A personal experience

Stephen Gibson provides a civil engineering designer's experience of applying trenchless technology on numerous projects in the UK

I WOULDN'T count myself an expert in trenchless technology, but I have specified and produced designs encompassing many trenchless solutions over the last decade. Once a project is tendered and a contractor selected, I take the approach that we should listen and work as a team to fine-tune the specific details. To date, every project using trenchless techniques has proved successful.

For those who work in the specialist field of trenchless technology, it may be useful to learn how a 'generalist' civil engineer sees the opportunities for trenchless techniques on otherwise relatively straightforward building and infrastructure projects. After all, I will have already made and won the case for such a technique, long before such an element of work is tendered.

I have found that among many UK consultants, there is often little knowledge, let alone experience, of trenchless techniques. Likewise, practically all my clients will never have had a project where such a technique has been used before, so naturally they are very conservative. From experience and research, I have subsequently written design advice/specifications for several major UK consultants on the various trenchless techniques. To my mind, much of the UK consulting industry is not that engaged.

Part of this may be down to an inherent conservatism and lack of experience. A civil engineering consultant does not need to have knowledge of all the complexities, but needs enough knowledge and experience to identify where and when an application would be most suited.

Illustrating the complexity of digging in London, Stephen Gibson cites this trench in Holborn, which contained 35 different buried services – including four different gas companies' apparatus, two redundant hydraulic mains and a long-disused tram rail

Many clients and consultants list a multitude of reasons for problems with trenchless solutions, as if digging a deep trench by open cutting is without any risk. Recently, I reviewed the Institution of Gas Engineers and Managers communication on 'Trenchless Techniques'. It is nearly 100 pages of "safety concerns to consider", of which perhaps 80% apply also to traditional non-trenchless methods.

> **"Among UK consultants, there is often little knowledge, let alone experience, of trenchless techniques"**

Typical statements made include "care taken in selecting methods, identifying hazards, evidence of ground disturbance, maintaining a safe working distance from buried services, identifying underground services and avoiding tree roots". But these are also part of traditional open-cut proposals. Whether for open-cut or trenchless, all the radio-detection scans in the world will not make it possible to see through the ground and identify all problems.

I end up designing trenchless solutions for a wide range of projects, from water infrastructure to commercial developments, and for private clients. Often, when the project commences, it is not apparent what, if any, trenchless solutions may be required. Yet many consultants on fixed fees wish to minimise design time and potential liability by sticking to traditional open-cut methods for new installations, irrespective of the costs to the client.

Trenchless solutions normally require far greater design complexity. I often produce two designs, one involving a trenchless solution and one a traditional solution, and then request them to be priced. Once the lower cost of the trenchless solution becomes evident, I find client support follows swiftly.

TRENCHLESS AIDS SEWER ACCESS

By far the most common trenchless solution on many projects is the lining of foul drains, where replacement is not viable. Yet the speed of installation of directional drilling and relative low cost has the potential to make it a key way for the UK to comply with the European Framework Directive – in relation to reducing the discharging of treated effluent to groundwater and watercourses across the UK.

No accurate figures exist, but best estimates are that millions across the UK do not yet have access to public sewerage. It is common in the UK to find commercial and housing estates serving thousands in rural areas using primitive septic tanks.

Pipe bursting has been tried in the UK, but the Victorian clean-water mains have retained their strength extremely well and often resist attempts to rupture them

Diverting groundwater from a Highgate home

A recent example of a successful trenchless application was for a multi-million-pound private house redevelopment in Highgate, London.

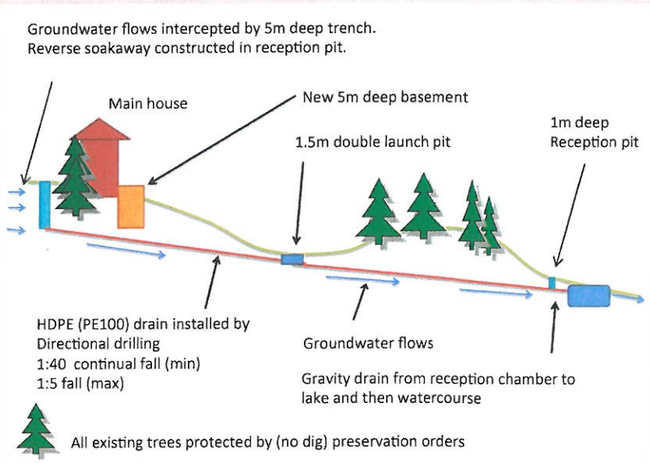
Highgate is at the top of Hampstead Heath and has a relatively permeable sandy strata that sits on an underlying layer of London Clay. As such, springs occur at the interface. Many springs feed the Hampstead Ponds – reservoirs built in 1777 to supply drinking water for north London – and also form the main source of the River Fleet, which is the largest subterranean river in London.

The project involved a large basement. When the basement was in construction, a considerable amount of groundwater was discovered. It is often difficult to entirely waterproof new basements around existing buildings, so I proposed a 5m-deep cut-off trench on the upper side, to reduce groundwater flows locally. The issue therefore was how can a gravity-based groundwater discharge system be constructed, with the house and basement in the way?

To make matters worse, the surrounding ground had trees that were protected by conservation orders. To any extent, a 5m-deep open-cut trench is not recommended near trees or foundations. I therefore designed a 200m-long horizontally directional drilled drain installation to discharge the water on a gravity basis to a pond in another part of the grounds.

