

## **Groundwater Management for Metro Construction in Copenhagen**

### **Hölscher Wasserbau provides sophisticated groundwater management**

***Copenhagen/Haren (Ems), XX.XX.2015* – Copenhagen is currently building a 15,5 km long new Metro line which is expected to open in 2018. In order to construct the tunnel system with 17 underground stations and four special structures, sophisticated and precise monitoring and controlling mechanisms are required. The German company Hölscher Wasserbau has developed an intelligent groundwater management system specifically for the Danish large-scale project.**

In the new Copenhagen Metro line "Cityringen", driverless Metro trains will transport up to 240.000 passengers per day through a twin-bore tunnel system (Fig. 1). Underground construction works in an inner-city environment pose considerable challenges for all concerned. Apart from ensuring that a safe traffic-flow is maintained and that noise and fume emissions are being controlled, protecting the aquifer (groundwater horizon), which is considerably affected by the construction works, is of prime importance. This applies both for the tunnel tubes running at a depth of 25 m below the surface and for a total of 21 required shafts, which reach down as far as 40 m into the Copenhagen limestone. These shafts, averaging 65 x 20 m in size, are required for the underground stations as well as for various special structures and for tunnel boring machine (TBM) access.

Inside the shafts, it is necessary to lower the groundwater level – in order to allow shaft sinking and to relieve the shaft floor. As there is no impermeable layer, this entails a drop in the groundwater table in the areas surrounding the shafts. This, however, is prohibited in Copenhagen for specific reasons: its inner

city is built on old wooden piles which must on no account be allowed to dry out.

### **Re-infiltration with treated groundwater**

Hölscher Wasserbau from Haren (Ems) in Germany has developed a custom-built groundwater management concept for this ambitious infrastructural project. The company is renowned internationally as an experienced specialist for providing high-quality single-source solutions – from planning to installation and through to the monitoring operations during the construction works. For the construction of the new Metro line, the experts have developed a system which ensures an unaffected groundwater level outside the shafts by infiltrating treated groundwater back into the aquifer (Fig. 2).

All in all, the system developed and implemented by Hölscher consists of approximately 500 extraction and recharge wells, around 300 groundwater monitoring wells with radio data loggers, 21 water treatment plants, approximately 25 km of pipeline and a fully automatic SCADA system (supervisory control and data acquisition). The company managed to deal cost-effectively with the geological conditions, which were technically challenging with respect to drilling, by using the DTH (down-the-hole) method. Specifically developed water treatment plants make it possible to infiltrate the extracted and treated groundwater back into the ground. In so doing, large amounts of expensive drinking water can be saved: during the construction phase, a total of around 20 million m<sup>3</sup> of groundwater are treated in the water treatment plants and subsequently recharged (Fig. 3).

### **Precise monitoring and controlling**

The entire groundwater management system is controlled and monitored centrally by means of a supervisory control and data acquisition system (SCADA). Current operating parameters can be retrieved, controlled and documented on iPads by service staff (Fig. 4). The intelligent overall design of the system has proven effective in practice: the achieved tolerances for the groundwater level amount to a few centimetres. It would have been virtually impossible to obtain this degree of precision with conventional, manually operated recharge wells.

## **New forecasting software**

The currently used monitoring and controlling facilities of the entire system are very precise and do already satisfy high safety requirements. In order to increase the degree of safety in construction projects even further, Hölscher Wasserbau is refining and expanding its groundwater management. Project manager Henrik Koers has developed a forecasting tool which can immediately simulate the consequences in case of a breakdown. "If, for example, a pump breaks down, the new software makes it possible for us to simulate the hydrogeological effects and to identify the optimal countermeasures in no time", Koers explains the innovation.

These possibilities of forecasting offer significant advantages for assessing the risks of construction projects as complex as those currently under way in Copenhagen. Henrik Koers has received various awards for the original development of the tool and has been invited to present the software at numerous conferences and symposia. There is considerable demand for this type of software in the industry, as could be seen only recently at the "Wasser Berlin International" (international trade fair and congress for water management), where Koers' talk was received with keen interest by the expert audience.

