Bough Beech WTW

upgrade phase 2 is a challenging project to expand capacity at Sutton & East Surrey Water's principal surface water storage and treatment asset

by Mike Lynch

Sutton & East Surrey Water (S&ESW) is a water-only company serving customers in east Surrey, parts of West Sussex, west Kent and south London. Approximately 650,000 consumers in 278,000 properties are supplied by the utility, which has an operating region of 834km^2. The bulk, 85%, of S&ESW's supply comes from groundwater resources. The remaining 15% of raw water is abstracted from the River Eden and stored at Bough Beech Reservoir prior to treatment at the WTW. S&ESW is investing £17.5m at its Bough Beech Water Treatment Works (WTW). The investment will help increase the WTW's capacity and ensure long-term security of supply for the utility's customers.

The RGF building is the largest of the new structures, ground conditions were among the most significant construction challenges - Courtesy of Black & Veatch

Background

Bough Beech's treatment train comprises clarifiers, rapid gravity filters (RGF), granular activated carbon (GAC) adsorption, trihalomethane (THM) stripping, ultraviolet (UV) and chlorination disinfection. Treated water feeds three service reservoirs.

During the winter months S&SEW is licensed to abstract up to 273 million litres per day (Ml/d) from the Eden. With a capacity of 45Ml/d the existing WTW does not allow the utility to realise the full benefits of the abstraction licence. A three-phase programme of enhancements at Bough Beech will address this by increasing capacity to 70Ml/d. Phase 2, the focus of this article, will contribute to this goal by raising capacity from 45 to 50Ml/d.

Upgrade - phase 2

Phase 2 will provide a new filter block and upgrade the GAC and THM plants. In addition, the sludge handling plant needs to be upgraded to meet the works' increased throughput. This part of the project includes new sludge thickeners and a sludge dewatering press. Supernatant will be returned to the reservoir.

Another significant element of the project is the upgrading of Bough Beech's electricity supply. Achieving this requires a new high-voltage (HV) ring main and 7 (No.) new transformers. To ensure resilience a standby power supply is being created by way of 3 (No.) 2 megawatt (MW) diesel generators. These have the potential to feed power back into the local grid when not supplying the WTW. Ancillary works include new treated water pumping system and new roadways, hardstandings and landscaping.

Undertakings

Black & Veatch is undertaking the project for S&SEW in its capacity as an integrated, full service provider. This means the company will be delivering services throughout the project's life cycle. Black & Veatch's role encompasses enabling work such as planning consent and specialist geotechnical and hydrological consultancy.

The company will also be undertaking detailed design, construction, and finally commissioning. Design work is multidisciplinary in scope including process; mechanical, electrical, instrumentation, controls and automation (MEICA); and civil design.

Bough Beech Reservoir is S&SEW's principal surface water storage asset
Courtesy of Black & Veatch

A major element of the project was upgrading the electricity supply, requiring a new HV ring main and 7 (No.) new transformers
Courtesy of Black & Veatch

Existing foundations will be used for both the new GAC and THM vessels, saving cost and improving environmental performance
Courtesy of Black & Veatch

Project delivery

Bough Beech Phase 2 is being delivered to a burgundy book target cost contract. Black & Veatch was appointed following a competitive tendering process although, having prepared the bid and outline design for S&SEW, the company's involvement predates award. Construction commenced in October 2010 and is due for completion in October 2012.

Expanding the capacity of an existing works requires a combination of creating new assets and upgrading existing facilities. The design split is approximately 70% new-build and 30% refurbishment work. New structures include the RGF building, generator building, sludge thickener tanks and sludge press building.

Although the location is rural, both the new and extended structures have to be accommodated within the footprint of the existing works. The constrained space necessitated careful integrating of activities. During the most labour intensive period, when the formwork contractor was on site, more than 80 people were working on the busy WTW and construction site.

Challenges

A combination of the constrained site and ground conditions gave rise to one of the project's most significant challenges.

