Boskalis
Dredging & Marine Experts

CAPABILITY SHEET

ENVIRONMENTAL MITIGATION MEASURES
AIR BUBBLE SCREEN

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

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.

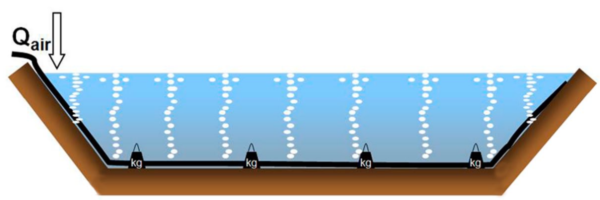
Over the past decade, Boskalis has gained extensive experience in environmental monitoring around dredging works as the demand from clients to monitor the impact on the marine environment related to dredging works has increased. In this process the in-house engineering department Hydronamic has proven to be innovative partner in the design, application and monitoring of environmental mitigation measures, such as Air bubble screens.

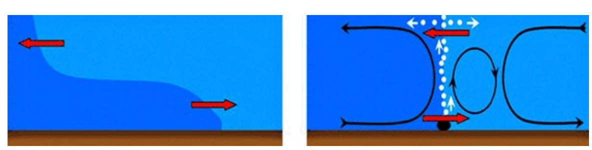
MECHANISM
When compressed air is forced through a submerged perforated hose anchored to the seabed, a continuous 'bubble barrier' results. The rising bubbles cause a vertical current of water to flow towards the surface. This generates a flow towards the barrier in the lower-layer of the water column, 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 *(Figure c)*. 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 Confined Disposal Facilities (CDF). Currents and waves generate turbulence in the water column, which prevents the rising air bubbles from forming a continuous barrier.

CASE STUDY
HAMINA PORT PROJECT — FINLAND

Project description
The case study at the Hamina Port Project was executed by Boskalis Terramare Oy and Hydronamic. Part of the Hamina Port Project *(see Figure a, e and f)* concerned the disposal of Tributyltin-contaminated sediment in a CDF. The CDF consisted of two enclosed areas with a depth of 9 m. Two 40 m wide entrances allowed 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, two air bubble screens were installed at the entrances. The air bubble systems 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 perf rated 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.

A


B


C


A Successful application of air bubble screen at the Hamina Port Project in Finland executed by Boskalis and Terramare.
B Schematized air bubble screen.
C Problem: density exchange flow (red arrows) generating fines dispersion into surrounding waters (l). Solution: air bubbles generate circulation flow which keeps sediment-laden and clear water separated (r).

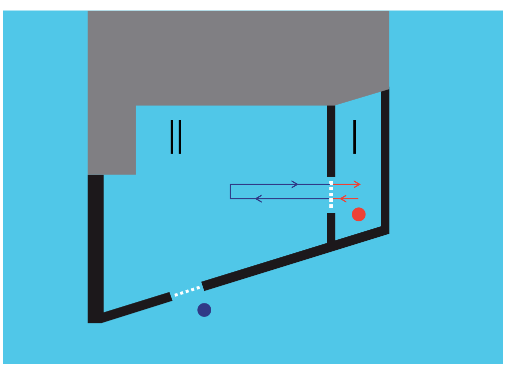
To verify the effectiveness of the system, the suspended sediment concentration (SSC) was monitored. Two fixed buoys were installed outside the disposal area and vessel-based measurements from within towards outside the CDF and v.v. (Figure h) were performed during the disposal activities. The mobile 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).

CONCLUSIONS

- 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 (and currently at the Genoa 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 succes fully applied for rather quiescent hydrodynamic conditions (e.g. little wave action, small tidal range).

C Project location and layout Hamina Port.
D Location on the map

E Part of air bubble screen system showing the perforated hose and weights for anchoring to the seabed.



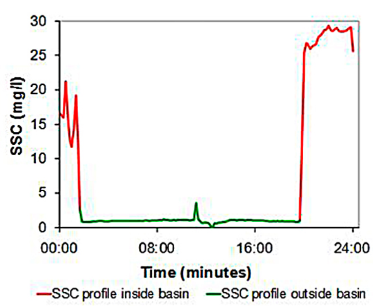
LEGENDA — PROJECT LAYOUT

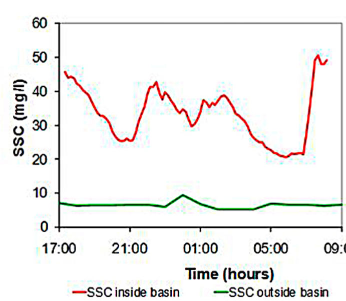
set up of Air bubble screen system

- fixed monitoring station
- profile measurement
- Air bubble screen
- disposal

SSC MEASUREMENTS AT HAMINA PORT

examples of (l) and fixed (r)





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