Wing Water Supply Programme
for growth in South & East Midlands

by
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Anglian Water's £116m Wing Water Supply Programme has recently been completed to meet forecast demand growth in the South and East Midlands. Central to the scheme is Rutland Water, which was completed in 1976 with spare capacity for future expansion. The scheme has successfully increased the deployable output from Rutland Water by 90MLD. Water from Rutland Water is drawn off at the Raw Water Pumping Station which serves the existing Wing Water Treatment Works 8km away, and which has a deployable output of 220MLD. From Wing about half the treated water flows by gravity to Peterborough and the remainder is pumped 15km to Beanfield Reservoir near Corby. A further pumping station at Beanfield transfers part of the inflow another 19km to Hannington Reservoir in Northampton serving the southern part of the supply zone.

Morcott Water Treatment Works under construction *Courtesy of Galliford Try Imtech*

The current scheme has provided a new pumping station with a dedicated raw water main to the new 90MLD Morcott WTW, which is adjacent to the existing Wing plant. Major upgrades to the pumping stations at Wing and Beanfield, together with the construction of a new treated water pipeline, allow the additional output to be transferred to Beanfield and on to Hannington.

Rutland Water is an internationally recognised site for a number of migrating wildfowl species, including Gadwall and Shoveler, not to mention several breeding pairs of Osprey. In order to mitigate the potential impact on wildlife of increased abstraction the project is constructing 84 hectares of shallow water lagoons at the western end of the reservoir.

Mott MacDonald provided programme management, technical and environmental support to Anglian Water for this project. GTM (Galliford Try/Imtech Joint Venture) completed the design and construction of the new treatment works and pumping stations, JN Bentley laid the transfer pipelines and Carillion took responsibility for the new lagoons.

Sir David Attenborough and Peter Simpson, AWS Chief Operating Officer, cut the first turf on the Wing Project in 2008 *Courtesy of Anglian Water*

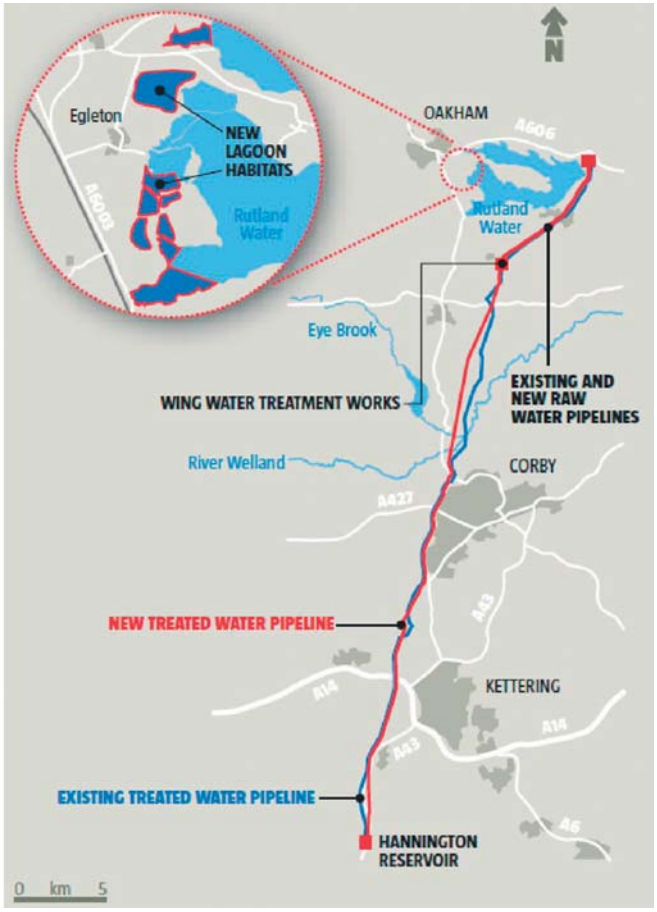


Figure 1 Wing Water Supply Scheme

The Wing Programme

Wing is part of an integrated supply system, known as "Ruthamford" within Anglian Water, which includes Rutland Water, Grafham Water and Pitsford reservoir. Forecasts made during the late 1990s and early 2000s predicted that there would be major development growth within the supply zone; half a million new homes are expected to be built over the next 15 to 20 years, with a consequent increase in demand. The anticipated growth was defined in regional development plans issued by the Office of the Deputy Prime Minister.

