

# Knitsley STW

## filter refurbishment and modification works to a medium sewage treatment works

by Grant Crawford

**K**nitsley STW is a medium sized works south of Cossett, County Durham. The site, operated by Northumbrian Water (NW), serves a population equivalent of 5,172 with a flow to full treatment (FFT) of 3,701m<sup>3</sup>/d (43l/s). The main process stream comprises inlet works, primary settlement, mineral filters for biological treatment and final settlement tanks. The facility also houses both storm and sludge storage tanks. In the three years prior to the scheme, the works had seen a reduction in process performance leading to concerns around the consent compliance. In particular, the filter beds showed a deterioration in performance, particularly through the winter months. This was believed to be as a result of a combination of media deterioration, clogging of the media with biomass and extreme low temperatures. Refurbishment and upgrade of the existing works was proposed to provide certainty around the future works performance.



Filter complete - Courtesy of JN Bentley

### Undertakings

JN Bentley was commissioned to undertake the extensive modifications to the site. The scope of work included:

- Refurbishment of the three original filter beds.
- Modifications to the inlet works bypass arrangement.
- Improvements to the primary tank de-sludging.
- Humus tank de-sludging and humus sludge return improvements.
- Provision of filter recirculation flows.

### Challenges

The main challenge on this scheme was ensuring that process treatment remained functioning while critical assets were taken out of service. Undertaking substantial modification works to process critical components could present a significant risk to compliance or pollution event.

Each main stage of the treatment process was affected – inlet works, primary settlement, biological treatment and final settlement. The success of the project was therefore dependent on careful management of the flows and treatments processes, continuous monitoring of treatment parameters and prompt reaction to the monitoring results. The most critical work in terms of affecting the works performance was taking each of the filter beds out of service.

An additional challenge was the lack of working room around the existing treatment units. NW had negotiated the use of a piece of land adjacent to the STW, large enough to allow the establishment of the site office and welfare facilities, material storage and access to the inlet works for plant.

### Temporary treatment

It had been identified that a filter bed could not be taken out of service without compromising the ability of the works to meet the

7mg/l ammonia consent. Therefore, it had been decided that some form of temporary treatment would be required.

As an enabling contract to the main work, JN Bentley installed 3 (No.) HSAF units – submersible aeration filter units to provide additional treatment.

These package treatment plants contain plastic media and were set-up for nitrification. Once they were fully seeded, the units reduced the effluent ammonia levels. This tertiary treatment stage would reduce the impact of taking a biological filter off line for refurbishment. Post filter effluent alkalinity deficiency also identified the need for temporary dosing of a lime slurry; this was installed with pH control prior to the humus tanks. This ensured HSAF nitrification to meet the 7mg/l consent and improved alkalinity of recirculated effluent to further boost filter seeding.

The team successfully implemented the temporary treatment units which themselves required integration, seeding and commissioning requiring diligent input from both teams to gain confidence in their performance. NW and JN Bentley worked closely together in order to fully mitigate all the process risks. The tertiary treatment units were installed and handed over to NW under a separate contract, ahead of the main refurbishment works.

#### Filter refurbishment

Refurbishment of the three older 23m diameter filter beds included replacement of the stone media, tiles, and under-drains, installation of new distributors and local repairs to the brickwork walls.

This refurbishment of the filters was on the critical path to completing the scheme. Even with the temporary treatment, only one biological filter could be refurbished at a time, so that the treatment works continued to be compliant with its discharge consent. On completion of the actual refurbishment works to each

filter, it then had to be fully seeded and proved to be providing the necessary level of treatment before the next filter could be taken off line and refurbished. Effluent from a refurbished filter was recirculated back to the primary tank distribution chamber; this was monitored daily with flows only being put through the humus tanks when sufficient treatment was being achieved.

Taking each of the filter beds off-line in turn required the team to carefully balance flows between the remaining existing assets, and also the temporary units. The team implemented a rigorous sampling and monitoring regime to provide information to allow informed decision making and monitor process performance. Four spot samples were taken daily with a portable test kit for ammonia and alkalinity, with one sample each day sent for lab analysis. In addition composite samples of raw, settled, filter effluent, HSAF in and HSAF out were undertaken throughout the filter refurbishment.

A series of weekly coordination meetings with the NW operational teams was held. The JN Bentley delivery team constantly monitored their planned activities and took programme updates to the weekly meetings. Using the results from sample analysis, the JN Bentley and NW teams worked together to collaboratively plan upcoming works. This ensured the most efficient working sequence was adopted and also ensured any risks from process failure were minimised.

The refurbishment of the first filter started in July 2013 and took three weeks to complete. The contract had originally stated that eight weeks should be allowed for seeding each filter and that 7mg/l ammonia should be achieved. Wanting to make the most of the summer to carry out the work, and with the team working exceptionally well together, it was jointly agreed that work could start on the next filter as soon as a filter was performing as well as its pre-refurbishment performance, given that there was also temporary tertiary treatment on site as well.



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JN Bentley was therefore able to start the next filter only two and a half weeks later. This minimal seeding period was also down to a combination of continued good weather in July and the recirculation of humus sludge through the filter to help the nitrifying bacteria establish and grow on the filter media.

#### Other refurbishment work

Modifications to the inlet works were required to resolve local flooding issues. The work comprised constructing a new inlet and fine screen by-pass channel, incorporating an adjustable weir, and bypass penstock.

Modifications to the primary de-sludging arrangements were made by replacing the actuated bellmouths with timer operated progressive cavity pumps. Improvements to the humus tanks de-sludging arrangements included actuating the existing bellmouths. The operation of the humus sludge return pumping station was modified so it could also provide recirculation flows to maintain the minimum filter wetting rates. This required replacement of the humus sludge return pumps as well as a new humus sludge return rising main.

In addition, mixers were installed in the sludge dewatering tanks and the washwater storage tank was replaced.

The necessary electrical and control modifications for all the work were undertaken by TES (NI) Ltd and Peak 42 Limited under a subcontract.

These other refurbishment works were completed in parallel to the refurbishment of the filters.

#### Conclusion

Work started on site in March 2013 and was successfully completed in September 2013, eleven weeks ahead of the original contract programme. Teamwork was key to the early completion of highly intrusive construction works within a congested treatment works without jeopardising the works consent, or causing a pollution incident.

The use of short term collaborative planning techniques ensured all team members had clear direction in what they needed to do and the confidence that others would deliver their actions to keep the programme moving forward. Diligent monitoring of process performance by the project team allowed the programme to be accelerated and critical treatment assets taken out of service early.

Drawing on the strengths of each team member, the team dissected the complex process issues, devised and implemented a mechanism for monitoring, developed a detailed collaborative work plan and delivered the works. The JN Bentley team worked fully together with the NW operational teams to deliver the project ahead of programme, with an excellent safety record, and without any environmental incidents.

The NW Treatment Works Manager, Stuart Barnes commented:

*'...despite numerous challenges Knitsley STW refurbishment went extremely well. This was due to excellent team work, commitment from Bentley's and NW to make the project a success. The project team was prepared to balance risk against key analytical data of refurbished filters being provided by the site team to bring forward the start of the next filter.'*

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Filter tiles - Courtesy of JN Bentley



Media on tiles - Courtesy of JN Bentley



Media to level - Courtesy of JN Bentley



Filter complete - Courtesy of JN Bentley