The Emscher Project - Back-to-Nature!

Dr. Klaus Rieker
The Emscher Project is located in north-western Germany, between the river Rhine and the city of Dortmund.

The project will clean up the heavily polluted river Emscher running westward.
In the 3,280 km² catchment area shown in green live about 1.4 million people.

In the 865 km² catchment area shown in blue live about 2.2 million people (apprx. 2,500 per km²).
In the Emscher area coal mining started around 1860. Over the years production increased to more than 100 million tons/year. Mining led to subsidence and flooding. Over the last decade mining decreased and has now ceased.
Mining attracted more and more people to the region. Industrialization picked up in the 19th century as well. Both led to a steady increase in waste water volume.

At that time, the only way to dispose, was the river Emscher and its tributaries. With the before mentioned subsidence by mining, this didn’t work well and even led to all sorts of diseases.
The first solution to avoid stagnant water areas, was the construction of open channels collecting both fresh and waste water. Where subsidence had already occurred, dikes were built and the water was pumped into.
Channel construction began in earnest in the 1920’s (about 60 years after start of mining). The Emscher-Genossenschaft, the organisation in charge, was created in 1899 as a registered co-operative of various cities of the region. Construction was manual work, aided by some plant.
With time more and more channels were constructed. Maintenance in case of subsidence was relatively easy. However the danger stemming from the open channels increased due to the load of waste and the ever increasing number of people living along them.
As a first measure, wastewater treatment plants were built and/or enlarged.
The next step was the creation of an underground tunnel system which would replace the open sewers and channel all polluted water to the treatment plants underground → the Emscher Project!

In January 2012, construction section BA30 was awarded to Wayss & Freytag Ingenieurbau AG.
The contract called for the construction of 47 km of pipe-jacked tunnels and 117 shafts (yellow pins). The shafts ranged in diameter from 5 to 24 m and were between 10 to 40 m deep.
The 47 km of tunnels were constructed by pipe jacking in 117 single drives, with the longest being 1.15 km long. The geology consisted predominantly of layers of clayey / silty sand and weathered / fissured marlstone. The clay content was high (41%) and (partly) adhesive. Groundwater pressures of up to 3 bar had to be allowed for.

The internal diameters of the to be constructed tunnels ranged from 0.3 to 2.8 m; whereby almost 45 km were 1.6 m or larger.

Below, the various internal diameters and the corresponding total drive lengths are tabled.

<table>
<thead>
<tr>
<th>Diameter (DN)</th>
<th>Length (m)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN 300 - 1400</td>
<td>2,450 m</td>
<td></td>
</tr>
<tr>
<td>DN 1600</td>
<td>18,372 m</td>
<td>(Slurry)</td>
</tr>
<tr>
<td>DN 1800</td>
<td>3,923 m</td>
<td>(Slurry)</td>
</tr>
<tr>
<td>DN 2200</td>
<td>6,294 m</td>
<td>(Slurry)</td>
</tr>
<tr>
<td>DN 2400</td>
<td>9,297 m</td>
<td>(Slurry)</td>
</tr>
<tr>
<td>DN 2800</td>
<td>6,634 m</td>
<td>(EPB)</td>
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</tbody>
</table>

For the majority of the drives, slurry pipe-jacking machines were utilized. The principle setup is shown above (jacking frame / separation plant).
For the construction of the tunnels, 6 TBMs owned by w&f were being utilised simultaneously for internal diameters of 1.6 m and above. The 2.5 km of smaller tunnels were subcontracted to various companies.

For the construction of 18.4 km of 1.6 m internal diameter tunnels, 2 TBMs were utilized. Due to the high clay content, the mixed-face cutterheads were changed to open-face cutterheads.
The 1.8 m id TBM was fitted with an open-face cutterhead (not shown). The 2.2 m and 2.4 m id TBMs had closed- and open-face cutterheads.

All machines up to 2.4 m id were operated as slurry TBMs with separation plants and mud treatment facilities on the surface.
In some areas further downstream, parallel tunnels had to be constructed.
The 6.6 km of 2.8 m internal diameter tunnel, were driven with an EPB-TBM. Thus mucking-out was done with skips as shown below.
Tunnelling with the first machine started in October 2012 and by October 2015 all tunnels 1.6 m id and larger were completed.
In the Emscher area, steel wire and rope production required years ago large manufacturing facilities. To have minimal impact on the environment, old production facilities were utilized / converted for precast pipe production.
The production facilities were set up to produce 13,000 pipes ranging fr. 1.6 to 2.8 m internal dia.
All pipes were cast standing upright. Subsequently placed into an intermediate curing and storage area. Finally turned to the horizontal position and stocked until required on the individual jacking site.
Most of the permanent walls of the shafts were constructed using self-climbing formwork. Working-hours were from 6 am to 10 pm. For durability reasons, all shaft base slabs had to be brick-cladded.
From the start of the project, the public was informed regularly about progress.

During construction, open days were held and the tunnels were lit in different colours and opened for walk-throughs.

The public interest in the project was high and turnout at such events huge.

This, but also the prospect of having soon clean rivers and even recreation facilities where previously waste water was seen and smelled, made acceptance felt at all times.
During the construction of the 47 km of tunnels, the Back-to-Nature initiative began along the tributaries of the Emscher.

To date, 120 km of open wastewater canals have already been demolished and about the same length of walkways and cycle paths created.
As can be seen, Back-to-Nature is already in full swing.

Canals are being demolished and turned into meandering creeks.
Singapore – 11 November 2016

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Currently some shaft roof slabs still have to be cast and fit-out installations have to be completed. Hand-over and project completion for this construction section is scheduled for September 2017.

By 2020, almost all wastewater will run below surface in the newly created tunnelling system and at the same time the formerly constructed open sewer system will have been demolished. The river Emscher and its tributaries will have been restructured to their natural state or will have become an attractive urban river. The initiative Back-to-Nature will continue to serve future generations.