Rushmoor STW

an e5 alliance major projects programme scheme to upgrade the existing sewage treatment works with collaboration and innovation at its core

by Rob Culledge, Matthew Clixby & Manjit Chadha

Serving Telford from its rural setting, Rushmoor STW is approximately a mile west of the town and forms part of the Shropshire Area Sludge Strategy, and is a strategic centre for sludge digestion, dewatering and cake storage. Work at Rushmoor comprises of four separate projects, (i) the Growth Project, (ii) P-Removal, (iii) Odour Removal and (iv) the Sludge Project, to upgrade the existing STW with a total value of £16.5m. The project is part of Severn Trent Water's e5 (efficiency 5) Major Projects Programme, an alliance formed between four framework contractors and Severn Trent Water to deliver eleven major wastewater non-infrastructure projects. Collaborative working and innovation have been, and will continue to be at the core of the delivery; maximising efficiencies to drive results for both the client and alliance partners alike, facilitating the One Supply Chain (OSC) ideology and driving the success of Severn Trent Water's AMP5 Capital Programme.

Installation of refurbished PST scraper bridge - Courtesy of Mott MacDonald Bentley

Background

Between 2008 and 2026, the Rushmoor STW catchment (population equivalent) is expected to grow by nearly 100%. Flow and load (F&L) surveys undertaken between 2007 and 2011 on Rushmoor STW have confirmed the expected growth profile is materialising at the predicted rate.

If Rushmoor STW is to effectively treat the flows and loads derived from the expected growth, the sites existing primary settlement tanks (PSTs) would need refurbishment and additional secondary treatment capacity provided.

This growth will significantly increase Rushmoor's current production of primary and SAS sludge. By 2016 this will result in the digesters of the Rushmoor Sludge Treatment Centre (STC) being approximately 65% under capacity.

The existing sludge digestion facility treats 4,113tds/year. By 2016 this requirement is expected to rise to 5,741tds/year and by 2026 the total sludge load will be 6,749tds/year, well beyond its existing processing capabilities.

If additional sludge digestion capacity was not provided, sludge imports would have to be turned away from 2013 onwards, and indigenous sludges tankered elsewhere from 2016.

Rushmoor STW was required to meet the Urban Wastewater Treatment Directive (UWWTD) total-P consent of 1mg/l or 80% removal by March 2013, and biological phosphorus removal has successfully been achieved. Initially the slow uptake on biological nutrient removal (BNR) during its short 3-month maturation period was supplemented by a top up chemical dosing, which is slowly being reduced towards zero.

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New 4-lane 3-pass ASP lanes with blower kiosk in foreground
Courtesy of Mott MacDonald Bentley


Anaerobic/anoxic tank
Courtesy of Mott MacDonald Bentley


New ASP with MCC kiosk, blower kiosk and busmain in foreground
Courtesy of Mott MacDonald Bentley


Precast chamber with Hydrobrake pre-installed off site
Courtesy of Mott MacDonald Bentley

e5 collaboration

As an integral partner of the e5 Major Projects Programme, Mott MacDonald Bentley (MMB) has fully adopted the key themes of innovation, collaboration and the spirit of shared purpose throughout the delivery of the Rushmoor STW project. This is to achieve the e5 vision of combining the skills, knowledge and experience of the key stakeholders and their suppliers in a collaborative working arrangement to equally share the risks and rewards of the overall programme.

Through the e5 collaboration process, including overall programme management from a collaboration hub, a high degree of co-location, regular project review meetings and the establishment of 'task and finish' groups to focus on selected elements of the works, bulk procurement negotiations and discounts have been gained on the following element of the Rushmoor STW project:

- Gas mixing to digesters.
- Bulk procurement of reinforcement.
- New sludge screens.
- Steel gas phase digesters and other steel tanks.
- 3 (No.) cake pads all constructed using precast panels and fibre reinforced slabs by the same company (Strongford, Rushmoor and Worksop) using a standardised design.
- Flare stacks and gas bags on the sludge projects.

These enabled programme and cost savings on the project due to reduced construction time and procurement outlay. The alliance also established Design Lead and Project Manager forums to share knowledge across other projects, as well as facilitating problem solving and lessons learnt.