Developing and implementing a groundwater management system for Copenhagen is a tremendous success for Hölscher Wasserbau. The system's cost effectiveness and environmental compatibility in challenging conditions is of considerable benefit to the project partners. Due to the profound professional expertise of the company's specialists both with respect to development and implementation of the system, the cooperation with authorities and client's representatives is based on mutual trust, and a maximum level of safety during construction is achieved.

### **Additional information on Hölscher Wasserbau:**

<http://www.hw-dewatering.com/>

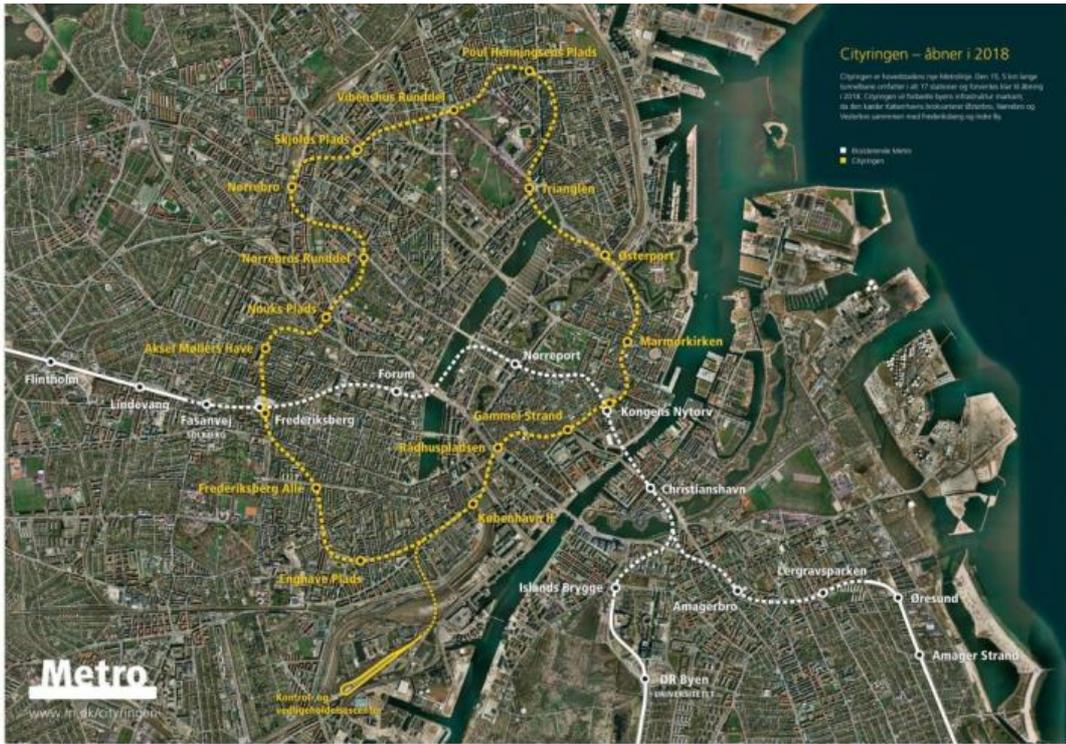


Figure 1: Copenhagen's new Metro line "Cityringen" (yellow line) increases the current network (white line) by approximately two-thirds.

