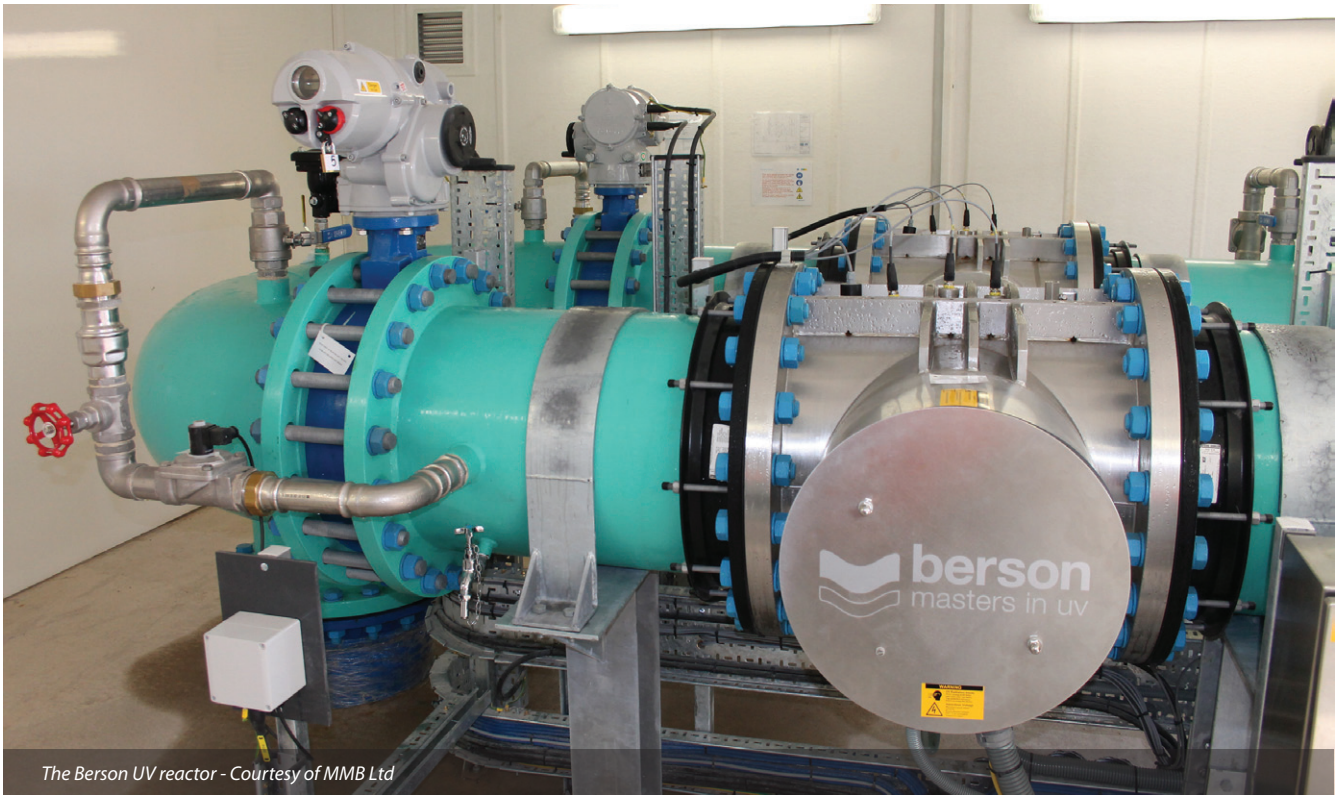
Shelton WTW UV Scheme

installation of a new UV disinfection plant to address a high cryptosporidium risk

by Shane Porter MEng

Shelton WTW is located on the north-west outskirts of Shrewsbury providing drinking water to Shrewsbury, Oswestry and their surrounds. The main works treats water abstracted from the River Severn. In addition, Shelton WTW has one on-site borehole (No. 1) and one off-site borehole (No. 2) at Udlington Farm approximately 0.5km away, which both abstract groundwater to augment the river abstraction. As part of Severn Trent Water's Groundwater Serviceability Portfolio Risk Assessment, Shelton WTW Boreholes were identified as one of a number of sites where it would be appropriate to install additional disinfection. The Cryptosporidium Risk Assessment (CRA), which forms part of the Drinking Water Safety Plan, assessed the borehole sources as having a high risk of Cryptosporidium detection. Borehole No. 2 had been out of service since the completion of the CRA, but is normally required to cope with the summer demand on the main works. For both boreholes it was decided that marginal chlorination was not appropriate for the challenges presented by the raw water, and that additional disinfection should take the form of UV treatment.



