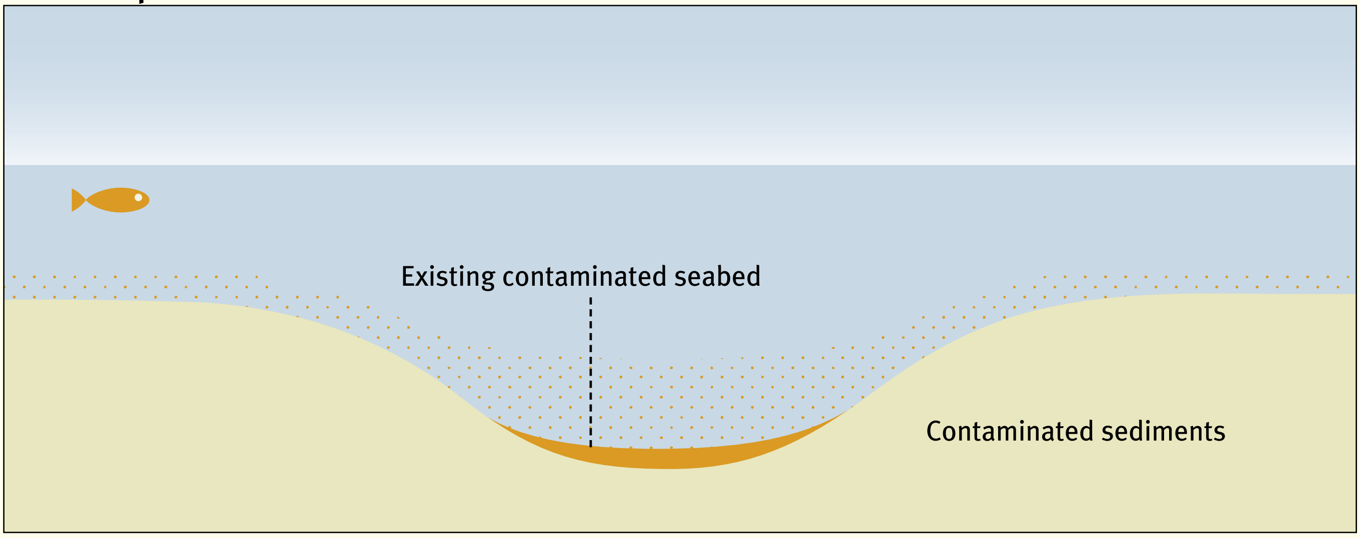
The pump is lowered into the barge's hold and the sediments are pumped directly into a transport line which extends right down to the seabed with a diffuser (flow dampener) at its base which changes the direction of the outflow by 90 degrees. The diameter of the transport line increases with increasing depth and this, together with the diffusor, slows the material's outflow velocity into the seabed and reduces the likelihood of particle dispersion to the water column.

In order to maintain high water density at increasing depths, salt is added to ensure that the excess water accompanying the dredged material achieves a density equal to or higher than the bottom water in the disposal facility. Between 800 and 1500 kg of salt are added to each barge load, depending on the quantity and salinity of the excess water.

