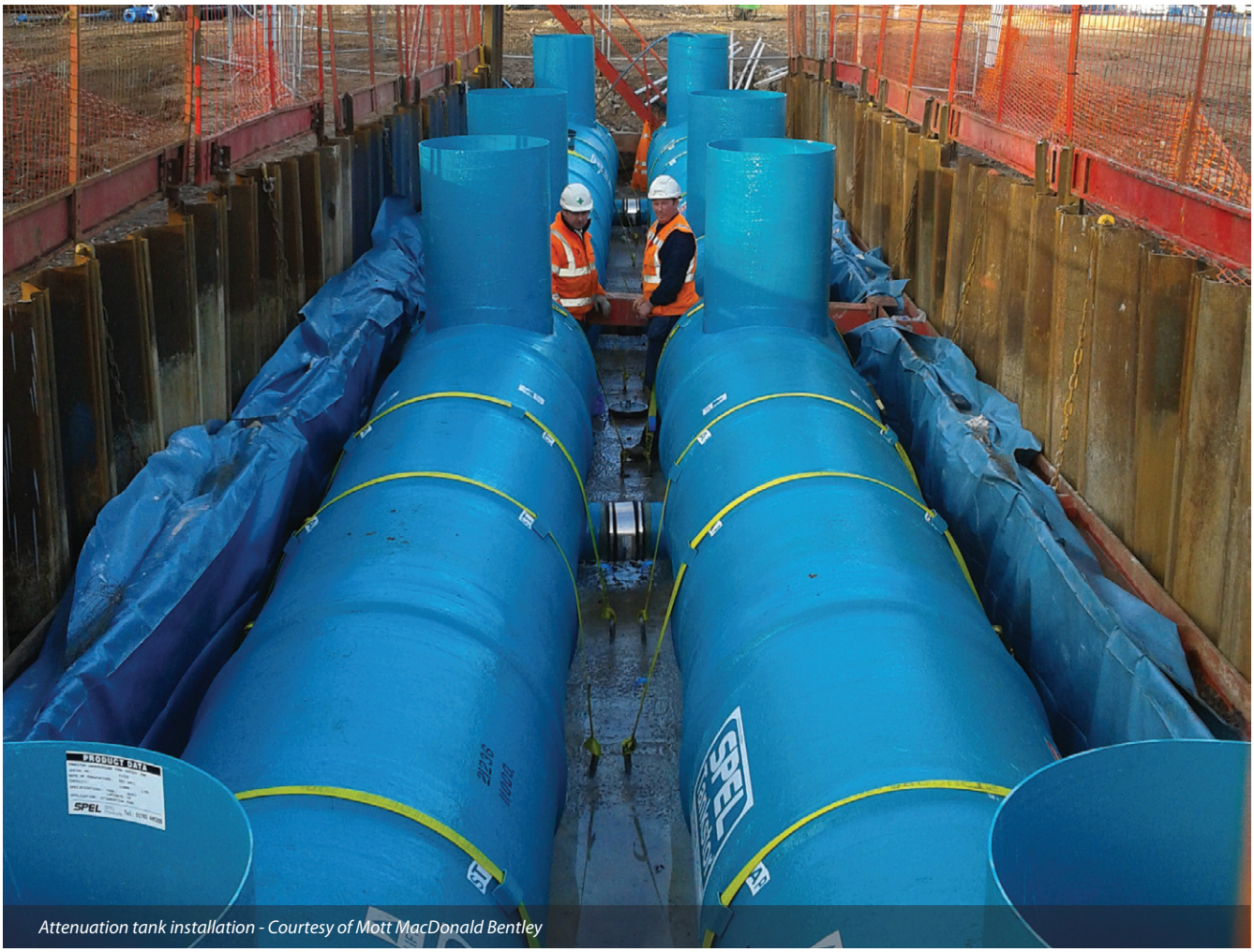
Shifford's Bridge Nitrate Improvement Scheme

improvement scheme involving the upgrade of existing facilities to incorporate a new nitrate removal facility for Severn Trent Water

