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Stormwater strategy delivers sustainable solutions

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Tricky balancing act

Delivering pipeline efficiencies and new techniques in constrained times

MWH Technical Director of Pipeline Engineering across Europe and Africa, Sandra Rolfe-Dickinson examines how regulation, carbon footprint, and cost pressures are increasingly challenging clients and their suppliers to create new and sustainable ways that will deliver cost effective short – and long-term solutions.

The water industry in general is facing the ongoing challenge of trying to deliver capital programs with very constrained budgets. This is a difficult environment in which to work, and so different from the heady days when the industry was much better financed.

In England and Wales, going through successive Asset Management Plan (AMP) periods, the industry has had to become more efficient, and never more so than in the current AMP5 period (2011-2016). This throws out harsh challenges to the supply chain servicing the water industry – it feels like clients are now saying, "We know you were clever and innovative before, but now we need you to be even more clever and innovative." But rightly clients do not want to be left with consequences of the supply chain being too gung-ho, and leaving a legacy of "cheap and cheerful" solutions that will start breaking down in a few years time.

So for those on the supply side, it is a tricky balancing act to challenge long-held industry standards, specifications and ways of doing things, and coming up with solutions that will deliver the long-term needs of the water industry as well as the short-term necessary efficiencies.

Sweat those assets

A key plank to efficiencies in most water companies is making use as far as possible of existing assets, and this is particularly critical in my specialist area of pipelines. There are obviously many reasons why a pipeline may not be performing as required, including failure history, inadequate capacity, and internal corrosion causing dirty water. In addition, further industry challenges in the United Kingdom are being faced such as ensuring that the Service Incentive Mechanism (SIM) score for water companies is not compromised, and delivering carbon-efficient solutions. The UK Water Services Regulation Authority (OFWAT) recently introduced the SIM score. It is essentially a measure of customer experience when having contact with the water company or its supply chain. The water companies may be financially penalized for poor SIM scores.

Reduce carbon emissions

In 2008 OFWAT published its guidance document "Preparing for the future – OFWAT's climate change policy statement" in which it outlines the importance of carbon-efficient and sustainable solutions. The Climate Change Act (2008) set UK targets for carbon reduction of at least 34 percent by 2020 and 80 percent by 2050, based on 1990 levels. It also requires five-year carbon budgets to be set. In 2009 the government published its "Low carbon transition plan" for meeting these carbon budgets.

Water companies are subject to specific requirements to:

- Report their annual emissions from operational activities in their June return to OFWAT;
- Incorporate carbon impacts in the economic appraisal of capital investment, which they did in their AMP5 Business Plans and are preparing to do again for AMP6.

In 2010, OFWAT compiled results of water companies PR09 submissions on carbon emissions in its report "Playing our part." OFWAT's report showed that in the UK water industry:

- Operational activities account for 0.7 percent of UK's annual greenhouse gas (GHG) emissions;
- Capital programs will account for a further 0.4 percent of UK GHG emissions (assuming spread evenly over the years 2010-2015).

UK water companies have already made a clear commitment to carbon reduction, and in some cases real progress has already been made. For example, Thames Water Utilities Ltd has set a voluntary target of a 20 percent reduction of GHG emissions on 1990 levels by 2015, and has recently shown that it is making significant progress towards this target, with its emissions being 11.4 percent lower than they were in 1990. The total embodied emissions from AMP5 capital program is estimated to be 11.6 million tonnes CO2e. Of these, a significant proportion (marked) is attributed to water and wastewater network improvements.

Many water companies now require their contractors and suppliers to report their emissions and demonstrate how they are taking action for carbon reduction.

New impetus for no-dig techniques

Whilst no-dig techniques such as sliplining, spray lining, pipe bursting, and directional drilling have been used for many years, they are gaining a new impetus driven by the industry's need for greater carbon accountability.

The US company Insituform completed a polyethylene lining project on pressurized lines in Hong Kong using the InsituGuard™ system.

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Considering the components of a typical open-cut pipeline installation, carbon emissions arise from:

- Trench excavation and shoring;
- Processing, transport and laying of pipe bedding material;
- Manufacture and transport of pipes and fittings
- Trench backfill and compaction

If the pipeline is laid in a road, then there are additional carbon emissions arising from road reinstatement. The most significant carbon emissions savings come from the reduction in the amount of plant required for no-dig rehabilitation solutions. Trenchless technologies mean fewer diggers, little or no muck away, and no need to process and transport pipeline bedding materials. Chart 1 shows a 90-percent reduction in carbon emissions for the no-dig solution versus the conventional open-cut solution with the majority of this saving resulting from the reduced need for plant.

As pipe diameters and installation depths increase so do the carbon savings, not just from plant emissions, but also from the embodied carbon due to plant manufacture. Trenchless technologies usually use plastic pipe to rehabilitate existing pipelines, which, again, contain significantly less embodied carbon than metallic pipe materials.

