

**PIPE WORLD 2•2006**

**SLIPLINING MINIMIZES THE IMPACT ON THE ENVIRONMENT AND TRAFFIC**

**Horizontal drilling cross the river | Weholite is the system of the future**

**PIPE WORLD – THE KWH PIPE CUSTOMER JOURNAL**





# *Relining and Renovation Systems Made by KWH Pipe*

*In addition to being one of the leading suppliers of polyethylene pipework in the world KWH Pipe is an innovative designer and supplier of polyethylene pipes for various pipeline rehabilitation techniques:*

- VipLiner - short module relining
- Weholite - large diameter relining
- WehoPipe - solid-wall long-length relining
- Inspection Chamber renovation
- Pressure and gravity pipelines
- Pipes for relining  $\varnothing$  20mm -  $\varnothing$  3000mm





## Out of sight, out of mind

Very few people ever think about the complex world beneath their feet or are even aware of its existence. Still, our society and its wellbeing depend on pipelines for transporting clean water to our taps, wastewater to treatment plants, and heating, cooling and gas to buildings, for cable protection and for numerous industrial applications that keep the economy going. When pipelines fail, the consequences can be disastrous.

Old concrete, clay and metal pipes have not been replaced to the extent needed, which day by day leads to an increasing leakage of potable water, wastewater or even chemicals. Increasing ecological awareness and scarcity of water have made governments and water companies more inclined to act before it is too late. However, it is difficult to lobby for budget funds for investment in areas where the problem cannot be seen.

Increased urbanisation further complicates the replacement process. It is unthinkable to lay pipes using open trenches in cities, close major roads and railway lines and thus disrupt traffic, affecting private property and businesses. Fortunately there are well developed methods for pipeline rehabilitation that minimize the need for surface excavation. In many cases citizens go about their daily lives unaware of the underground work that is being carried out for their benefit. Furthermore, there are considerable savings in both time and money if excavation can be avoided.

No-Dig methods are used not only for rehabilitation, but also for laying new pipes. For both these applications, plastic pipes have proved to be an excellent option and KWH Pipe has been involved in projects worldwide, from Bangkok and Kolkata to Warsaw and Toronto. This issue of Pipe World features cases demonstrating the superiority of No-Dig Methods to more conventional ones when it comes to especially challenging circumstances.

**Jan-Erik Nordmyr**  
Editor in Chief  
COO and Executive Vice President

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#### PIPE WORLD

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## NEWS

### Online calculator tool makes pipe design easier

**| PIPELINE PROFESSIONALS** and students are now offered a helping hand by KWH Pipe. The new, online calculator evaluates your selection or recommends the best pipe size and grade to suit the hydraulic capacity, internal pressures, pressure surges, thermal factors and burial conditions of your application. Calculation modules are available for both Weholite profile wall pipe and WehoPipe/Sclairpipe PE-HD pressure pipes.

The program is a supplement to KWH Pipe's design brochures, PE Pressure Pipe Systems, Sclairpipe Systems Design and The Basics of Weholite. It is also based, in part, on the Plastic Pipe Institute -Handbook of Polyethylene Pipe, and the relevant ISO, EN, ASTM and CSA specifications.

Use of the program is not intended to replace the evaluation and judgement of a professional engineer competent in this field. It should be considered a tool to evaluate design conditions. The user is expected to have an understanding of the equations and principles involved, their applicability and limitations.

The online calculator is available for calculations using the imperial system and the metric system. Both are available via the KWH Pipe websites. Feedback regarding the calculator can be sent to the e-mail address [calculator@kwhpipe.com](mailto:calculator@kwhpipe.com).

#### DIRECT LINKS:

- **Metric system:**  
<http://calc.kwhpipe.com>
- **Imperial system:**  
<http://www.kwhpipe.ca/calculator>

### Antistatic pipes for combustible substances

**| FOR SAFE TRANSPORTATION** of flammable or explosive substances, it is crucial to avoid static electricity. KWH Pipe has recently developed a new multilayer pipe with antistatic properties.

WehoAntistatic pipes can be made with an antistatic inner or outer layer or, if needed, even both. They are available in sizes OD 63–400 mm and may be used for a number of applications, including the transportation of:

- Fluidised powders
- Wooden pellets
- Grain
- Non-combustible solids

### Customized pipes for abrasive conditions prolong service life

**| MINING IS ONE OF** the toughest piping applications because of the very abrasive conditions. Depending on the type of slurry, pressure, temperature and flow velocity, process conditions vary considerably for different pipelines. Although high-density polyethylene pipe performs excellently compared with other materials, KWH Pipe has developed extra abrasion-resistant pipes and the means to customise them according to their purpose.

Using KWH Pipe's slurry pipe simulation equipment and a sample of the slurry intended to be transported in the pipeline, it is possible to simulate the abrasion affecting the pipeline and, as a result, customise the design to achieve maximum service life.

The testing equipment consists of a model slurry pipeline, where three different types of pipes can be tested simultaneously. Alternatively, the same pipe can be tested for different types of pressure, temperature or flow velocity. It is also possible to test the pipes for the optimum bend radius and alternative jointing methods.

KWH Pipe has invested heavily in product development for the needs of the mining industry and can offer three products suited to different operating conditions. The testing equipment determines whether the best solution for the pipeline is a solid-wall PE-HD pipe or if a pipe with a special inner layer of abrasion-resistant material is needed. With a customized pipe, the lifetime of the pipeline can be considerably prolonged.

Replacing slurry pipelines less frequently offers mining companies considerable cost savings over the working life of the pipeline. Above all, increasing the effective working life of the pipeline can result in greatly reduced labour and installation costs.

The new WehoSlurry pipes are currently available in sizes DN 63–400 mm, but in the near future, KWH Pipe plans to produce them in sizes up to 1,600 mm. By using KWH Pipe's mobile plants, solid-wall polyethylene pipes can be produced on-site at the mine where they are needed. It will soon be possible to offer this option to customers for the new multilayer slurry pipes.

## APPOINTMENTS



### Europe

Mr **Mikael Strandell** M.Sc. (Econ.), B.Sc. (Eng.) has been appointed Director, Key Accounts as of November 1, 2006. Mr Strandell has previously worked as Business Manager, Building Technology at KWH Pipe Finland.



### Sweden

Mr **Tomas Nordin** has been appointed Market and Sales Director as of October 1, 2006. Mr Nordin has previously worked as Sales Manager, Municipal Technology at KWH Pipe Sweden AB.



Ms **Maria Johansson** has been appointed Market and Quality Development Manager as of September 1, 2006. Ms Johansson has previously worked for Borgstena Textile Sweden AB.



### KWH Pipe Finland Building Technology

Mr **Stig Johansson** has been appointed Business Manager for Building Technology, Finland as of 1 November 2006. Mr Johansson has previously worked as Key Account Manager within Building Technology, Finland.



### Technology

Mr **Pentti Moilanen** transferred to KWH Pipe Technology on October 1, 2006, to assume responsibility for Project Services Sales and Coordination of Technology Sales in the CIS countries. Mr Moilanen previously worked as Exports Business Manager at KWH Pipe Finland.



### Extron

Mr **Heikki Halonen**, B.Sc. (Eng.) has been appointed Managing Director of Extron Engineering Ltd and RT-Systems Ltd as of October 1, 2006. Mr Halonen has previously worked as Technical Director and Managing Director at RT-Systems Ltd.