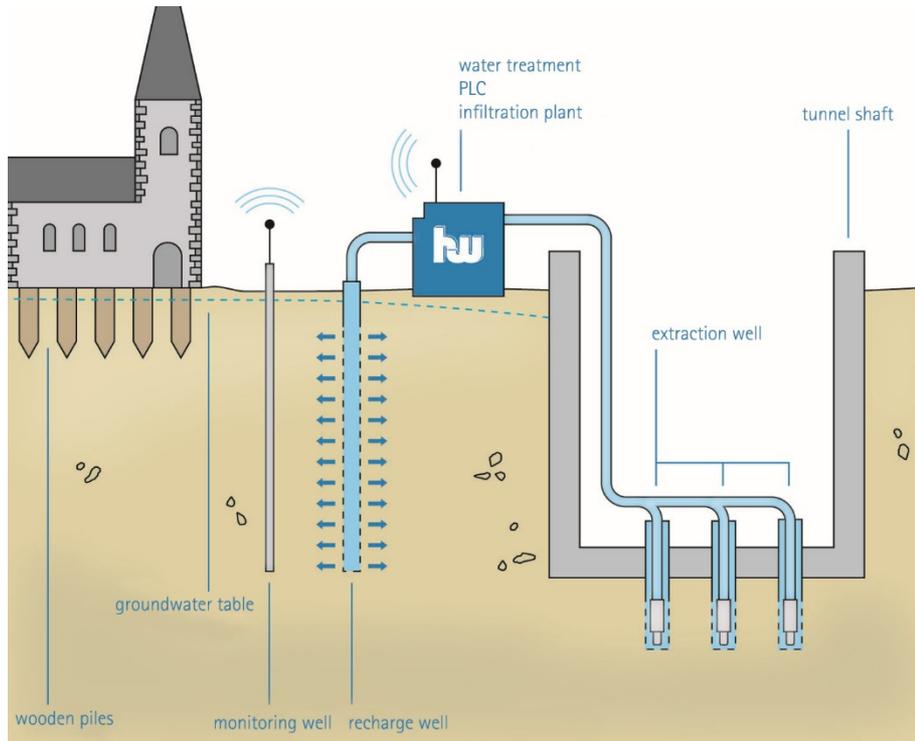


Figure 2: Schematic diagram of Holscher's groundwater management concept.

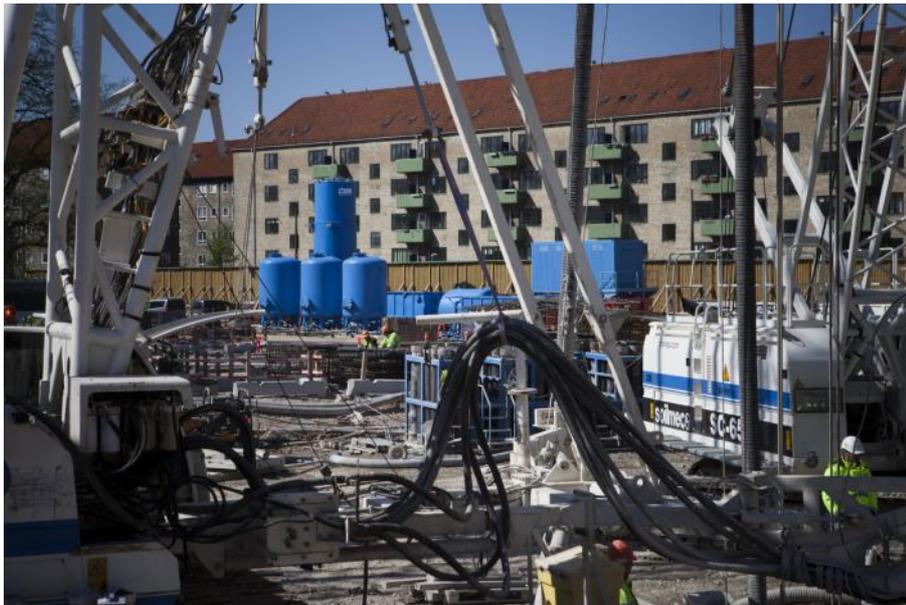


Figure 3: Water treatment plant at a TBM (tunnel boring machine) launching shaft in Copenhagen.

