

Cudworth WwTW

thinking 'outside the pipes' to deliver a cost effective solution to meet demands of a growing population

Cudworth WwTW is situated approximately 4 miles north-east of Barnsley in South Yorkshire and serves a growing population of almost 12,000. The existing inlet works was undersized for the 5.4ML/day full flow to treatment FFT and also asset life expired, resulting in the carry forward of solids/grit and screenings. Ultimately this would affect the way the process operated causing an increased risk of consent failure. The work undertaken was in relation to the Water Framework Directive (WFD) and the Freshwater Fish Directive (FFD) in terms of reducing ammonia and BOD to meet Environment Agency compliance.



Disc filter and MBBR - Courtesy of MGJV

Solution

Morgan Sindall Grontmij Joint Venture's (MGJV) initial solution was a £9.7m conventional treatment process using activated sludge plant (ASP), which would have high operating costs. MGJV chose to 'think outside the pipes' and deliver a more cost effective solution that would still meet demands of a growing population.

The solution came with MGJV offering new innovative technologies that would work with the site's current assets. A packaged inlet works, Moving Bed Biofilm Reactor (MBBR) and disc filter system, with the latter two for tertiary treatment were tabled, along with a new approach to design management. This had a single detailed design acceptance (DDA) encompassing all the works rather than individual DDAs. All of these were a first for Yorkshire Water (YW).

Packaged inlet works

MGJV promoted innovation through using a package plant inlet works rather than conventional inlet works. This resulted in a capital efficiency (savings that can be reinvested back into Yorkshire Water for further improvements) based on a shift from traditional travelling fine screens and screenings handling in a concrete

structure to a modern method of construction using a prefabricated package plant inlet works complete with screens, screenings handling and coarse grit removal. MGJV identified this method of construction for the inlet works to save time on the programme yet not compromising the standard of assets being built.

The manufacture of the package plant inlet works was completed off site, meaning only a minimal amount of civil engineering preparatory works was needed. The unit was delivered to site fully tested in package form. The package plant was then off-loaded directly onto a concrete slab on the site which was constructed adjacent to the existing inlet works. This enabled commissioning and testing of the package plant off line without compromising effluent quality during that phase of the works. Following commissioning the flows were turned through the package plant with the comfort that the plant was operating within the agreed parameters.

This has also seen a cost saving to Yorkshire Water of £130,000, against the construction of a conventional inlet works and reduced the on-site construction period by 4 months.

With sustainability being high on Yorkshire Water's agenda the inclusion of a package inlet works has also provided a reduction in the carbon footprint of the works being undertaken, with only minimal amount of in situ concreting being completed for this element of the works. This is also the first time this approach has been taken on a Yorkshire Water WwTW site.

Tertiary treatment

The effluent from the humus tank after the existing three trickling filters had a BOD₅ of 25mg/l, ammoniacal nitrogen of 15mg/l and total suspended solids of 80mg/l.

In order to meet the new 95thile consent for discharge to the River Dearne of 10mg/l total BOD₅, 3mg/l ammoniacal nitrogen and 55mg/l total suspended solids, it was originally proposed to install a conventional activated sludge plant followed by sand filtration. Utilising Yorkshire Water's Risk and Value intervention process, the MGJV team challenged this standard approach and investigated alternative treatment process options which would retain as much as possible of the existing assets.

Moving Bed Biofilm Reactor (MBBR): MGJV worked closely with Veolia Water Solutions & Technologies to develop an innovative solution to treat the full flow of 5.4ML/day from the existing trickling filters. The result was a £490,000 plant consisting of biological nitrification using Veolia's AnoxKaldnes™ Moving Bed Biofilm Reactor (MBBR) technology followed with tertiary filtration by Veolia's Hydrotech™ Discfilter.

The MBBR is a fixed film process that resulted from research at the University of Trondheim, and was developed in the 1980s by AnoxKaldnes. Unlike most fixed film systems, the media are free to move within the aeration reactor. This combines the high biomass concentration achievable with fixed film processes with the small footprint of a conventional activated sludge process.

The MBBR plant consists of two parallel streams each with two reaction compartments in series. To ensure complete nitrification, each compartment is charged with 44m³ of Veolia's AnoxKaldnes™ Type K5 carrier elements which have a protected surface area for biofilm growth of 800m²/m³. The design allows one compartment to be taken off line for maintenance by pumping the media into the corresponding compartment in the other stream. The media only occupies 30% of the aeration tank volume, enabling it to circulate freely, and this is aided by the aeration system which consists of a floor mounted fine bubble diffuser grid supplied by variable speed blowers controlling the dissolved oxygen concentration to 5mg/l.