## Three-metre-diameter pipes produced on-site

**| IN PIPE WORLD 2/2005** you were able to read how KWH Pipe could now take solid-wall pipe production to the customer's site with the help of its mobile plants. The main ideas are to offer more flexibility, reduce logistical costs and to be able to serve customers operating in remote areas. The mobile plants can also be leased to pipe manufacturers that do not themselves have the capacity to produce large-diameter pipes.

During 2006, KWH Pipe has developed and tested its first mobile plant producing Weholite structured-wall pipes. Utilising the latest technology, it produces DN/ID 1,000–3,000 mm Weholite pipes with ring stiffness classes SN 2, SN 4 and SN 8. With modifications, the same extrusion line can produce WehoPipe solid-wall pipes in sizes up to OD 630 mm. The mobile plant has been designed and developed in-house by KWH Pipe Technology.

Since its introduction in 1982, Weholite has gained world-wide recognition as a top-quality and highly versatile pipe for gravity and low-pressure applications, both on land and under water. It is available in diameters up to DN/ID 3,000 mm, which makes it one of the largest pipes manufactured in the world today. This, of course, can create challenging situations when the pipes are transported. Anders Nystrand, General Manager of KWH Pipe's Project Services operations, explains the logic behind the mobile plants: "Transporting large pipes basically means transporting a lot of air. For large projects, it's simply more convenient and indeed, cost efficient to produce the pipes at the site where they will be installed. For the customers this option means reduced costs and more convenience."

The production line is built into eleven 40-ft containers that can be easily lined up and quickly start producing pipes. Experienced production staff are seconded from various KWH Pipe production units for the duration of the project.

"As Project Services focuses on customised solutions, we can also supply fittings, welding and installation if the customer wants a complete package," says Nystrand.

**A**s well as pipes sold for new pipelines, the market for renovating water and sewage systems using No-Dig methods plus industrial media transfer pipelines is growing rapidly.

An increasing number of modern coatings for renovation and protection are available as well as special sleeves mounted on existing pipelines. The effectiveness of repairs of this kind often depends on the technical condition of the pipeline being repaired. In the case of pipelines threatened with loss of carrying capacity and those featuring considerable corrosion, such solutions may turn out to be half measures with no guarantee that the investor will say goodbye to the problem in the longterm.

Long-standing experience shows that more expensive techniques are more cost-efficient than the less costly techniques, as they ensure longer life and better final effect. <sup>1)</sup>

As a rule, destructive factors or factors reducing the trouble-free pipeline operation period include the specific properties of the transported medium, such as high abrasive wear (in the case of hydraulic transport) or corrosives (in the case of aggressive liquid industrial wastes).

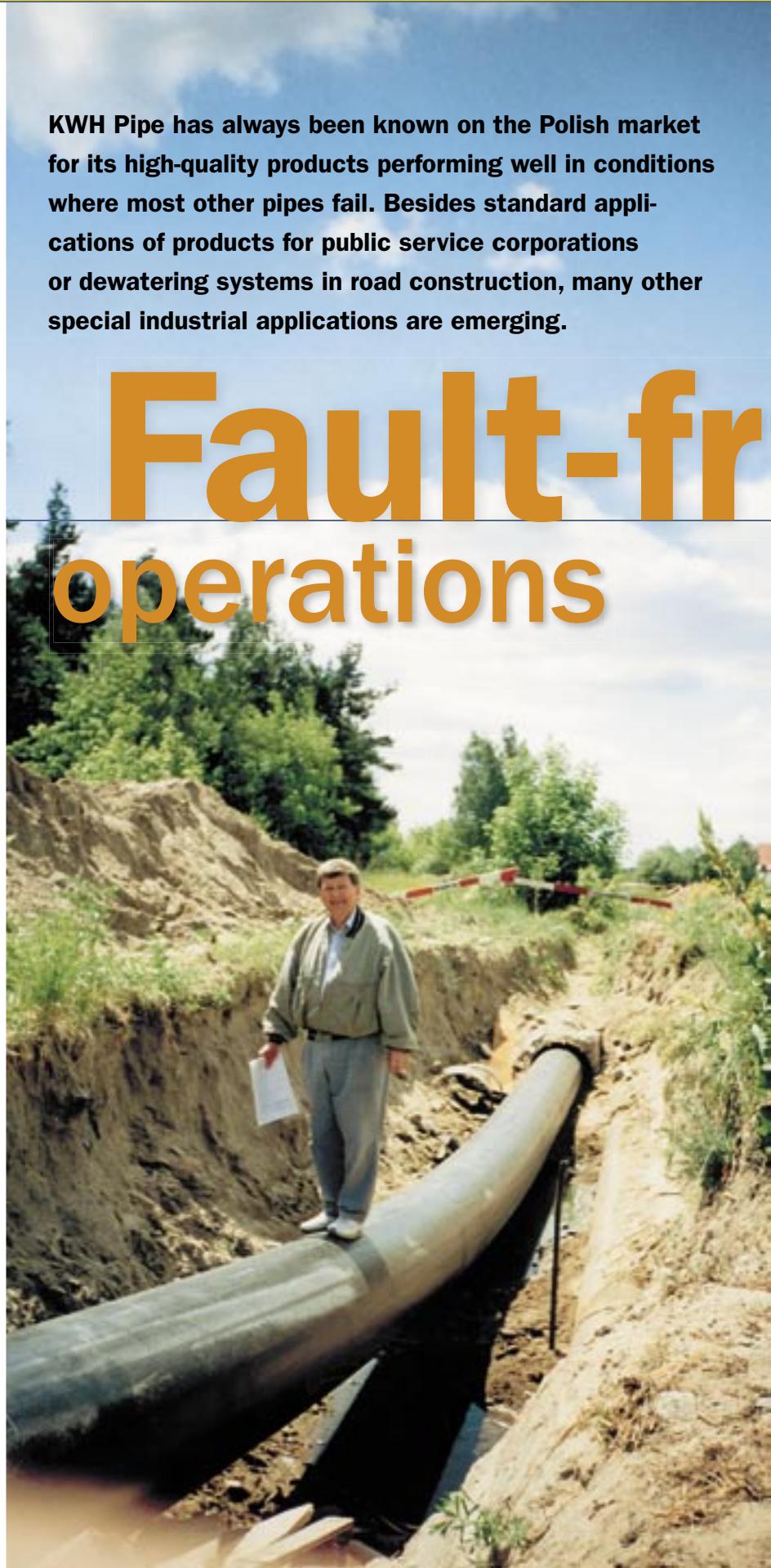
Liquid wastes originating from manufacturing processes in the pulp industry contain some of the most difficult agents. Precisely this problem was experienced by Zakłady Celulozowe Intercell in Ostrołęka.

**MASSIVE CORROSION**

The pipeline used for transporting process liquid wastes from Zakłady Celulozowe to the biological treatment plant runs under the streets of the town of Ostrołęka. This pipeline has been in use since 1965. A 10 mm steel pipeline of nominal diameter 700 mm was used for transporting liquid wastes. Due to their aggressive nature, massive corrosion was detected after only a few years of operation. Part of the pipeline was repaired by constructing a reinforced concrete covering. This work required excavation along the entire length of the section undergoing repair. In spite of the covering, further corrosion of the pipeline occurred. Several failures and local leaks into the ground were experienced.

