

Cotton Valley STW

innovative refurbishment

by
Brian Hughes

Anglian Water's Cotton Valley treatment works is located adjacent to Junction 13 of the M1 motorway at Milton Keynes. This sewage works has been in operation since 1974 when Phase 1 of the works was commissioned and with subsequent expansion now provides treatment capacity for a population of 304,000. The works has a common inlet works providing screening and grit removal facilities, followed by 3 parallel treatment Phases. Each Phase comprises 4 rectangular primary treatment tanks, 4 aeration lanes and 8 final settlement tanks. The last Phase of the works, Phase 3, became operational in 1993.



Cotton Valley: Phase 1 - Final settlement tanks

courtesy Anglian Water Services Ltd

A mandate to cater for maintenance and growth at the works was issued by Anglian Water in July 2005, early in the AMP4 programme requiring completion by March 2009. This mandate was issued to maintain compliance from increased population within the catchment area, and increased load arising from a new enhanced digestion plant being constructed at Cotton Valley.

Aker Solutions E & C Ltd, working in joint venture with Skanska Construction UK Ltd., are one of the @one Alliance partners delivering AMP4 Capital Programme for Anglian Water.

The JV was ideally positioned to undertake the mandate having worked closely with Anglian Water as a Framework Partner throughout the AMP3 programme developing engineered solutions for Cotton Valley.

The project focus throughout all Phases of work has been on:

- * Ensuring that Cotton Valley consent compliance is maintained during the refurbishment.
- * Minimising whole life cost utilising Anglian Water and @one Alliance's Risk and Value Management process.

- * Providing energy efficient solutions;
- * Ensuring Health & Safety compliance.

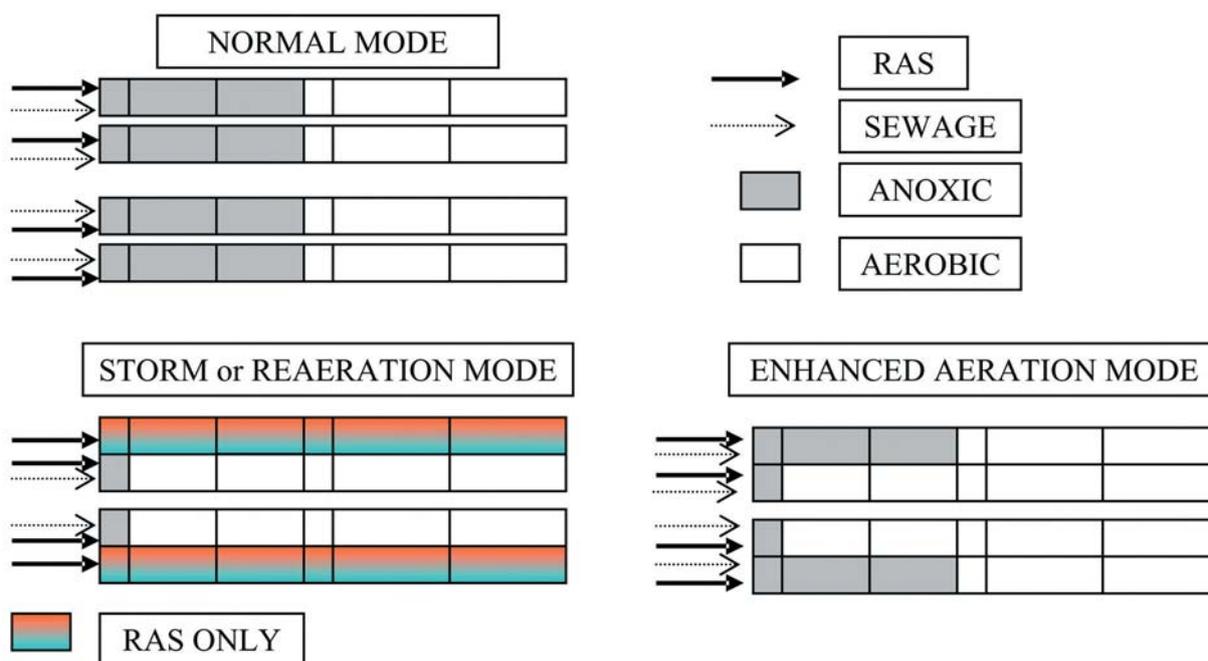
Mandate

The mandate divided the overall scope into 4 projects:

- * Project 1 - Preliminary Works and Screens.
- * Project 2 - Phase 1 Re-commissioning.
- * Project 3 - Phase 2 Refurbishment.
- * Project 4 - Phase 3 Refurbishment.

