

# Innovative riverbank restoration using Geotube® elements filled with contaminated sludge

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**Introduction:** The city of Zutphen in the Netherlands is located on the river IJssel, a tributary of the Rhine, one of the main rivers under authority of the Dutch National Waterboard. To guarantee future developments, it was necessary to refurbish the harbour in industrial area De Mars. This project is part of a restoration plan of the entire 550 acre area.

Because of the diversity and financial scale of the revitalising program, the industrial area De Mars was assigned a Pilot Status by the ministry of EZ and VROM.

The entire industrial area and the industrial harbour were neglected for the last 40 years: fully loaded ships could only enter the harbour at high tide without grounding on the bottom. To enable “Rhine-class” ships to enter the harbour and stimulate further economical activity, two problems had to be solved: the port had to be dredged and the riverbanks restored. Without riverbank restoration, the harbour would again be filled with sand and sludge within a few years.

The city wanted to solve the two problems in a sustainable and economic way. The harbour itself was contaminated with 25.000m<sup>3</sup> of polluted sludge that had to be removed. The same amount of material was needed for the refurbishment of the riverbanks and to protect the entrance against the streaming river. Both problems were solved with a single and unique solution: Geotube® units filled with contaminated sludge from the harbour. They were used to make the embankments stable for the future and raise the embankments to the required level. The sludge was stabilized by using a Polymer, carefully selected after several laboratory examinations of the river sludge.

**This project shows that authorities have to think “out of the box” in order to enable innovative projects that solve typical delta problems in a sustainable and cost-effective way.**

The paper is challenging and will deal with the problems that were encountered with the influential National Water Board and possible improvements for future applications.

