

# Wanlip STW - AMP4 Improvements

## £58m investment by Severn Trent Water

by  
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**W**anlip Sewage Treatment Works is one of Severn Trent's major sewage treatment facilities and treats domestic and industrial waste from inhabitants and factories in Leicester and satellite villages. The works covers some 40 hectares and serves an actual population of 500,000 and a design equivalent population up to 900,000. The works consists of two separate works, "Old" and "New" operating in parallel both of which discharge into the River Soar. Under dry weather conditions the treated sewage effluent discharge is equivalent to two thirds of the flow of the River Soar.



Wanlip STW: Aerial site photograph

*courtesy Biwater Treatment Ltd*

### Existing works - treatment process

Sewage arrives at the works from three sewers, the Brick 8 foot sewer, the Rothley Valley Trunk Sewer and the Abbey Tunnel Sewer.

The "Old Works, built in 1964, uses the activated sludge process for carbonaceous removal only. The concept was unusual in that the site was planned as an integrated sewage and household waste treatment facility. Over the following 12 years the plant was extended which included a nitrifying filter commissioned in 1975 to deal with a new ammonia consent. By 1987 more capacity was needed an approval was given to construct a parallel new works, using a nitrifying activated sludge plant. The "New Works" was commissioned in Autumn 1992.

The current design FFT is 310 MI/d and the current flow split is 30% to the "New Works" and 70% to the "Old Works".

### Existing works - energy recovery

Two CHP engines are used on site to convert excess biogas produced by the digesters into electricity and heat. The heat is used to maintain the digestion process. Wanlip can produce up to 5Mwh/d of

electricity from this renewable resource - more than is needed to run the works and the excess is sold to the National Grid.

### Existing works - conservation

Extensive flood plain grasslands bordering the river form part of the site and Severn Trent have created a conservation area supporting various species of flora and fauna.

### Wanlip STW - AMP4 improvements - a £58m investment

Under AMP4 Severn Trent are making significant investment in improvements to the Wanlip Sewage Treatment Works. This investment is being driven by:-

- \* a tightening discharge consent for ammonia to be applied by March 2010 in response to a Fisheries Directive;
- \* a new discharge consent limit for Phosphorus to be applied by December 2008 in response to the Urban Waste Water Treatment Directive;
- \* capital maintenance of existing assets based on risk scoring of operability and maintainability, as assessed by Severn Trent.

The planned investment at Wanlip is phased over the AMP4 period 2005 - 2010 to minimise disruption to the existing live operational assets and maintain the existing discharge consent. As a result of the planned conversion of the Activated Sludge Plants on the "Old" & "New" Works (Phase 5) part of the investment, to achieve Biological Nutrient Removal (BNR), both the above listed quality drivers will be achieved by December 2008.

### Project Description

#### Phase 1 - Capital Maintenance Works (Target Price £2.096m)

Wanlip's existing primary tank M & E assets on both the old and new Works present some operational and maintenance difficulties as each tank is tightly arranged with its neighbouring tank, existing side roads and storm storage facilities. A number of the assets are life expired. Consequently, capital maintenance activities have been undertaken which include replacing valves, pipework and primary de-sludging pumps in the "Old" Works Primary Tank Pipework Gallery. There have also been modifications to the de-scumming arrangements which has necessitated extensive alterations to the structures and provision of a new pumping station.

#### Phase 2 - Centrifuge Centrate Liquor Treatment Plant (Target Price £2.95m)

A dual stream Sequenced Batch Reactor (SBR) liquor treatment plant to treat 1500m<sup>3</sup>/d is required to remove 50% of the ammonia load from the sludge centrifuge centrate. This is to enable aeration lanes to be removed from service in both the "Old" and "New" works at the same time for conversion to BNR, whilst maintaining the existing discharge consent standard. The SBR plant consists of two 20.5m Dia x 7.3m high steel tanks fitted with fine bubble membrane diffusers and floating draw off mechanisms, aerated by duty/assist/standby blowers each rated at 3470m<sup>3</sup>/h. Caustic soda dosing is also provided for close pH control of the liquors, critical to treatment.