Discfilters: Final solids removal is provided by two 100% duty HSF 2208/7-1F Veolia's Hydrotech™ Discfilters. The technology was developed in Sweden where the first full scale plant was installed in 1995. Since its introduction to the UK in 2003, it has become the first choice for tertiary sewage treatment for an increasing number of water companies. The disc filter is a self-cleaning filter consisting of a series of hollow segmented discs supporting a 10µm woven polyester screen and mounted on a central shaft.

Influent liquor enters along the centre line of the unit and is distributed radially on the inside of the discs. The flow passes through the mesh leaving suspended solids retained on the inner face of the filter elements. Filtered water is collected in the chamber around the disc filter and an outlet weir, which is part of the structure. This maintains the filtered water level so that the discs are approximately 65% submerged. This retained volume provides backwash water for filter cleaning. Filtered water flows over the weir and away to the outfall. When the head loss increases to a pre-set level a backwash cycle is initiated which rotates the disc filter and presents clean mesh to the influent liquor. At the same time filtered water from the integral reservoir is pumped at high pressure to jet wash the dirty mesh.



Cudworth WwTW prior to works beginning in March 2012
Courtesy of MGJV



Packaged inlet works - Courtesy of MGJV



Moving Bed Biofilm Reactor - Courtesy of MGJV



Anox-K5 media within the MBBR reactor
Courtesy of Veolia Water Solutions & Technologies

The low head loss through the disc filters eliminated the need for a new interstage pumping station between the MBBR and filtration units. This also reduced the operating and whole life cost of this solution; creating further capital efficiency savings as well as savings on time and cost.

The MBBR provides greater operational flexibility for maintenance allowing for more efficient matching to the design flow capacity. It is also a more effective and robust process unit which removed the need for an additional (3rd) humus tank on the site. The MBBR also eliminates the need for a distribution chamber feed connection and sludge take off system associated with an additional humus tank, all of which are necessary should the MBBR option not have been taken.

The Veolia solution offered significant advantages as it:

- Retained much of the existing process with additional tertiary polishing to achieve the consent.
- Minimised the footprint of the overall treatment process units.
- Retained much of the existing hydraulic profile which was important given the existing steeply sloping and constrained site.
- Eliminated the need for either deep excavation into difficult ground conditions and/or coal measures, or additional interstage pumping together with minimising waste management on the site.
- Reduced sludge handling requirements.

The risk and value management workshop developed for AMP5 also enabled MGJV to challenge requirements in terms of sludge storage. Sludge production from the ASP process is a greater quantity than humus sludge production in conjunction with biological filter beds. As a consequence, this eliminated the need to build a new sludge holding tank. With some improvements in access arrangements to the sludge holding area it was possible to retain the existing asset; creating further capital efficiencies.

Project benefits

On Cudworth WwTW, MGJV has been able to identify a number of opportunities for capital efficiencies through our risk and value intervention process and a proactive management approach to the investigation and design process. This has resulted in challenge to the process design resulting in:

- Reuse of biological filter beds in lieu of a standard denitrifying ASP.
- Modification of the tertiary treatment process by installation of Veolia's MBBR and Discfilter.
- Selection of innovative process units such as moving bed biofilter reactors and disc filters which has removed the need for an additional humus tank and interstage pumping.
- Enabling a reduced sludge storage capacity.
- Reduced operating costs.
- Reduced carbon footprint.

The positive interventions on the Cudworth site have also helped promote operational excellence through ensuring environmental regulations are met and that assets on the site are working to a high standard.

The innovative technology used has also had a positive impact upon the environment, reducing the carbon footprint through providing more environmentally friendly assets, which will also provide a considerably reduced OPEX for the site by utilising biological treatment in preference to the ASP process.

Project completion

The site successfully completed in March 2013 and handed over to Yorkshire Water 6 months ahead of schedule. Overall MGJV has:

- Provided £2.6m in capital efficiencies and £900,000 in outperformance savings.
- Used new technology which provided a reduction in energy consumption and OPEX costs, and is simpler to operate, access and maintain.
- Reduced ammonia and BOD limits to achieve an average reading of 0.05, against a Compliance Target of 3.
- Reduced embedded carbon by 25% when compared to the installation of the accepted ASP solution.
- Reused and recycled materials on site.
- Completed over 50,000 RIDDOR free hours adding to MGJV's total of over 1 million hours RIDDOR free, and identified all external hazards by marking with yellow paint.

The Editor & Publishers would like to thank MGJV and Veolia Water Technologies for providing the above article for publication.



Packaged inlet works - Courtesy of MGJV