**KWH Pipe has always been known on the Polish market for its high-quality products performing well in conditions where most other pipes fail. Besides standard applications of products for public service corporations or dewatering systems in road construction, many other special industrial applications are emerging.**

# Fault-free operations





After receiving expert opinions in 1996, the investor decided to repair the most endangered section of the collecting pipe by relining it with long PE pipes. KWH Pipe offered complete delivery of the material together with execution as a turnkey project.

Taking temporary increases in the waste temperature of the transported liquid into account (in summer it can reach a maximum of 45°C under a forcing pressure at up to 0.35 Mpa), PN6 DN 630x37.3 mm PE63 pipe was selected. Eight installation cuts (starting and receiving) of approx. 15–18 m average length were used for inserting the pipes. The length of the inserted pipe sections varied from approx. 160 m to approx. 370 m. The work was completed inside 4 months.

The removal of the reinforced concrete covering inside the excavations (B-30 concrete–20 cm thick) turned out to be the most time consuming task. The high degree of fouling and corrosion inside the pipeline was surprising. Concrete intrusions originating from the repair covering reduced the internal diameter of the pipe. Such intrusions (which are not a typical problem in repaired pressure pipelines) required vigorous mechanical cleaning. Pipeline sizing by pulling a PE pipe pilot section immediately behind the head to assess the degree of scratching on the pulled-in pipe is very important in such cases. The whole operation of pulling in the individual sections lasted less than twelve hours.

Existing pipeline bends were dealt with by bending the pipes and dispensing with segment bends. It was necessary to install a 28° segment bend in one case only. During the repair work, liquid wastes were transported by means of a 500 mm diameter emergency pipeline running next to the main collecting pipe. All work was completed in approx. 4 months. The 8 pipeline sections were tested separately and then a final test was performed on the entire repaired pipeline.

According to the investor, renovation with PE pipes turned out to be less expensive than pro-



**Massive corrosion was detected in the older steel pipes after only a few years of operation.**

viding the repaired section of the pipeline with a reinforced concrete covering.

At that time (1996) PE pipe relining was an innovative solution in Poland – it was a lesson in new technologies for all of us.

#### **THERMOPLASTIC PRESSURE PIPES**

In 2003, the investor decided to repair another 3,285-metre-long section of pipeline. This time, the tender was won by a Polish contractor who was a direct competitor of KWH Pipe. The renovation method chosen was identical with that used in the first stage. The situation was simpler, with no reinforced concrete covering in this section of steel pipeline. Moreover, inserts and flange connections of pulled-in pipes were given up. After pulling in, long pipe sections were connected in excavations using electrofusion fittings. Nevertheless, KWH Pipe still supplied the PE80 PN6.3 DN 630x30 mm pipes, the PE fittings and the butt welding machine.

A decision made by Urząd Dozoru Technicznego (the Polish Office of Technical Inspection) and delivered to the investor, granting KWH Pipe permission to manufacture thermoplastic pressure pipes for transporting dangerous materials with toxic and caustic properties, turned out to provide additional confirmation of the high quality of the pipes.

However, fault-free operation of the repaired pipeline section using PE pipes supplied by KWH Pipe turned out to be the investor's own most important experience of the entire project. ●

#### **THE SCOPE OF THE WORK INCLUDED**

- Excavation work
- Inspection of the inside of the pipeline
- Pulling the steel rope in and installing a power winch
- Cleaning the inside
- Welding PE pipes and fittings
- Pulling the head in, together with a pilot PE pipe test section
- Installation of inserts – flanged connecting members, fixtures
- Making resistance blocks
- Pressure test (compressed air)

1) See A.Kuliczkowski: "Problemy bezwypokopowej odnowy przewodów kanalizacyjnych"; Politechnika Świętokrzyska, Kielce 1998 and A. Kuliczkowski: "Questions of The Rehabilitation of Sewer Pipes Using The No-Dig Method", published by the Kielce Institute of Technology, Poland, 1998



The pipes were pulled into place using a winch truck and a hydraulic ram.



Sami Niemi preparing the relining pipe.



The new pipes were inserted into the old ones in three stages. Each individual pipe had a length of 18 metres.

# The great relining of Tervasaari

**A tricky sliplining job was carried out at the UPM Tervasaari mill in Valkeakoski, Finland, in June–July 2005. A 710-millimetre polypropylene pipe was inserted into an existing 900-millimetre pipe for its entire 600-metre length.**

**T**he Tervasaari pulp and paper mill has a single large-diameter pipe taking most of its wastewater to a biological treatment plant. The pipe carries the process water produced by three paper machines and three pulp lines plus all other wastewater generated by the mill, so it is vital that it functions smoothly. If the pipe is out of order, the mill will shut down.

“The temperature of the wastewater running in the pipe is between 40 and 50 degrees but it may sometimes be higher,” explains Tero Lahtinen, maintenance engineer at UPM, who worked as the manager for the relining project. “There is considerable variation in the flow inside the pipe and it can occasionally reach 500–600 litres per second.”

The old pipe, made of glass-fibre-type material was already in poor shape and in fact it had ruptured twice in spring 2005 resulting in small amounts of wastewater ending up in the surrounding lakes. Before that there had been ruptures in 1997 and 2001.

As Pauli Lepo, maintenance engineer at UPM, points out, “We had a lucky escape as the leaks only caused minor damage. The pipe, installed in 1982, was built for lower pressures and temperatures, and changing usage over the past two decades also caused the temperature inside the pipe to rise. Besides, the infill in the foundations was not solid enough.”

The management at the Tervasaari mill were well aware of the poor condition of the pipe and design work on the replacement began in the summer of 2004. Be-

fore the year was out, UPM had made the necessary investment decision, followed by the selection of KWH Pipe as the supplier.

As Tero Lahtinen says: “UPM had a number of piping options to choose from. Several alternatives and rehabilitation methods were considered but in the end it was decided to insert a plastic pipe inside the old pipe. This meant less excavation and saved time. The material can also withstand the temperatures arising inside the pipe and the impact of the chemicals flowing in it. Price was also a major factor.”

According to Pauli Lepo, there were two main reasons for choosing the pipes offered by KWH Pipe: quick delivery and the fact that in the KWH Pipe option the traffic in the mill area could continue during the installation work. The option chosen allowed UPM to keep downtime to a minimum.

## NUMBER OF CABLES A SURPRISE

Relining work started in week 25.

According to Tero Lahtinen, the stop-



page in the Finnish paper industry meant that work could start earlier than envisaged even though, at the time, the contractor did not have the whole of the work force required. Although involving a number of challenges, the project was completed on schedule.

The problem spots in the old pipeline were surveyed in advance using a camera, and a few sections requiring repairs were found. The pipe was cleaned of sand and the supports inside it were removed. The work took one full day instead of the expected three hours.

The earth-moving work and the excavations needed for the relining were the responsibility of a contractor working directly for UPM.

A number of previously unknown cables and pipes were discovered during the excavation work. The soil was also fairly rocky.

According to Lahtinen, there were no up-to-date maps for each section of pipeline. Summing up the work of his team, he acknowledges that the supports keeping the pipe in place underground could have been planned earlier.

A pipe rack was laid on top of crushed stone below the pipeline. Sand was used to provide an even surface for the bases.

