

# Elsham WTW

## upgrade to increase output and improve performance of non-potable WTW to meet forecast industrial growth on the south Humber Bank

by Stewart Bell

**E**lsham Water Treatment Works (WTW) is located approximately 10km east of Scunthorpe in North Lincolnshire and consists of a potable WTW with a nitrate removal plant, and a non-potable WTW which provides water to industry based on the Humber Bank. The original works was constructed approximately 40 years ago as a general-purpose works. When additional processes were required for potable treatment to meet stricter water quality standards, a new potable works was constructed, leaving the existing works dedicated for non-potable production. Anglian Water has invested £12.3m at Elsham to increase the output of the non-potable plant and improve performance of the existing treatment facilities. This paper explains the work undertaken between September 2011 and June 2013 by GTM as part of a Special Projects team for Anglian Water.



Washwater clarifiers – inlet and flocculator tanks - Courtesy of Anglian Water/GTM

### Background

Both plants treat raw water which is pumped from Cadney Carrs Reservoir. The potable plant also treats water from the Ulceby borehole, to give a total output of up to 40MI/d. The non-potable plant has an output of up to 60MI/d, which is produced solely from the reservoir source. At the inlet to the works, water from Cadney Carrs Reservoir flows to the microstrainer plant, then excess flow is directed to the non-potable plant, for processing and distribution to industrial users.

The output of the non-potable industrial was required to increase by 15MI/d, due to forecast industrial growth on the south Humber Bank. During feasibility work, it was identified that the capacity of the non-potable works was being eroded by the return of unsettled filter wastewater and waste from the existing microstrainers.

Approximately 2MI/d of waste was being lost to the system. These problems were caused when the new potable works was constructed, without increase in waste treatment facilities.

### Scope of work

In order to increase the output of the non-potable plant and improve performance of the existing treatment facilities, the following was required:

- Construction of a zebra mussel trap, to serve both works and new microstraining facilities for the non-potable works.
- Provision of new clarifiers and rapid gravity filters, for the non-potable works, plus associated chemical dosing facilities.

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High rate lamella clarifiers - Courtesy of Anglian Water/GTM



Existing filters flow balance pipework - Courtesy of Anglian Water/GTM



Lamella clarifiers and new filters - Courtesy of Anglian Water/GTM



Raw water mains connections - Courtesy of Anglian Water/GTM

- Improvements to the wastewater handling, treatment and waste disposal facilities serving both works
- Construction of new blind lagoons, to receive overflows and process waste from both works.

#### Mussel trap and microstrainers

The mussel trap serves both potable and non-potable treatment works. In recent years, the River Ancholme which supplies the reservoir has been colonised by zebra mussels, which are taken into the system as larvae. They then adhere to the transfer main and other structures, reducing capacity and pumping efficiency. Furthermore, dead mussels detach and are carried through the system to the works where they frequently blocked the microstrainers that served the potable works.

The trap has an upflow velocity which is insufficient to entrain the mussels. These then settle and are discharged manually to a reception chamber by periodically operating a drain valve. A single mussel trap was installed on the basis that there is little mechanical equipment to fail and maintenance (such as cleaning out) will be planned. If maintenance is needed, the trap can be bypassed to the microstrainers, by operating penstocks and in this instance the potable supply is taken from the microstrainer inlet channel.

As this structure serves both potable and non-potable streams, the trap and the microstrainer inlet channel were required to fully comply with Regulation 31: *Controlling materials in contact with water for potable use*. Careful hydraulic design has ensured a break is maintained between the potable and non-potable works to avoid cross contamination.

3 (No.) new microstrainers, which operate in parallel, have been installed. The nominal mesh size is 50 micron and each strainer is rated to filter 27MI/d. From a common inlet channel, the flow passes from the inside of the drum to the outside, and over a weir to further treatment. The weir maintains the level in the microstrainer and provides a means of headloss comparison.

