

Welshpool STW

reducing risk and maximising the gains of innovation in the delivery of a new oxidation ditch plant

by William Downes MEng

Adjacent to the River Severn, Welshpool STW serves the market town of Welshpool and the surrounding area. The catchment has a population of over 6,000 with a number of businesses in the area pushing the population equivalent up to over 13,000. The high proportion of trade load is due to a large scale confectionery manufacturer and a livestock market which hosts Europe's largest one day sheep market. The AMP5 capital project to replace the secondary treatment process was designed to accommodate growth in the Welshpool catchment and had a value of £3.5m.



*Constructability, the devils in the detail
Courtesy of MMB*



*A resilient treatment process tailored to the catchment
Courtesy of MMB*

Background

The Welshpool STW was originally opened on the 6 April 1967 and consisted of two pairs of alternating trickling filters with associated humus tanks. Prior to this scheme the trickling filters were prone to fly emergence with a risk of customer complaint issues and performance was temporarily compromised when the beds were switched fortnightly.

The works received high strength, intermittent shock loads from two businesses within the catchment. When measured, the trade waste was seen to make up 70% of the incoming load to the works. High loading on the trickling filters increased the risk of ponding,

which can lead to septicity and odour issues. There were also health and safety risks relating to manual handling and working at height activities associated with the routine cleaning operations performed on the beds due to moss growth.

Without replacement of the main treatment process, the existing filter beds would have continued to deteriorate with a high risk of the works' compliance being compromised and the asset becoming progressively more expensive and unsafe to maintain.

Welshpool STW was an AMP5 growth scheme to deal with the identified issues and an expected increase in domestic population

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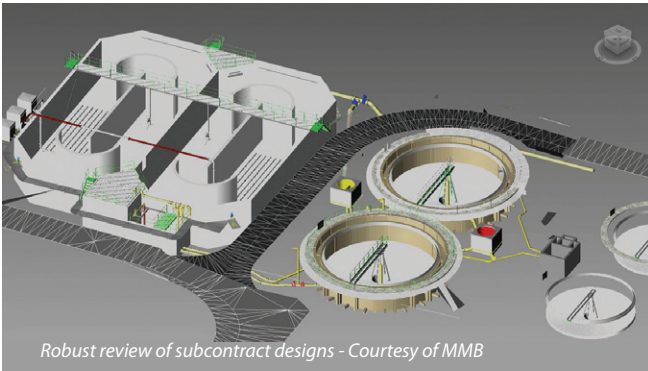
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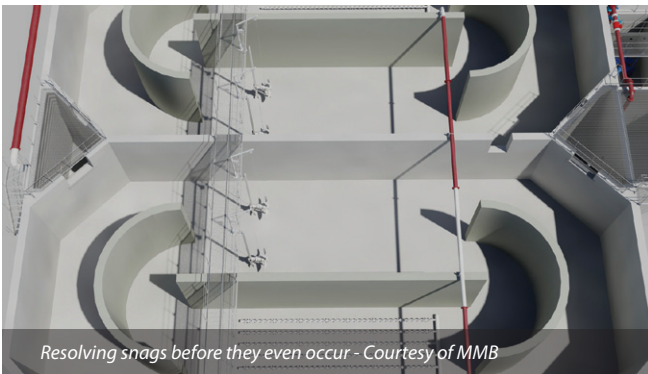
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Temporary works informing the permanent design - Courtesy of MMB



Robust review of subcontract designs - Courtesy of MMB



Resolving snags before they even occur - Courtesy of MMB



One of the 13.5m diameter final settlement tanks with half bridge scrapers - Courtesy of MMB



Safer, better, faster, thanks to precast design - Courtesy of MMB

of 7% in the catchment over the next five years. The scheme would provide the robustness and capacity of treatment required to effectively treat all sewage flows from the catchment with an asset that was safe to operate and offered the best whole life cost.

MMB (a joint venture between JN Bentley and Mott MacDonald) that undertakes the design and construction of non-infrastructure schemes across Severn Trent Water's 21,000km² operating area) is main contractor for the Welshpool STW upgrade project.

The process solution

The treatment process solution was selected to address the specific issues faced in the Welshpool catchment. The trade effluent from the livestock market provided prolonged periods of high ammonia loading and the confectioner's shock loadings contained high COD levels.

The large retention volume and homogenous mixed liquor inherent in an oxidation ditch meant that peaks in the volume and strength of incoming sewage flows were attenuated.

Early dialogue with key traders in the catchment was essential prior to finalisation of the process design in order to fully understand the likely nature of sewage flows. By taking the time to investigate and understand the traders' operations the process design was revised to take account of the traders desire to increase their trade effluent discharge. It also provided an opportunity for the traders to learn more about what they could do to manage their waste at source.

Efficient use of interceptor tanks at the confectioners allowed their highest strength waste to be separated and prevent diffusion of the high strength waste for reuse.

This type of separation of waste allows other forms of waste reuse options such as transfer to sites with digestion facilities for energy reclamation, which contributes towards Severn Trent's target of generating 30% of the company's electricity from renewables by 2015.

The 3,082m³ oxidation ditch was designed to treat a settled sewage loading of 925kgBOD/day broken into allowances of 400kgBOD/day from the confectionery trader, 270kgBOD/day from the livestock market and 255kgBOD/day from the domestic population.

With a design flow of 66.5l/s 2 (No.) final settlement tanks were selected at 13.5m diameter to provide the settlement capacity required. An activated sludge return system was installed to accommodate between 1,011 and 4,044m³/day to maintain the oxidation ditch mixed liquor suspended solids (MLSS) levels.

A new surplus activated sludge (SAS) thickening and storage system was also installed in order to reduce tanker movements.