Anglian Water is able to meet this growth in demand by increasing abstraction from Rutland Water up to the amount permitted under the original licence. To ensure an adequate and resilient water supply to the Ruthamford zone up to the year 2030, with sufficient headroom, Anglian Water included the Wing Programme in its AMP4 business plan. The fact that the Wing/Morcott site is the furthest treatment works from the main demand areas within the zone means that it is a "swing" source; in other words its full capacity is utilised only when closer sources are approaching maximum output. Hence the ratio of peak output to base output is much higher than might otherwise be expected. This had a significant bearing on the choice of process for the new works in terms of plant turn-down ratio and the need to ramp up rapidly.

Early work on the scheme was carried out by Anglian Water prior to the start of the AMP4 period and included the compilation of an initial Environmental Statement to support the planning application to Rutland County Council for the treatment works. Negotiation of the planning approval took place over a number of years and culminated in the inclusion of the new lagoons as well as other amenity enhancements at Rutland Water.

Detailed habitat and protected species surveys were carried out by Mott MacDonald in 2005/6 as part of the preparation of detailed Environmental Statements for the separate planning applications for the pipeline and for the lagoons.

Construction firms were invited to prequalify for the programme in autumn 2006. An extensive assessment process followed, during which the bidder's commitment to the environment, health and safety and to collaborative working were subject to rigorous evaluation. The three successful construction partners joined the programme in June 2007 which allowed for a period of six months during which they had the opportunity to get thoroughly immersed in the details of the scheme before entering the final negotiations of target price.

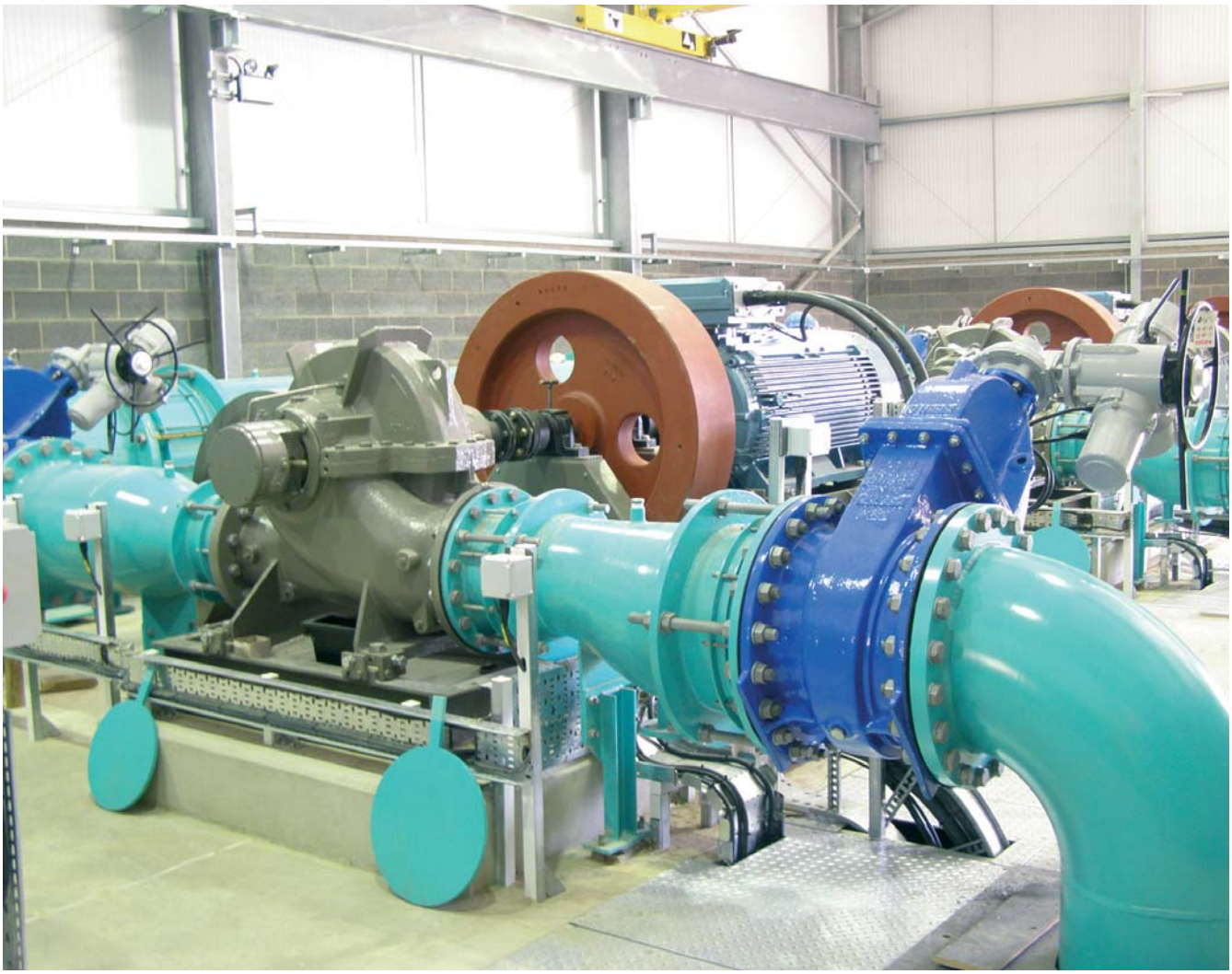
Unsurprisingly the initial cost estimates prepared for each component were above what had been allowed for in the programme budget by Anglian Water. Challenging the scope defined by the outline design helped to bring the cost down to within range of the budget but the final savings were won through all of the partners and client coming together and agreeing to share risk.