Without the collaborative 'buy-in' from the delivery teams, project-specific benefits such as those described above would have not been a reality, demonstrating the strength of the e5 working model and its vision at a framework level.

Engineering sustainable outcomes

Throughout the delivery phases of the overall project, innovation has played a central role and continues to be at the core of the delivery. Innovation has delivered measurable results including:

Precast concrete (PCC) baffle walls: 4 (No.) new activated sludge plant (ASP) aeration lanes have been built as part of the Growth Project. An assessment of cast in-situ vs. precast concrete was undertaken to identify opportunities for cost savings for the construction of the ASP lanes. Due to the relatively shallow depth of the aeration lanes at Rushmoor STW, the assessment showed that cast in-situ concrete would be the most cost effective option for the structural elements of the new lanes.

However, an assessment of the internal baffle walls found that there could be cost savings from using precast concrete (PCC). The precast baffle walls were manufactured from pre-stressed concrete, which were considerably thinner than the cast in-situ alternative, presenting an opportunity to reduce the overall footprint of the ASP by over 1m in each direction, realising an additional saving of 50m^3 of in-situ reinforced concrete, providing additional cost savings. Benefits of PCC baffle walls application on Rushmoor STW include:

- Cost savings of approximately £35,000 by using PCC sections for baffle walls.
- Construction programme reduced by 4-weeks.
- Precast sections allow baffle walls to be thinner resulting in cost savings of approximately £11,000.
- Reduced amount of steel fixing and concrete handling reduced H&S risks on site.
- Reduced carbon footprint due to reduction in materials and reduced transportation.

- The most efficient design of panel sizes and planned just-in-time deliveries were achieved though collaborative working with the supplier.

Rotary Lobe PST: Two rectangular primary settlement tanks (PSTs) have been refurbished on the project, each PST is 50m long by 20m wide and 3.5m deep, with 4 (No.) pyramidal hoppers of circa 50m^3. Initially, the clients preferred option was to use Ram-type pumps for PST de-sludging. Following an in-depth assessment undertaken by the project team in collaboration with key suppliers in relation to the de-sludging of PSTs, it was proved that the use of rotary lobe (RL) PST de-sludging pumps would provide a more sustainable and effective solution offering the following benefits:

- Low OPEX & CAPEX providing the client an attractive TOTEX solution.
- Simple Installation.
- Easy access for blockage removal (bi-directional) & low spares cost.
- Simple overhaul (typically 1 hour).
- Can be installed in series to achieve higher pressures & can be run dry for short periods.
- Significant design improvements in shaft seal lubrication and lobe design since earlier AMP period.

Given the right application, the choice of rotary lobe pumps had a significantly lower CAPEX cost compared to the initially preferred Ram type pumps. In addition to this, the RL pumps had a lower power usage and therefore offered the client an attractive TOTEX solution, identified through supply chain interaction and detailed assessment. By considering the system design as a whole for each application, the correct sludge handling application was chosen.

Swale for surface water drainage: A number of design options were considered for the surface water drainage requirements of the new road constructed during the Growth Project, including a soak-away and discharge directly into the nearby watercourse. However, concerns remained regarding the potential risk of polluting the existing major aquifer and watercourse, increased risk of general flooding and unsuitable ground conditions meant these options were discounted.

It was decided by the project team that all surface water run-off must be kept on site. The existing pumping station was insufficient to cope with the additional run-off; therefore the solution was attenuation in the form of a swale.

A precast hydro-brake unit was installed onto the outlet of the swale, limiting the flows passing forward to the pumping station to within the available capacity. Some of the existing site drainage was also redirected into the swale to increase the capacity of the pumping station and reduce the overall risk of flooding.

Benefits of using the surface water swale include:

- Utilisation of the existing infrastructure as the surface water run-off is stored and fed to the pumping station at a controlled rate.
- Saving £50,000 by reducing the need for upgrading the existing pumping station and installing a new larger rising main.
- Prevention of any contamination of the major aquifer underlying the site, using a geosynthetic clay liner to simplify installation and avoid the need for specialist techniques on site).
- A reduction in grit and sediment entering the pumping station.