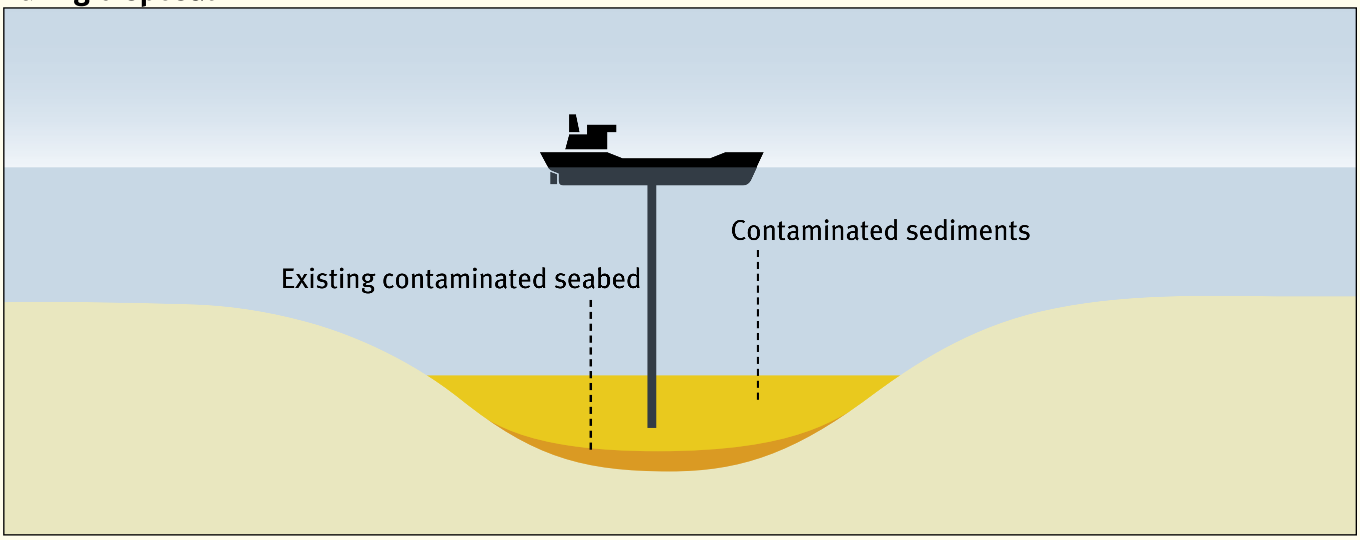

NGU
Norges geologiske undersøkelse

Placement technique for dredging material in deep-water deposit site

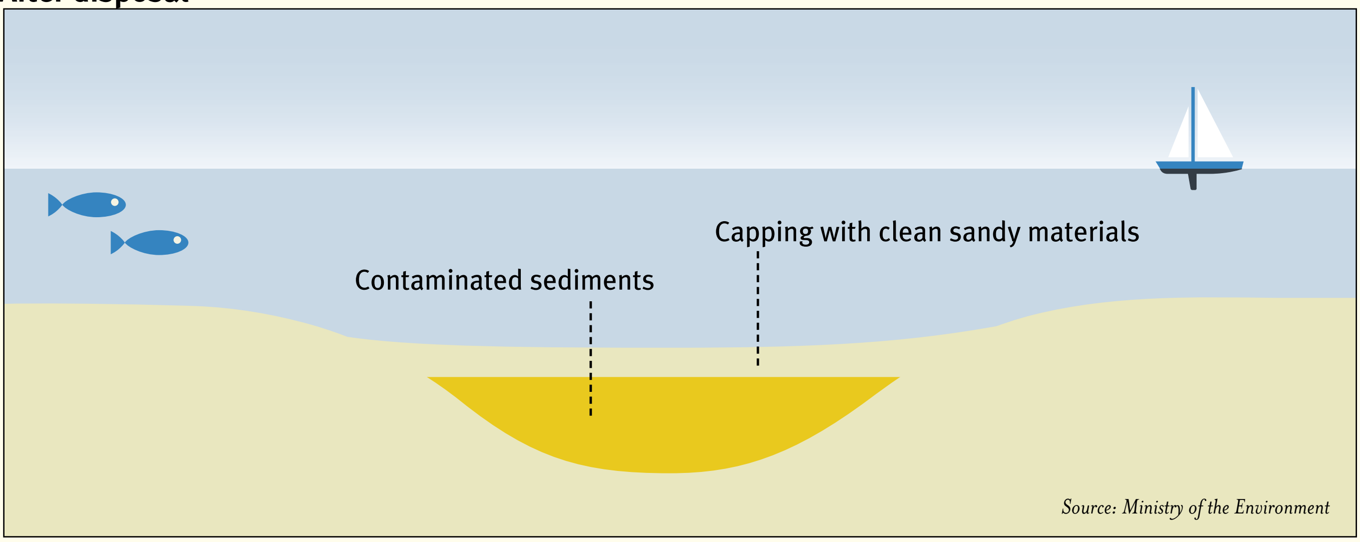
Before disposal

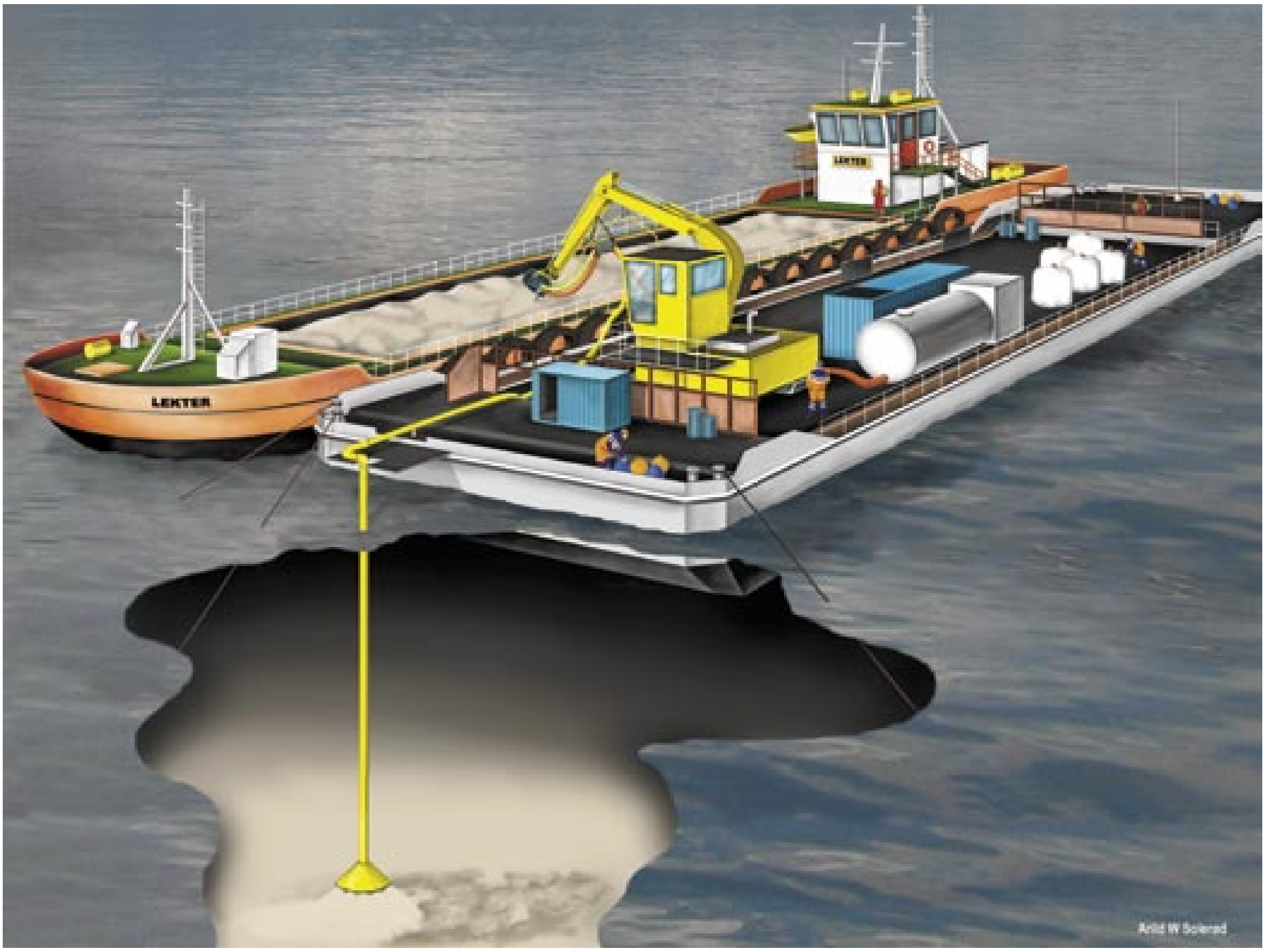


During disposal



After disposal





Monitoring and control of the disposal facility

The Norwegian Geotechnical Institute is responsible for the extensive control and monitoring programme around the disposal facility and the dredging operations. The measurements are carried out as follows:

