Royal Oak WTW - Southport DMZ Phase 1

the construction of a new water treatment works to serve the town of Southport and surrounding areas

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The Southport Demand Monitoring Zone (DMZ) consists of ten supply zones with a total population around 245,000. Southport DMZ covers the majority of the areas of the District Councils of West Lancashire and Sefton. Most of the population is located within the coastal towns of Southport, Formby and Ainsdale together with the inland towns of Maghull, Ormskirk and Skelmersdale. The remainder of the area contains the rural communities of West Lancashire. There are five direct filtration water treatment works within the DMZ (Bickerstaffe, Blundell House, Mill Brow, Springfield, and Dark Lane) with typical outputs of 5MLD. The three principal water supplies for the Southport DMZ are: (i) Skelmersdale and Maghull, supplied by River Dee water off the Liverpool North Trunk Mains, (ii) Southport, Formby, Ainsdale, Tarleton and Birkdale, supplied by River Dee water blended with local groundwater sources (Bickerstaffe, Blundell House, Mill Brow and Springfield) at Gorse Hill SR, and (iii) Ormskirk, supplied by Dark Lane groundwater with additional Rive Dee water as required.

Aerial View of new Royal Oak WTW - Courtesy of United Utilities & KMI

Major issues

Southport DMZ faces a number of major issues:

- ***Peak Demand***: Summer months (from May onwards) see a dramatic increase in demand due to both tourism and the market garden industry prevalent in the area. This demand can increase from 60MLD to 100MLD placing stress upon the current infrastructure and storage. In the future this could cause low pressure issues for people in the area.
- ***Growth***: The Liverpool North Trunk Mains carry water to both north Liverpool and supply 65% of the water to Southport. The last ten years have seen much expansion in both of these areas that has resulted in an extra demand of 9MLD since 2000. This is now presenting itself as decreased pressure in the north Liverpool area at peak times
- ***Water Quality***: The five water treatment sites within the DMZ have a range of operational and water quality problems - typically increased turbidity due to the age of the filters and increased solvents in the raw water.

Solution strategy

The solution strategy consists of the construction of a new water treatment works with a capacity of 54MLD at Royal Oak on a green field site immediately adjacent to the existing Bickerstaffe WTW.


Lime stabilisation - Courtesy of United Utilities & KMI


Rapid gravity filter construction September 2012
Courtesy of United Utilities & KMI


Rapid gravity filter construction November 2012
Courtesy of United Utilities & KMI


Control building & lamella - Courtesy of United Utilities & KMI

The solution also involves the construction of new boreholes and the re-commissioning of existing boreholes to provide raw water for the new water treatment works. Because of financial constraints the strategy will be phased over two AMP periods.

The AMP 5 project currently in progress consists of the construction of a new WTW at Royal Oak with a treated water output of 13MLD. At the same time 4 (No.) existing boreholes at Melling which have been out of service for a number of years will be refurbished and brought back into supply. An existing raw water main, which was previously used to convey Melling water to an industrial user in Skelmersdale, will be intercepted and extended to supply the new Royal Oak WTW.

During AMP6 the new WTW will be expanded to output 54MLD and new raw water sources will be conveyed to the works. The majority of the civil engineering works required to facilitate the expansion to 54MLD will be completed in the current project.

The new works is being built by United Utilities alliance partner KMI (a joint venture of Kier, Murphy, and Interserve) under a target cost contract with pain/gain risk sharing. Commissioning was programmed for completion in April, 2014. Outline design was completed by United Utilities in-house design team and detailed design by KMI designer GHA Livigunn.

The new water treatment works operating system will see raw water being pumped from the source boreholes at Melling, through the Royal Oak chemical building where sodium hypochlorite and caustic soda are dosed for pH correction and oxidation along with polyelectrolyte to facilitate manganese and iron removal. The raw water will then be filtered via the rapid gravity filters before receiving UV disinfection and final chlorination and phosphate dosing.

The rapid gravity filters are elevated to permit the treated water to drain into the adjacent service reservoir under gravity. The clean and dirty backwash tanks for cleaning the filters are located below the rapid gravity filters. Dirty backwash water will be treated using a lamella clarifier and the sludge stored in existing sludge lagoons.