## WORKING UNDER THE GLARE OF THE SUN

The 600-metre pipeline was installed by KWH Pipe. The pipe sections were joined using butt welding and between three and five fitters worked on the site.

The relining was carried out in three stages. The individual pipes were 18 metres long and they were supplied by KWH Pipe's Vaasa plant. One transport vehicle could carry nine pipe sections at a time.

According to Ari Vaarala, Operations Manager at KWH Pipe Finland's rehabilitation department, the first section of liner was about 175 metres, and the longest of the three sections had a length of 250 metres. He adds that the pipes were pulled into place using a winch truck and a hydraulic ram and that the wire in the winch truck was 300 metres long.

Working conditions at Tervasaari were ideal. There was a splendid lawn behind the mill with plenty of working space, and the sunny weather also helped to speed up the project.

Even though the long pipe sections were difficult to handle, everything went as planned and KWH Pipe took a flexible approach to the work. The relining work itself was easier than handling the pipes on the ground.

## THE TERVASAARI MILL

○ **The Tervasaari mill** has four paper machines producing label paper, envelope paper and sack paper. The mill also has three pulp lines and an energy-generating facility.

○ **The mill provides** employment for about 830 people and has an annual production capacity of 400,000 tonnes. The Tervasaari mill, located in the centre of Valkeakoski, started production way back in 1872.

## THE VALKEAKOSKI PIPES

- PN 4 polypropylene pipe 710 mm
- Pressure chamber 710 mm

The new pipe was secured in place by filling the space between the old and the new.

KWH Pipe also supplied the Tervasaari mill with a pressure chamber made of polypropylene. The 710 mm angle chamber was installed at the same depth as the pipeline and was the only angle piece required.

Wastewater started flowing in the new pipe in late June and by mid-July everything was ready, except for minor finishing work and tidying up the yard. ●

The lawn behind the mill offered ideal working conditions.



**Trenchless solutions are often a necessity when it comes to renovating culverts under railway lines and major roads. Even temporary closures create logistical problems that disrupt traffic and are detrimental for homeowners and companies.**

**W**hen corrosion has severely damaged old concrete and metal pipes, companies turn to KWH Pipe to provide a solution. Weholite pipes are excellent culverts due to their corrosion resistance, light weight and ability to flex according to different ground loadings, such as heavy traffic loads.

After a meeting between members of the Canadian National Railway (CN) project department and the consulting firm UMA, approval was given to renovate a concrete box culvert under the main CN railway

line, near l'Épiphanie, in Québec, Canada.

In making their final choice, the specialists at CN considered not only the quality of Weholite products, but the fact that the installation of threaded Weholite, which creates a product with a smooth interior and exterior wall, could be performed safely without interruptions to the train timetable.

CN was able to maintain the productivity of its railway while avoiding the logistical problems resulting from the temporary closure of the railway. With a small work

# Ideal solutions for roads and railways





force of only four men, the team completed the project in record time, which confirmed the ease with which Weholite pipe can be installed. Experienced personnel from KWH Pipe supported the CN Team on site during the process. CN voiced their satisfaction with this project to KWH Pipe and will be using the company in the future for renovating similar culverts along its railways.

### LONG SERVICE LIFE

Canadian Pacific Railway (CPR) provides freight transport services in Canada and the U.S. CPR owns hundreds of miles of railway that crosses the rugged terrain and the agricultural regions of the province of Ontario. CPR maintains this railway through a variety of activities including an extensive culvert inspection programme. The culvert inspection programme enables the owners to determine the condition of the culvert and decide whether it needs to be upgraded.

In October 2005, CPR renovated two existing 800 mm corrugated steel pipe culverts located beneath their tracks by sliplining them with Weholite PE-HD structured wall pipe. Weholite was chosen for its long service life (Weholite is made from abrasion and corrosion resistant materials) and inherent resistance to the external loads and vibrations that railway traffic creates. In addition, the lightweight Weholite pipe minimized the impact on the environment, as the contractor was able to use light-duty lifting equipment.

Weholite's smooth outer wall and threaded joints ensured quick and easy insertion into the deteriorated corrugated steel pipe culverts. After installation, the annular space was grouted in order to fill the voids and to provide structural support. The culvert ends were left exposed as Weholite has lifetime protection against UV degradation. The entire construction process (from inspection to clean-up) took only four days to complete.



**The culvert was sliplined with DN/ID 96 inch (approximately 2.4 m) Weholite. With a small work force of only four men, the team completed the project in record time.**

### MONTHS OF DISRUPTION SAVED

The residents of the village of Gates Mills, a quiet community just outside Cleveland, Ohio, were spared months of disruption to traffic and their village when Weholite was selected for their culvert renovation project. The existing 120 inch (approximately 3 m) corrugated metal pipe culvert was under more than 10.5 metres of cover and corroding badly. Open cut construction would have resulted in hundreds of haulage trucks going in and out of the community, affecting the private property of homeowners and the general safety of the village.

The culvert was sliplined with DN/ID 96 inch (approximately 2.4 m) Weholite. Weholite was selected for its ease of installation, abrasion resistance and lon-

### THE LIGHTWEIGHT WEHOLITE PIPE MINIMIZED THE IMPACT ON THE ENVIRONMENT.

gevity. According to the Chief Bridge Design Engineer, "The Weholite structured wall PE-HD Pipe solved most of the design and construction challenges that this project presented. After spending a lot of time exploring other rehabilitation and replacement alternatives, we could not find another solution that matched the constructability, material and cost benefits provided by your product."

The project was completed in six weeks at a third of the cost of open-cut construction and in less than half the time. ●

**“A growing understanding of the environmental and social impacts of pipe infrastructure is driving the increase in the use of trenchless technologies”, says Dr. John W. Heavens. Those who are spreading the message of trenchless technologies also highlight the global need for information on the value of water.**

# Trenchless is more people-friendly

**T**he basic idea of trenchless technologies sounds easy to sell. Why break the soil, if you can avoid it? Why dig, if there is a ‘No-Dig’ solution?

“The question is not why should we use trenchless technologies. The question is why should we not use them as the first choice,” argues Dr. John W. Heavens.

Heavens, 63, has a wide range of experience in trenchless technologies spanning more than 25 years. He is the Technical Secretary of the International Society for Trenchless Technology (ISTT). He also works as an independent pipeline rehabilitation consultant.

According to him the major advantage of trenchless technology is the reduction of social costs and environmental impact.

“Trenchless technologies are more people-friendly,” he says.

## **TRENCHLESS BEATS OPEN TRENCH**

Conventional open trench work often disrupts the traffic in cities. The lives of people are disrupted when a trench blocks a road. Time is lost and nerves are tested.

“The public will not tolerate this in the future. Time is money in business terms. Roadblocks have a clear impact on the economy of crowded cities.”

Heavens says that the trenchless method involves fewer risks. It causes less pollution, noise and accidents.

There is less risk in practical terms as well: “When you dig a hole, you never know

what other services and possible damage you may find.”

In addition to rehabilitation, the use of trenchless technologies has increased for the installation of new pipes.

The motives for increasing use are the same whether it’s a matter of installing new pipes or repairing old ones.

## **OLD IDEA BUT NEW PRACTICE**

The term “trenchless technology” was created at the first No-Dig conference in London in 1985. This event also led to the formation of the International Society for Trenchless Technology.