- On-line control of turbidity and near-bottom current velocities. Measuring sensors are suspended three metres above the seabed as well as at different depths and transmit readings directly to the NGI by SMS.
- Regular and systematic sampling and analysis of the water to ascertain the quantity of heavy metals, PCBs, PAHs and TBTs.
- Periodic sampling and analysis of sediment deposited in sediment traps outside the disposal site.
- Measurement of dissolved PCBs and PAHs at different depths using passive samplers to achieve a time-integrated sampling.
- Visual checks by Remotely Operated Vehicle (ROV)

Monitoring buoys have been deployed to measure turbidity in the water around the deep-water deposit site. In addition, background turbidity measurements are monitored from a reference buoy further to the north in the Bekkelag Basin.

End result

The dispersal of PCBs and PAHs from the dredging of the contaminated seabed in the Port of Oslo is divided into three phases:

Dispersal prior to project implementation

Estimated (based on measured values) at 232 grams of PCBs per year and 5.7 kilos of PAHs per year. Relevant mechanisms assessed are diffusion and resuspension of particles/propeller erosion.

Dispersal during dredging operations

Estimated at a total of 388 grams of PCBs and 13.9 kilos of PAHs during the remediation period. The raised levels are due to particle resuspension. There is additional diffusion from the sediments in the dredging areas and resuspension/propeller erosion. Since the bulk of the contamination is bound to particles, the Norwegian Pollution Control Authority has focused on monitoring and control of turbidity in this phase.

Dispersal after project completion

The Norwegian Pollution Control Authority requires the seabed to match condition level II after dredging, which is a stringent requirement in urban areas. Dispersal after project completion is estimated at 12 grams of PCBs and 228 grams of PAHs per year. Dispersal is by diffusion and resuspension of particles from dredged areas.

Dispersal of PCBs and PAHs during disposal of contaminated seabed sediments at Malmøykalven is also divided into three phases:

Dispersal from the disposal facility area prior to project implementation

The seabed in the disposal facility area is contaminated at present. Dispersal from the area is estimated at 5.2 grams of PCBs and 822 grams of PAHs per year. Since current velocities are low, dispersal is by diffusion alone.

Dispersal during disposal

Estimated at a total of 160 grams of PCBs and 4.1 kilos of PAHs during the remediation period. Dispersal is via excess water, particle resuspension, diffusion and expulsion of pore water.