Although HDPE (PE100) is commonly used in the UK for pumped sewerage rising mains, gas and clean-water mains, it is rarely used for surface-water drains. The other concern was to make sure that all drilling fluids were collected and none would be released into the ponds or watercourse.

A trenchless approach had several merits – financial savings, less risk to the foundations and trees, and a considerable safety advantage with shallower excavations.



How a trenchless solution overcame drainage challenges at a residential basement extension project in Highgate, London

One project I had in Oxfordshire required connecting a large section of the village of Long Hanborough to the public sewer. I proposed a directionally drilled rising main solution with pumps, which was priced at around US$184,000 by a local contractor. The water company estimated the same proposal using open cut at a cost of US$828,000, but it then rejected the open-cut proposal, based on its own estimate, as "too expensive".

In competitive project tenders, the UK government (ie the water regulator OFWAT, the Environment Agency, and the Department for Environment, Food and Rural Affairs) has yet to grasp the enormous environmental benefits and public savings that could arise from widespread use of trenchless methods such as HDD.

For some projects where an adopted public system is not required, there are considerable savings. I designed the civils work for a US$3 million community college rural centre near Witney, Oxfordshire. The ground was relatively impermeable and the septic-tank system was redundant. I proposed a directional-drilling solution to install a rising main to the public sewer, approximately 1km away. The pumped solution worked out to be considerably cheaper than the installation of a treatment works. It also cut the operating costs by one-tenth. ➔

Sliplining on Kensington High Street. Carrying out such work in London's busy main roads can be difficult

→ DIFFICULTIES IN LONDON

While working previously as lead design engineer for the UK's largest water company, one of my key considerations was the type of trenchless solution that could be applied to install new water mains across central London.

Excavation costs in London are considerable. The roads are not built on ground, they are suspended on an array of live and redundant services. Perhaps no city in the world has such an array of services that stretch back to the start of the industrial revolution.

I saw a single trench in Holborn that had 35 different services – including four different gas companies' apparatus, two hydraulic mains (to power hotel lifts prior to the advent of electricity) and a rail for a redundant tram line.

VARIED TECHNIQUES NEEDED

As such, I specified a multitude of techniques such as slip-lining, pipe bursting and directional drilling. Assessing the technique against the street circumstances came first and then the hydraulic design followed to fit.

For example, Kensington High Street is a very important and busy shopping street – it is also relatively wide. The Victorians traditionally chose such streets for the larger-sized clean-water trunk mains. My design showed new trunk mains installed by directional drilling in the more recent, smaller and quieter side streets. This enabled the existing mains on the High Street to be slip-lined without reducing the overall network capacity.

Horizontal directional drilling deserves greater acceptance in the UK, argues Stephen Gibson

Butt-fusion welds used as a new pipe is threaded under an old piece of infrastructure

> "Pipe bursting was attempted at a number of locations, but London's Victorian clean-water mains, despite leaking, can still have considerable strength"

Excavations still have to be undertaken to make connections, so it is not always a case of 'no dig'. However, given the way installation and commissioning is usually carried out for clean water, it means essentially digging once and not twice!

Pipe bursting was attempted at a number of locations, but London's Victorian clean-water mains, despite leaking, can still have considerable strength.

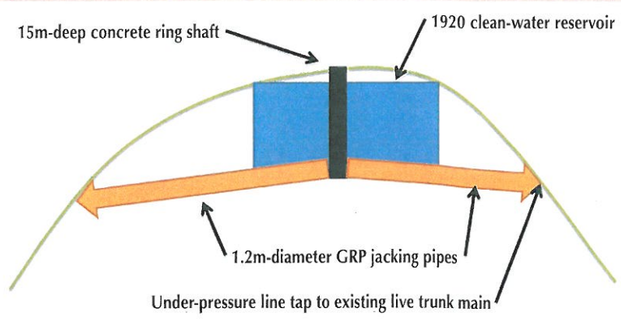
As all the clean-water mains were being replaced at the same time, it was more cost-effective to just slip-line one street and upsize the next to maintain the required flows and pressure within the localised network.

So my conclusion is that if only consulting civil engineers and the authorities in the UK could understand or experience the benefits and potential for transformation that trenchless technology could bring, the industry will have a great future.

Pipe jacking around hill-top water reservoir in Oxfordshire

One of the largest trenchless solutions that the author has specified was the use of 1.2m-diameter GRP jacking pipes to enable the installation of a new 1m-diameter clean-water trunk main. This was used to install a new connection around the top of a reservoir located at the top of Beacon Hill in Oxfordshire.

The main connected with a 15m-deep concrete ring shaft and then back out of the hill on the other side. The concrete ring shaft was constructed first and then the central shaft used for jacking outwards on either side of the hill. The work needed to be done within 10m of the reservoir and a key advantage of using pipe jacking was the minimisation of disturbance of the ground.



GRP pipes of 1.2m diameter formed a new trunk water main through Beacon Hill, Oxfordshire, thanks to pipe-jacking techniques

Stephen Gibson founded Wilsham Consulting following experience of leading civils teams for Cifford and Ramboll, and as lead design engineer for Thames Water. Wilsham is a leading UK professional practice, with experience of trenchless solutions across the highway, building and water sectors. Further details: www.wilsham.co.uk