The drums can be set to rotate at variable speeds and as they rotate, filtered water is sprayed onto the mesh at the top of the drum, to flush retained solids away. One spray pump is provided per strainer. The strainers are periodically cleaned by spraying the mesh panels with a dilute citric acid solution. This is prepared adjacent to the strainers and a pump supplies a spray lance for application.

#### Pre-chlorination

The existing pre-chlorination system was adapted to serve the whole non-potable works, by delivering the chlorine solution to the non-potable microstrainers outlet channel. The existing chlorinators were retained, but with larger gas control valves and rate tubes.

#### 15MI/d extension

**New clarifiers:** 2 (No.) new 15MI/d clarifiers were installed, to increase the capacity of the non-potable works to 75MI/d and also to provide full capacity during periods when a clarifier is offline for maintenance. The clarifiers are of the solids contact type with sludge being extracted from the clarifier and returned to the flocculator section to assist in flocculation of incoming coagulated water.

The clarification system incorporates several stages: rapid mixing, flocculation and settlement. The mixing stages are operated by vertically-mounted powered turbine mixers. The settlement stage is enhanced by lamella packs. A rotary floor scraper conveys sludge to the central pocket, where it is pumped to the sludge tanks for disposal.

The clarifiers operate independently, with chemical dosing systems serving each stream. The clarifiers operate at a manually set flow which is automatically controlled by modulating clarifier inlet

valves. All clarifiers will work at the desired flow rate and any unit being worked on can be isolated. The chemical dosing regime of the new clarifiers mimics that of the existing clarifiers and includes lime addition for pH correction and softening.

**Rapid gravity filters:** 2 (No.) additional rapid gravity filters were constructed in a separate block from the existing filters. These were loaded with sand-anthracite filter media. The additional filters receive clarified water, primarily from the new clarifiers. A cross-connection between the existing filter inlet channels promotes an even flow distribution between the existing filters.

All filters, new and existing, have the same washing queue and sequence. In filtration mode, the filters operate in constant level operation, maintaining the level in the filter and balancing inflow and outflow. Ideally the filters would be controlled to filter a set flow, but this was impractical due to the lack of flow monitoring on the existing filters.

The filtered water transfers to the existing filtered water channel through a 800mm pipe connection. The air scour and backwash water is supplied by extensions of the existing mains from the building.

**Chemicals systems:** In addition to the modification outlined above, the existing chemicals systems were adapted as follows:

- **Ferric sulphate:** The existing storage tanks were retained, along with the existing dosing systems serving the existing clarifiers, which are unchanged. New duty/standby dosing pumps supply each of the new clarifiers.
- **Lime:** The existing powder storage and make up systems were retained unchanged, with the existing dosing systems serving the current clarifiers. New duty/standby dosing pumps supply each of the new clarifiers.

- **Polyelectrolyte:** A new polymer preparation system was provided, to make the polymer used in the non-potable plant (including wastewater clarification). The existing dosing pumps have been retained and new pumps provided for the new clarifiers.
- **Sodium hexametaphosphate (Calgon):** The Calgon preparation system was renewed, to serve the whole of the non-potable works.
- **Chlorine:** The existing chlorine drum storage and changeover system is suited to the new duty and did not require uprating. The existing chlorinators and their control systems were retained but adapted to the new duties. The chlorinators were adapted to increase the dose capacity and the capacity was also increased by fitting uprated internal parts.

#### Waste water system improvements

**Microstrainer waste recovery:** Washwater from the microstrainers, together with the drainage water and the mussel reception sump, gravitates to an existing tank for buffer storage, prior to being pumped through a recovery (Boll) filter and returned to the microstrainer inlet channel. The recovery system is intended to recover at least 80% of the microstrainer waste. In the event of the mussel trap being bypassed, the return is made to the outlet of the new microstrainer, to avoid the risk of contamination of the potable feed.