Even before these tough negotiations were complete, sufficient trust had been generated to allow construction to begin during the closing months of 2007.

Raw Water Pumping Station

The new Raw Water Pumping Station is situated at the eastern end of Rutland Water, adjacent to the original station. Eight hundred metres of new suction main had to be constructed within an existing tunnel to connect into the southern draw off tower.

The pumping station consists of four horizontally mounted pumps to be operated as three duty and one standby unit. Each 500kW pump/motor unit is capable of delivering 37MLD against a delivery head of up to 78m. Power supply to the Empingham site was reinforced by 1.5MVA from the local substation. Standby generator capacity has also been provided which allows the station to be operated in the event of a power outage, but can also be used for peak



Flywheel Pump at the Raw Water Pumping Station (safety guards removed) *Courtesy of Galliford Try Imtech*

lopping during triad periods (periods when the power supplier offers an incentive to reduce consumption) resulting in significant cost savings to Anglian Water, and ultimately its customers.

The limited area available at the site drove the project team to seek alternatives to a conventional surge vessel arrangement, which was required to control pressure transients on the discharge main. The pumps are instead fitted with flywheels which not only gave a major saving on construction cost but avoided the need to spend £100k on surge vessels.

Morcott Water Treatment Works

Although the new Morcott Water Treatment Works is adjacent to the original Wing Water Treatment Works it operates as a completely separate plant. A conscious decision was made during the project development phase that only a stand alone plant would be able to provide the resilience required by Anglian Water.

Operational experience gained by Anglian Water on the Wing works allowed the process for the new plant to be selected with confidence. However, by adopting dissolved air flotation (DAF) instead of upward flow clarifiers an additional dimension of resilience is available in the event that extreme raw water conditions make either process temporarily less suitable. The inclusion of DAF clarifiers also allows the plant to meet the demanding turn-down ratio and ramp up criteria required of a "swing" source.

In brief the treatment process includes the following stages:

- Primary Ozonation;
- Flocculation;
- DAF Clarifiers;
- Rapid Gravity Sand Filters;
- Secondary Ozonation;
- Rapid Gravity Granulated Activated Carbon (GAC) Filters;
- Disinfection;
- Treated Water Storage.

Sludge from the clarifiers and dirty filter washwater are thickened in lamella separators and passed to the filter presses on the original works, which have been refurbished and fitted with additional capacity. Supernatant is normally returned to the head of the works.