Optimised Activated Sludge Plant (ASP): The pipework, aeration mains, control/balancing valves, tapping points and diffuser drop

New cake pad - Courtesy of Mott MacDonald Bentley

legs have been designed to minimise H&S risks from working over deep aerated water and for ease of use and operator accessibility. Access to the ASP lanes is designed purely to facilitate DO probe maintenance with no H&S issues.

The benefits of using optimised ASP include:

- Minimised H&S risks on site, not only during construction and commissioning, but also minimises the need for operators to conduct routine activities on gridded walkways above open water and no 'step-overs' required.
- Cost savings of approximately £10,000 by reducing quantity of metalwork.
- Cost savings of approximately £12,000 by reducing pipework quantity and improving ease of construction by optimising busmain and valve station layouts.
- Reduced installation programme by 2-weeks due to reducing quantity of metalwork and simplifying access of installation of busmain and valves.
- Essential controls grouped in one location.

The busmain is installed at ground level along the longest tank face. Diffuser drop legs are then presented to the busmain in groups of easy to access 'valve stations'.

Diffusers are arranged in a 2-zone, 3 (No.) grids per zone configuration. Use of Aerostrip Hydrofoil diffusers, supplied by Hydrok UK, allows an innovative linear taper configuration to be used in the vicinity of the first controlling DO probe which reduces step changes in air flow between grids.

ASP tank lanes showing aerostrip hydrofoil diffusers in base - Courtesy of Mott MacDonald Bentley

Positioning the DO probe within the linear taper section optimises control sensitivity and minimises the likelihood of having to reposition the probe. The combination of reduced DO probe swing and placing valves at ground level reduces the requirement for excessive steel walkways over the deep water tanks.

Aerostrip diffusers are mounted closer to tank floor (50mm). This increases the depth of submergence and results in a more efficient system under average conditions (compared to conventional diffusers 250mm). The diffusers have an automated purge system which flexes the membranes to clear scale build up. This extends the service life and reduces the chance of losing oxygen transfer efficiency in service. By rationalising the grid design, pipework and associated control valves, a more logical, user friendly layout has been achieved which optimises pipe lengths and prevents the need for large pipes which may restrict access across walkways.

Reuse of existing client infrastructure

Where applicable on the project, the reuse of existing infrastructure has been utilised to maximise project efficiencies. Examples of where we have re-used elements of the existing treatment works as part of the new project include:

- Existing SAS buffer tank and PFT tanks are being re-used as new buffer tanks for screened sludge before thickening.
- Existing anoxic box extended for use as the anaerobic and anoxic box rather than 2 (No.) separate structures.
- Existing primary settlement tanks (PSTs) have been reused by refurbishing existing scrapper bridges and replacing de-sludging system rather than original scope of 3 (No.) new circular PSTs.
- An existing outbuilding has been converted into new LV switchroom, reducing the requirement for a large kiosk. The other added benefit of siting the LV switchboard closer to the existing asset life expired LV switchboard, is the reuse of and jointing to existing cables, rather than resizing and providing new feed cables to existing assets, which has provided a significant cost saving.

Conclusion

The Rushmoor STW project has been an excellent demonstration of how the e5 model of collaborative working can facilitate both project and framework efficiencies through collaboration, best-practice knowledge sharing and innovation. Severn Trent Water's commercially innovative procurement strategy, supported by its supply chain partners has; eliminated significant tender/bid costs for all parties, integrated key delivery partners and linked the pain/gain mechanism to key performance measures, ensuring a united drive towards efficiency and the right behaviours across the whole team.

The project to date has achieved the outputs for Growth (commitment to OFWAT) and outputs for P-removal (Regulatory output). The sludge project is a named output (Year 4) in the AMP5 business plan to provide increased Quality & Growth (Q&G) sludge digestion capacity, and is on target to be commissioned by March 2014 ensuring that the Rushmoor STW facility retains its status as a strategic centre for sludge digestion, dewatering and cake storage in the Shropshire area and will continue to service the ever-growing requirements of the increasing population that it serves.

MMB is successfully delivering the Rushmoor STW upgrade for Severn Trent Water, as well as projects in Strongford and Worksop in the same e5 project grouping.

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