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# WORLD FIRST IN WASH BORING

**Dutch horizontal directional drilling (HDD) specialist Visser & Smit Hanab has collaborated with a collection of European contractors to complete a ground breaking project, using wash boring to replace a damaged pipeline underneath the Spree River, Germany.**

In 2015, LEAG – or Vattenfall Europe Mining AG as it was known at the time – awarded a contract to TrappInfra Rohbau Welzow GmbH for the construction of a large-diameter, twin-pipe culvert underneath the Spree River in Germany. It was decided that trenchless methods would be utilised for the installation of two large-diameter polyethylene (PE) pipes. The pipes had respective outside diameters (OD) of 1,400 mm and 1,200 mm, and were supplied by FRANK GmbH and manufactured by AGRU Kunststofftechnik GmbH.

Dutch contractor Visser & Smit Hanab completed the HDD on the project, before the pipe was installed using the wash boring process. According to AGRU, this was the first time, anywhere in the world, that PE100 pipe had been installed using this method.

## SCHWARZE PUMPE POWER STATION

Located near Spremberg, Germany, the Schwarze Pumpe power station had a nominal capacity of 1,600 MW, with brown coal for the station excavated in the nearby open cut mines in Nochten and the surrounding region. However, as the brown coal stratum being excavated was located below the natural groundwater table, the water table in the area surrounding the mine needed to be lowered.

Two parallel underground glass fibre reinforced plastics (GRP) pipelines were used to transport groundwater from the mine to a water processing plant and then on to the Schwarze Pumpe power station where it was used as cooling water. Nochten Water Pipeline 1, sized DN1200, was commissioned in 1998, while the DN1100 Nochten Water Pipeline 2 began operation in 2012. Both pipelines crossed the Spree River on a pipe bridge close to the town of Spreewitz.

## THE CHALLENGE

A series of floods around the pipe bridge between 2010 and 2013 resulted in a pipe rupture in a GRP bend in the first pipeline. Repairs to the existing GRP pipelines would





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**A:** The high flexibility AGRU's pipes allow for changes of direction without fittings.
**B:** Visser & Smit Hanab drilled two holes approximately 210 m long underneath the Spree with absolute precision using HDD.
**C:** Visser & Smit Hanab threaded the 220 m long AGRULINE pipeline under the river without, setting a new record.
**D:** A special flange connection with an OD of 1,400 mm, was manufactured by FRANK KUNSTSTOFFTECHNIK GmbH.

be time-consuming and disrupt on the activities of the coal mine, which could only operate without the pipelines for a few days.

However, continuous, temporary repairs did not represent a sustainable solution, particularly as the Nochten mine was estimated to be operational for another 30 years. To complicate matters even further, the damaged line and the pipe bridge were situated in a landscape conservation area in the Spree flood plain.

Inspections of the pipe bridge also revealed that its piers had lifted slightly, with the resulting damage causing a deformation to the pipeline and the possibility of excessive stress on the GRP piping. Furthermore, there was no guarantee that the complex repair of the damaged section would rule out the risk of further damage to other sections of pipeline around the crossing.

## FINDING A SOLUTION

To secure the continued safe operation of the two pipelines, it was necessary to devise a permanent and economical solution that minimised the impact on the operation of the mine and represented a technically sound plan that took the expected service life into consideration. As a result, four different approaches were investigated before the engineering work began:

- the complete reconstruction of the pipe bridge with related makeshift pipeline repairs
- the partial reconstruction of the pipe bridge with related makeshift pipeline repairs pipeline
- the construction of a new culvert using microtunnelling
- using the HDD and bore washing method.

The necessary soil investigations were

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carried out in the run-up to the decision making process, which was also taken into consideration.

## MATERIALS AND METHOD

It was decided that a new installation using HDD with PE100-RC pipes was the most economical and the easiest solution to implement.

Project proponents saw the benefits of the HDD method, including the minimised impact on the environment, as well as the least amount of underground construction work requiring drainage. A speedy approval process and a calculable geological risk were also contributing factors towards the decision.