Foundation design of the treatment works structure required geotechnical ingenuity. The site is adjacent to a unique geological feature (warranting Site of Special Scientific Interest status) consisting of an extensive glacial depression filled with soft,

Wing to Beanfield Pipeline *Courtesy of N Evison/Anglian Water*

A processing bucket breaking up the soil being used to backfill around the pipe *Courtesy of JN Bentley*

inconsistent sediments. Additional piling was needed next to the SSSI feature whilst in other parts of the site the softer clays were overlain by a thin hard crust of ironstone. The foundation design in these parts required the piling contractor to auger oversize holes through the ironstone, backfill the augered holes and then complete a conventional CFA pile through each hole.

Wing and Beanfield Pumping Stations

One of the more complex decisions made when defining the project scope was whether to construct a new stand alone pumping station at Morcott or whether to exploit the provision for future expansion that had been designed into the original Wing pumping station. Considerations of operational flexibility, affordability, construction risk and long term resilience were reviewed by the project team and operational staff. The process for making these complex decisions has been formalised by Anglian Water into their Risk and Value Intervention (R&VI) procedure, which ensures both the buy in of all affected internal stakeholders and that a rational solution is adopted.

By following the R&VI procedure it was demonstrated that the flexibility offered by making use of the existing pumping station building outweighed the resilience benefits of constructing a stand alone installation.

Two additional pump units have therefore been provided at Wing, bringing the total to six. Both of the 750kW pump/motor units are capable of delivering 65MLD against a delivery head of up to 45m. Standby capacity is provided by the original pump units.

Prior to this project, Anglian Water was unable to make full use of the service reservoir capacities at Beanfield because of poor suction performance of the existing pumps. The original pumps have therefore been replaced with four new pumps (three duty, one standby) with improved suction characteristics. Each of the new 355kW pump units is capable of delivering 70MLD against a delivery head of up to 38m.

Another major enhancement at Beanfield has been realised through modifications to the reservoir inlet pipework and to the overall control system for the pumping stations. It is now possible to pump directly from Wing to Hannington, effectively bypassing Beanfield Reservoirs, meaning that there is much lower risk of supply interruption when one of the reservoirs is taken out of service.

Rutland to Hannington Pipeline

The pipeline component of the project consists of three elements:

- Rutland to Wing: 8km of Raw Water Pipeline, 1000mm diameter ductile iron;
- Wing to Beanfield: 15km of Treated Water Pipeline, 1000mm diameter ductile iron;
- Beanfield to Hannington: 19km of Treated Water Pipeline, 900mm diameter ductile iron.

The pipeline diameters were selected following hydraulic modelling of a large number of options which were narrowed down through the R&VI process to provide the optimum balance of whole life cost, operational flexibility and resilience.

Early involvement of environmental and archaeological specialists ensured that the pipeline route could be adjusted to avoid known “hotspots” wherever possible. Where it was not possible to avoid sensitive areas, the project team was able to engage with landowners, interest groups and regulatory authorities to minimise impacts and to agree mitigation actions. The project team has been careful to maintain good relations with the 116 landowners along the route, making sure that they are kept informed about how the project will affect them and gaining valuable early feedback on any issues as they arise.

During construction, there was continuous interaction between environmental and archaeological staff and the construction teams to ensure that all pre-construction requirements were completed without delaying the work. JN Bentley assigned five pipelaying teams to the project who were deployed as sections of the route became available following the harvest of different crops and completion of the environmental and archaeological enabling works.

For four of the major road crossings and for one of the rail crossings the pipe was installed within a pipejacked sleeve to avoid disruption. Similarly, in two locations the new pipe had to cross the original pipeline where it had been constructed using pre-stressed concrete pipes. Because of the criticality of the pipe for supplying customers, these crossings were also made using pipejacking rather than open cut excavation.

On a second rail crossing the new pipe was installed by excavating a trench within an existing underbridge. The configuration of the underbridge was such that even with extensive propping, Network Rail required continuous movement monitoring using an automated total station. Beneath the A14 trunk road, an existing duplicate pipe was re-used following a detailed condition survey using ultrasound and magnetic flux leakage methods, and refurbishment of the internal epoxy coating to extend its life.