The Berson UV reactor - Courtesy of MMB Ltd

Description of existing WTW

Water from Borehole No. 1 is pumped directly to the WTW balance tank, undergoing marginal chlorination only. Water from Borehole No. 2 is pumped to the Shelton WTW and is treated for iron and manganese removal in two filters. Sufficient chlorine is added to provide a residual post filtration. The treated water is then pumped to the balance tank where it blends with water from Borehole No. 1.

The combined borehole water flows by gravity from the balance tank to the Shelton Treated Water Reservoir to mix with treated water from the Shelton WTW for storage and onward transmission by the Shelton High Lift Pumps.

The combined licence for these works is 27MLD from the river plus 9MLD from the boreholes. However, the boreholes also have an emergency abstraction license of 25MLD. The normal plant daily output is approximately 30MLD.

Scope of work

The Shelton scheme was undertaken by design and build contractor Mott MacDonald Bentley (MMB). A tight programme to achieve the regulatory compliance date made it essential that the team collaborated together efficiently and communicated effectively.

The work undertaken at Shelton WTW was the installation of a new UV treatment plant, sized to treat 25MLD, comprising new UV Reactors and the associated monitoring, control and power equipment. The new UV plant was installed on the existing gravity main between the balance tank and the treated water reservoir.

Two new Berson IL15000+ DVGW UV Reactors were installed to provide treatment on a duty/standby arrangement. Each UV reactor is connected to a local control and a local power panel. Both control panels and power panels are connected to a STW standard supervisory MCC supplied by Boulting which controls the

start-up and shut-down sequence and provides automatic control and monitoring of the UV treatment plant. The existing borehole control was modified to ensure that the borehole pumps could not operate without the UV plant status being healthy.

A flowmeter was installed upstream of the UV reactors to ensure the correct UV dose is applied to the water. A UVT monitor was installed downstream of the UV reactors to ensure they were operating within their validated range and to provide monitoring and reference. Two actuated butterfly valves were installed upstream and downstream of each reactor and close when either the borehole water is no longer required or a major fault in the system is detected. These actuated valves ensure no flow passes between the UV reactors when the system is offline or during warm-up.

The new installation was housed in a new GRP kiosk with a partition wall to provide a separate room for the control panels.

Programme and budget

The new UV system was delivered as an AMP5 gated project with an agreed regulatory date of 31 July 2013 for treated water compliance. MMB first began work on the contract in September 2012. To achieve the compliance date, work on site needed to start at the beginning of March. This meant that the design needed to be progressed rapidly in order to allow sufficient procurement time for the new equipment. With a compliance date of July, work on site also needed to progress on programme to allow the reactors to be fully commissioned. The budget for the scheme was £884k.

Effective teamwork

To deliver the scheme to the tight programme, the team needed to work together effectively. Engagement of the whole team, previous experience, sharing of knowledge with other contractors, and effective construction and operational input at the planning and design stage were all implemented.

The MMB design lead's previous experience with UV installations helped to identify potential issues from the outset. The project delivery manager (who would subsequently manage the construction work) was regularly involved throughout the design to provide a construction point of view.

A Severn Trent UV steering group had been set up to coordinate and oversee the whole batch of UV installations and consisted of members of STW, MMB and other One Supply Chain contractors and consultants. The steering group met monthly to ensure lessons learnt from previous and on-going schemes by other contractors involved in the UV installations was shared. This approach to common problem sharing and having the steering group involved in design reviews and HAZOPs helped to ensure that all potential risk issues were identified upfront.

A 3D model was developed to assist in optimising the development of the layout and to help in visualising the construction. The model was vital in engaging the Severn Trent service delivery team during both client design reviews and during the HAZOP; therefore gaining valuable insight at design stage into potential issues from an operational point of view.

Risks and cost efficiencies

Not only did these teamwork strategies ensure that the programme would be achieved they also helped to identify cost efficiencies that could be included in the project. Key risks identified early on in the scheme included the inadequacy of the existing power supply, the impact on the existing hydraulics and other work being carried out on the site adjacent to the proposed UV plant.