At that time trenchless methods were still relatively unknown as an option for the underground infrastructure, even though the trenchless idea has been around for a long time. “The first known trenchless project was probably the tunnel under the River Thames that was constructed in East London in 1815 using a shield.”

Dr. Heavens is an Englishman living near Oxford. He has worked with trenchless technologies in many countries and on many continents.

Here he describes a No-Dig project that was carried out on the Isle of Man in the early nineties: “We achieved the remote lining of several hundred lateral sewer connections, using a sophisticated robot placed in the main pipe. We managed to line up to 4 metres away from the connection without surface access.”

The ISTT shares information and experience on trenchless technologies. In addition to holding regional and international conferences, it also cooperates directly with the academic world and supports practical education.

The trenchless message will soon be publicized more effectively via the Internet. Heavens is developing The Trenchless Resource Centre on the ISTT web site.

“It will provide process descriptions, conference papers and a wide range of other trenchless data and will be up and running at the beginning of 2007.”

## **DEPENDS ON THE COSTS**

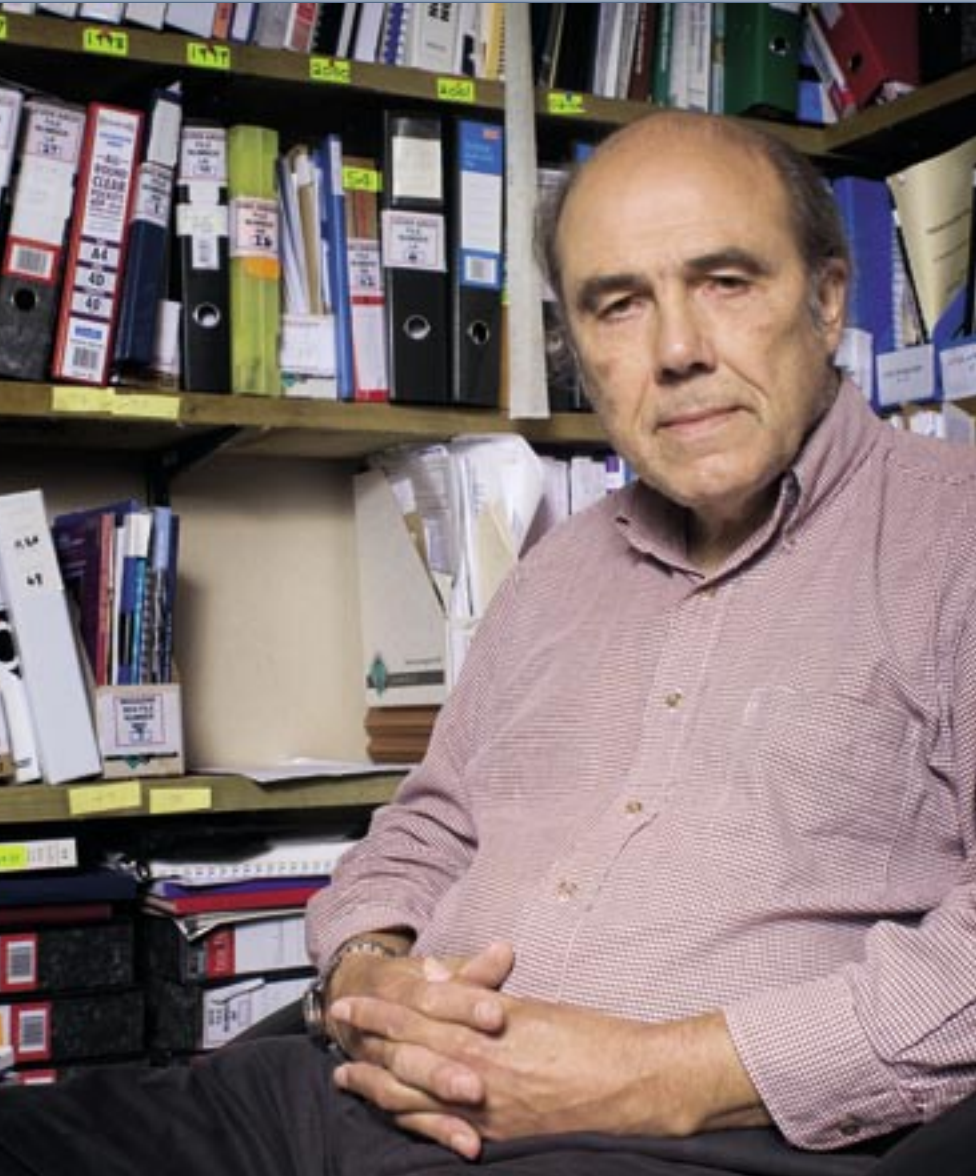
The ISTT’s challenge is to persuade utilities to take into account social and environmental costs when planning underground infrastructure investments. The trenchless option becomes a more obvious choice when social and environmental costs are assessed and included.

“There is a need for cost models that are able to evaluate all the effects – even if these models only compare such costs in relative rather than absolute terms.”

Over the past few years, the trenchless method has often offered lower direct costs than the open trench way.

“When you include social costs such as time losses and accidents, which are frequently twice as high as direct costs, the trenchless method nearly always has the lowest costs and is the most environmentally responsible choice.”





## FACT SHEETS

### Dr. John W. Heavens

- Ph.D in fracture mechanics, University of Bristol.
- Technical Secretary of the ISTT.
- Lives near Oxford, England.
- Early on in his career, he worked with glass-fibre reinforced cement products.
- Moved onto polyethylene-lining technologies for potable water pipelines.
- Five years working with trenchless technologies in the USA.
- Works for both the ISTT and an independent rehabilitation consultancy.
- Throughout his career he has written and presented numerous technical papers at major international conferences.

### International Society for Trenchless Technology – ISTT

- Promotes trenchless technologies globally.
- Organizes regional and international conferences and supports training and education.
- Founded in the UK, at the first No-Dig conference in 1985.
- 26 affiliated associates and more than 3,500 members worldwide.
- The annual No-Dig conference was held in Brisbane, Australia this year, and next year it will be held in Rome, Italy.
- [www.istt.com](http://www.istt.com)

Heavens claims that the major problems limiting the growth of trenchless technology are lack of knowledge, experience and training.

“In addition, many of the technologies have been developed by individual companies. They seek to recoup their investment through licensing and other forms of technology transfer.”

### VALUE OF WATER

The way in which countries invest in their water mains and sewer systems varies significantly.

“The range of variance is incredible. For example, the countries in Western Europe annually spend an average of 502 euros per person on sewers. In eastern Europe the same figure is currently only 11 euros.”

According to Heavens, the yearly pipe replacement rate is less than 0.5% even in the richest countries. This means that the infrastructure is assumed to have a 200-year service life, which is not realistic.

“The annual replacement rate should be at least 1%.”

Climate change, as forecast, will tend to accelerate the need for investments in new pipe infrastructure. The universal key element – water – will continue to grow in importance.

“There is a tremendous amount of work and investment involved in the processing of clean water. Water is never cheap – you have to pump, clean and transport it.”

H<sub>2</sub>O’s value is especially high if you don’t have enough of it. Or if there is too much of it. The challenges of climate change are still impossible to foresee.

“You can say that there are wet countries and dry countries.”

“In dry countries the main problem is leakage, which wastes precious supplies. In wet countries it is sewer overloads, which lead to pollution.”

