

Case Study



Salhouse Spit Restoration

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Broads Authority

The Broads - a member of the
National Park family



PRISMA

Promoting Integrated
Sediment Management

Cover photo: Geotextile structure under construction on Salhouse Broad ©Mike Page. The edge of geotextile bags marks the fringe of the new reed bed. The narrow strip of land separating the broad and the River Bure is to be strengthened.

Introduction

The Broads Authority has a duty to dredge the waterways within the Broads Executive area to keep the navigation channels open for boating. Finding a location for the dredged sediment however, has always proved a problem. Transporting sediment over large distances is not a desirable option.

The dredging is carried out as part of navigation maintenance on the river. Boating is at the heart of the history and culture of the Broads. The rivers and broads are excellent for sailing and there are many yacht clubs in the area. There is also a large hire boat industry which caters for holidaymakers. Day boats are also available, some of which are electrically powered and therefore less damaging to the fragile Broads environment.

A large amount of sediment that accumulated on the river bed can be traced back to erosion. A specific example of erosion is the project location of Salhouse Broad, Northeast of Norwich. (A broad is a shallow manmade lake, conventionally dug for peat). Erosion over the last 60 years has caused the land between Salhouse Broad and the river Bure to become significantly narrow, down to 2 metres in places. Currently the anchors of the sheet piling (riverside) are becoming exposed, threatening the integrity of the river bank and its riverside mooring. In the event of a breach of the spit the river would flow straight into the broad, instead of via the original river bed. A breach would mean the destruction of a historic landscape and a huge impact on navigation and tourism. The strengthening of the spit is therefore immensely important.

The Broads Authority has now restored this lost reed bed and strengthened the spit of land at Salhouse Broad, by re-using dredged sediment. This type of restoration upgrades the sediment from a waste to a valuable resource while benefiting both wildlife and boaters.

Details

Now 7,000m² of reedbed (BAP priority habitat) has been constructed using dredged sediment retained by four giant geotextile bags. The TenCate Geotube® units made of polypropylene are a geotechnical product used in dewatering or marine applications (revetments, breakwaters, groynes, embankments, etc). TenCate Geotube® units are used worldwide in various applications, but in the United Kingdom the product has not been extensively used and is still innovative.

TenCate Geotube® units are fixed to locally sourced alder poles cut from river banks near Salhouse Broad. Alder has historically been used in the aquatic environment because it contains natural oils and its use can be combined with appropriate alder carr management with the trees coppiced from a nearby site. The coppicing prolongs the life of the trees and is regarded as good practice management. Also the coppicing allows light to penetrate the woodland understory and biodiversity is increased. The trees are used in a sustainable way as part of the engineering. With the units filled, the poles no longer form part of the structural integrity.

TenCate Geotube® units, which are 8.5m wide and have a circumference of 18.6m, are big enough to drive a car through! Now filled, they sit below the waterline and the void behind the bags has been filled in with 9000m³ of dredged sediment to restore the reed bed as it was in 1946. An MOD aerial photograph was used to superimpose the 1946 waterline for the restoration.

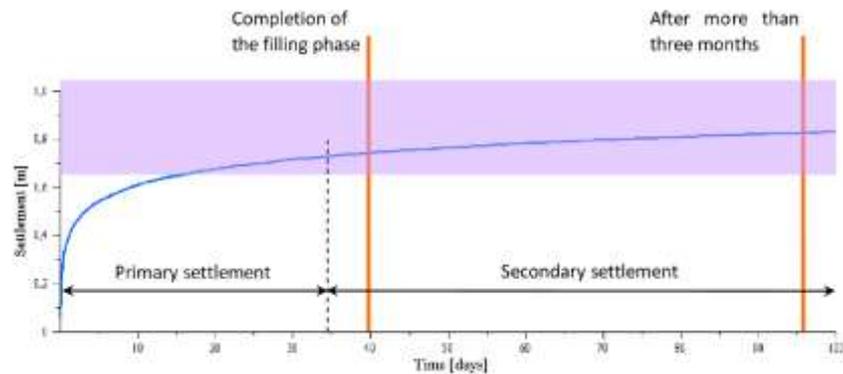


Project simplistic plan, based on MOD aerial photograph 1946

The 1946 waterline was chosen as post war surveys provide the earliest comprehensive aerial photographic record, and it predates landscape changes which may be associated with rapid changes in agricultural practices and increased boat tourism.