The mandate was generally non-prescriptive in detailed technical requirements for the plant refurbishment. In order to determine the optimum solution for each project, the Intervention Planning and Delivery Process which had been developed by the @one Alliance and Anglian Water was utilised.

This process is a systematic and logical progression through the various phases of the project lifecycle and employs intervention gateways at key junctures to measure and quantify the Risk and Value of Planned Works. The process requires direct involvement by the plant operations representatives and provides a platform for them to



Re-aeration showing aeration lanes in Phase

courtesy Anglian Water Services Ltd

influence the choice of the final engineered solution.

Project 1 and 2

At the time of mandate issue Phase 1 of the Cotton Valley works had been decommissioned. Data captured during a process audit determined that all Phases (1-3) of the plant would be needed to provide treatment capacity for the required design horizon consent conditions.

The intervention process concluded that Projects 1 and 2 would require the following main activities:

- * Refurbishment of the Air Compressor plant;
- * Replacement of inlet screens and new dewatering plant;
- * Conversion of non-functioning primary tanks to provide storm capacity;
- * Replacement of air diffusion piping, laterals and diffusers in 4 aeration lanes;
- * Replacement of 8 final settlement tank scraper mechanisms;
- * Penstock replacement throughout the plant;
- * Replacement and extension to plant control panels;
- * SCADA and control system.

Cotton Valley STW is served by a common air compressor plant with 4 no 523kW HV centrifugal guide vane compressors providing process air to all three Phases of the works. Continuity of air supply is critical to sustaining the activated sludge process to maintain works compliance. Whilst blowers were taken off-line for mechanical refurbishment, 24 floating surface aerators, powered by 8 diesel powered 150 KVA generators were installed to mitigate the risk of process failure.

The blowers were removed one at a time, refurbished and then returned to site. After re-installation the refurbished blower underwent a run-time test prior to removal of the next unit for refurbishment.

The common inlet works had three 19mm bar screens. These were removed sequentially under Project 1 and replaced with EIMCO 6mm band screens along with two new Huber Washpress screening handling/washing plants.

Process vessels - primary tanks, aeration basins and settlement tanks were drained and cleaned out for inspection and essential repair works. These tanks were found to be in good condition and only minor civil engineering repairs were necessary. Wholesale resealing of construction and expansion joints was carried out.

Four primary tanks fitted with travelling bridge scrapers were converted for use as storm tanks. This involved modification to the penstock controls and fitting submersible venturi jet flushing pumps.

The original ceramic air diffuser system in the aeration basins, along with major sections of air header piping and valving were isolated, removed and disposed off site. A subcontract was awarded to Brightwater to design, supply, install and commission new in-tank aeration systems. Installation work was carried out in the basins whilst civil engineering repair/sealing works and penstock removal/replacement was carried out by other sub-contractors. Submersible anoxic mixers - 2 per lane were installed as part of the design of the aeration system.