#### Phase 3 - Ferric Sulphate Chemical Dosing Plant (Target price £0.439m).

A Ferric Sulphate dosing system, comprising a Lintott Series 5 Dosing Rig, 120m<sup>3</sup> of Chemical Storage, 2No secondary contained dosing lines to the "New" Works inlet works and the "Old" works pre-interstage pump channel are provided. The dosing system is required to remove solids loading from the treatment process via the Primary Sludge from both existing works, again to enable aeration lanes to be removed from service in both the "Old" and "New" works at the same time for conversion to BNR, whilst maintaining works compliance.

The dosing point on the "New" Works Inlet Works is at the outlet of the existing flow measurement flume, a highly turbulent area, to achieve adequate mixing energy. The dosing point on the "Old" works incorporates a mixing system designed to achieve optimum mixing energy upon dosing.

#### Phase 4 - "Old Works" Final Settlement tank capacity (Target Price £7.196m)

As a result of the Phase 5 conversion to BNR at Wanlip the "Old" works sludge loading will increase to 3000mg/l MLSS, requiring an increase in the FST surface area from 5248 to 7947m<sup>2</sup>. This 51% increase in area is to be accommodated by the provision of 4NO. new 29.2m dia, 7.5° floor slope and 2.5m high sidewall, FST's. The new tanks will treat one third of the current 'Old' works flow and will return RAS at one third of the current RAS flow.

Flows collected from existing "Old" works aeration lanes outlet channels will be diverted into a new FST feed pumping station located between existing aeration lanes. The FST Feed pipework from the new pump station will cross over the existing FSTs at high level on pipe supports, allowing operatives to safely operate and

maintain existing equipment. Scum from the new FSTs is removed via 2No. diametrically opposed draw offs per tank and is directed to a new scum pumping station, comprising duty/standby submersible pumps. Scum from the new pump station is returned using the same high level support as the feed pipework, with scum flows going in the opposite direction to the FST feed pipes.

Return Activated Sludge (RAS) from the new FSTs gravitates to a new RAS pumping station comprising duty/assist/standby submersible pumps, pumping RAS to the head of the "Old" works ASP plant. The pump station capacity is 182 to 546 l/s. The RAS delivery main comprises a single 600mm dia pipe splitting into twin 450mm dia mains crossing over the existing FSTs again using the high level pipe supports holding the FST feed and scum return mains.

Final effluent from the 4 new FSTs gravitates via a new 1200mm diameter main to the existing "Old" works final effluent outlet chamber for discharging to the River Soar. The 4 new FSTs have been built at a level that ensures flow can discharge under gravity to the River even in flood conditions.

As part of Phase 4, protection of the existing "Old" works 16 No. FSTs is provided, as these tanks are lower than the current 1:100 year River Soar flood levels and hence flooding was a real risk. New actuated penstocks, pipework and a new Final Effluent PS have been provided to ensure the existing FSTs can also discharge to the river under all flow conditions. The new Final Effluent Pumping Station comprises duty/assist/standby canister pumps capable of lifting 1675l/s maximum to a higher level to be able to gravitate to the river.

The existing "Old" works RAS pumping station is also to be refurbished under Phase 4. The "Old" RAS PS will have a capacity of 364 to 1092 l/s. The work comprises removal of the pump station superstructure, replacement of the 4No. RAS pumps with 3No. new pumps operating duty/assist/standby, each rated at 182 to 546 l/s, and a new MCC located in a new and separate adjacent kiosk. A new washwater pumping station will also be constructed drawing Final Effluent from the common outlet chamber through a 2mm band screen into a wet well. Three dry well pumps, each rated at 50l/s @ 5 bar, draw from the wet well and feed the existing works, and the new FST wash water mains via a new section of pipework.

#### Phase 5 - Conversion of "Old" & "New" Works Activated Sludge Plants to achieve Biological Nutrient Removal (Target Price £20.5m.)