Sludge thickening

With an anticipated surplus sludge yield of 204m³/day at 0.5% dried solids, a disc thickener supplied by Huber Technology was selected to provide a 6% dried solids thickened sludge. This was the first time this type of technology had been installed by Severn Trent.

The disc thickener was considered alongside the typical solutions of a drum or belt thickener and provided the best whole life cost due to its lower energy usage and low capital cost. The physical footprint of the disc thickener unit is smaller than its counterparts allowing savings in the surrounding civil structure.

The angle of the disc is set during commissioning and the performance of the unit in operation is easily altered by changing the disc rotation speed via an inverter. All maintainable parts are easily accessible keeping maintenance downtime to a minimum, therefore reducing OPEX and operator risk.

Upstream dosing of polyelectrolyte aids the flocculation of colloidal sludge solids, maximising the capacity of the disc thickener and minimising the whole life cost of sludge handling at the site. A sludge holding tank supplied by Kirk Environmental Ltd then provided seven days of thickened sludge storage based on a production of 17m³/day before tankering to a nearby Severn Trent site for digestion.

Marginal gains providing big results

Small changes and improvements may appear to have little impact individually but they contribute to the overall success of the project.

Early involvement of parties across the supply chain helped to reduce the construction programme and associated costs. Design reviews by formwork and steel fixing subcontractor Offafix Formwork Ltd ensured rebar detailing complimented construction techniques, such as preformed rebar cages well in advance of the construction works commencement.

The permanent design was modified to remove the structural toe surrounding the oxidation ditch which allowed closer access for scissor lifts, again aiding construction.

Engagement with the One Severn Trent philosophy across the supply chain demonstrated the value to all involved in the asset delivery and operation process. Communications and knowledge sharing systems, expertise and experience from across Mott MacDonald's global consultancy and Severn Trent's expert client network contributed to the design of Welshpool STW. Structural design and detailing of the oxidation ditch was completed by Mott MacDonald's Water Design Centre in Ahmedabad.

MMB, in conjunction with Carlow Precast, has previously used a precast concrete system of FST tank construction on a number of projects which was further refined for use at Welshpool.

Final settlement tank civil construction was completed ahead of time and at reduced cost versus a traditional in situ construction with a higher quality of finish. The half bridge scraper systems were manufactured and installed by Tuke & Bell Ltd complete with horizontal McKinney Baffles fixed to the diffuser drum to direct flows and promote settlement of solids.

BIM and managing the risk of innovation


Innovation and departure from the status quo inherently introduce uncertainty; this can be perceived as an increase in risk to quality, cost and safety. Whilst this need not be a barrier to innovation and progress, it does mean that trial and error of new technologies and techniques is not an acceptable verification method.

The use of appropriate BIM techniques and software allowed innovations to be robustly assessed at Welshpool in a virtual environment prior to construction.

Appropriate filters and extraction methods of the BIM design data ensured the right information reached the right people at the right time. Realistic 3D walkthroughs allowed informed discussions with the client's operations team, which in turn meant that the final design took full account of the operational and maintenance tasks the client would be required to perform.


The arrangement of the Huber Technology disc thickener unit and associated pipework benefitted greatly from this kind of engagement with the end user.

Flow inducers in the oxidation ditch are essential to maintaining the homogenous mixed liquor and prevent short circuiting of the treatment process. The flow inducers supplied by Wilo were optimised using computation fluid dynamics for the specific application at Welshpool STW, giving confidence in the supplier selection and design.



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Interfaces between subcontractor design and overall scheme design were quickly evaluated. The aeration system was supplied by Suprafil and designed using a 3D fabrication design package. This was easily combined with the overall scheme model to verify final detailing, greatly reducing design approval turnaround time.

Construction sequence modelling in association with the Welshpool construction team identified temporary works requirements early in the design stage. The permanent design of the oxidation ditch positioned construction joints to enable the temporary crane pad to be installed centrally to the oxidation ditch. This reduced the size of crane required for construction from 70 tonne to 50 tonne.

Early planning of temporary works also meant that sheet piling for excavation support was greatly reduced. Upfront design work and surveys meant that with careful spatial modelling of the congested site the majority of temporary piling was replaced with sacrificial gabion baskets filled with material dug from the excavation.

The project design programme was driven by the data management and the required outputs identified when developing the BIM strategy for the project. The design programme and construction programme were considered as one, to take full advantage of the design and build contract.

With a fixed completion date and under performing existing assets, efficiencies were found in the programme by identifying where design and construction could be overlapped and staged. This required well defined staging of not only the core design data but of all aspects of CDM.

Sharing a confined site with the client's existing operational assets and personnel provided further challenges to the CDM planning as responsibility for areas of the site changed during the construction programme.

Community engagement

As the commercial model of the water industry is set for fundamental change, understanding customers' expectations is essential to providing a quality, reliable service which is demonstrably good value for money for both domestic and commercial customers.

An open evening at Welshpool run by the One Severn Trent partners invited the local residents and businesses to a drop in session to learn more about waste water treatment, the Welshpool project in particular and the methods of construction. Advertised in the local press, through letter drops and Severn Trent media streams, the event was well received by all attendees.

A site tour of both the operational and construction site allowed the public to understand the challenges faced in waste water treatment and construction.

Summary

At the time of writing (May 2014) the new process at Welshpool STW is now largely complete; all civil and mechanical works are well advanced with final electrical works currently underway.

Turn of flows is programmed for June 2014, after which Severn Trent will receive a treatment works with a reliable process tailored to the specific challenges of the Welshpool catchment.

Collaborative working and innovation continue to be at the core of the MMB treatment delivery process; maximising efficiencies to obtain results for both the client and supply chain partners alike, facilitating the One Severn Trent ideology and leading the success of the remaining Severn Trent Water's AMP5 Capital Programme.

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