Soon after the start of the scheme, the team identified that there was not enough power on site for the new UV plant. A new 500kVA transformer and ring main unit were therefore required as part of the scheme to provide an extension to the existing power supply

The new UV disinfection plant - Courtesy of MMB Ltd

and feed the new installation. The early identification of this risk allowed a new transformer to be procured without causing delay to scheme.

An example of a cost efficiency was the specification of a cast-resin transformer instead of a traditional oil-filled transformer. This negated the need for a bunded base presenting an overall cost-effective solution despite the cost of the transformer itself being higher. The cast-resin transformer also eliminated any environmental risks (aquifer contamination) associated with oil spillages near the borehole source.

Another cost efficiency was included as part of the lamp breakage plan. A fast acting actuated butterfly valve and a new washout were installed downstream of the UV reactors to allow broken quartz and any potentially contaminated water to be trapped and then removed from the system in the event of a lamp breakage. This solution prevented the need for two washouts, minimising the number of shutdowns required and also reducing the construction and supply risks associated with the connections.

NMC was working on the installation of a new generator directly adjacent to the new UV kiosk as part of Severn Trent's power resilience scheme, so coordination with this scheme was also undertaken to ensure the footprints did not overlap. This also presented an opportunity for further cost efficiency by using the same telemetry outstation for both schemes, rather than procuring separate ones.

Shutdowns

The most significant construction challenge for the team was the intrusive work that needed to be carried out. A number of shutdowns were planned to allow installation and commissioning of the new UV plant. The treatment works water shutdowns were limited to a maximum of four hours. This four-hour period included the time required to drain the system, undertake the work and then restore supply. The overall programme meant that the shutdowns were required during the peak summer demand period, so it was critical to ensure that the plant could be fully operational again after four hours.

The shutdown to provide the 2 (No.) 500mm diameter tee connections for the new plant on the existing 600mm diameter main was considered the greatest of the shutdown challenges. Work was planned meticulously and every risk and contingency considered by the team and discussed in detail with the client.

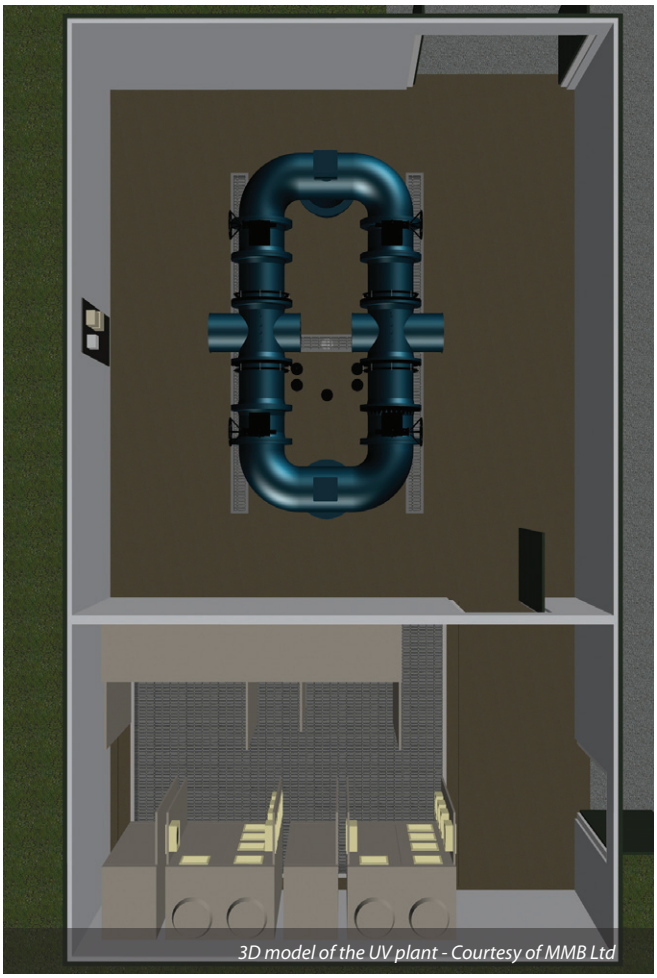
The new below ground pipework needed to be installed exactly as per the drawing to ensure the pipework specials designed for the above ground pipework would fit together.