Finally, the HDD method selected made it possible to decommission the pipe bridge, which reduced the risk of external influences such as vandalism and the impact of temperature fluctuations. Since it was possible to continue to use the existing pipeline during the construction work, it was not necessary to implement a temporary makeshift solution, with sufficient space available on both sides for the pipe connection.

However, it did present a challenge, with longer lengths of the pipelines required and the extra amount of drainage required during the installation of the connection pipes from the wash boring up to the existing pipeline.

In regards to the pipe material selected for the project, contractors determined that AGRU's PE100-RC pipe offered many advantages, with the material being permanently resistant to corrosion from the mine water. The high flexibility of the pipe also meant that wash borings with small installation radii were also possible.

Any ground subsidence that occurred could be absorbed by the permissible deformation of the pipes, without the danger of damage as a result of cracks or breaks. Prior to project works taking place, AGRU's PE 100-RC pipes were tested and approved in accordance with PAS 1075 for trenchless laying techniques.

## AWARDING THE CONTRACTS

The project was divided into three stages and tenders were requested for each stage:

- Construction of the wash boring for both pipelines, OD 1,400 mm and OD 1,200 mm
- Construction of the connection to the existing Nochten Water Pipeline 1 on both sides
- Construction of the connection to the existing Nochten Water Pipeline 2 on both sides.

Because the pipeline was to run approximately 6.5 m below the bed of the Spree, the section of the wash boring needed a wall thickness of SDR 17 and the pipelines beneath the Spree had to be filled with water at all times to prevent the pipe from buckling.

TrappInfra Rohrbau Welzow GmbH was awarded the contract for the entire construction project, while FRANK GmbH was responsible for project delivery and site management. AGRU Kunststofftechnik GmbH fabricated the AGRULINE PE 100-RC piping and electro-socket fittings, with FRANK KUNSTSTOFFTECHNIK GmbH responsible for designing and manufacturing the bends, junctions and special flange connections. Visser & Smit Hanab received performed the wash boring and HDD.

The wash boring involved the fabrication of two 220 m long conduits, with an OD 1,200 mm and OD 1,400 mm, welded out of individual 13 m pipe segments. Each conduit, which weighed as much as 76 t, was positioned on roller blocks in order to reduce the force required to pull them in. It was the first time anyone had ever attempted to constructed a culvert made of PE pipes of this size.

## PROJECT WORKS GET UNDERWAY

Even Visser & Smit Hanab – world leaders in HDD – had never laid a PE pipeline with an OD of 1,400 mm using this particular method before. As a first step, the construction team drilled two pilot borings from the west to the east bank of the Spree, before an underground channel was drilled with one of the most modern HDD systems, cutting holes with a diameter of 30-180 cm, and able to withstand tensile forces of up to 450 t.

Visser & Smit Hanab advanced the drill string along the planned path, adding segment after segment of drill pipe, and guiding it precisely down to the centimetre with the help of a gyrocompass. It was able to cross under the Spree at a relatively shallow depth of just 6.5 m, reducing the length of the borehole to about 210 m. A special viscous liquid called drilling fluid or drilling mud conveyed the cuttings up and out of the borehole.

After successfully crossing under the Spree, Visser & Smit Hanab widened the pilot bore to a maximum diameter of 1,778 mm by pulling the drill string back, segment by segment, with the back reamer tool fastened to the end while the fly cutter, a continuously rotating tool fitted with nozzles and teeth, cut through the ground. During the process, the drill string at the location of the drilling equipment on the west side of the river had to be shortened continuously, while being lengthened segment by segment on the east side. A mixture of water and clay, also known as bentonite, transported the cuttings out of the borehole, stabilising the borehole and reducing friction. The drill string remaining in the second borehole was used as a return pipeline to reclaim the drilling fluid, which meant the construction of a return pipeline for the drilling fluid to the separation plant was not required.

