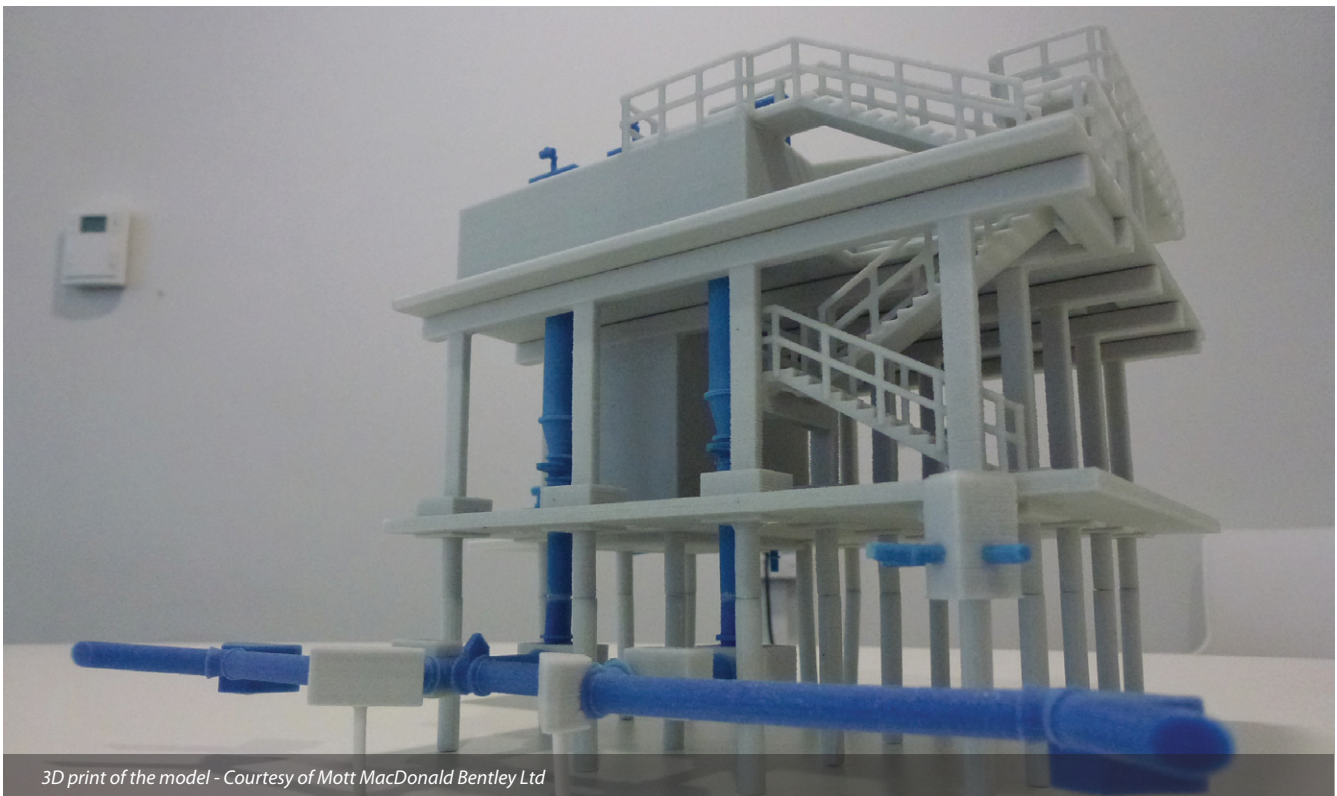


# Sutton WwTW

## major capital efficiencies on FFD scheme achieved through early contractor involvement and value engineering

by Chris Glover BSc CEng MIET

Sutton WwTW treats wastewater from the towns of Pontefract, Knottingley, Ferrybridge, and surrounding villages. It serves a population equivalent of approximately 60,000 with a current DWF consent of 128l/s and a maximum flow to full treatment of 362l/s. Sutton WwTW comprises an inlet works, interstage pumping to the primary tanks, mineral and plastic media filters and humus settlement prior to discharge to the River Aire. The existing 95%ile consent for final effluent spot samples was 25mg/l BOD, 17mg/l Amm.N and 35mg/l SS.



3D print of the model - Courtesy of Mott MacDonald Bentley Ltd

### Scheme drivers

As part of the Freshwater Fisheries Directive (FFD) the existing final effluent ammonia consent was to be tightened by the Environment Agency (EA) from 17mg/l to 3mg/l from September 2014. With significant growth expected in the Sutton catchment, it was considered probable that a new increased DWF consent would also be required. This could also result in a corresponding reduction in the final effluent BOD consent to ensure that there is no deterioration in the receiving watercourse.

