WORLD PIPELINES®

Volume 10 Number 12 - December 2010

Andre Huettmann and Tim Roeder Hölscher Wasserbau GmbH, Germany, describe the process of dewatering using a horizontal drainage system on the OPAL pipeline project.

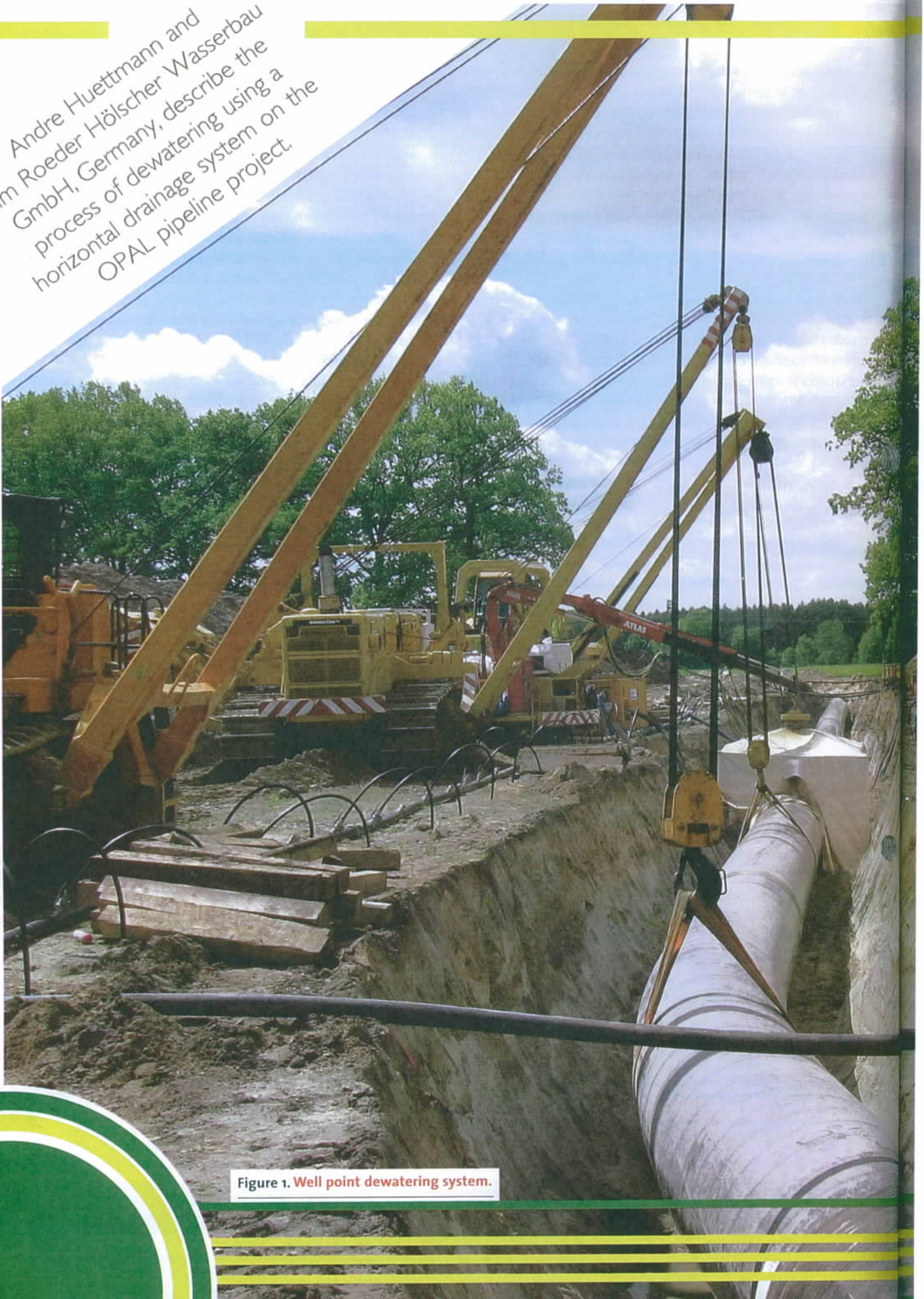
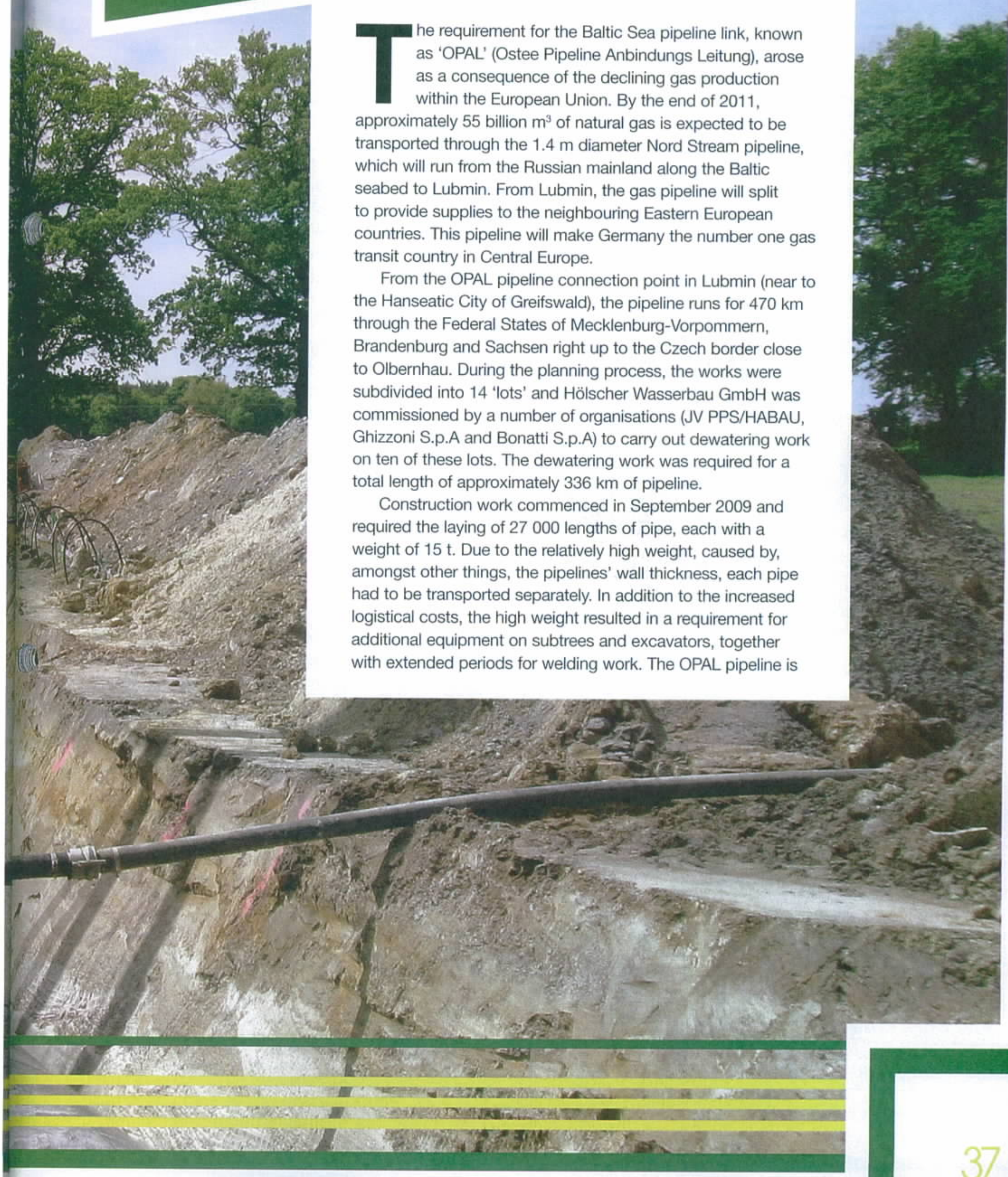


