Acomb Landing WTW

rebuilding York's water treatment works

by Norman Johnson BSc(Hons) CEng MICE

Yorkshire Water's Acomb Landing WTW is located approximately one mile to the west of York city centre on the west bank of the River Ouse. Development of the site dates back to 1846, with numerous phases resulting in the current layout, which comprises four separate process streams. Yorkshire Water Services Ltd (YWS) purchased the Acomb Landing WTW from York Waterworks plc in early 1999, and have since undertaken work to increase the pesticides removal capability by the introduction of the granular activated carbon (GAC) sandwich process in the existing slow sand filters. Further work to improve the automation of the process streams and upgrading of the sludge handling facilities has also been undertaken.

The main plant building at Acomb Landing – Courtesy of ETM

Existing works

Currently only two streams are operational, one being the Number 3 plant at the north end of the site, and the other a hybrid of the Number 1 and 4 plants in the southern part of site.

The site currently provides a reasonably constant base flow of 21ML/d to serve the city of York, but since the regional water resource plan calls for an output of 35ML/d, the 14ML/d deficit is made up from Elvington WTW, located to the south-east of the city.

The existing treatment process is clarification, roughing filters followed by slow sand filters. The process units are old and cannot be easily upgraded. The majority of the water treatment works assets are also old and beyond their asset life. In total Yorkshire Water have identified 66 business risks associated with the existing water treatment works.

Contract award

Following a competitive tender process the Acomb Landing scheme was awarded to ETM, the AECOM Galliford Try joint venture, in August 2010 for £12.8m with a completion date of September 2012. The wining tender was based on a new build 35ML/d plant.

Process selection

The selected process was clarification, rapid gravity filtration and pesticide removal.

Numerous options were reviewed for the clarification stage including flat bottom clarification, Actiflo, pre-settlement followed by DAF. DAF was ultimately selected on a whole life cost basis and also because it is a process with which Yorkshire Water have extensive operating experience. Due to the high turbidity spikes in the River Ouse a pre-settlement tank was adopted upstream of the

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River intake cofferdam – Courtesy of ETM


Filter pipework gallery – Courtesy of ETM


Dissolved air floatation (DAF) plant area – Courtesy of ETM


Dissolved air floatation (DAF) – Courtesy of ETM

DAF. This option was made more cost effective by recommissioning an existing tank on the site to use for pre-settlement and by ETM's in-house DAF design.

Dual media rapid gravity filters of anthracite over sand with combined air/water washing were adopted as the second stage of treatment. The filters were designed conservatively at a maximum filtration rate of $4m^3/m^2/hr$ to allow for any increased load resulting from high turbidity spikes in the raw water. Facilities for adding a small polymer dose prior to the filters on any DAF system is included for use under adverse conditions, particularly in winter, to retain solids in the filters and prevent premature breakthrough.

To provide pesticide removal the established process of ozone followed by ground granular carbon (GAC) was adopted. These have been sized to provide an empty bed contact time of 12 minutes with one adsorber out of service for carbon regeneration and one out for backwashing.

After the new treatment process the water flows into the existing site contact tank before being stored in the on-site treated water tank from where it is pumped into distribution.

Chemical dosing

The raw water's pH is corrected and then dosed with a coagulant to remove the turbidity and colour. From experience of treating the River Ouse water, aluminium sulphate has been found to be the most effective coagulant. This in conjunction with dosing sulphuric acid to provide the optimum pH of 6.7 has been found to be the most effective and value solution.

After the water flows through the DAF and rapid gravity filters, it is dosed with lime to achieve the required pH of 7.5 for distribution. Lime was selected from a detailed whole life costing over caustic which is also commonly used for pH correction.

The water flows from the new treatment process to the existing contact tank. Chlorine gas is currently dosed before the tank for disinfection. Although chlorine gas offers the lowest whole life cost, in order to minimise the business risks associated with on site storage of chlorine gas bulk sodium hypochlorite has been adopted to replace the chlorine gas.