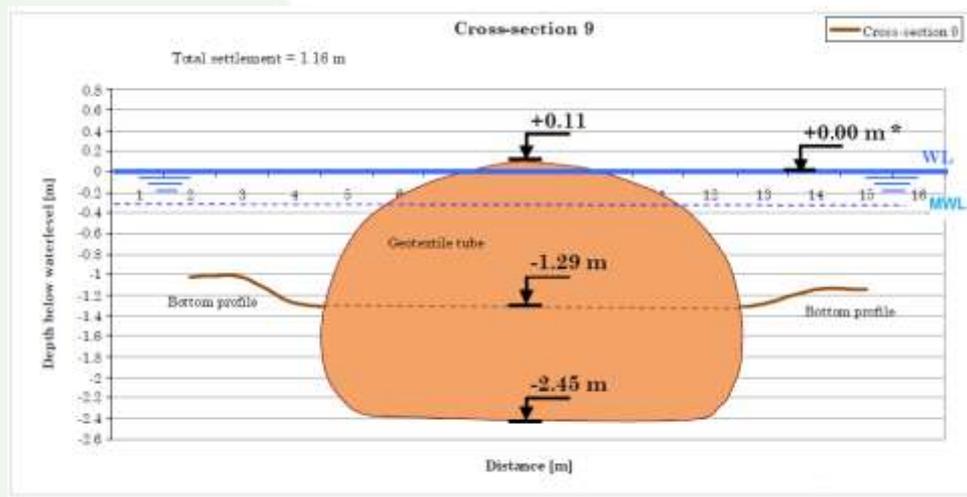
The bed of Salhouse Broad is made up of about 5 metres of soft (accumulated) sediment. Such ground conditions make the construction of a stable retaining structure difficult, using the conventional light piling used widely across the Broads. Therefore a gravity retaining structure was chosen and the use of TenCate Geotube® units filled with local dredged material provided a feasible engineering solution. Creating a mass gravity structure from local material took advantage of similar relative density to convert an engineering problem into a beneficial environmental solution.

The settlements of the TenCate Geotube® units were essential to analyse because of the structural purpose and the functional fill level. Approximately 90 percent of the total settlement was attributed to the primary settlement phase occurring in a matter of days as the underlying ground compacted. Further settlement associated with consolidation over several months was calculated to be significantly smaller. It has to be recognised that the correct filling process is an expert procedure and should not be underestimated.



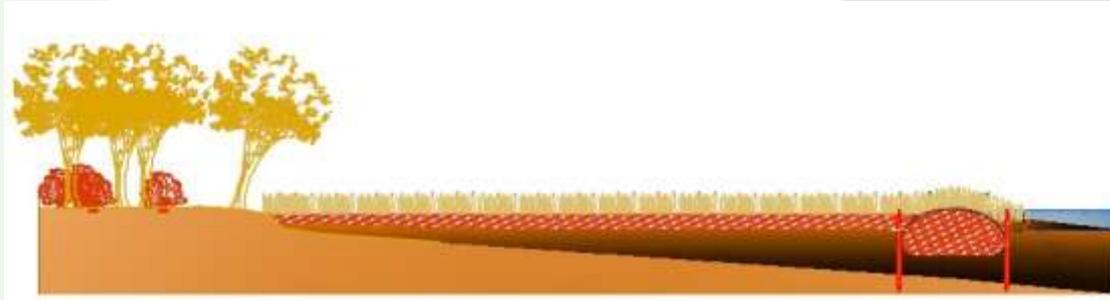
Settlement predictions of the Geotube® units at Salhouse Broad.

The actual settlements and consolidation has been monitored over the period since construction and actual settlements have proven to be similar to those predicted. It is noted however that the behaviour of the TenCate Geotube® units will be influenced by local variance in water level. Further settlement is expected but now in the secondary settlement phase the changes are expected to become negligible.



Monitoring; cross section of one of the TenCate Geotube® units at Salhouse Broad.

The TenCate Geotube® units have been covered by reed and sedge vegetation for stability, erosion protection and wildlife. To speed up the vegetation growth mature vegetation turfs (roots and rhizomes) were scraped from a neighbouring site. Forming the scrapes provided reed material but is also regarded as good management practice because succession is retarded and pioneering species are encouraged. The turf scrapes are applied to the restoration site and are expected to establish much quicker than propagated seed (plugs). By using locally sourced vegetation take up is expected to be high due to minimal changes in environmental conditions.



Cross section of the proposed reedbed restoration with dredgings

The TenCate Geotube® units were filled with approximately 3000m³ of sediment dredged from the River Bure to provide a 170m retaining bank. Sediment from the River Bure was being carried to Salhouse by barge where it was unloaded into a pump by an excavator. The piston pump, conventionally used for concrete, filled the bags via a pipeline. The use of a concrete pump was required to effectively move undiluted, in-situ sediment. TenCate Geotube® units have been filled with sediment before, however not located underwater filled with in-situ (solid) sediment by concrete pump.



Filled TenCate Geotube® units and pipeline at Salhouse Broad ©Broads Authority.