Once the borehole had the required diameter along its entire length, work started to pull the prefabricated and tested PE pipeline back through. A bullet-shaped pull head was screwed to the front end of the pre-welded, 220 m long and 1,400 mm diameter pipeline, which was then connected to the reamer tool on the end of the drill string by means of a swivel. The swivel between the pull head and the reamer tool prevented the large-diameter pipeline from being rotating while being drawn in.

The construction team then lifted the section of pipeline closest to the borehole, while at the same time pulling it towards the hole to thread the pipeline into the borehole. The pipeline slid into the drilling fluid in the borehole trench and automatically adapted itself to precisely fit the exit angle of the borehole.

After the first few metres of the pipeline had disappeared into the drilling fluid in the borehole, the carrier pipe was pulled into the borehole segment by segment by the drill string. To prevent the pipeline from buoying upwards, the pipeline was filled with water while being pulled in, which reduced the buckling pressure, making it possible to reduce the wall thickness of the pipeline.

As a result of the high flexibility of the PE material, the pipeline adapted itself to fit the parabolic form of the drilled tunnel, successfully completing the record-breaking wash boring procedure.

After the carrier pipe had been pulled in, the inside diameter of the pipe was tested using a measuring plate that had the planned inside diameter. The inside diameter or each pipeline was verified beyond doubt, and it was confirmed that neither of the pipelines had buckled during the installation.

The annular gap was then sealed, to avoid water permeability in the rock mass and a special filler was inserted into the annular gap. In order to insert the filler effectively, three pipes of different lengths were pulled into the borehole at the same time as the carrier pipe.

The filler was able to be inserted into the annular gap at various points via these pipes until it reached the surface at the bore ends. The quantity of filler required equalled the quantity of drilling fluid. Due to the higher density of the filler, the annular gap was filled continuously from the lowest point to the highest point of the borehole.

## THE FINAL CONNECTION

Following the wash boring, the first of the two pipelines was connected to the existing underground GRP pipeline. Given the availability needed for the pipeline, there was only a time window of six days downtime available for connecting both ends.

Within this time frame, the existing pipeline had to be emptied and disconnected, and the last section of the new PE pipeline welded to the pre-welded connection fitting, before the connection fitting could then be connected to the existing pipeline.

To connect to the existing flanges on the original GRP pipeline, FRANK supplied special flanges made of PE100-PC, one with a DN1,200 flange connection, and one with an OD 1,400 x 83 mm pipeline connection. Because the heating element butt welding process could not be used for the last welds, AGRU electrofusion couplers with an OD of 1,400 mm were used instead.

"We are proud to be the first to have successfully laid such large diameter PE 100 pipes using the wash boring process," Visser & Smit HDD Consultant Jorn Stoelinga. "The robust AGRU pipes came away with hardly a scratch. They were easy to weld, and also very easy to pull in thanks to their flexibility."

Besides the technical benefits of the PE100-RC pipes produced by AGRU Kunststofftechnik GmbH, it was possible to adhere to the very tight time schedule due to the detailed project management, punctual delivery and the intensive on-site support provided by FRANK GmbH. The drilling of the pilot bore and subsequent enlarging of the bore, as well as the process of pulling in the pipeline, took 10 days to complete.



### ABOUT AGRU

Founded in 1948 by in Austria, AGRU is one of the world's most important single-source suppliers for high-quality piping systems, semi-finished products, concrete protection liners and lining systems made from engineered plastics. An expert in producing engineering plastics components and developing tailored solutions, AGRU has a presence in virtually every sector of industry, including water and gas infrastructure, the energy sector, chemical and heavy industries, semiconductor and life-sciences, tank and apparatus building, naval and aviation industries, civil engineering, mining and building construction.

For more information visit **www.agru.at**

**E:** The reamer cleared the way for the PE100-RC pipeline.
**F:** The AGRU pipeline adapted itself precisely to fit the exit angle of the borehole as it was pulled in.