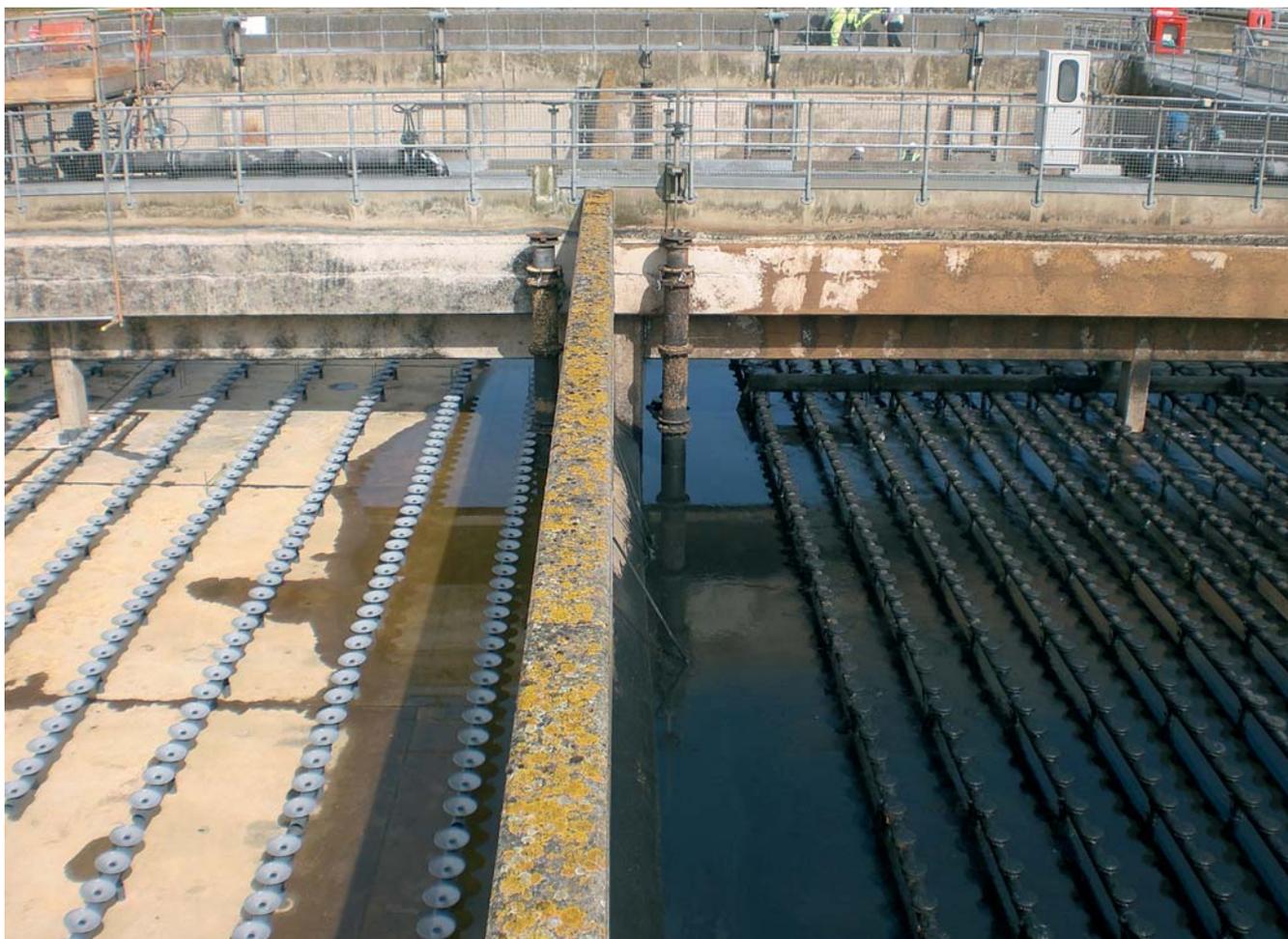
Cotton Valley has strict environmental discharge consents for TSS, BOD, ammonia, nitrogen, phosphorus and iron, as shown below.

The plant upgrade was specifically to achieve the following:

- * Fully Treat FFT of 2,700 l/sec;
- * Meet the ammonia limit of 5 mg/l;
- * Meet the total N limit (Avg. Removal > 72%);
- * Reduce the air demand and hence power consumption;
- * To treat the increase of loads brought about by growth in the catchment.

Aker Solutions process engineers utilised a process called re-aeration in order to achieve these tight environmental objectives without a major and costly plant expansion. Re-aeration ensures that during periods of high flow the FST's do not become hydraulically overloaded, thereby protecting the TSS, BOD and total N and P consent.

The principles of re-aeration is to limit sewage flow to two from four lanes in each of the phases during a storm event - the other two lanes becoming RAS-only lanes.



Aeration Basins 12-11

courtesy of Anglian Water Services Ltd

Effectively re-aeration temporarily reduces the biomass concentration (MLSS) going to the FSTs and hence increases their effective hydraulic capacity. The main factor responsible for poor ammonia removal was the lack of oxygen transferred during the warmer summer months. As the wastewater temperature rises in summer the amount of oxygen that can be dissolved reduces (Henry's Law) and consequently the rate of oxygen transfer will decrease. This has been improved by making more air available by improving air blower availability, reducing the air demand by allowing one third of the flow to be treated in Phase 1 aeration lanes fitted with the efficient Brightwater diffusers, and by fitting additional diffusers to Phase 1 to permit enhanced aeration during particularly warm periods.