In response to the requirement for compliance with the Urban Wastewater Treatment Directive and the Fisheries Directive it is planned to convert Wanlip's "Old" & "New" Works Activated Sludge Plants (ASP's) to achieve Biological Nutrient Removal (Removal of Phosphorus & Ammonia).

Prior to the conversion of the two main "Old" and "New" works ASP's there is a requirement to convert two existing flow balancing tanks, each 55m long x 17m wide x 3.8m deep, a total volume of 7120m<sup>3</sup> in the Old works to BNR aeration lanes. In conjunction with Phase 2 & 3, this will allow the existing "Old" Works, 16No. aeration lanes to be taken out of service in blocks of four in order to meet the consent date. It also avoids the need to work on live electrical assets, as the aeration lanes are arranged in blocks of four, and controlled by dedicated Motor Control Centres.

The Balance Tanks will treat 12% of the "Old" Works element of the Flow to Full Treatment.

The conversion of the Balance tanks involves construction of baffle walls within the existing tank civil structure to create the zones necessary for BNR aeration. These include 2 anaerobic zones, 2 anoxic zones and 4 aerobic zones. A new Feed Pumping Station to

achieve the correct flow split between the balance tanks and the existing 16 lanes is being provided, with two pumps, one dedicated to each balance tanks installed within the station. As part of the BNR conversion of the Balance tanks Recycle Pumps are to be fitted within the tanks, recycling flows at a maximum duty of 122l/s, from the anoxic zones to the anaerobic zones for mixing with the Return Activated Sludge and feed flows. The pumps are of the submersible type and utilise submerged pipework to return the flows.

RAS Booster Pumps are also being provided to return activated sludge into the balance tanks in the correct proportion compared to the existing "Old" works 16 lanes. The RAS Booster pumps will draw from the RAS returns from the "Old" Works upstream of the discharge point at the head of the existing 16 lanes.

BNR conversion of the "Old" Works existing 16 lanes again involves anaerobic, anoxic and aerobic zones, however as the existing lanes are configured with pockets for carbonaceous surface aeration, most of the baffle walls exist with the exception of creating an additional pocket by sub-dividing one of the existing 9 pockets per lane to leave a total of 10 pockets in each lane.

The aerobic zone element of the "Old" works BNR conversion of the existing 16 lanes involves the redistribution of the surface aeration taper within the lanes. The conversion also involves raising the outlet weir levels within the existing civil structures by 200mm to create the required total treatment volume of 53,000m<sup>3</sup>.

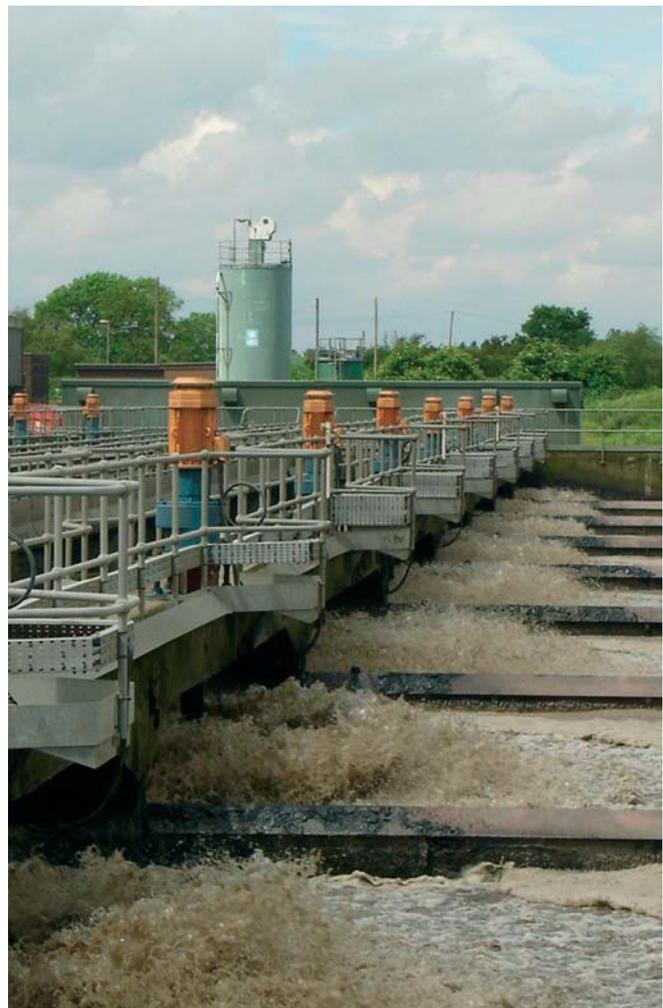
Once converted each of the 16 lanes will contain 2 anaerobic zones, 2 anoxic zones, and 6 aerobic zones. The surface aeration units to be fitted within zones 4,5 & 6 of each lane are existing units that will be removed and re-positioned from the existing surface aeration system. The surface aeration units in zones 1 - 3 are new. A 2.5kW submersible recycling pump will be provided for each of the 16 lanes again recycling flows at a maximum duty of 122 l/s, from the anoxic zones to the anaerobic zones for mixing with the Return Activated Sludge and feed flows.