- ***Constrained site:*** Virgin ground at Bough Beech is weald clay, stable when dry but challenging to work with when wet. Adding to the challenge was the fact that much of the site was less stable made ground which had been cut and filled during the construction of the reservoir and existing WTW. The need to work within the boundaries of the existing works meant that some of the new structures were built upon made ground, often very close to the footings of existing structures. Opportunities to use more stable ground were limited.

- ***Ground conditions:*** Ground conditions were such that major excavations, utilising a cofferdam, were necessary during the construction of the RGF building. This was the largest of the new structures at 60m x 30m with basement set 4m below ground level, and roof ridge at 14m above ground level. The structure's location, in the centre of the site, added to the difficulty of excavating 4m footings. For both this and other structures, sheet and permanent piling was required. Ground bearing piles were necessary for those structures in poor ground closest to existing buildings.

- ***Live works:*** Avoiding disruption of supply to S&SEW's customers while significantly expanding a live works was another exacting aspect of the project. Managed shut downs were an unavoidable element of the work and demanded close liaison and a strong working relationship between Black & Veatch and S&SEW's operations team. This was achieved successfully, allowing shutdowns to be minimised in frequency and duration; and conducted at times of low demand.

  Working around buried services on a live WTW was a major issue for both the design and construction teams. The compact site meant there was very little ground unaffected by the presence of buried pipelines, cables and dosing lines.

  Working on a live works significantly influences the commissioning process. The commissioning sequence, in turn, has an impact upon the design. There is a need to determine what additional work or structures are required to control flow during commissioning, and the order in which new plant is required to be available for commissioning.

Although the location is rural, both the new and extended structures have to be accommodated within the footprint of the existing works
Courtesy of Black & Veatch

Environmental issues

Minimising the environmental impact of the project has been a priority for the team. Where possible existing structures have been re-purposed or reused. This has the multiple benefits of reducing the demand for materials, and their transportation to the site, as well as reducing the need to dispose of excavated material to landfill. The reduction in construction activity resulting from the reuse of existing structures also has a positive impact upon the project's overall carbon footprint.

Utilising existing assets

Existing foundations are being used for both the new GAC and THM vessels, while the new sludge pumps are being accommodated within the existing sludge building. The fuel tanks are being refurbished. Where concrete has been removed it has been crushed and reused either at Bough Beech or other projects. Other recycled materials include hydraulically-bound aggregates which have been used on the new roadway.

The team provided an environmentally beneficial solution for the disposal of the 12,000m^3 of clay excavated from the site. The material was transported half a mile to a local farm and used to construct a new slurry lagoon. This approach provided cost savings as well as reducing the environmental impact and carbon footprint that transporting material over long distances to landfill would have generated.

Integrated team

Using an integrated consulting, design and construction team from the same business has also brought benefits. Many of the design team understood the client's priorities and were able to bring prior knowledge of the project having worked previously with S&SEW on the bid and outline design.

Because they work for the same company the design and construction teams have ready access to each other. This speeds up problem solving and makes design modifications more straightforward to implement. More importantly, the need for extensive design changes has been averted as a result - from the project's early stages onwards - of close dialogue between designers and constructors.

There are also health and safety benefits, for both operations and construction staff. Black & Veatch's award-winning Behaviour on Safe Sites (BOSS) behavioural health and safety programme encompasses design as well as construction teams. The result is close dialogue between the two teams, from the project's formative phases onwards, with the goal of *'designing-out'* risk from activities undertaken by those building and operating the WTW.

As well as the close proximity of the design and construction staff Bough Beech WTW Phase 2 also benefited from the fact that both S&SEW and Black & Veatch's UK water business have their main offices in Redhill, Surrey. This close proximity enhanced the decision making process as well as the relationship between utility and delivery partner.

Progress

Bough Beech Phase 2 is on schedule to be completed in October 2012, allowing S&SEW to make better use of the winter flows abstracted from the River Eden.

In one of the UK's most water-stressed regions this enhanced resource will help support effective management of the supply/ demand balance.

The Editor & Publishers thank Mike Lynch, Project Manager with Black & Veatch, for preparing the above article for publication.