The provision of educational information on the value of water is a global challenge. “The utilities need to make a bigger effort to educate the general public on the need to spend money on the infrastructure to ensure safe and reliable supplies.” ●

In the Åland archipelago between Finland and Sweden, it is impossible to build roads without bridges and causeways. However, when building causeways, it is vital to ensure that the structures intended to secure transport links for local residents and holiday-home owners do not cause any damage to nature. The inlets cut off by the causeways need fresh water so that they can support life and maintain their recreational value. In many cases, sheet metal culverts have been used to ensure water circulation between the inlet and the surrounding sea area.

Dick Mattsson from the provincial road maintenance unit points out that the seawater around the Åland islands is fairly aggressive. According to him, this had caused the Åvabro culvert, built to ensure water circulation in a small inlet with several holiday homes, to rust so much that it had to be replaced. Mattsson says that after this had been noticed, the process of considering different repair alternatives began. While sheet metal is a common material for big culverts, the small size of the Åvabro culvert (only two metres) made several options possible.

“The inconvenience the work caused to road users was a major consideration,” says Dick Mattsson. “No alternative rout-

ing was possible, so a quick and low-cost way of fixing the culvert was needed. Replacing the culvert with a similar new one would have kept the road closed for 2–3 days, as this would have been the time required to excavate the old culvert and lay the new one.”

It was clear that in a small inlet the flow of water would not be affected even if there was a slight shrinkage in the diameter of the culvert. So the road maintenance unit began planning a solution in which a new pipe would simply be inserted into the existing one. After the decision had been made, a solution that would be low-cost and lend itself to relining had to be found. For example, pipes with joints requiring external clamps were rejected and in the end the choice fell on a plastic pipe with a smooth outer surface and threaded joints. Consequently, it was decided to go for a solution based on Weholite 1,600 mm SN4 pipe.

“In the end, it became clear that only KWH Pipe was able to offer the type of product we wanted,” says Mattsson. The choice was made easier by the fact that the provincial government had already carried out similar jobs in the past. The relining on the Vårdöbro construction site had gone without a hitch.

photo: Kivapössi



Constructing roads in the Åland archipelago requires a large number of bridges and causeways. At the same time, it is vital to ensure that there is no environmental damage and to secure the flow of water to the inlets behind the causeways.

# Relining

## allowed road traffic to flow unhindered

**The sheet metal culvert through the Åvabro causeway was no longer able to withstand the aggressive impact of the Åland archipelago seawater. Building a new culvert would have meant a road closure lasting several days. The problem was solved by inserting a plastic pipe into the existing culvert.**

### COMPLETED IN ONE DAY

The provincial government of Åland ordered five six-metre Weholite sections for the project. A total of 30 metres of new culvert was sunk into the sea.

According to Mattsson, the sections were brought to the site by lorry and hoisted to the installation point using an excavator. The work was carried out under water by pushing the pipe through the sheet metal culvert. “The sea had to be calm for the duration of the work, so a day with very little wind was chosen.”

The installation work was over in about eight hours and involved two machines, a diver and two fitters. The traffic on the road was not affected.

“The diver went through the old culvert





## THE PIPES

○ Weholite DN/ID 1,600 mm SN4,  
total length 30 metres.



using fire-fighting equipment to remove all sand, rocks and other litter from inside the pipe,” says Mattsson. “The next stage was the most difficult phase of the work as it involved bringing the first new pipe section to the mouth of the culvert. Sinking a large pipe under water was not easy, as it had considerable buoyancy, but in the end the fitters managed to push the pipe inside the culvert using iron bars. This is the kind of work where new solutions are needed every time.”

The remaining pipe sections did not pose any problems. As the new pipe has a smooth surface and is smaller than the old one, pushing it through the existing culvert was easy. One excavator was used to lift the sections, while the other helped

to join the pipes and push them into the culvert. A boat was also used.

Connecting the sections with threaded joints is more difficult on water than on the ground. The danger is that the pipes start rotating because supporting a pipe ready for laying is more difficult on the water than on the ground. So, the supporting work was carried out with the help of an excavator and iron bars.

### THE SEA WILL TAKE CARE OF THE REST

It was decided not to fill the space between the new and old culverts or to secure the new pipe to the bottom of the sea.

As there was already a layer of sand and rocks at the bottom of the old culvert,

the assumption is that the sea will take care of the job on behalf of the contractors. The road maintenance unit will, however, keep an eye on the structure and should the assumption prove false, appropriate measures will be taken. In that case, one option would be to fill the space between the two pipes with lightweight concrete.

Another development that will be closely monitored is the sinking of the road surface. If the old culvert rusts right through, it is theoretically possible for the road surface to sink by 20 cm (the space between the new pipe and the old). However, the solid and durable structure of the plastic pipe inside the metal culvert should provide sufficient support. ●



# Tamar river crossing

**In 2000, KWH Pipe and LMR Drilling UK Ltd., a world leader in the directional drilling industry, cooperated on the installation of a new polyethylene pipeline from Saltash in Cornwall to Ernesettle in Devon.**

The pipeline was constructed to transport sewage to the new facilities at Ernesettle Waste Water Treatment works, owned by South West Water and situated in Plymouth. The length of the pipeline was 1,400 metres, which made this project the longest pull-back of polyethylene pipe to be installed by the technique of horizontal directional drilling at that time.

The routing of the pipeline proved to be a challenge, due to the fact that it had to cross the River Tamar. The location of the treatment works and the position of a Ministry of Defence establishment required the pipeline to cross beneath the river and a railway line at an angle making the crossing

longer than the natural width of the river. Conventional methods had been considered but dismissed because of problems with water depth and environmental issues across a large area of mud flats on the Ernesettle side of the river. The only construction technique suitable was horizontal directional drilling. The length of 1,400 metres was therefore considered to be a great challenge for engineering a solution.

For the project KWH Pipe supplied 1,400 metres of 560 mm SDR 17 PE 100 WehoPipe, which was butt-fusion welded on site. Because of the restricted amount of space available, prior to its installation, the pipeline had to follow a tortuous route across playing fields and double back on itself over a golf course to return to the initial departure point.

Low friction conveyors were used to support the pipe during pull-back and prior to the pull commencing. The system was checked using a trial pull to ensure the rollers were correctly aligned. A pre-hydrostatic test of 8 bar, in accordance with the Water Research Council's procedure CESWI 5 was conducted on the pipeline before installation into the drilled hole.

Geological investigations had shown that the drilled profile would have to pass through hard rocks, soft silt, sand, gravel and made ground. Difficulties were foreseen with the interface between the hard and soft ground and great care was taken when drilling passed this point on the drill profile. To facilitate the drilling, the decision was taken to start on the Saltash side of the river, going directly into the hard phyllite rock.

The pull-back, having an average load of 40 tonne, crowned this considerable engineering achievement, which pushed out the boundaries of technology for the drilling and installation of a pipeline. This was in order to meet the necessities of a project, which could not have been achieved economically and environmentally by any other method. ●



# Drinking water for Kalundborg, Denmark

**Kalundborg has been obtaining its drinking water from Nordvestsjælland through a pumping station at Marke south of Svinninge which brings together water from several water supplies.**

This was no longer sufficient to meet demand, and an additional water supply was therefore needed.

Langerød waterworks south of Holbæk received permission from the County of West Zealand to increase their annual production by 0.65 million cubic metres of water to help the situation in Kalundborg.