Construction

The construction of the Southport DMZ project was divided into three main areas, the Royal Oak site, the rising main and the Melling Borehole site.

Royal Oak

The Royal Oak site was to be located alongside the existing Bickerstaffe WTW and UU Emergency Depot, which required close liaison due to the shared access road and conflicting interfaces that would occur during construction and commissioning.

The initial works at the Royal Oak site consisted of diverting existing overhead HV lines and burying them around the perimeter of the main site to allow the main construction works to commence and also bringing the new HV & LV lines into the site for future connection. A large area of Japanese knotweed was present which was removed and treated on the site. An existing coagulation loop from the Bickerstaffe WTW also had to be diverted during the site establishment works to allow the Royal Oak site to be clear from all existing services.

Rapid gravity filter block: The rapid gravity filter (RGF) is a 40m x 40m x 15m reinforced concrete structure which KMI constructed using direct and agency labour. In order to achieve the required ground bearing capacity, approximately 22,000m^3 of excavated material would have been taken from the site and sent to landfill and replaced with imported aggregate. KMI decided to lime/cement stabilise the existing material in lieu of sending to landfill and reuse the stabilised excavated material for hardstanding areas

and building foundations. Consequently, no material would be taken from site and the overall volume of aggregate imported into site greatly reduced.

The structure includes clean and dirty backwash tanks and equipment, filters, media, channels, gallery and plant room, roof and access stairways. clean and dirty backwash pumps, blowers, mixers, sampling and instrumentation, crane and lifting equipment, nozzles, flowmeters, pipework and valving.

A large temporary works scheme was developed with a Peri UK shuttering system to allow the bases, walls and soffits to be constructed in the optimum sequence. Approximately 640 tonnes of steel was fixed and 5,440m^3 of concrete was cast during the construction of the RGF structure, and despite extensive weather/wind delays due to the exposed nature of the surrounding area, the main RGF structure was completed in eleven months. The filters were designed and installed by Filtec, with a plenum floor and media retention troughs, with the media consisting of anthracite and sand.

Due to the Royal Oak AMP6 extension works (programmed to follow the completion of the AMP5 contract), 50% additional duct work was included throughout the site to ensure that during the future expansion there would be no requirement to install any further infrastructure.

The large mechanical installation was installed and tested by North West Total Ltd, with the valves and flowmeters free issue from KMI. The metal works to all the structures were designed, manufactured and installed via European Platform Systems Ltd. The extensive electrical installation throughout the project was installed by Interface Contracts Ltd. The internal cranes to the RGF structure (plant room, basement corridor and filter gallery) were designed, manufactured, installed and tested by T-Allen Ltd.

The RGF structures also required a central roof over the filter gallery and perimeter cladding around the structure in accordance with planning conditions, which were both installed by Gallaway Construction. Throughout the RGF, chemical building and control building the louvres and doors had to be installed to an LPC4 rating, due to the security requirements.

Throughout the Southport DMZ project KMI self delivered all the civil aspects of the works, including all below ground interconnecting pipework, duct chambers and duct runs, base slabs to all structures and infrastructure for the security and future AMP6 expansion works.

Chemical building: The chemical building base slab and extensive below ground pipework was constructed by KMI, with the structural steel frame, metal cladding and 3m high internal walls to the perimeter (as per security building hardening requirements) erected by Gallaway Construction. The chemical storage tanks are sized for the 54MLD works along with all associated dosing rig, flowmeters and mixers.

The tanks were supplied by Forbes with the polyelectrolyte dosing by Tomal. The chemical dosing systems including dosing lines, dosing rigs, sample boards and lances, were installed by PCM. The roof was designed to allow the individual roof sections to be removed to allow easy access/removal of the chemical tanks should they require replacement.

Control building and lamella clarifier: The control building is a steel frame, with blockwork internal walls and a steel cladding exterior. The building was again erected by Gallaway Construction with KMI constructing the base slab, MCC substructure and interconnections for the ducting. The control building includes a laboratory complete with clarity bowls, mess room/kitchen, W/C and shower, control room and MCC room.


