Magherafelt WwTW

sustainable design and construction to deliver effective, low carbon wastewater treatment

by Martin Gillen

As part of its ongoing strategy to modernise many of its existing assets and improve the quality of river and bathing waters throughout Northern Ireland, Northern Ireland Water is investing £7m in upgrading its Magherafelt Wastewater Treatment Works (WwTW) in mid-Ulster. Getting underway on site in March 2010, the focus for the NI Water contract team has been on value engineering, sustainable design and eco-conscious construction to produce a highly cost-effective, low maintenance treatment solution.

New 35m diameter tertiary trickling filters and distribution arms *Courtesy of NI Water*

Background and previous situation

Constructed in 1977, Magherafelt WwTW was of conventional design, incorporating inlet works, primary settlement, biological filters and humus settlement before discharge to the Moyola River – one of Northern Ireland's premier salmon and dollaghan (Lough Neagh trout) rivers. Phosphate reduction was achieved by dosing the effluent with Ferric Aluminium Sulphate just upstream of the humus tanks.

The works treated flows from the Magherafelt catchment (including the village of Annaghmore), and since 2003, 40% of the flows from the Castledawson catchment. As it stood then, Magherafelt WwTW did not have the treatment capacity to receive the remaining flows.

Magherafelt WwTW had also previously operated as a sludge management centre for NI Water, and as such, was equipped with two large-scale sludge storage tanks. However, following the extensive upgrade of Cookstown WwTW (situated approximately 10 miles away) in 2008, the regional sludge management was centralised at that location, meaning that Magherafelt WwTW needed to deal only with indigenous sludges.

In 2005 a MBR supernatant treatment plant was introduced to treat the large volumes of sludge supernatant arising from the sludge treatment centre, thereby reducing the organic loading on the wastewater treatment process.

Additionally, in 2005, minor upgrades to improve the WwTW's performance were completed including filter bed media replacement, Lockertex screening on the humus tanks and auto de-sludging of primary settlement tanks.

Final effluent from the works is pumped to the Moyola River via a final effluent pumping station, which was also constructed in 2005. The discharge consent standard (95%ile) at that time was 35:50:10:1 (BOD5:SS:NH_3-N:P (annual average) as mg/l), however it was deemed that the existing works would be unable to comply with a proposed, more stringent Northern Ireland Environment Agency (NIEA) registered discharge standard (RDS). Deterioration in the works performance was also likely to occur due to age and increase in future load conditions. These combined factors led NI Water to consider various options to ensure that future compliance would be met.

Existing secondary filters prior to refurbishment *Courtesy of NI Water*

Existing PSTs under refurbishment *Courtesy of NI Water*

Solution analysis and preferred option

A number of solutions were extensively analysed and weighted in terms of PE, compliance, capital expenditure and whole-life operating costs. After careful consideration of all data, NI Water and its design team from McAdam Design, put forward an ambitious solution that would use all of the existing assets on site to completely overhaul the existing Magherafelt WwTW, and create a modern new treatment facility that would be capable of treating not only the entire Magherafelt catchment, but also 100% of the Castledawson flows, to meet the stricter 20:30:5:1 (BOD:SS:NH_3-N:P) NIEA standard.

Contract award

The Magherafelt project was tendered to a consortium of suitably qualified contractors who had been previously selected as part of NI Water's 'Integrated Wastewater Framework'. Using the NEC Option A conditions of contract, the design and build scheme was awarded in January 2010 to the joint venture contracting team of BSG Civil Engineering (civils) and Williams Industrial Services (process/M&E).

Approach

The tender was flexible in its approach to allow the JV to bring forward their own innovations and ideas. Value Engineering has played a major role in the contract from the outset, and early collaborative working enabled all parties to be totally involved in the development phases to 'shape' the final solution.

As part of the Value Engineering exercise, the team looked at sweating existing assets, the condition of the existing works and how a reduction in operational costs could be achieved. This joined-up thinking resulted in a revised solution being put forward that would deliver significant operational cost savings – a two-stage biological filtration process (originally it was proposed that an activated sludge process would be incorporated).

