Boskalis
Dredging & Marine Experts

PROJECT SHEET

HAMINA, FINLAND
ENVIRONMENTAL MITIGATION MEASURES:
THE APPLICATION OF THE AIR BUBBLE SCREEN

INTRODUCTION

Hamina, which is close to the Russian border in south-east Finland, is a home port for the oil industry and a transit harbor for timber, cars and other goods on their way to Russia. To provide access for larger vessels it had to deepen the existing channel by two meters to 12 meters and create a new channel section. Terramare Oy, a subsidiary of Royal Boskalis Westminster, won this assignment in late 2008. The project started in July 2009.

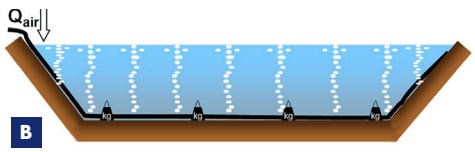
ENVIRONMENTAL CHALLENGES

In the harbor basin, the first step was to remove a contaminated layer of sludge 20 cm deep. The Tributylin contamination was caused in part by fragments of paint from the anti-fouling coating on ship hulls. One of Terramare's top-class vessels was used to dredge up the sludge: the Kahmari 2, which has been fitted out with an HPG Bucket with a capacity of 16 m^3 . The grab can clear an area of 40 m2 at a time. The contaminated sludge (approximately 150,000 m^3), which was spread over an area of about 770,000 m^2 , had to be deposited in accordance with government instructions in a Confined Disposal Facility (CDF). The CDF consisted of two enclosed areas with a depth of 9 m. Two 40m wide entrances allowed

FEATURES

Client	City of Hamina / Finnish Maritime Administration
Location	Hamina, Finland
Period	2009
Contractor	Terramare Oy / Boskalis Westminster

A Aerial view
B Schematized air bubble screen
C Part of air bubble screen system showing the perforated hose and weights for anchoring to the seabed
D Aerial view of the Port of Hamina



dump barges to pass. Sills of 4 m depth were applied to prevent mud from flowing out the CDF along the bed. To prevent the contaminated suspended sediments from being dispersed into surrounding waters and to allow barges to pass unhindered, an innovative sealing technology, developed by Hydronamic, the Boskalis in-house engineering consultancy, was applied: the air bubble screen.

THE AIR BUBBLE SCREEN TECHNOLOGY

Minimizing the impact of dredging operations on the environment becomes increasingly important. This implies the application of specific equipment and work methods, for example a silt barrier to prevent the dispersion of suspended sediments due to dredging operations. An air bubble screen at the

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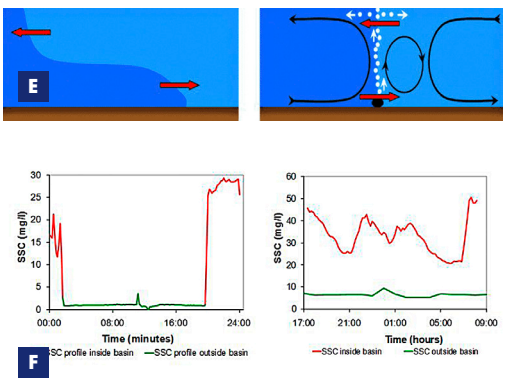
entrance of disposal areas can act as such a barrier, which is generated by pumping air through a perforated hose on the sea- or riverbed (Bray, N. et al 2008).

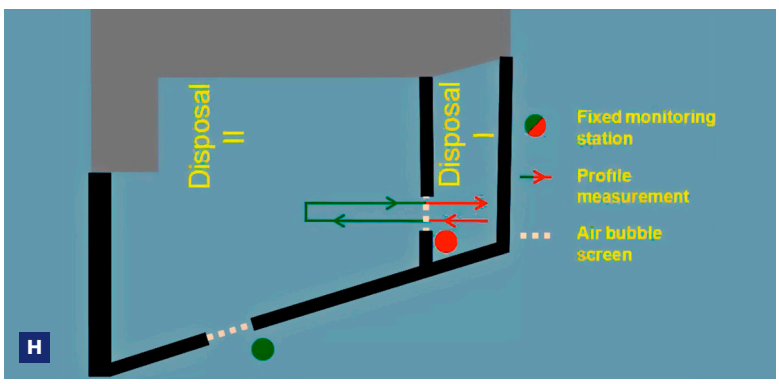
The main advantage of air bubble screens compared to fixed silt screens are:
- Passable for vessels
- Simple to install, operate and maintain
- Efficiency can be adjusted regulating the air flow.

Over the past decade, Boskalis has gained extensive experience in environmental monitoring around dredging works as the demand from clients to monitor the impact on the marine environment related to dredging works has increased. In this process the in-house engineering department Hydronamic has proven to be innovative partner in the design, application and monitoring of environmental mitigation measures, such as Air bubble screens. When compressed air is forced through a submerged perforated hose anchored to the seabed, a continuous 'bubble barrier' results. The rising bubbles cause a vertical current of water to flow towards the surface. This generates a flow towards the barrier in the lower layer of the water column, and a flow away from the barrier in the upper layer. This circulation flow reduces the exchange flow resulting from a density gradient in the water column). Hydronamic has developed a model based on experimental data presented in literature calculates the required air discharge of bubble screens as function of the density gradient and the dimensions of the entrance of the CDF. Air bubble screens can only be applied for relatively calm hydrodynamic conditions, e.g. at the entrance of CDF. Currents and waves generate turbulence in the water column, which prevents the rising air bubbles from forming a continuous barrier.

THE APPLICATION AT THE HAMINAPORT PROJECT
The air bubble systems in Hamina consisted of a perforated hose and an air compressor. A rubber hose was applied as this is flexible and withstands water pressure. The diameter of the perforated air holes was about 2 mm, with a spacing of 33 cm. The air compressor generated sufficient power to deliver the required air flow and to overcome frictional losses and the (hydrostatic) water pressure at the seabed. To verify the effectiveness of the system, the suspended sediment concentration (SSC) was monitored. Two fixed buoys were installed outside the disposal area and vessel-based measurements from within towards outside the CDF and v.v. were performed during the disposal activities. The mobile measurements indicate that SSC levels of 20 to 30 mg/l inside the disposal area, whereas at the other side of the bubble screen only 2 mg/l was measured. Also data from the buoys confirm the effectiveness of the air bubble system. SSC inside the CDF varied from 20 - 50 mg/l, with peak levels shortly after material was disposed. Outside the CDF SSC levels exhibit significantly lower and less varying values (6 - 11mg/l).

CONCLUSION
- Advantages of air bubble screens compared to silt screens is that (1) the exchange flow between sediment-laden and clear water is significantly and permanently reduced as it does not have to be removed when vessels pass, and that (2) it is relatively simple to construct and operate.
- An air bubble screen was successfully applied at the Hamina Port project to significantly reduce the dispersion of contaminated, suspended fines from within a confined disposal area into surrounding waters.
- A newly developed model is available at Hydronamic to design air bubble systems. This model indicates that these systems can successfully applied for rather quiescent hydrodynamic conditions (e.g. little wave action, small tidal range).





E Problem: density exchange flow (red arrows) generating fines dispersion into surrounding waters (left)
Solution: air bubbles generatLe circulation flow which keeps sediment-laden and clear water separated (right)

F Examples of mobile (left) and fixed (right) SSC measurements at Hamina Port

G Successful application of air bubble screen at the Hamina Port Project in Finland executed by Boskalis and Terramare

H Project layout and set up of air bubble screen system

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