The original rotating bridge scraper mechanisms were replaced with new fixed half bridges with full rotating scraper arms.

This element of the project was subcontracted to another Alliance partner Biwater who had a proprietary design for the equipment.

Wholesale replacement and modification to access and handrailing was carried out for Project 1 and 2 to ensure compliance with current legislation.

Works commenced on site in July 2006 and Project 1 and 2 were commissioned in December 2007 ready to receive additional liquors generated from the new enhanced sludge digestion process being constructed in parallel on the site.

Project 3 & 4

Project 1 and 2 had been executed with the project team members located in various offices. Design was carried out remotely from the Aker Solutions offices in Stockton, with particular disciplines resident in Anglian Water's offices in Peterborough. Support services

such as planning, drafting, document control and financial management were similarly remotely located and were shared with other projects being executed for Anglian Water.

The project execution strategy for Projects 3 and 4 - refurbishment of Phases 2 and 3, provided the opportunity to re-evaluate execution strategy for the remainder of the project.

A new dedicated project office was established to co-locate the project team on site directly adjacent to Phases 2 and 3 of the works. Core members of the team were replaced and disciplines were supported with additional dedicated resources. This approach provided a new outlook and fresh perspective upon the project.

At this juncture, Phase 1 was operational and its output and impact on the whole of the works could be measured and established. The original design concepts agreed through the Intervention Planning and Delivery Process for Phase 2 and 3 were revisited and significant savings were found by de-scoping non-process critical activities from the remaining works.

A review of the process design based on operational performance achieved from projects 1 and 2 culminated in scope reduction with associated cost savings. Reduction in anoxic zone requirements for Phases 2 and 3 eliminated the need for 16 additional anoxic zone mixers and also eliminated the need for temporary control panels and a major site power upgrade. The project team undertook a detailed scoping exercise and condition survey of the Phase 2 and 3 assets. This concluded that wholesale replacement of equipment was not necessary - particularly within the electrical scope of works. The condition survey of the vessels found that civil repairs and joint sealing was non essential and could be eliminated from the original scope of works.

The de-scoped works for Phases 2 and 3 included the following main activities:

- * Refurbishment of 4 primary tanks - 2 per phase.
- * Replacement of air diffusion piping, laterals and diffusers in 8 aeration lanes.
- * Refurbishment of 16 final settlement tank scrapers mechanisms.
- * Actuator refurbishment throughout the Phases.
- * Extension to existing plant control panels.
- * New sludge ram pumps.

CONCLUSION

Progress to date

Phase 1 of the Cotton Valley works is operational and providing compliant treatment to 26% of the incoming flows and return liquors. Phase 2 and 3 refurbishment works are being carried out in a phased manner to ensure minimum impact to the works treatment capacity and are on target for completion to provide the mandated output in March 2009.

Lessons Learned

Refurbishment work on a live plant is never easy, particularly when the works is operating at the limit of its capacity. Working within the environment necessitates a close working relationship between the contractor and the operator and can only be successful if there is an understanding and appreciation of the needs of each other.

Flexibility in the refurbishment programming, reciprocated by flexibility in plant operation to allow vessel possession has promoted a strong collaborative working relationship between the project team and the operations team which has been key to the success of the project.

Change normally meets resistance but sometimes is necessary. Prior to commencing Phase 2 and 3 the decision to collocate the project team at the coal face proved to be crucial to the outcome of the project.

Phases 3 and 2 required the project team to adopt a more clinical approach, being more conscious of Anglian Water's business drivers and to demonstrate open mindedness, willingness to change and a clarity of vision to determine the best value for money solution to the problem.

The approach used by the @one Alliance to perform this project has allowed innovation to continually drive costs down to meet tight budgetary constraints, whilst still delivering a product with an acceptable risk profile for the Anglian Water.

Note: *The Editor & Publishers wish to thank Brian Hughes, Project Manager, Aker Solutions E & C Ltd, for producing the above article for publication.* ■



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