It was therefore decided to build a drinking-water pipe from Langerød waterworks to the pumping station at Marke for connecting to the existing distribution pipe to Kalundborg.

The new water pipe was built using horizontal directional drilling, with 240-metre pipe sections. These sections were assembled with segment welding before being pushed into the boreholes. The sections were then joined by electrofusion, creating a single unbroken section of pipe 13.5 km long. The entire process left only negligible marks on the landscape.

The project also included 18 chambers of various sizes – manufactured and



**The connection to one of the many chambers on the pipe. The components are being joined by electrofusion.**

delivered by KWH Pipe – such as measuring chambers, ventilation chambers and cleaning chambers.

The new water pipeline from Langerød waterworks was built using pipes from KWH Pipe just like the existing water pipeline from Marke to Deigvad waterworks east of Kalundborg. ●

**Before pushing the pipes into the boreholes, they were segment welded into 240-metre sections.**



## 15 KM OF PE PRESSURE PIPE LAID BY HORIZONTAL DIRECTIONAL DRILLING

- **Project:** Building of drinking water pipe from Langerød waterworks at Holbæk to the pumping station at Marke
- **Contractor:** The water cooperative Vandfællesskabet Nordvestsjælland a.m.b.a (NV)
- **Consultants:** RAMBØLL
- **Contractor:** NCC Construction Danmark A/S
- **Installation:**
  - Building 13.5 km of 250 mm diameter drinking-water pipe
  - Building 1.6 km of 90 mm diameter drinking-water pipe
  - 18 inspection chambers (meter chambers, ventilation chambers and cleaning chambers)

## ABOUT KWH PIPE (DANMARK) AS

- KWH Pipe (Danmark) AS has been one of the leading suppliers of polyethylene (PE) pipes and fittings on the Danish market for more than 40 years.
- The pipe factory in Middelfart produces PE pipes in over 200 different sizes from 20 mm to 1,400 mm diameter.
- KWH Pipe is the only supplier in Denmark that can deliver gravity pipes and pipes for rainwater basins, wells, etc. at diameters up to 3,000 mm.
- Fittings and chambers are customized at the production workshop in Svinninge.



# Minimal





**KWH Pipe often teams up with expert companies to provide the best possible solution for customers' pipe renovation needs. In this case, KWH Pipe were asked by Subterra to manufacture a special large diameter, thin-walled pipe for their project to reline almost 1,000 metres of 42 inch diameter ferro-concrete aqueduct. KWH Pipe subsequently supplied 1050 mm SDR 58 liner pipe, which was installed using the Subline technique.**

# effect on environment

**W**hen Yorkshire Water constructed a new water treatment plant at Headingley near Leeds in 2001–2002, they also examined the pipelines leading to the plant. It turned out that an 863-metre length of one of the main feeder pipes suffered from leaking joints and significant root ingress. The 42-inch diameter ferro-concrete pipeline carrying raw water from Eccup reservoir was badly in need of renovation. However, it was vital that any renovation method would have minimal effect on highways, the public and the environment. Furthermore, because of the strategic importance of the main, a short installation time was necessary. These reasons made new lay an inconvenient option, so the designers and constructors contacted pipeline renovation experts Subterra.

Subterra recommended the use of their close-fit polyethylene lining technique, Subline. Subline is specifically designed for thin-wall application in diameters from 75 mm to 1,600 mm and can negotiate bends up to 45°. The Subline technique uses pre-welded polyethylene pipe that is pushed through a former to fold it into a 'heart' shape which is temporarily held by restraining bands. The reduced cross section creates a clearance to facilitate

the insertion of the polyethylene pipe into the original pipe that is being renovated. Once installed, the folded pipe is then returned to its circular form by pressurisation with water at ambient temperature, which breaks the temporary restraining bands. This creates a close fit within the host pipe, sealing leaks and preventing corrosion.

## **THOROUGH PLANNING**

The location and route of the main presented the construction team with many varied and interesting challenges. The pipeline route started at the upstream end

## **THE RESTRICTIONS OF THIS PROJECT CALLED FOR AN INNOVATIVE SOLUTION AND THOROUGH PLANNING.**

adjacent to an access road to a major local cricket ground and training pitch for Yorkshire County Cricket Club. Via a series of 11.25° and 22.5° bends the pipeline then crossed under the busy northern section of the Leeds A6120 ring road and was then joined by two adjacent large diameter aqueducts. The three pipelines, in very close proximity then followed a route up to 4.5 metres deep in places, below a narrow track weaving its way through a

major public park containing mature trees supporting a vast array of wildlife. The park was used extensively by the public as a recreation area. Vehicular access to the park by a narrow, twisting access track via an ornate stone gateway prevented the use of large or heavy equipment.

The pipeline route contained a total of ten bends, numerous pulled joints, two air valves and a washout. One of the air valves was located in an access chamber adjacent to a mature tree on the edge of a steep embankment. Excavation there risked destabilising the embankment and jeopardising the stability of adjacent water

mains and mature trees. The washout was located in the middle of the anti-clockwise carriageway of the ring road, which made excavation impossible as it would have caused too much disruption over a period of several weeks.

The restrictions of this project called for an innovative solution and thorough planning. It was decided to utilise the access pit at the upstream end as a common insertion pit for winching all of the ►►

Sublined liner. However, the weight of 860 metres of PE liner coupled with the quantity and alignment of bends would produce installation forces too high to allow the liner to be inserted in one length. The liner was therefore installed in three sections, 147 m, 327 m and 351 m long, each length being determined by the location of the fittings to be renewed. Only small pits were needed at these intersection locations to provide access for final connection of the pipework. The installation team carried out a complete end-to-end internal inspection to confirm alignment, condition and number of fittings. The main was then cleaned using heavy-duty scrapers following removal by manual cutting of root masses intruding through the joints.

The welding site was located in a field some 200 metres upstream from the insertion pit. The 1050 mm SDR58 PE-MD liner was delivered by KWH Pipe in 14.5 metre lengths to a loading area and then taken in individual lengths to the welding

site, where it was welded up into longer strings using a KWH 1200 automatic butt-fusion machine, owned and operated by the welding contractor, A.G. Wilson. The Subline machine was positioned near the insertion pit on the edge of the access road. The first 147 metre length, weighing approximately 9 tonnes, was moved from the welding site to the Subline machine, deformed into the characteristic 'heart' shape, banded and connected to the winch rope. It was then pulled through the main 860 metres until it reached its correct position. The second and third lengths, weighing 20 and 22 tonnes respectively, were installed in the same way later the same week. The liner ends were mechanically re-rounded to enable fitting of mechanical end couplings. Blank flange plates were fitted and the liner was returned to its original circular shape using water pressure.

The concrete pipe prevented the use of conventional mechanical transition coup-

plings to 'piece in' at intervention points. This was resolved by terminating the liner 300 mm short of the end of the host pipe, anchoring it to the concrete with specially made steel retaining bands and effecting a hydraulic seal using an Amex-10 seal. Tailor-made mechanical couplings completed the seal between the ferro-concrete pipe and the new ductile iron pipe and fittings, bridging the gap between the ends of the host pipe at access pits. Replacement air valves could then be used in conjunction with these standard ductile iron fittings.