Yorkshire Water had also identified a number of base maintenance issues. As a result, at the end of 2010, it raised an Investigation Contract to identify all business risks on the site and gather sufficient data to allow optioneering and identification of the preferred solution. This investigation and optioneering work was undertaken by design and build contractor Mott MacDonald Bentley (MMB).

### Investigation scheme

MMB undertook a number of process, civil, M&E and environmental investigations to fulfil the requirements of the contract.

The existing secondary treatment comprised 15 (No.) 36m diameter mineral filters and 1 (No.) 28m diameter plastic filter. These were actually performing well, with the works achieving a 95%ile Amm.N

of 5mg/l on spot samples. However, as well as further nitrification being required to achieve the new consent of 3mg/l, the existing filters would be significantly overloaded against the expected future growth.

The investigations also revealed that the condition and performance of the inlet works was not adequate.

### Original options and scope of works

The construction of a new activated sludge plant (ASP) would be the most reliable means of meeting the new ammonia consent. However, this also represented the highest capital and operational costs and would entail high write-off costs associated with the existing filters.

A number of options were therefore considered around augmenting the secondary treatment to account for the future growth, and providing tertiary nitrifying filters in order to meet the new consent. The preferred asset standard compliant solution comprised:

- 4 (No.) additional plastic media secondary filters at 23.6m diameter.
- 4 (No.) tertiary plastic filters operating in alternating double filtration mode at 17.2m diameter.

However, it was still considered to be a risk that nitrifying filters would not reliably meet the consent, particularly during spells of cold weather. In addition, space on the existing site was limited to actually build the new process units.

The value of the filter scheme was estimated to be £5.3m (with the cost of an ASP solution estimated at £3m higher than this). In addition, the base maintenance scope and new inlet works was estimated at a further £3m.

#### An alternative approach

MMB process investigations concluded that to achieve the tighter ammonia standard, an additional 10 to 15 kg of ammonia per day needed to be removed in total. It was felt that the considerable investment required for an ASP or nitrifying filters at Sutton WwTW greatly outweighed what would actually be a relatively small impact on the River Aire.

At this point, April 2011, MMB took a step back to review the actual scheme drivers – which was primarily the FFD objective to improve the river water quality. The team considered whether there might be an alternative means of achieving the same improvement in river quality at the Sutton WwTW discharge point.

An investigation was therefore carried out to determine if there were any other works discharging to the same receiving watercourse, upstream of Sutton, where this amount of ammonia could be more readily removed; for example an existing ASP works.

In particular, it was immediately identified that a significant discharge upstream was from Knostrop WwTW, which is one of YW's largest wastewater treatment works (serving Leeds and the surrounding areas), and where the treatment process is by ASP.

This approach introduced an additional risk that the time required to undertake modelling and negotiate with the EA might overrun the compliance date, especially if a new consent was not agreed. However initial discussion with the EA revealed they would be open to an alternative solution, and it was agreed that this would be pursued.

River modelling work was therefore carried out which confirmed that a minor tightening of the upstream Knostrop ammonia consent would achieve the same improvement in river quality; with no additional work being required at Knostrop in order to meet the tighter consent.

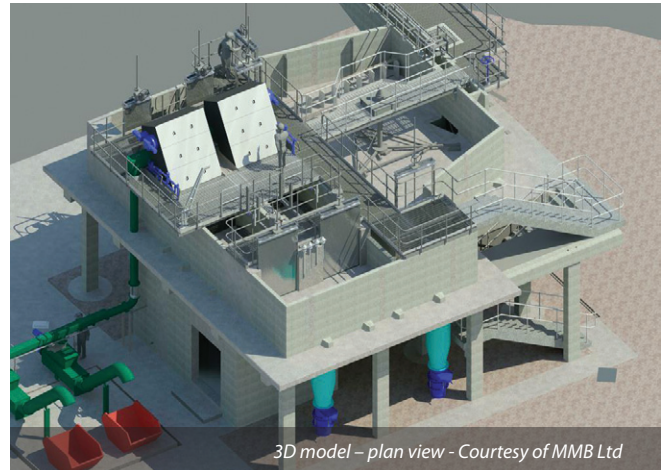
These findings were discussed with both the EA and Ofwat, and the revised consents were negotiated. The final agreed revised consent at Sutton was 8mg/l Amm.N to be effective in April 2014.