by Mike Lewis

The Shifford's Bridge borehole is located in a rural agricultural area away from related infrastructure. Rising nitrate trends within the raw water required improvements to be implemented to maintain supplies within strict water quality limits. Two solutions were available to the delivery team: (a) provide blending in order to maintain nitrates within acceptable limits or (b) construct a nitrate removal plant. The latter option was chosen by Severn Trent Water (STW) due to the remote nature of the facility. The project required the construction and installation of a new nitrate treatment plant capable of treating 3.3Ml/d. Additional improvements included replacing the borehole pumps with high lift pumps and replacing the existing gas chlorinators with an on-site sodium hypochlorite generator and dosing system. The new facility is housed in a new steel portal-frame structure and clad in a composite aluminium insulation material, with associated access and road improvements.



Attenuation tank installation - Courtesy of Mott MacDonald Bentley

Project methodology

The existing site provided a number of challenges for the Mott MacDonald Bentley (MMB) delivery team, all of which required diligent consideration during each phase of the project. These included a sloping site, location next to a watercourse and sand-gravel ground conditions. The delivery team worked with supply chain partners to build collaborative relationships early in the design phase. This promoted a *'one team'* ethos and a *'right first time'* approach.

Working collaboratively enabled expert knowledge of the process equipment to be ascertained from the supply chain partners, including Asset Creation, Service Delivery and ACWA Services Ltd (nitrate plant supplier). This linked with the use of powerful 3D modelling enabled the team to design a safe and efficient nitrate removal plant. The delivery team also listened to feedback from similar schemes in AMP4 and they also visited Anglian Water to see a similar facility and presented 3D models to the Service Delivery Area Team, incorporating their feedback into design.

The early engagement with the supply chain was important to drive MMB's lean approach to design, construction, waste minimisation and re-working. It was also crucial for meeting one of the principal challenges at the site; maintaining water supply

Concrete slab construction
Courtesy of Mott MacDonald Bentley


Construction of the new steel frame facility
Courtesy of Mott MacDonald Bentley


Construction of the new steel frame building
Courtesy of Mott MacDonald Bentley


Completed new facility
Courtesy of Mott MacDonald Bentley

throughout the construction works. The delivery team utilised the collaborative Construction Lean Improvement Programme (CLIP) to develop a plan for the delivery of the project by encouraging all key stakeholders to have input into the planning of the scheme.

Examples of how this saved programme time include the undertaking of the landscaping and reinstatement works following the casting of the structures concrete base, meaning the team did not have to wait until the following year to undertake these works. Secondly, MMB constructed a new pipeline and disposed of nitrate rich water to a wastewater treatment facility while the nitrate removal plant facility was being constructed by the specialist sub-contractor.

Health and safety was also at the core of the design approach adopted. The team understood that an important area of potential problems was the interface between the differing disciplines integrated into the scheme. Therefore, during the design phase the team identified all hazards and sought expert advice where required to evaluate the risk level and highlight the appropriate control measures.

Providing a facility that is safe to operate was another important aspect; through the HAZOP process the team identified the potential to provide significant health and safety benefits for Severn Trent Water's operational personnel by removing potential trip hazards within the plant room, by installing cabling ductwork within the plant room floor slab. This was only possible by utilising the knowledge and experience of the integrated design team and 3D model to ensure a 'right first time' design.

Client collaboration

Key to overcoming difficulties on site was the scheduling of regular visits from the client team. By meeting regularly; safety and operational improvements could be quickly agreed and implemented efficiently. Examples include the installation of:

- Anti-vandal guards to lightning conductor tape.
- Drop kerbs to allow vehicular access to the process water pumping station.
- Cess-tank to avoid STW wastewater employees having to enter the site to maintain a pumping station which would have otherwise had been classed as a wastewater installation.

The safety of Severn Trent Water's Service Delivery staff was always considered, with improvements including the elimination of trip hazards on the completed works and the removal of 'working at height' risks for lighting maintenance.