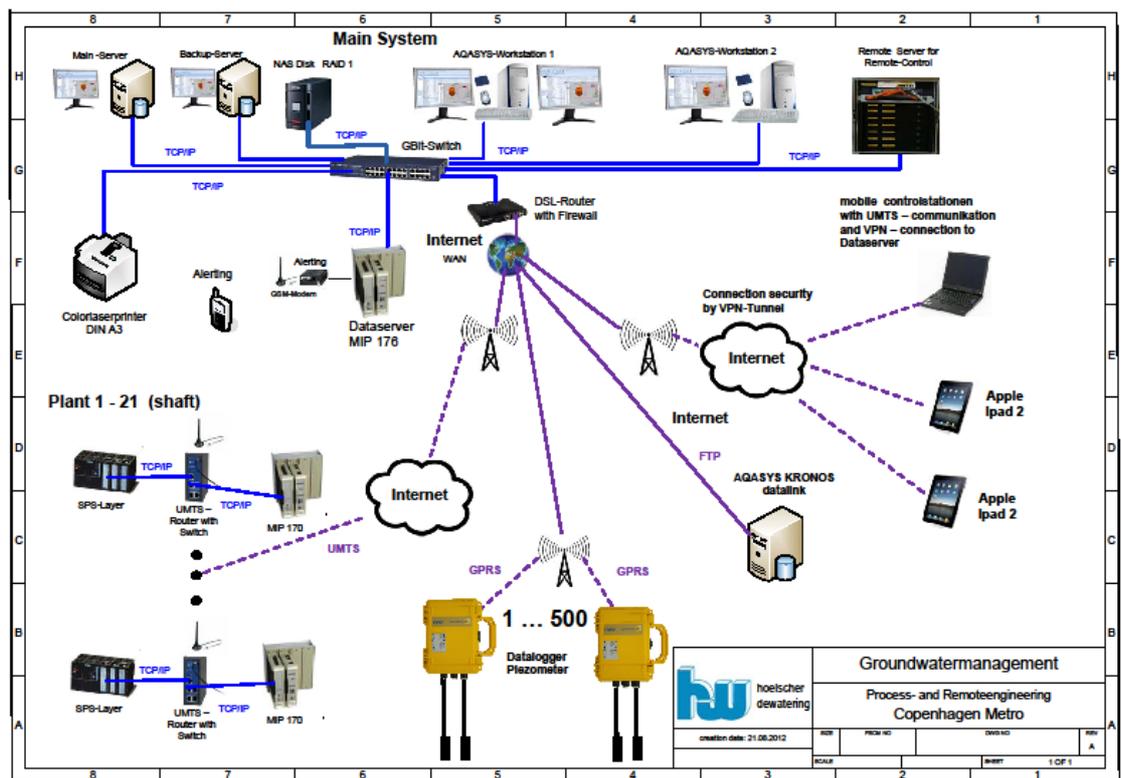


Figure 4: Schematic diagram of the SCADA system.

## **Hölscher Wasserbau – information about the company**

Hölscher Wasserbau GmbH from Germany is a family-owned business operating internationally and rooted in Haren, a provincial town located in the Lower Saxon district of Emsland near the Dutch border. More than 450 employees at eight German locations provide services in the areas of dewatering, environmental engineering, well drilling and groundwater management. The company, which is known for its employee-friendly personnel policies, is highly experienced both in the construction of infrastructural and industrial facilities and in energy and environmental engineering.

The company is represented internationally by BUDWUG in Poland, Reinders Wessemius in the Netherlands, and Uniquip Hoelscher in Qatar. There are additional locations in Romania, Italy, Denmark and Great Britain. Furthermore, the subsidiary "SL – Service & Logistik", responsible for repair and transport services for construction sites, is also part of the corporate group and works exclusively for Hölscher Wasserbau.

The company has been servicing up to 800 construction sites in recent years, including large-scale projects like "Stuttgart 21" (new underground railway station), "Metro Cityringen Copenhagen", "OPAL Pipeline" (the Baltic Sea Pipeline Link), or "A2 Motorway Tunnel Maastricht".

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