No-dig pipeline installations are increasingly being used in place of open-cut construction, for reasons of cost-saving, minimizing disruption, and practicality. For example, as part of the joint venture Optimise, MWH is delivering a multi-million dollar mains replacement program, which includes major pipeline rehabilitation projects within the client's capital program. Because these have the potential to create disruption, huge expenditure, and significant carbon emissions, Optimise has had to find alternative and low carbon solutions. To achieve this, MWH engineers designed and implemented innovative pipeline rehabilitation techniques that could bring significant costs savings to pipeline projects. These include no-dig techniques to reduce carbon emissions and the use of pipe bursting and spray lining techniques for pipeline rehabilitation.

Four typical no-dig processes being used by MWH and Optimise include:

- Directional drilling: The installation of a new pipeline on a new route, installed by drilling a pilot hole, which is then back reamed up to the required size. This technique is typically used for new installations up to 600-mm diameter, although larger diameters are possible, depending on soil conditions.
- Pipe bursting: This involves the displacement of an existing host pipe, and the simultaneous installation of a structural replacement pipe of the same or greater diameter. The technique is generally suitable for the replacement of pipelines in diameters ranging from 75mm up to 900mm. Service connections or laterals require reinstatement by open cut.
- Sliplining (loose and close-fit): Sliplining is similar to pipebursting, except a pipeline smaller than the existing main is installed. No pipe displacement occurs, so there is no risk to adjacent services. This is ideal for water pipeline renewals where the capacity can be reduced.

Close fit sliplining involves reducing the diameter of the polyethylene liner pipe by drawing it through dies, or folding it into a smaller cross-sectional area. The reduced liner can then be pulled into position, and is usually reverted by water pressure. Once reverted, the liner has a close fit with the host pipeline, minimising diameter loss. Service connections are usually reinstated by open cut.

- Spray lining: This technique is typically carried out on cast, spun or ductile iron water mains, usually in response to a water quality issue. However, burst reduction may also be achievable in certain circumstances. Generally service connections are not blocked in the lining process removing the need to excavate in order to reinstate communication pipes, making it very carbon efficient.

Many water companies are using these and other no-dig techniques to extend the life of pipeline assets. However, a comprehensive desktop study of options should be conducted in order to gain the most benefit from a no-dig method. This will identify constraints such as adjacent services, numbers of connections onto the pipeline to be rehabilitated, number of previous repairs, and any changes in size, alignment, and direction. Many of these constraints would require digging down onto

Swagelining reduces rehab project costs in Australia

Swagelining Limited's Australian-based partner, ITS Trenchless completed the largest polymer lining drinking water project undertaken in Australia.

The pipeline rehabilitation project involved lining 4,630m of existing 24-inch nominal diameter water main, which runs beneath one of the busiest roads in Adelaide. The US$4.1-million contract was the second project to be carried out for South Australia's water utility corporation, SA Water, following a similar project in Adelaide in 2007.

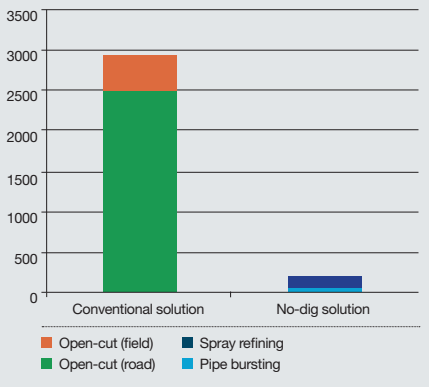
According to Stephen Barnes, managing director at Swagelining Limited, swagelining is life-extending technology for new and existing pipelines. It provides an effective solution where techniques such as open trench and pipe bursting are not suitable. "Project highlights included achieving polymer liner installation runs of up to 600m, swagelining through a sweeping bend, and completing the project on time and within budget," Barnes said.

The Swagelining system is versatile with liner thickness varying from project to project. The Adelaide project used a 594-mm polyethylene (PE) 100 liner with a wall thickness of 56mm to meet the client's requirement for a liner with full structural capability. This is in contrast to another water project recently completed in the United Kingdom where the requirement was for a thin semi-structural liner, which saw a 1016-mm PE100 liner with a wall thickness of only 20mm being installed.

David Jaensch, asset manager of SA Water said: "Using the innovative swagelining technology resulted in a significant reduction in the impact on the community and environment with only small sections of the road having to be closed for a short space of time to be dug up."

Based in Glasgow, Scotland, Swagelining Limited specializes in the control and prevention of internal corrosion in new and existing pipelines.

Case study: carbon emissions for conventional vs. no-dig pipeline installation (tonnes CO_2e)



The US company Insituform completed an InsituGuard project on Madison Avenue, New York City, New York in 2009.

the pipeline, and if there are too many, a rehabilitation option might quickly become uneconomic.

In addition, work should be scheduled to gain efficiencies. Often projects are scheduled to cover small areas at a time, so efficiencies from taking a more comprehensive view of engineering phases can be missed. For example, real savings cannot be achieved if rehabilitation is carried out on short lengths of disparate pipelines. Programs have to target areas where volumes of work can be executed on an ongoing basis; this will reduce the cost of rehabilitation and impact on the local community.