Currently the chlorine residual of water leaving the contact tank is trimmed with sulphur dioxide before being dosed with ammonium sulphate for chloramination. This is prior to the treated water storage reservoir on the site. As a guard against taste and odour problems, Yorkshire Water wanted to retain the chloramination facility. The existing sulphur dioxide gas system is however to be replaced with sodium bisulphite dosing as part of the scheme.

The treated water is finally dosed with monosodium phosphate to protect against plumbosolvency.

Sludge treatment

Currently the washwater is thickened by a DWI thickener and then the sludge is dewatered by a filter press. The filter press is old and requires a high level of manning. As part of the scheme the DWI thickener is to be retained and the press is to be replaced by duty/standby centrifuges. New polymer make up and dosing systems are to be provided.

Solution summary

The proposed solution is outlined below:

- Construction of a new intake with a new passive intake fish screen and a raw water pumping station.
- Provision of raw water pre-settlement by utilising an existing subsiding reservoir.
- New dissolved air flotation (DAF) clarification stage.

- New dual media rapid gravity filtration (RGF) stage.
- New ozonation plant and granular activated carbon (GAC) adsorbers for pesticide removal.
- Reuse of existing contact tank.
- New chemical storage and dosing facilities including: sulphuric acid, Alum, lime, sodium hypochlorite, sodium bisulphite, MSP and polymer.
- Retain treated water storage and high lift pumping station (new pumps and motors).
- Retain existing wash water handling facilities.
- Provision of two new centrifuges for sludge dewatering.

Key design factors

A number of factors influenced the design. The main ones were:

- The level of the main plant building was set to allow the flow from the final stage of treatment to pass by gravity into the existing contact tank. This had the additional advantage that it limited the depth of the required excavation needed which in turn reduced the risk of interference with existing live services and problems from the high groundwater level. The building was 12m at its highest point. To reduce the visual impact of this, the roof profile was modified in collaboration with York City Planners to reduce its level where it was viable to do so.
- The ground conditions around the site are very poor resulting in the need for piling of the main plant building.
- The site is located adjacent to the East Coast Railway line. To minimise risk the main building was kept a minimum 15m away from the rail fence line. Piling calculations and lift plans were checked and approved by Network Rail.
- The site is located adjacent to the River Ouse. With the exception of a small area, the level of the site is below the 1 in 200 year flood event. Yorkshire Water have constructed a flood wall around the existing works to provide protection to this level of service. The new plant has been sited within this flood wall. Since the existing sludge area falls outside the flood wall, new buildings and plant in this area have been set above flood level.
- The new works is in the middle of an operational site, which must be kept live until the new works is commissioned.

Challenges and solutions

There have been a number of challenges experienced during construction of the works due to the complexity of the work and site conditions.

Existing services: The site is very old and the service records are very poor. Trenches were dug along the proposed routes of pipelines to locate services to allow them to be designed and minimise risk of damage.

Intake screen construction: The new intake screen is supported off piles in the river. This protrudes 3m out from the bank into the flow of the river. It is protected from large floating debris by piles spaced around the screen. Due to services and limited space in the river bank the intake pumping station has been constructed immediately inside the flood wall protecting the site.

To construct the intake screen a cofferdam was constructed in the river. A second cofferdam was also required to construct the intake pumping station, this cofferdam was approximately 11m x 7m x 7m deep. A short interconnecting pipe was required between these cofferdams. In order to overcome problems resulting from existing services in the river bank, groundwater ingress and maintain flood protection to the site, the interconnecting pipe was constructed by directional drilling.

Commissioning: To functionally commission the new works, water will be recycled from the outlet back to the pre-settlement tank in

DAF floc tanks – Courtesy of ETM

a loop. Once the new plant is working satisfactorily final water will be diverted into the existing roughing filters until the water quality is satisfactory and the plant reliable. By commissioning the new works in this way interference with existing plant is minimised.