Figure 1. Well point dewatering system.

MULTIPLE GAINS with horizontal drains



The requirement for the Baltic Sea pipeline link, known as 'OPAL' (Ostee Pipeline Anbindungs Leitung), arose as a consequence of the declining gas production within the European Union. By the end of 2011, approximately 55 billion m³ of natural gas is expected to be transported through the 1.4 m diameter Nord Stream pipeline, which will run from the Russian mainland along the Baltic seabed to Lubmin. From Lubmin, the gas pipeline will split to provide supplies to the neighbouring Eastern European countries. This pipeline will make Germany the number one gas transit country in Central Europe.

From the OPAL pipeline connection point in Lubmin (near to the Hanseatic City of Greifswald), the pipeline runs for 470 km through the Federal States of Mecklenburg-Vorpommern, Brandenburg and Sachsen right up to the Czech border close to Olbernhau. During the planning process, the works were subdivided into 14 'lots' and Hölscher Wasserbau GmbH was commissioned by a number of organisations (JV PPS/HABAU, Ghizzoni S.p.A and Bonatti S.p.A) to carry out dewatering work on ten of these lots. The dewatering work was required for a total length of approximately 336 km of pipeline.

Construction work commenced in September 2009 and required the laying of 27 000 lengths of pipe, each with a weight of 15 t. Due to the relatively high weight, caused by, amongst other things, the pipelines' wall thickness, each pipe had to be transported separately. In addition to the increased logistical costs, the high weight resulted in a requirement for additional equipment on subtrees and excavators, together with extended periods for welding work. The OPAL pipeline is at an average depth of 3 m; this being made up of 1.4 m of coverage (plus topsoil) added to the 1.4 m pipeline diameter. At culverts and excavation pits for undercrossing (roads and rivers etc.), the pipeline is at a depth of approximately 6 m.

Figure 2. Map showing the OPAL pipeline project.

Figure 3. Casing drilling rig.

Figure 4. Deep wells.

Due to the depth at which the pipeline is to be installed and because of how this interfaces with the groundwater level, there is a requirement for dewatering measures along almost the entire route.

Hölscher Wasserbau GmbH has been working simultaneously on the 10 lots with five deep-well drilling rigs, two water pressure drilling devices for high output installation of well points, four trenchers for installation of horizontal drainage, 15 4x4 trucks, 10 maintenance vans, 30 pick-up cars, together with a workforce of 100 of our employees.

Description of dewatering procedures

On lots 1 - 10 of the OPAL pipeline, the following four types of groundwater lowering procedures have been utilised:

Sump pump dewatering

Sump pump dewatering is generally the simplest way of getting rid of water and is typically used to collect rainwater or seepage-water. However, this system is not suitable for lowering the groundwater table in sedimentary soils, as fines and other particles can enter the excavation causing unstable and muddy ground conditions.

On pipeline construction projects, sump pump dewatering is used in addition to other dewatering systems locally at small pits inside the pipe trench e.g. at pipe welding points or pipe inspection points.

On the OPAL project, a typical sump pump dewatering installation included a hole excavated to approximately 0.5 m below the bottom of the pit, in which was placed a drainage hose. The hose was then connected to a diesel piston pump, which typically generates a vacuum of 0.7 bar in the system. The groundwater extracted by this vacuum pump is then directed into the appropriate receiving water course through a discharge pipe.

Wellpoint system

Wellpoint systems are particularly suited to dewatering for shallow foundations and short lengths of trenching works. A typical wellpoint system consists of a closely spaced series of small-diameter shallow wells, and each of these wellpoints is connected to a common headermain and are operated by a vacuum piston pump. By utilising this type of installation, a drawdown of up to 6 m may be achieved. Rapid and cost-effective wellpoint installation may be achieved in sandy soils by jetting using high-pressure water.

In total, around 5000 wellpoints have been installed by Hölscher Wasserbau GmbH on the OPAL project, using a high output water pressure drilling rig which has included installation of filters to a depth of 8 m to achieve the required drawdown.

Deep wells

Deep wells are effective for operations where the soil permeability values [k] are between 1×10^{-2} m/s and 1×10^{-5} m/s. Typically, they are created by drilling a hole with a diameter between 0.3 m and 1.2 m to a depth of up to 50 m. Borehole installation is by the casing or rotary drilling method with the method adopted being dependent on the geology, diameter and depth of the well ultimately required. The drilled borehole is equipped with a submersible pump and filter string with the remaining space refilled with filter gravel.

Figure 5. Piston pump connected to a drainage system.

Hölscher Wasserbau GmbH has installed approximately 1600 wells on the project, which were drilled at depths of up to 14 m by using a casing drilling rig.

Deep wells were used at deep excavations (e.g. at pipeline crossings) where large volumes of water were anticipated.