Project successes

Engineering sustainable outcomes: One of the greatest successes was the level of innovation and promotion of sustainable options that were integral to the scheme. These included:

- The construction of the piling, retaining wall and composite building was borne out of ideas and development between the delivery team and designers. Producing a 'buildable' and efficient scheme that would stand the test of time and be achieved via thorough investigation of products/materials matching the client's criteria. The composite clad building solution yielded a reduced build-time, lower material quantities and a reduced carbon footprint.
- The use of stone vibro-piling techniques for ground improvement, instead of traditional CFA or precast concrete piles, saved time and money in the improvement of the strata for the construction of the new nitrate building.
- Fibre-reinforced concrete (eradicating the need for steel reinforcement) and use of the old building for the welfare room further reducing material/manpower requirements.

- All spoil was reused for on-site landscaping.
- The temporary car park/footpaths were crushed and reused, enhancing the entrance to the field used for the compound.
- Collaborative discussions with specialist sub-contractors to agree building a gabion stone retaining wall. As well as being cheaper, using locally sourced stone would be more sustainable and aesthetically pleasing.
- A shorter route for the waste pipeline avoided disruption to an A-road. Crossing private grazing land, resulted in significant cost savings both to labour/plant durations, and due to the shorter pipeline required.
- A major road crossing used open-cut techniques rather than auger boring, which halved the cost.
- Maximising the strengths/skills of his in-house team for many parts of the project saving specialist fee costs.

Health, safety & environmental (HSE) performance: An exemplary HSE performance was achieved throughout the delivery of the scheme, with a number of measures introduced ensuring an excellent approach to safety and successful management of potential environmental risks. This was achieved through:

- The introduction of sub-contractors to our Safe Systems of Work and Operational Safety Standards (OSS), ensuring high levels of safety always maintained.
- Visibility splay works completed prior to main construction works; enhancing safety of STW and MMB employees.
- Communication of audit findings at weekly team meeting.
- Development of a *key points* guide communicating critical messages at all inductions.
- Pursuing the alternative route for the waste pipeline also reduced safety risks.
- Numerous safety improvements implemented including elimination of trip hazards on the completed project and removal of working at height risks for lighting maintenance.
- High level sensors on septic tanks reduce the risk of overspill/leakage and preventing pollution to principal aquifer.
- The use of *Envirowattles* (the first in the west region to use this new system) to prevent silt entering watercourses.
- Thrice daily checks for potential pollution.

Met or exceeded the client's expectations: Severn Trent Water were delighted with the finished product. Maintenance times were almost immediately reduced because of the new plant's greater efficiency.

By meeting regularly with the client, solutions/improvements were quickly agreed and implemented, including maintaining client access through appropriate programming, as well as many health and safety related improvements. Familiarisation days for client employees ensured regular feedback and visits to similar sites provided further best practice ideas/key learning.

Successful public interaction: The delivery team did an excellent job liaising with local landowners. On changing the route of the waste pipeline, the team kept them informed at all stages and particularly helpful were text messages to landowners 24 hours in advance of planned works.

Teamwork and leadership: Key to successful delivery was clear communication and organisation between all parties involved, and the diligent planning used to pull together designers, commercial team and management. This was backed up the site team, who were able to progress the works without delay due to the availability of designs, materials and clear instructions.

Efficient supply chain management: Through using well-established systems and procedures, and drawing on previous experience, the team procured the most appropriate subcontractors/suppliers, confident in their performance and that health and safety standards would meet our strict criteria.

Careful planning between the delivery team meant supply chain management was effective and well programmed throughout, avoiding any lost time. A team approach was consistently promoted, encouraging the supply chain to work with the delivery team to ensure an excellent, safe site. The team also helped to integrate the supply chain's management systems into the quality control procedures and by considering their methodology, maximised safety.

The selection of specialist sub-contractors helped to ensure the project's financial success. A particular example relates to the engagement of alternative sub-contractors for the supply/commissioning of an anti-scalant dosing rig, resulting in significant cost savings by cutting fabrication time by two thirds.

Conclusion

From the outset effective planning, an integrated core team approach, early sub-contractor involvement as part of the delivery team, regular communication and knowledge sharing, was key to MMB successfully delivering the Shifford's Bridge scheme.

The innovations and the lessons learnt will be passed on to delivery teams on similar projects to ensure they are as equally successful, sustainable and cost-effective.

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