Rapid gravity filter construction June 2013
Courtesy of United Utilities & KMI


Rapid gravity filter construction March 2014
Courtesy of United Utilities & KMI


Chemical building steel frame - Courtesy of United Utilities & KMI


Chemical Building - Courtesy of United Utilities & KMI

The lamella clarifier was designed, manufactured and installed by Hydro International Ltd. The clarifier allows the treated filter backwash water to be returned to the head of the works via the supernatant return and sludge disposal via new interconnecting pipework to the existing lagoons. These have also been refurbished as part of the KMI contract.

Two UV reactors were required for the AMP5 works with the infrastructure constructed for a third to be provided in AMP6. KMI built the base slabs and below ground pipework with Trojan supplying, installing and commissioning the UV reactors. The UV reactors are housed in LPC4 steel kiosks to meet security requirements.

The access roads to the Southport DMZ site were constructed via Aggregate Industries. KMI, with agreement from United Utilities, installed their Roller Compacted Concrete, which is a relatively new construction technology to both KMI and United Utilities.

Due to the lack of fall at the Royal Oak site, KMI designed and installed an Envirokerb system which allows the flow of rain water from the buildings and access roads to be collected and conveyed to a newly constructed outfall structure at Knoll Brook which runs adjacent to the Royal Oak site.

Rising Main

A new rising main was required to introduce the Melling borehole raw water into the Royal Oak works. This work consisted of a 1,200m long rising main installed and connected to an exiting/redundant main which historically fed a papermill in Skelmersdale. Extensive establishment works were carried out including pre and post land drainage, brook crossings, easement fencing, easement land stripping and reinstatement. Throughout the progress of the works close liaison with landowners and tenants was carried out as the easement of the new rising main ran through agricultural fields.

The pipework material was challenged by KMI to change from polyethylene pipework to ductile iron, which was approved by United Utilities. This gave a saving initially on the material and the infrastructure required for the installation, as the as-dug material could be reused on site as backfill to the main, again reducing the material being taken to landfill and reducing the aggregate to be imported.

The new rising main was required to pass under the M58 motorway. KMI via AMS No-Dig successfully directionally drilled this section (circa 150m drive) with no effect on the day to day operation of the motorway. To carry out the connection to the existing/redundant paper mill pipeline, KMI had to clean and test the existing 4km long line to establish its integrity for the future works.

During these works it became clear that no accurate as-built information was available with only proposed works drawings issued. Through trial holes and tracing KMI located and successfully tested and proved the existing main with only one pipework failure and repair on the existing line.

Melling Borehole site

The Melling Borehole site had not been used for a number of years, and as part of the contracted works KMI had to prove that the existing infrastructure would be sufficient for the new scheme.

The initial work was to strip out and replace the existing transfer pumps from the main pump house, install a new transformer and MCC, refurbish the aeration building, install four new borehole pumps with associated kiosks, renew the borehole head works and provide new security doors to the main pump house.

During the testing of the existing pipework and valves, it soon became apparent from the failures that all the existing pipework

and valves were not fit for purpose. KMI had then to carry out extensive additional works to the site, changing the majority of the pipework and valves, including new borehole pipelines to the valve house, the pipework and valves within the existing valve house and also the pipework and valves within the aeration building. Following this work the access road and drainage throughout the existing site also had to be renewed.

The works at Melling turned out to be a much more intensive part of the project than was initially foreseen, due to the amount of additional items required to the site to ensure that it met the specification.

HSQE

Throughout the Southport DMZ project approximately 800 tonnes of steel, 7,500m^3 of concrete and 24,000 tonnes of imported aggregate have been brought into the various site locations without any material being taken off site. Southport DMZ has utilised thirty-six subcontractors to complete the works. Throughout the duration of the project over 250,000 man working hours have been completed without a RIDDOR reportable accident. Environmentally, the team has worked closely with the EA and Ecology Services, through brook crossing, temporary consents, water vole surveys and bat/bird surveys again without a reportable incident.

Conclusion

The project was an excellent example of the use of partnering with a team work approach from all the contractual parties. This enabled a complicated project with some scope growth to be delivered within the original programme and with an excellent health and safety and environmental record. Water into supply was successfully achieved ahead of schedule on 31 March 2014.

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