Four New Motor Control Centres, one serving each block of four lanes are being provided along with 2 x 1500KVA sub-stations to allow power to be taken from the existing on-site HV ring main and be distributed to the BNR aeration systems on each lane. Close dissolved oxygen control within the existing 16 lanes is also being provided to again optimise energy usage.

The "New" Works conversion involves the construction of a new 6200m<sup>3</sup> fifth aeration lane, to be configured for BNR and conversion to BNR of 4No. existing lanes, each 6200m<sup>3</sup>. The existing "New" works is a "Hybrid" type aeration plant comprising an anoxic zone then two aerobic zones, the first using high speed surface aeration, the second using fine bubble diffused air technology. The programming and sequencing of the conversion of the "New" Works aeration lanes requires the new fifth lane to be constructed and commissioned in parallel to converting 2 of the remaining four existing lanes one at a time. Once the new fifth lane is completed and the two existing lanes are converted, the remaining two lanes can be removed from service together for conversion.

The conversion of the "New" Works involves construction of baffle walls within the existing tank civil structure to create the zones necessary for BNR aeration. Once converted, each of the 5 lanes will contain 3 anaerobic zones, 3 anoxic zones and 2 aerobic zones.

The first aerobic zone will be fitted with a **75kW Variable Speed High Speed type Biwater Surface Aerator**. The second aerobic will contain fine bubble diffused air technology comprising membrane diffusers capable of transferring 22,541m<sup>3</sup>/hr of air efficiently to the sewage, supplied by 4 (3 duty/1standby) high speed centrifugal type



Existing "Old" Works Aeration System, One of the 16 lanes

blowers, each rated to deliver 7,514m<sup>3</sup>/hr against a pressure of 620mbar.

A submersible recycle pump will be provided within each of the 5 lanes again recycling flows at a maximum duty of 210 l/s, from the anoxic zones to the anaerobic zones for mixing with the Return Activates Sludge and feed flows. In addition to the aeration equipment, provision of two new RAS pumps of the borehole type, complete with variable speed motors, rated to deliver up to 782 l/s will be installed within an existing screw pump station wet well. This will involve modifications within the existing structure to accommodate the RAS pumps.

Additional modifications to the existing RAS draw off system from the existing 8 final settlement tanks on the "New" works are also included within this phase of work to facilitate a finer control system as required by the BNR process. This involves actuation and flow balancing of the existing draw off and return mechanisms

### Future work

**There are a number of additional phases of work planned for the last two years of AMP4 and these phases are currently in the feasibility stage. This work includes the refurbishment of the Inlet Works, replacement of Old Works PST Scrapers, improvements to the sludge treatment route, odour control and Safety improvements. ■**

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