Two of the techniques mentioned, directional drilling and pipe bursting, give the client a completely new asset, with a lifetime in excess of 50 years. Sliplining with a loose liner also provides a new asset, which does not rely structurally upon the host pipeline, but does require a reduction in hydraulic capacity to be acceptable to the client. However, techniques such as spray lining, which relies upon the structural integrity of the existing pipeline, means that a reliable condition assessment is required in order to gain a better understanding of the assets under improvement. This will clearly involve more effort in investigation and design stages.

Condition assessment of existing pipelines creates new challenges, but is crucial to the longevity of a solution relying upon the integrity of the host pipeline. Pipeline structural condition may vary along its length for many reasons, including changing soil conditions, different loadings, stray currents, and material deterioration. Condition assessment is based on discrete locations where the pipeline has been exposed and evaluated, and involves an inherent assumption that the condition of the pipeline at the testing site is representative of the pipeline as a whole. How many test locations are required per kilometer of pipeline for this assumption to be supportable is a question that is difficult to answer and is largely dependent on the specific conditions of the pipeline in question. Similarly, basing the decision on previous failure history can be unreliable unless it can be clearly established why and how the pipeline failed. Pipelines that are subject to failures caused by third-party damage or localized corrosion may be sound for the majority of their length, and identifying this may lead to more cost effective solutions.

Not rocket science

To conclude, the key planks to driving efficiency into the pipeline renovation area of the water industry includes a full understanding of the client's requirements, effective condition assessment of pipelines, correct selection of rehabilitation technique based on optioneering, and proper programming of rehabilitation site works. None of this is particularly dramatic or innovative, but it is surprising how difficult it can be to effectively implement in the real world. Done well, it can lead to improved efficiencies, reduced carbon emissions, and significant cost savings.

Author's Note

Sandra Rolfe-Dickinson is the technical director of pipeline engineering for the global consultancy MWH, which specializes in water, environment, and program management. A recognized international pipelines expert, the author is an active member of the British Standards Institution Committee and was one of the principal authors of the new standard BS9295 - "Guide to the structural design of buried pipelines." Published in 2010, it helps engineers to understand the concepts behind the structural design of buried pipelines. For further information, please send an email to: sandra.rolfe-dickinson@mwhglobal.com or visit www.mwhglobal.com

Small-scale compaction for Abu-Dhabi pipeline

Turkish contractor Aydiner Constructions used a Dynapac CC 900 compaction roller and six LG 160 compaction plates for pipeline compaction involved in the Mussafah Water Transmission Scheme, part of the Mussafah-Abu Dhabi potable water pipeline project.

This new pipeline project is underway to meet peak period demand during the summer months for Abu Dhabi, the capital of the United Arab Emirates, with a population approaching two million. With a design capacity of 166 liters per day, the 32-kilo-meter pipeline will connect the water pumping station at Mussafah and Delma Street substation in Abu Dhabi.

Previously, Aydiner Constructions completed the Shuweihat Water Transmission Scheme, a major initiative combining one of the biggest water pipeline projects undertaken using ductile iron pipes with a desalination plant in the region. The twin pipeline, carrying 378,000 cubic meters per day, spans 250 km between the Shuweihat desalination plant and Mussafah, carrying water to join the regional supply network serving Sila, Mirfa, and Mussafah. The new Lot M contract pipeline features similar ductile iron pipe with a 1.6-m diameter.

Its route traverses salt-laden areas with a high water table – requiring extensive dewatering. Initially passing through open desert-type areas, the route also includes densely populated urban areas through the city. Ground conditions have so far not presented any problems for the contractor but, according to Ömer Ali Aydiner, chairman of sister company Aydiner Constructions – Abu Dhabi, unrecorded utilities are posing a particular problem. These include frequent underground electrical lines and water pipelines. The route also runs parallel with a number of oil-related and gas pipelines.

The pipeline will also pass below the Maqtaa creek at a depth of 20 meters. In the event of possible failures and common practice, the pipeline splits into two 730-meter pipelines below the creek, re-joining into a single pipe; relying on horizontal directional drilling techniques.

Using 45-t and 60-t class excavators for trench excavation, Aydiner is excavating to depths of up to 5 meters, but generally 3 m x 3 m depending on the surface gradation.

Two "bedding-in" 30-cm-deep base courses are initially prepared prior to laying the ductile pipes and compacted by purpose-ordered Dynapac LG 160 plate compactors.

The pipe is then surrounded with hand-tampered sand layers using approved backfill with no rock content. Above the pipe, the back-fill is initially compacted in 30-cm layers to be continued using a recently delivered Dynapac CC 900 double drum vibratory roller.

Once again ordered through local distributor INMA, the CC 900 is undertaking up to four static passes to meet the specified degree of compaction.

With a drum width of just 900 mm, the roller is used for small-scale compaction duties. The roller features a maximum operating weight of 1665 kg and is powered by a Perkins 403D-11 water-cooled diesel engine.

Aydiner Constructions started pipe laying in October 2010 and completion is anticipated by February 2012 with 9 km completed by the end of July 2011.

The LG 160 is a compact forward/reverse plate with speed and compaction depth regulated steplessly via hydraulic servo controls, which ensures smooth plate motion.