Dispersal after capping

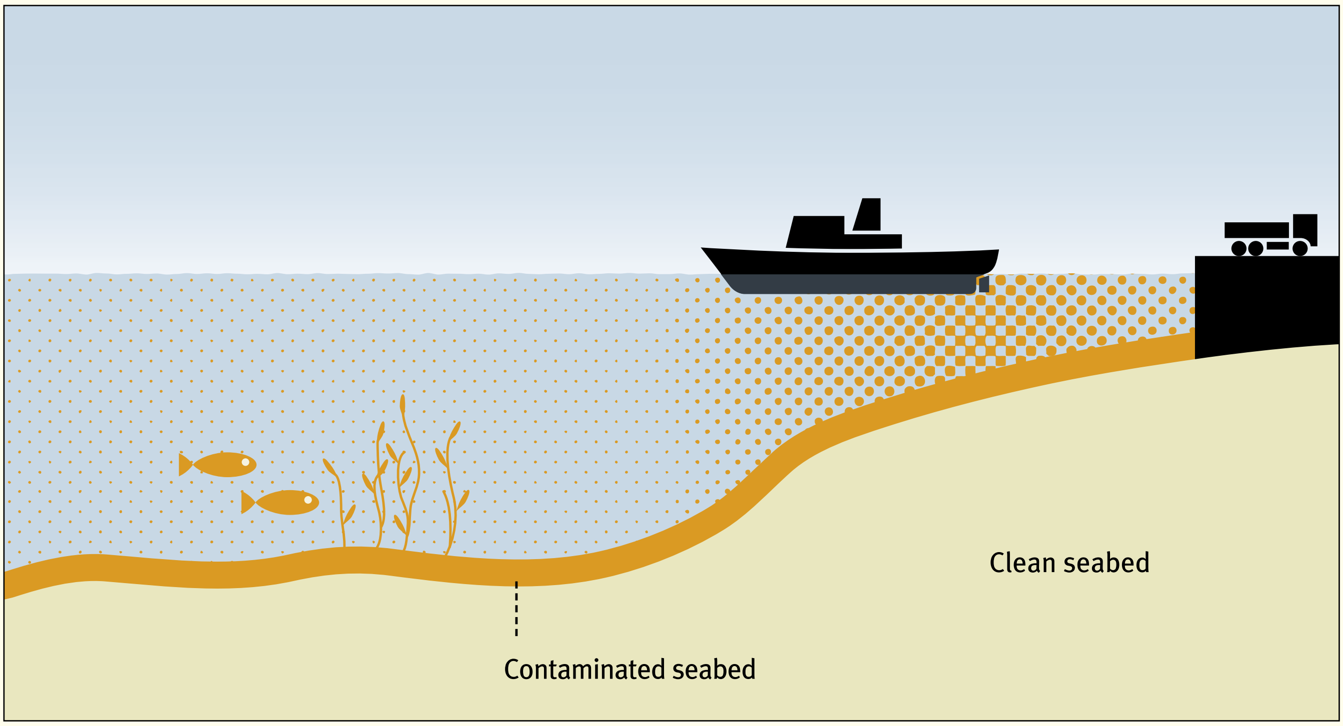
Estimated at 0.5 grams of PCBs and 1.6 grams of PAHs per year. Only dispersal by diffusion through the cap is considered relevant. Also measured at the Solbergstrand research station.