The wells installed have a bore diameter of 700 mm and a filter pipe of 315 mm diameter. The submersible pumps are each connected to a riser pipe of 100 mm diameter, through which the groundwater is pumped to the next receiving water course.

Horizontal drainage system

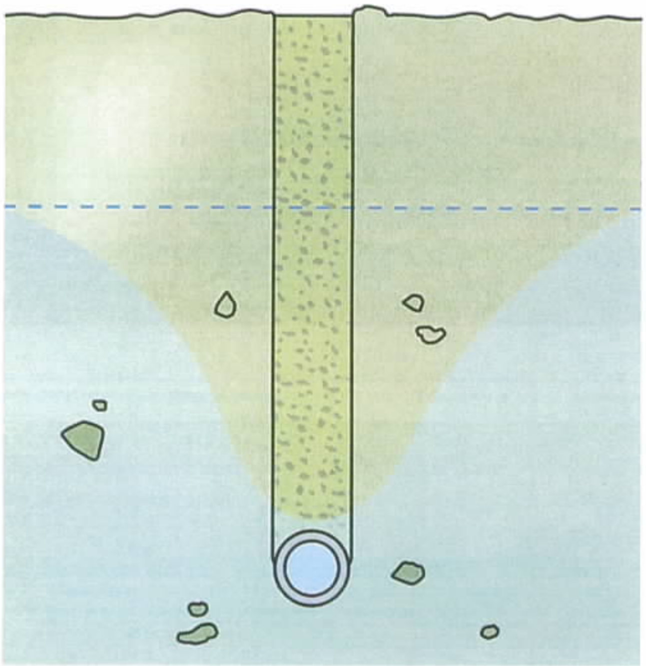
Hölscher Wasserbau GmbH has installed 95 000 m of horizontal drains on the project to date. This type of dewatering is considered an environmentally-friendly process, as it has very small cones of drawdown and drawdown cone radii thanks to low trenching depths.

Lowering the groundwater

The horizontal dewatering system is applied primarily for large areas and large or long stretches of trench typically found in pipeline construction. The system is essentially made up of drains with a diameter of 80 - 100 mm, which are installed in the ground to a depth of up to 6 m. Such an installation is effective for operations with soil permeability values [k] between 1×10^{-3} m/s and 1×10^{-7} m/s.

Figure 6. Installation of horizontal drainage by trencher.

The drains are installed in a trench with a width of approximately 0.3 m, which is cut to the required depth using a machine-mounted rotary cutting chain. The trenching machine also lays the drains at the base of the trench. After the drains are installed, the trench is refilled. As an option, the soil can be replaced simultaneously with filter gravel at a predefined depth. This increases the filtration performance of the drain in difficult types of soil. The drains are connected to a vacuum piston pump, which creates the necessary vacuum for pumping the water, with typical pumps operating at a vacuum of up to 0.9 bar. The water extracted from the surrounding soil is pumped to a runoff ditch via a drain pipe.



Figures 7 (above) and 8 (below). Principal sketches of a horizontal drainage system.

Advantages of horizontal drainage system on pipeline projects

In relation to well points, there are four major advantages for horizontal drainage systems:

- There is less groundwater abstracted to achieve the same drawdown. This is because the effective filter area is horizontal instead of vertical and therefore the drawdown cone radius is shallower. The consequences are: less impact on the environment and also reduced equipment resource requirements.
- There are no wellpoint heads or header main pipes to obstruct the works, and the piston pumps can be placed outside the construction field. The drains are routed underground towards the piston pump.
- The installation price of horizontal drainage is much less than that of well points.
- A high installation output is achieved using trenching technology. A single trencher can install up to 1000 m of drainage per day.

Summary and outlook

What is currently the largest construction site within Germany requires major dewatering resources. It was proven that the horizontal drainage system was capable of fulfilling the technical requirements of this project whilst also providing a highly economic solution.

A further benefit is that the horizontal drainage system, as installed, offered the utmost in safety and ongoing advantages regarding environmental compatibility. This was particularly demonstrated in what is now recognised as the key area of limiting the quantities of abstracted groundwater, which is achievable by using suitable dewatering systems such as the horizontal drainage system. WP

Figure 1 is courtesy of Wingas GmbH & Co. KG.
Figures 2 - 8 are courtesy of Hölscher Wasserbau GmbH.