Conventionally, TenCate Geotube® units are filled via pipelines using water as a medium through suction dredging. However, the Broads Authority set up this project as a pilot to fill the TenCate Geotube® units with solid (in-situ) sediment without using water as a medium. A concrete pump

was used to pump the sediment from a barge straight into the tubes. This method only transports the actual product, the sediment, and not the water. Therefore the energy required is reduced and emissions are minimized.

The benefit of this method is that the material does not require dewatering. Polymers (floculants) are not required and discharge of excess water is eliminated, reducing potential water quality problems. The sediment also retains an element of geotechnical strength and resistance which enhances the stability of the structure.



Construction underway at Salhouse Broad ©Mike Page.

Benefiting multiple targets

Enhancing habitats

It is widely known that reed bed (UK BAP Habitat) is disappearing nationally at a rate that is not naturally compensated. Therefore the creation of reed bed is of national importance to wildlife and associate recreation. For the restoration of the 7000m² reed bed (9000m³) dredged sediment has been used to fill in the eroded section. The sediment is retained with a structure made of geotextile, instead of other hard engineering (concrete, steel or wood) products. The geotextile retaining structure has a shallow front slope with a gradient 1:10 to encourage a natural reed fringe which also absorbs wave energy. Conventional retaining structures will not be able to deliver as many benefits to the natural environment, structural integrity and tourism. The whole structure will be covered with reed related species to enhance the natural environment. The habitat will invite wildlife species from neighbouring reserves and connect them all more tightly. The wildlife itself will attract more tourism to the site, enhancing awareness of the importance of BAP habitats.

To restore the reedbed vegetation scrapes of rhizomes were made from a neighbouring site to transplant mature vegetation into the restoration site. This is most likely to be achieved successfully

because they grow in the same local environment and the mature vegetation establishes more quickly than propagated plug plants. The vegetation scrapes will enhance the biodiversity of the source site as well, allowing pioneering species to establish. In addition to the transplanting of vegetation, reed and reed mace seed shall be spread during late spring.



Vegetation establishing May 2013 at Salhouse Broad ©Broads Authority.

Supporting tourism and recreation

This innovative project is essential to maintain current levels of tourism and to stop significant damage to the environment by erosion. The project itself has attracted public interest and in the long term visitor numbers to the site are likely to be increased. Salhouse Broad, managed by the landowner, provides visitors with information on the site and the importance of the special habitats and biodiversity. Once the reed bed restoration has been completed, it can become a habitat for rare species which will also attract additional visitors.

Partners, promotion and dissemination

The project is part of the PRISMA Project; Promoting Integrated Sediment Management. PRISMA is a European project set up under the Two Seas Interreg programme, with experienced partners - a water board in the Netherlands, a navigation authority in Belgium and a specialist engineering university in France who regularly meet to share ideas and monitor progress.

The work, that cost approximately £250,000, is match-funded by the European Regional Development Fund under the PRISMA project which was set up to develop innovative solutions for dredging, treating and reusing sediment from our waterways.

The techniques used are the result of sharing expertise with the PRISMA partners. The Broads Authority worked closely with the suppliers of TenCate Geotube® units and the Dutch engineers of Besekk who provided technical assistance on the geotextile bags. Effective communication was vital in the delivery of project's goals.

Broads Authority staff also worked closely with the landowner, Mr. H. Cator. The partnership was very successful because of the significant enthusiasm about the project and the innovative solutions. The landowner contributed, amongst other things alder trees from which the poles were cut.

We also worked with Natural England who acknowledged the win-win situation where the scraping could improve the vegetation (setting back succession) and supply vegetation for site restoration.

Sustainability and innovation

The project at Salhouse Broad is a piece of geotechnical engineering that is highly innovative. There are more than a few innovative aspects to this project. They are all solitarily applicable but also function strongly together. Much of the innovation is very simplistic and for that reason works very effectively.

The Salhouse Spit Restoration project is a pilot for the PRISMA project. Therefore the success of the project will lead the way in restoring many eroded areas in the Broads executive area. Parts of the project, such as the use of alder poles and vegetation scrapes, TenCate Geotube® units or the concrete pump for transporting sediment can be duplicated. In fact the whole restoration project could be repeated elsewhere.

This innovative work is acting as a catalyst for projects beyond the Broads as it has attracted much interest for other organizations. Interested parties can download information on the Salhouse Spit Restoration from the PRISMA website, <http://www.prisma-projects.eu/index.php/en/>, to learn about the methods used. We hope that this project will influence others to use dredged sediment for building and to reduce transport away from the river systems.



Construction completed at Salhouse Broad, awaiting vegetation to grow, ©Mike Page.

TenCate Geotube® is a registered trade name of TenCate Geosynthetics Europe.