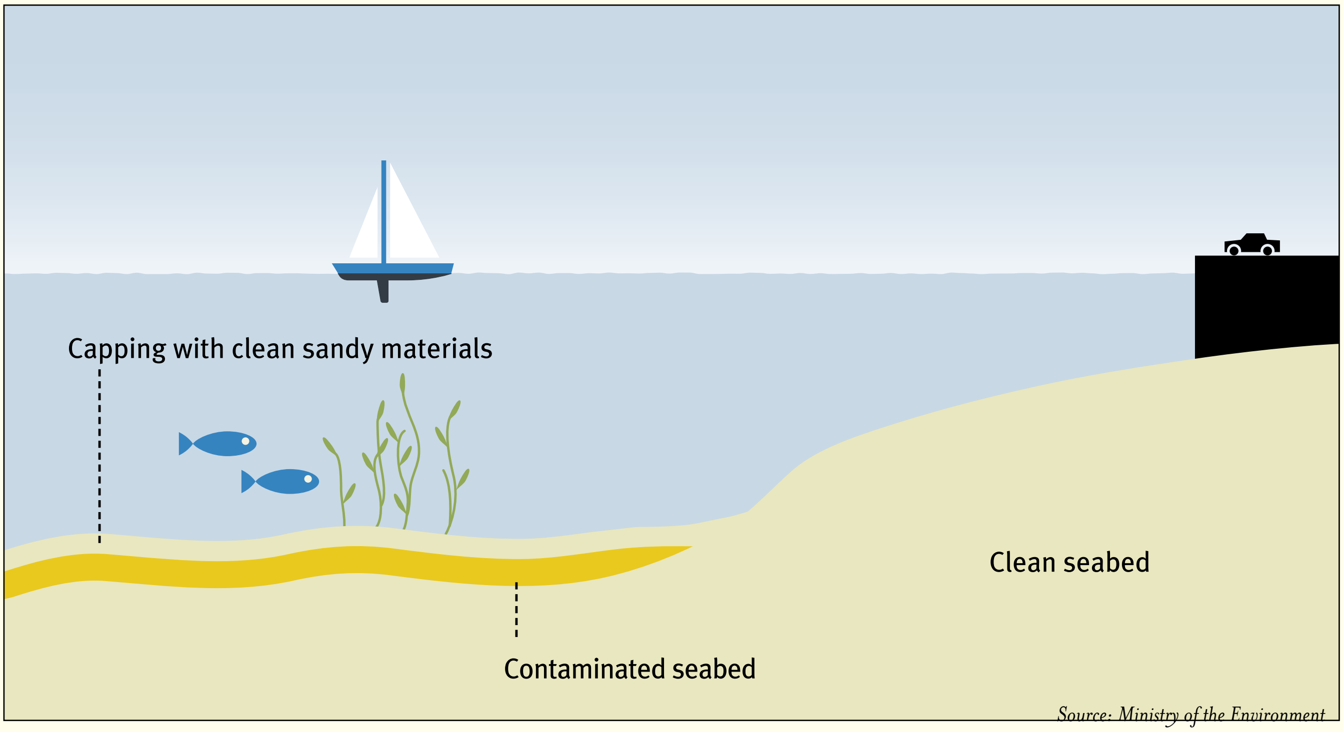
Major environmental benefits from remediating the seabed

Calculations show major environmental benefits from dredging contaminated seabed sediments in the Port of Oslo and disposing of them at Malmøykalven. The dredged material in the deep-water deposit site will be capped with clean material. The seabed in parts of the Port of Oslo will also be capped with clean material, bringing an even larger environmental benefit as a result of the clean-up.

Seabed before and after dredging and capping

Contaminated sediments





FAQs

Why is the dredged material not stored ashore?

Disposal ashore has drawbacks, for example extensive transport and disposal area requirements and risks for future run-off. The solution to move the material to a deep water disposal facility is considered to be safe and the overall best solution for clean up of the Oslo Fjord area.

Why won't pollutants leak from the facility?

The deep water deep-water deposit site will be established in a natural depression in the seabed, 60-70 metres below the sea surface. After the contaminated material is capped, dispersal of pollutants will be greatly reduced. Moreover, the cap is thick enough to ensure the safety of marine animals inhabiting the sediments.

Why not leave the contaminated material where it is?

This is not an option since environmental toxins will constantly be stirred up from the sea bed due to port activities and activities in shallow marinas.

What is being done to check that the deposited material will remain stationary after the job has been done?

Once the disposal has reached completion the facility and the cap will be regularly monitored. The Port of Oslo is required to demonstrate that no pollution is transported through the cap, and to survey animal life on the seabed. The Norwegian Pollution Control Authority will determine when monitoring can be scaled back.

Glossary

Diffusor	A device at the end of the transport line which reduces the speed of the material and distributes the dredged material over the seabed.
Dredging	An excavation activity or operation usually carried out at least partly underwater, in shallow seas or fresh water areas for the purpose of collecting bottom sediments and disposing of them at a different location.
Environmental toxins	Substances likely to damage the ecosystem even at low concentrations.
Resuspension	Stirring up of particles in the water column to form a mix of solids and water
Sediments	Seabed sludge, deposits
Turbidity	Expression of water's clarity or concentration of particles in the water

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Oslo Havn KF, postboks 230 Sentrum, 0103 Oslo
Telefon: 02 180, Faks: 23 49 26 01
E-post:postmottak@havnevesenet.oslo.kommune.no

www.ohv.oslo.no
www.renoslofjord.no