Following pressure testing, each section of pipe was swabbed to a temporary lagoon. The three lagoons were constructed near to the mid point of each section to catch the full volume of swabbing discharge from each end prior to gradual release into a local watercourse. For the treated water pipelines, disinfection water was dechlorinated before being captured in the lagoons to eliminate any risk of environmental impact.

Rutland Water Habitats

The project team worked in close cooperation with the Leicestershire and Rutland Wildlife Trust, who manage the Rutland Water nature reserve, to design and create the new shallow water habitats for migrating wildfowl at the western end of the reservoir.

Over the years, Rutland Water has not only become an important site for the birds themselves but for a large number of birdwatching enthusiasts as well, so the project team was active in liaising with the public as well as completing a prominent environmental improvement scheme.

Two types of lagoon have been constructed, termed “marine” and “terrestrial”. The “marine” lagoons have been created by isolating bays within the reservoir using sheet piles buttressed with rock armour. These lagoons fill naturally and are designed to retain water as the general reservoir level falls. The “terrestrial” lagoons have been created on what was previously agricultural land at the margins of the reservoir. These lagoons have a pumped supply from the reservoir which enables the Wildlife Trust to manage the seasonal water level.

As with the pipeline, the terrestrial lagoons required clearance by the archaeologists before construction work could begin. Their investigations revealed a ruined roman shrine which has been reconstructed on a new site where it can be viewed by members of the public.

Collaboration

With a project as diverse and openly defined as Wing it was clear from the beginning that a disciplined approach to development of the scheme would be required. Anglian Water addressed this by designing a systematic asset creation process (ACP). The ACP imposed clearly defined gateway points throughout the feasibility, design and construction stages of the project. Each gateway was preceded by a Risk and Value Intervention which ensured that all of the internal stakeholders were satisfied with the solution adopted, that the solution had a clear rationale and that it addressed the requirements of the original brief. The combination of gateways and R&VIs encouraged constructive challenge at the right time and at the right level, and then gave confidence to the project team that the scope was not susceptible to change.

Constructing a "marine" lagoon in Rutland Water *Courtesy of Carillion*

Implementation of this scheme has demanded a high degree of cooperation between all of the project partners. The collaborative spirit of the project was engendered by Anglian Water as the promoter but enthusiastically embraced by the other project partners. Whilst there was no contractual cross-linking between any of the partners, other than with Anglian Water, they were brought closer together by a commercial model which spread some of the risk to the other partners and hence encouraged a combined approach. The NEC contract forms proved to be an ideal platform to support this collaborative arrangement.

One of the many ways in which collaboration has paid dividends is in safety management. Each of the partners is able to contribute to the project safety forum and to disseminate the lessons shared. Safety inspections are carried out across the projects to ensure that uniform standards are upheld and there are regular Stand Down days to reinforce safety awareness and knowledge throughout the workforce.

Conclusion

The Wing Programme has delivered a state of the art extension to Anglian Water's asset base. Whilst the additional 90MLD of deployable treated water output to the Ruthamford zone will ensure that growth in demand is satisfied well into the future, the benefits offered by the new facilities are already being exploited. The scheme provides resilience where there was none before, resulting in an immediate increase in the security of supply index. However, the new assets also provide flexibility, making planned maintenance easier, and efficiency, because current rates of flow can be transferred using modern, energy efficient pumps through twin pipelines.

By adopting a straightforward, responsible and pro-active approach, positive relations have been built with landowners, regulatory authorities and parish councils throughout the project, resulting in an exceptionally low level of complaints and excellent compliance with regulators' requirements.

The partners (Anglian Water, GTM, JN Bentley, Carillion and Mott MacDonald) in the Wing Programme are proud of what has been accomplished over the last three years, and having proved what can be achieved by working together, are looking forward to using their combined strength to meet the challenges of AMP5.

Note: ***The Editor & Publishers thank Quentin Rea, Principal Water Engineer with Mott MacDonald, for preparing the above article for publication.***■

Sunrise over one of the newly created lagoons at Rutland Water *Courtesy of Carillion*

Aerial view of one of the newly created lagoons at Rutland Water *Courtesy of Carillion*