Barkers Haugh STW

£8m upgrade responding to catchment growth and a ratcheted total iron consent

by Dave Humphries CEng MICE

Barkers Haugh STW receives wastewater from a population of approximately 36,000 people. Due to a ratcheting of the Environment Agency consent in response to population growth (+4000) and a tighter total iron consent of 4mg/l an upgrade of the works was required. A total of £8m was invested to improve the quality of the effluent discharged to the River Wear. Interserve (now Tilbury Douglas)/Wood were appointed by Northumbrian Water under a Design and Construct Contract to develop an initial design.

Aerial photo of completed works - Courtesy of Wood PLC

Design development

The original solution identified a requirement to provide enhanced solids removal by the provision of a deep bed filter (DBF) to achieve a total-phosphorous (TP) (2mg/l) and total-iron (Fe) (4 mg/l) consent. The works was easily achieving the phosphorous consent but routinely struggled to meet the total-iron consent and as such was operating under a temporary 10mg/l Fe consent due to expire in December 2018. In addition to the tightened effluent consent the population growth also required the provision of supplementary storm water storage.

The design team undertook a detailed assessment of the performance of the existing works and a subsequent validation of the identified solution. After a detailed statistical analysis of the ferric sulphate dosing it was concluded that excessive consumption of ferric sulphate was in fact contributing to the excess Iron in the final effluent. The overdosing of ferric was required to enhance the primary and secondary settlement due to undersized and underperforming humus tanks to meet the biochemical oxygen demand, suspended solids and TP consent but introduced the unwanted side effect of a high level of Fe in the effluent.

Rather than providing a complex tertiary deep bed filter solution that was energy intensive due to the requirements to pump effluent to the head of the process and further pumping to backwash the filters Interserve (now Tilbury Douglas)/Wood offered an alternative solution that provided secondary and tertiary settlement tanks appropriately sized to provide the required solids removal. The only additional operational energy demands were to the motors of the scraper bridges and a sludge removal system. The alternative solution reduced the capital cost of the scheme by over £1.2m and presented further savings by reducing operating expenditure. Savings in OPEX were achieved by a 50% reduction in the volume of ferric sulphate consumed and power savings resulting from the elimination of the need to pump and aerate the effluent.

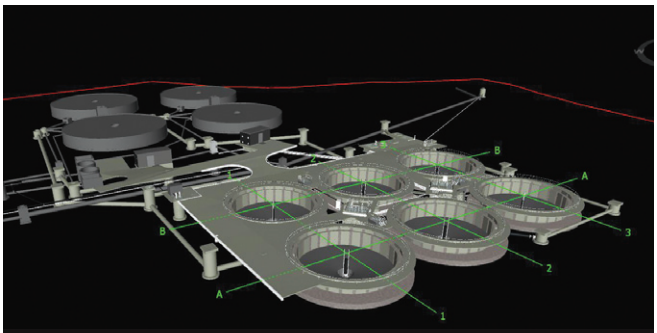
Detailed design scope

The design was accepted and progressed to detailed design with the following scope:

- 4 (No.) new secondary humus tanks complete with flow distribution and desludging.
- 4 (No.) new tertiary humus tanks complete with flow distribution and desludging.
- Modification to the chemical dosing algorithm to reduce the rate of dosing and adjustment to follow the diurnal profile.
- Modifications to the secondary and tertiary pumping systems to increase the flow capacity.
- Conversion of 2 (No.) existing secondary humus tanks to storm tanks.
- Provision of new final effluent sampling point and flow measurement.
- Provision of a new MCC housed within a GRP kiosk.

3D model

A 3D model of the new works was constructed using Autocad Civils 3D for the pipework and landscaping features and Revit for the structural elements. The models were combined into Navisworks file for presentation purposes. This enabled the design to be walked through and observed virtually which proved invaluable for design reviews with the Client and for tasks such as the Access Lifting and Maintenance (ALM) review.



Screen shot of the 3D model - Courtesy of Wood PLC

Construction

To meet the fast approaching December consent date several changes to the originally planned design and construction sequence were implemented and a second major design change was proposed and accepted. The design was changed to 3 (No.) of each settlement tank instead of the 4 (No.) accepted in the proposed design. Only 3 (No.) tertiary settlement tanks were required to ensure compliance with the December consent date, with the remaining new assets required to contend with forecasted growth beyond that date.

Constructing 3 (No.) tanks instead of 4 (No.) shortened the construction period thus ensuring timely completion of the critical elements. Furthermore, the 6 settlement tanks occupied a smaller footprint overall, reducing the volume of earthworks and size of the sheet piled excavation. In addition to the reduction in time generated by reducing the number of tanks, the construction period was further shortened by employing off-site build.

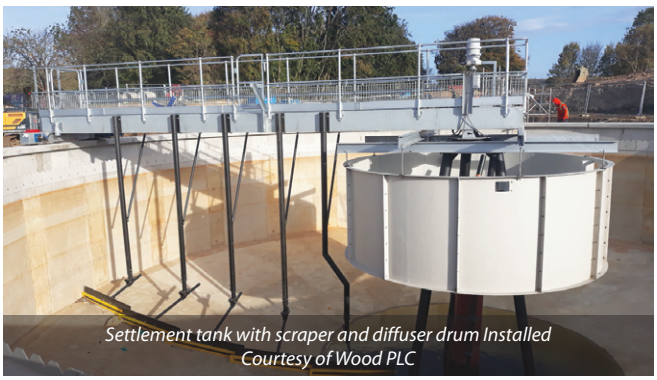
Aerial view showing tanks under construction
Courtesy of Interserve (now Tilbury Douglas)

FLI Carlow was appointed to design and manufacture precast settlement tank units and 2 (No.) de-sludging chambers. Each settlement tank consisted of 28 (No.) precast wall and launder units with in situ poured concrete stitches between each unit, an in situ poured concrete sloping base and an in situ/precast sludge cone. The settlement tank construction period was shortened by approximately 20 days per tank and the de-sludge chamber civils construction site works was shortened from 15 days to 1 as the unit was delivered as a single piece.

Aerial view showing tanks under construction
Courtesy of Interserve (now Tilbury Douglas)

With the sludge tank at 25 tonnes being by far the heaviest element of the works, careful planning was required to ensure it could be lifted into position without being hindered as the works progressed around them. Employing off-site build reduced both labour on site and vehicle movements to and from site improving health and safety. Where possible, off-site build and pre-assembly was encouraged.

Xylem provided a two-pump submersible pumping station with pre-fitted GRP valve chamber and wet well and the MCC enclosure manufactured as a single GRP structure. This was delivered to site and directly positioned on its reinforced concrete substructure.



Settlement tank with scraper and diffuser drum Installed
Courtesy of Wood PLC

Project success

The solution delivered significant financial benefits, enabling lower customer bills. Challenging the original solution achieved significant TOTEX savings through reduced capital, operating and chemical consumption costs. The project also delivered environmental improvements to the River Wear by delivering the consented total-phosphorus and iron emission limit values. Customer benefits were achieved through a shorter construction programme. Fewer vehicle movements were required due to off-site construction and retaining excavated material on site.

The project was completed early and under budget. Its success was only achievable due to the collaborative and open-minded approach taken by the entire project team.

Aerial photo of completed works - Courtesy of Wood PLC

The editor and publishers would like to thank Dave Humphries, Principal Civil Engineer with Wood PLC, for providing the above case study for publication. The author thanks Northumbrian Water and Interserve (now Tilbury Douglas) for their input.