### NO DISRUPTION TO THE USERS

Past experience had proved this liner-end termination method suitable for use 'in-pipe' supported by trained 'confined space' personnel. With this in mind the liner near the washout was cut immediately each side of the outlet branch taking care not to expose the joints – ensured by careful measurements taken prior to liner installation. The liner ends at these points were then terminated and sealed using the Amex-10 seals leaving only the branch exposed with the joints between tee and pipeline securely covered by the liner. This element of the work was carried out beneath the road and the park without any of the road users being aware of it, and experiencing no disruption. The air valve at the main access tee was similarly renovated from within the main, avoiding any excavation in this particularly sensitive location. The innovative use of well-developed no-dig technology made the refurbishment project possible without impact on road users and with minimal effect on the users of the park and its ecology.

The success of this installation, including the quick turn-round in production by KWH Pipe and the manufacture of special tooling which greatly reduced the overall installation time of the project, encouraged Subterra to approach KWH Pipe to manufacture other 'non-standard' pipe diameters and Sdr. ratings for other projects in the UK. ●

## THE INNOVATIVE USE OF WELL-DEVELOPED TECHNOLOGY MADE PROJECT POSSIBLE WITHOUT IMPACT ON ROAD AND PARK USERS.





# Weholite for stormwater storage

## The system of the **future**

**The advanced High Density Polyethylene (PE-HD) water management solution for stormwater attenuation tanks at a new site in Rochford, Kent, has been described by site agents Jackson Civil Engineering as ‘the system of the future’.**



**R**ochford Park, which will house five car showrooms, a petrol station and a car valet centre, is the largest private commercial site in the UK, so far, to make use of the plastic Weholite tanks. Jackson Civil Engineering commissioned the bespoke tanks from Weholite licensee Asset International Ltd.

The system comprising 350 metres of 1,500 mm diameter Weholite pipe and 1.2 km of 1800 mm diameter Weholite pipe, will enable storage of up to 3,500 cubic metres of water. The Weholite products, which were first developed in Finland, are lightweight, durable, easy to install and abrasion resistant.

Chris Manning of Jackson Civil Engineering commented on the impact of using

Weholite tanks compared with traditional concrete structures, on a development of this size: “Our team has been able to lay up to 300 metres of the pipes per day, which has meant that we have been able to save a considerable amount of time, which in turn means significant cost reductions. To lay the equivalent in concrete piping would have meant more time spent on site, increasing labour costs.”

“This is the first time I’ve personally worked with a team utilizing Weholite products and I truly believe they are the system of the future. Easily transported, quick to install and yet still durable and efficient, they offer an excellent alternative solution to similar concrete products.”

Simon Thomas, Managing Director, Asset International commented on the

product development carried out for this particular site: “We’ve worked with Jackson Civil Engineering on a number of sites in the past, but this is the largest private commercial project so far.”

“The bespoke design of the tank system has been developed with our engineers working in close partnership with the team at Jacksons. The storage system is a multi-legged configuration and has enabled all of the PE-HD pipework, including the prefabricated manifold sections, to be installed within a matter of weeks.” •



# No digging, no disruption

**The use of the sliplining method reduced the disruption of traffic in Bangkok and alleviated project-related traffic jams.**

In the past, drinking water for the entire city of Bangkok was mainly carried by steel pipelines. It is widely known that steel pipes will eventually corrode, causing leakage and further damage, as one thing leads to another. Leaking pipes cost the authorities a significant amount of money, and eventually these costs will burden the end-users.

Leakages in these old steel pipes also create exfiltration that will lead to loss of water, property damage, water resource pollution and other environmental problems.





All of these problems had been under surveillance and investigation by the Metropolitan Water Works Authority (MWA) for years. The MWA was searching for a suitable way to improve the quality of the water supply and distribution. The most widely used renovation method for underground pipelines has been the excavation of the old pipelines and their replacement with new ones. This antiquated technique causes many inconveniences to all parties involved. For example, a major problem that needed to be recognized for all the renovation work in Bangkok was the traffic flow on its streets.

Bangkok is one of the most highly populated cities in the world with a notorious traffic problem. Any installation or maintenance of infrastructure, such as underground water pipelines, must be done with minimal disturbance to the traffic. That's where 'No-Dig' technology comes in.



**A MAJOR PROBLEM THAT NEEDS TO BE RECOGNIZED FOR ALL THE RENOVATION WORK IN BANGKOK IS THE TRAFFIC FLOW ON ITS STREETS.**

## **PROJECT RECONFIRMS ADVANTAGES**

This was a demonstration project in 2004 to reconfirm the advantages of using No-Dig Technology in the central area of Bangkok for pipe renovation along the Rajapralob Road. The project was defined in conjunction with Per Aarsleff A/S and Wiik & Hoeglund Public Company Limited, based on an approved Partnership project run by the Danish Ministry of Foreign Affairs and financed by DANIDA. The total budget for the project was around 15 million Baht (approximately 300 thousand euros).

In the project, a very popular method called sliplining was used. It is performed by inserting PE-HD pipes into the existing damaged pipe and is widely known as the simplest method of No-Dig Technology.

PE-HD pipes OD 710 mm PN10 with a total length of 250 metres had been inserted into existing, damaged 800 mm ID steel pipes. Because of their superior flow characteristics the smaller PE-HD

pipes are still able to maintain the same volumetric flow as the steel pipes used previously.

The use of the sliplining method reduced the disruption of traffic in Bangkok and alleviated project-related traffic jams. Furthermore, the excavation of the road was completed with minimal effect on the existing road surface. After the layers of deposit in the old steel pipes had been removed with a mechanical scraper, PE-HD pipes that were delivered from the KWH Pipe factory in Rayong were welded.

The pipes were welded together as an entire project length and inserted into the existing steel pipe using a pulling head connected by a cable to a winch. The welding and insertion of PE-HD pipes had been done within one continuous period of 24 hours. To complete the flow, pipes were welded with stub ends and a steel backing ring in order to connect with an existing pipeline.

## **FIRST EXPERIENCE 25 YEARS AGO**

Actually, the city of Bangkok first had experience of the sliplining method around 25 years ago. In 1980, KWH Pipe International was invited by MWA to submit a proposal to renovate the Bangkok cast-iron water pipeline on the major Rama IV, Rajdamri, and Charoenkrung roads.

KWH Pipe was contracted to manufacture and deliver 9.6 km of PE-HD pipe PN6.3 ranging in size from OD 355 mm to 710 mm. The pipes were then shipped from KWH Pipe's factory in Vaasa, Finland to Bangkok. The actual relining work took around 10 months for the whole project. Upon completion, MWA's Project Director said that he was very satisfied with both the technical solution and working schedule.

This rehabilitated pipeline functions very well in supplying drinking water to the people in these areas. ●

# *Life is easy when pipework rehabilitation is carried out using KWH Pipe methods*

For decades now, KWH Pipe has focused on developing methods for repairing old, leaking sewers. We now offer various options for rehabilitating pipework outside buildings, whether rain water or wastewater drains, pressure pipes, main sewers or leaking inspection chambers.

## ***Our rehabilitation methods provide significant benefits:***

- Costs are kept under control – rehabilitation is carried out without the need for excavation.
- The sewage system can be kept functioning throughout the rehabilitation work.
- The rehabilitation work will not disrupt traffic.

***Contact us and ask for a quote. We will be happy to tell you more about our pipework rehabilitation methods.***