Sludge works: The refurbishment of the sludge plant will be undertaken when the plant is live. This work has therefore been carefully phased to ensure the existing plant remains operational at all times.

Innovations

A key driver at every stage of the scheme has been to identify innovations to reduce capital cost of the project and to maximise capital efficiencies. Capital efficiency claimed on the scheme to date stand at £1.75 million. The following details some of the innovations adopted on the project.

Intake screen: A passive screen was used at the intake. This is made from 2mm stainless steel wedgewire. It is sized to limit the approach maximum velocity to 0.15m/s to protect elvers and lamprays. The screen incorporates an auto backflush with air to keep it clean. This was designed to protrude into the river flow to minimise the risk of sedimentation around it. It is protected by piles from debris and river craft.

Ozone generation: The ozone generating plant is the first of its kind to be installed in the United Kingdom. It has been supplied by Primozone, a Swedish based company. Ozone is generated by a new plasma based technology. This system has a number of benefits both in terms of lower CAPEX and OPEX compared to the conventional ozone generating systems and also due to its relatively simple modular design.

Contact tank: The chlorine contact tank was constructed in 1980 and there are no records of its condition. It is a single compartment reinforced concrete structure with a capacity of 3TCM. It is suspected that the contact tank will require remedial works to maintain its asset life.

To allow the contact tank to be taken out of service for an extended period for its repair it was proposed that a standby contact tank be constructed. The estimated cost of the tank was £710k. To provide a capital saving to YW, ETM have designed an alternative solution to a new tank. In this solution one compartment of the existing treated water storage tank can be used as an 'auxiliary contact tank'.

This is achieved by additional high level pipework between the two compartments of the tank and additional sample and chemical dosing points. Once the contact tank is refurbished the 'auxiliary contact tank' will return to service as a treated water tank. It would then only ever be used to provide chlorine contact when the existing contact tank is taken out of service for inspections.

Maximise use of existing assets: Existing assets were utilised where it was viable to refurbish or convert them and integrated into the new process rather than construct new. This included the existing site pre-settlement tank, conversion of a sand wash sump to a dirty wash water transfer sump and conversion of existing buildings for chemical storage and offices.

Status of contract and undertakings

The principle contractor/designers are ETM (AECOM/Galliford Try JV), the technical consultants are Arup and the commercial consultants are Turner & Townsend. At the time of writing (June 2012) the contract is approaching construction completion. The media is installed and electrical testing is ongoing with completion forecast at the end of September 2012.

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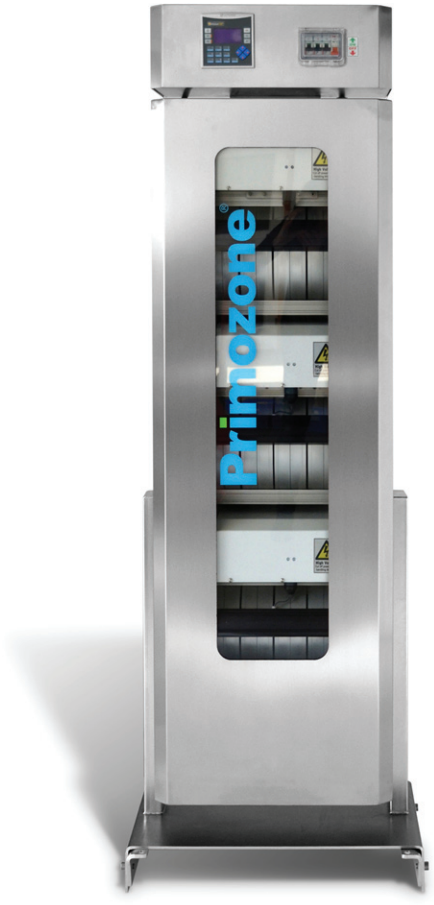

Photo showing the innovative, small footprint, ozone generating plant to be installed at Acomb Landing WTW – Courtesy of Primozone

Liquid oxygen storage tank for production of ozone – Courtesy of ETM

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