New inlet works at Magherafelt WwTW *Courtesy of NI Water*


New thickened sludge holding tank filling for water test
Courtesy of NI Water


Site finishing around the intermediate settlement tanks and odour control slab - Courtesy of NI Water


New final settlement tanks in operation *Courtesy of NI Water*

Project drivers

The primary objectives for the Magherafelt project team are:

- To improve the quality of discharges from Magherafelt WwTW in line with the latest NIEA standards.
- To protect the environment in line with Urban Waste Water Treatment Regulations (NI) 2007.
- To deliver improved treatment capability to meet future flows and loads, and a discharge standard (95%ile) of 20:30:5 (BOD5:SS:NH_3-N as mg/l), and (annual average) of 1 (Total P as mg/l) as confirmed by the NIEA.
- To provide storm storage capacity of 2,263m^3.
- To provide sludge storage and thickening facilities to produce sludge with a minimum dry solids content of 6%w/w.

Working towards these objectives the team strived to:

- Reuse existing assets wherever possible.
- Recycle any superfluous assets as fill material.
- Minimise visual impact, disruption, noise, air quality (odour) and any socio-economic effects.

Design for new Magherafelt WwTW

The rationalised and upgraded WwTW consists of:

- New storm separation and storm pumping station prior to inlet lift pumping station.
- Refurbished old sludge storage tanks as new storm storage tanks (wall depth increased by 650mm to provide 2,263m^3 storage as required by NIEA). *
- Provision of storm separation prior to inlet pumps, allowing the existing two stage inlet screw lift pumping station to be retained as a FFT pumping station. *
- New inlet works including duty/standby inlet screens and grit trap, and associated conditioning units to replace existing inlet works.
- Two existing storm tanks refurbished as two additional primary settlement tanks, to supplement existing 2 (No.) primary settlement tanks. *
- Refurbished existing biological filters by providing new flow split and distribution arms to deal with increased flows. *
- Replacement of final humus tanks with intermediate settlement tanks (unfortunately humus tanks were too small to be reused).
- The Provision of interstage pumping station to lift flows to 2 (No.) new blast furnace slag tertiary trickling filters and 3 (No.) new final settlement tanks.
- New recirculation pumping station.
- Retain existing P Dosing arrangement. *
- Existing sludge works was deemed to be beyond it is design life and as such was to be replaced. Operational requirement for sludge to be thickened to 6% DS and this was not possible with existing plant.
- New sludge works including sludge buffer tank, duty standby sludge thickeners, thick sludge holding tank and associated sludge pumps, and poly dosing equipment. Odour treatment provided to all the sludge area.

*All items marked * are examples of where the existing assets have been reused. These elements are being refurbished to extend their design life and to bring them up to current health and safety regulations.*

Challenges

Working within the confines of the existing site footprint, coupled with the need to keep the existing works live has probably been the biggest challenge that the construction team has faced. The amount of activity on site – the construction of new assets; the refurbishment of existing assets; the demolition of parts of the old

New 35m diameter tertiary trickling filters and distribution arms *Courtesy of NI Water*

plant as well as ongoing deliveries to site – has required meticulous planning and a constant flow of communications to ensure that operations at the old works were not affected by the construction/ refurbishment process.

To promote health and safety, information was produced on a regular basis, which showed clearly the areas of the site which NI Water plant operators could safely access to control treatment processes at the existing works.

During construction, no relaxation in discharge consent standards has been permitted, and therefore it has been imperative to maintain high quality standards to the Moyola River for final effluent.

Current situation

Currently (as of July 2011) all new elements of the works have been constructed. Refurbishment of the existing works is approximately 50% complete and it is expected that the team will enter into performance tests in the middle of October 2011.

The editor and publishers wish to thank Martin Gillen, Senior Project Manager with Northern Ireland Water, for preparing the above article for publication