**Potable RGF waste recovery:** Dirty washwater from the potable works rapid gravity filters was diverted to the filter waste recovery for treatment, prior to return to the non-potable works. This was achieved by transferring along the works overflow line to an interception chamber. It is then pumped to the non-potable RGF backwash wash drains. The pumping system at the RGF waste outlet sump was modified to provide a duty standby facility on this transfer.



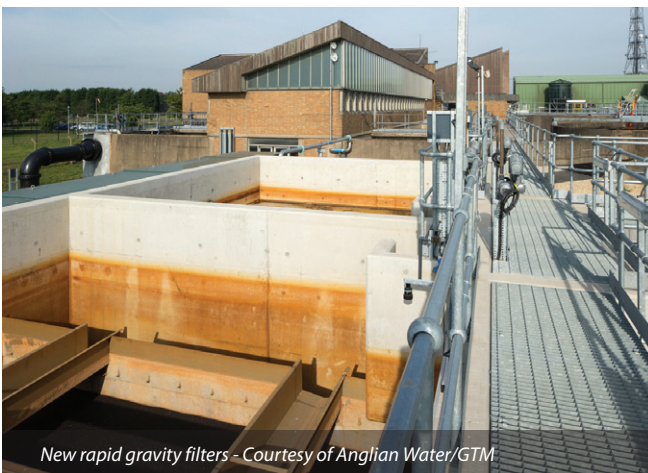
Wastewater clarifiers – outlet and settlement tanks - Courtesy of Anglian Water/GTM



Lamella clarifiers: Access and desludge kiosks  
Courtesy of Anglian Water/GTM



Lamella clarifiers: Inlet flow control and chemical dosing  
Courtesy of Anglian Water/GTM



New rapid gravity filters - Courtesy of Anglian Water/GTM



View from washwater clarifiers - Courtesy of Anglian Water/GTM

**Backwash waste settlement:** All of the rapid gravity filter wastewater and returns from the lagoon are sent to the washwater buffer tanks (previously settling tanks) as a buffer storage, prior to pumping to lamella settlers. The 3 (No.) tanks operate in parallel, with submersible mixers operating to prevent solid settlement. Variable speed pumps deliver the washwater to 2 (No.) lamella settlers, which operate in parallel to treat the wastewater.

These produce low turbidity supernatant and 1% sludge, through assisted settlement, with polyelectrolyte added to promote flocculation. The sludge from the settlers is pumped on a time-controlled basis to the sludge holding tanks. Supernatant from the lamellas is returned by gravity to the existing non-potable clarifier's inlet chamber.

**Sludge export and tidal discharge:** Sludge generated by all the clarification processes on the potable and non-potable works is collected in the sludge buffer tanks (converted thickeners), for transfer to the Humber discharge at Killingholme.

The transfer to Killingholme is continuous, either by gravity or pumped depending on the flow required. The site discharge licence only permits a discharge during four-and-a-half hours of each ebb tide, so the sludge is stored at Killingholme between tides and pumped to discharge when permitted. At Killingholme, a redundant tidal pumping station was refurbished and reused to cope with the additional sludge produced by the extension.

**Emergency lagoon:** The existing blind lagoon at Elsham had passed its design life. The replacement was divided into two compartments and the total volume of these is equal to the volume of the existing lagoon, plus the volume associated with maintaining a minimum water level protect and weigh down the liner. When the potable GAC contactors are anaerobically treated, to reduce Chironomid larvae infestation, the backwash is discharged to the lagoon to avoid passing a high chlorine demand to the non-potable works. Waste is stored in the lagoons until it can be returned at a steady rate to the waste water recovery system, to avoid process upsets.

#### Delivery partners

Each of these improvements was undertaken by GTM (Galliford Try/ Imtech JV) working as part of the Special Projects team on behalf of Anglian Water. All the schemes have now been successfully completed under budget and handed over to AW operations.

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Wastewater settlement lagoon - Courtesy of Anglian Water/GTM