During this shutdown, three cuts were made in the existing 600mm diameter main by two teams working simultaneously so that the existing pipe could be more safely lifted out in two sections. The tee fittings, together with isolation valves and the connecting pipework were lifted into place, piece by piece.

Flange adaptors were pre-bolted to the tee pieces to reduce the work that needed to be undertaken during the shutdown. However, more than two hundred M33 and M30 bolts still had to be tightened up within the four hours.

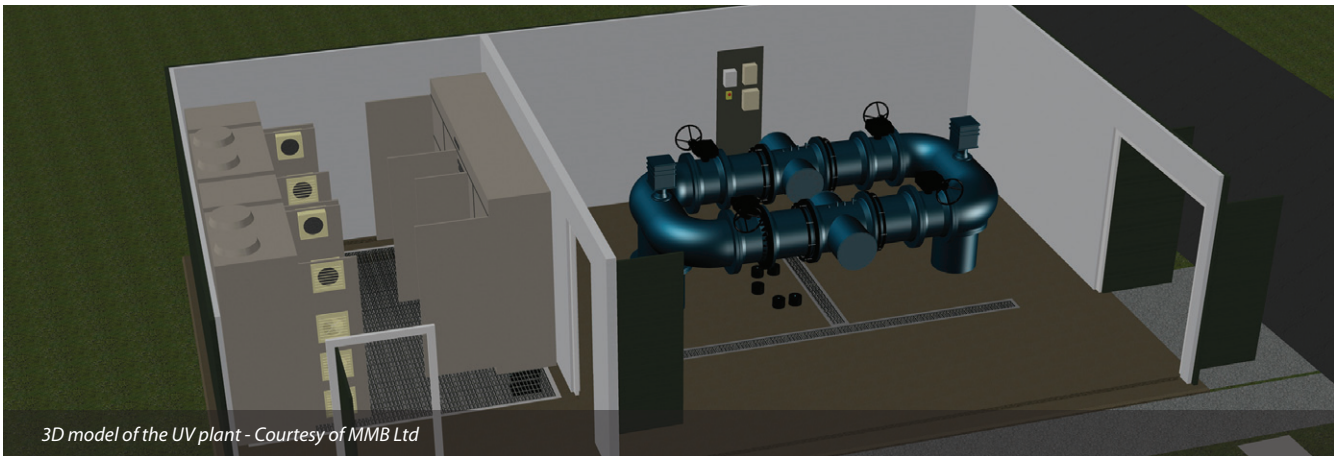
Further shutdowns were also undertaken for the installation of the new flowmeter, and the new fast-acting valve and washout installations. Two electrical shutdowns were also required for the installation and commissioning of the new transformer.

All the planned shutdowns went smoothly and were completed within the required four hours; and there were no disruptions to the water supply throughout the project.



3D model of the UV plant - Courtesy of MMB Ltd

The new UV disinfection plant - Courtesy of MMB Ltd



3D model of the UV plant - Courtesy of MMB Ltd

Conclusion

The scheme has been completed with the UV disinfection of Borehole No. 1 water operational and performing well. Unfortunately Borehole No. 2 is still not currently operational as there are still some on-going issues with the existing chlorination which requires the dosing system to be upgraded (outside of the scope of this contract). The team will therefore return to site to prove the control for Borehole No. 2 when it is up and running.

It was one of a block of UV disinfection schemes instigated by Severn Trent. Though it was the fifth scheme to be started, and was the highest value, it was the first to be completed and handed over.

To meet the tight programme it was vital that the team pulled together to deliver the scheme, with no surprises that would have caused delay. It is a great example of what can be achieved by working closely together, with full engagement of all the stakeholders at an early stage.

Not only did the team achieve the regulatory date and deliver a successful scheme, they also brought the project in under budget at £792k – a saving of over 10%, demonstrating a commitment to the consideration of cost, and identification of efficiencies throughout the delivery of the project.

Both the delivery team and the finished scheme have received very positive feedback internally, as well as from the Severn Trent project manager and service delivery teams, and also from other contractors involved in UV installations within Severn Trent.

The Editor & Publishers would like to thank Shane Porter, Project Leader with Mott MacDonald Bentley, for providing the above article for publication.

The author thanks Tim Brammer, Programme Manager, Ali Hull, Process Leader, and Sarah-Jayne O'Kane, Media & Customer Engagement, all with Severn Trent Water, for their input.