#### Final scope of works

The existing works at Sutton was re-reviewed against the revised proposed ammonia consent of 8mg/l. With a few relative minor improvements to the secondary treatment to improve the resilience of the existing works, it could reliably meet the new consent without any additional process units. However the condition of the inlet works still represented a high business risk. The final scope of works was valued at £2.7m and comprised:

- New inlet works.
- New sewage pumps in existing interstage PS.
- New washwater system for inlet works.
- Replacement of all existing mineral media filter drives & control panels.
- Upgrades to the site electrical installation.

To account for the future catchment growth, some additional secondary treatment filters are still planned at Sutton; however these will be phased over the AMP6/7 period.



3D model – plan view - Courtesy of MMB Ltd



3D model – Grit detritor & grit rake - Courtesy of MMB Ltd



Using the 3D print to plan construction - Courtesy of MMB Ltd



Construction works nearing completion - Courtesy of MMB Ltd



Mechanical and electrical equipment - Courtesy of MMB

### Value engineering and innovation

The new off line, elevated inlet works was designed for a maximum flow of 555l/s for predicted 2035 flows, and consisted of duty/standby 60 degree fine screens, a single (duty only) detritor with grit rake, and duty/standby screenings handling units.

In order to reduce the structural costs associated with building the inlet works, MMB looked to minimise the footprint, especially as the whole inlet works was elevated by 5m and the ground conditions required that the structure be piled. Although a physical hydraulic model was not required on this size of works by YWS, MMB elected to build and test a 1/5 scale model, in order to demonstrate that a compact design would function correctly.

The physical model was used primarily to check the flow presentation to the screens and across the detritor, to ensure that they satisfy the YW Asset Standards for velocity and linearity. The initial design of the inlet works structure was approximately 30m

by 15m. The final size of the value engineered inlet works was 13m by 13m, less than half the original footprint. This represented a significant saving of approximately £150k.

The inlet works was modelled in 3D to promote efficiency in both design and construction planning. Existing services were located by trial hole and included on the 3D model. Using the model the exact location of the inlet works and the associated new below ground pipework was then adjusted so as to avoid any clashes with the existing services and reduce diversion work during construction.

For the first time on a Yorkshire Water project, a 3D print of the model was generated, which was frequently used on site in planning construction activities.

In another "first" for a Yorkshire Water project, MMB transferred the 3D model into 3D gaming engine software to produce an easy to use, first person 3D walk-through of the plant. This and the 3D print of the works were used in design review and HAZOP meetings to engage the YW operations team, providing them with a full understanding of the proposed plant layout and access provision.

To reduce the amount of time on site, an off-site construction approach was adopted. In particular the use of pre-cast units to form the elevated inlet works vastly reduced the in-situ concrete works including concrete pouring, erection of formwork and rebar fixing. This also greatly reduced the working at height risks inherent in an elevated inlet works.

A further cost saving was generated by using solid walls to brace the elevated structure, therefore creating an enclosed space beneath the inlet works structure to serve as an MCC room, rather than constructing a separate kiosk. This also had the benefit of reduced cable lengths between the MCC and the inlet works plant and increased security.

## developing the engineers of the future



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An existing wet well/dry well interstage pumping station was adapted for reuse with increased capacity for 2035 projected inlet flows. Three existing interstage pumps were replaced by four variable speed sewage pumps capable of delivering 130l/s to 555l/s of raw sewage to the new raised inlet works.

This work involved a complex schedule of over-pumping, installation and commissioning activities to replace the old pumps and transfer control from the existing PLC system to the new system while maintaining full operation of the works which has no storm storage capacity.

The new power distribution board and sewage pumps' MCC was initially proposed to be located in a new high security kiosk. However, through value engineering, an alternative location within an existing disused building was used to house the MCC.

### Conclusion

The scheme was completed in March 2014. The new inlet works is operating well and the resilience of the works to meet the new consent has been greatly improved.

MMB has been working with YW as a design and build contractor since the partnership between Mott MacDonald and JN Bentley was formed in 1999. This long-standing relationship with YW and MMB's knowledge of YW's physical assets as well as their drivers and processes meant that they were able to work together with YW in the early stages of the scheme to challenge the obvious solution and identify a much more appropriate and cost-effective alternative.

As a result of re-negotiating the works discharge consent with the Environment Agency and OFWAT, MMB was able to remove the need for new tertiary treatment at Sutton which has saved approximately £3.9M.



Work at design stage building a physical model and generating the 3D model was more than offset by the resulting savings during construction arising from the compact and efficient design. Use of precast meant that programme on site was reduced. These and other cost saving initiatives led to cost efficiencies in design and construction which saved approximately £450k.

Other benefits of the reduced scheme include less work on the site with its associated risks, a lower energy use and a lower carbon cost both during construction and in the operation of the final works. .

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