Barrow WwTW

new stormwater storage facility to improve bathing waters of Morecambe Bay

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Barrow WwTW, in Cumbria, serves a population equivalent (PE) of 71,772 and has a consented flow to full treatment (FTFT) of 59,443m^3 per day. The plant was originally commissioned in 1996 to treat flows from Barrow, Dalton, Rampside and Lindal and a number of years later was extended to accommodate transfer flows from Walney Island and West Barrow. United Utilities had a need to address a number of unsatisfactory intermittent discharges (UIDs) to the Walney Channel in order to meet a regulatory requirement under the EU Shellfish and Bathing Waters Directives, limiting the number of spills to sea to 10 per annum and 3 spills on average per bathing season.

Stormwater detention tanks - Courtesy of KMI

Background

The project originally commenced in AMP3 as a result of the earlier Environment Agency's Fylde coast coastal modelling and United Utilities' Barrow network catchment modelling project but was subsequently delayed due to local objections and land purchase difficulties. The project was awarded to KMI during AMP5 in order to protect shellfish beds and improve bathing waters after UU proposed to install odour control to the new detention tanks and, following successful financial negotiations with the landowner, to purchase the additional land.

Existing works

Raw sewage entering the works is lifted by Archimedes screws to the inlet screens and passes through formula A flow control and 2 (No.) detritors. Following grit removal, the crude sewage passes FTFT flow control before being distributed between 6 (No.) primary settlement tanks. Settled sewage combines with return activated sludge (RAS) before passing through a selector tank to 4 (No.) aeration lanes.

The mixed liquors then pass to 5 (No.) final settlement tanks from where the final effluent passes through rapid gravity filters and a UV plant and finally on to the tidal pumping station and sea outfall.

There is a transfer pumping station taking raw sewage from the low lying areas of Barrow and Walney Island up to the inlet works channel and there are 3 (No.) existing storm tanks within the works with a combined storage volume of 6,240m^3.

Solution identification

Network modellers had recommended a solution entailing an additional 33,000m^3 of storm storage provided adjacent to the works. Due to site topography, the position of the available land and hydraulic considerations, the tanks were put forward as pump feed and gravity discharge. It was considered from a whole life cost perspective that, if the plant had been gravity feed and pumped return, the capital outlay for the earthworks would have far outweighed the additional OPEX costs for the pump feed option.

The scope of the project was also increased to ensure no detriment to existing works. Maximum FTFT remained unchanged, but the works would experience this flow for longer periods whilst returning the stored stormwater. In order to safeguard the works against consent failures, which would become more likely as a result, modifications were undertaken to the activated sludge system and the final settlement tanks to introduce an element of redundancy into the system.

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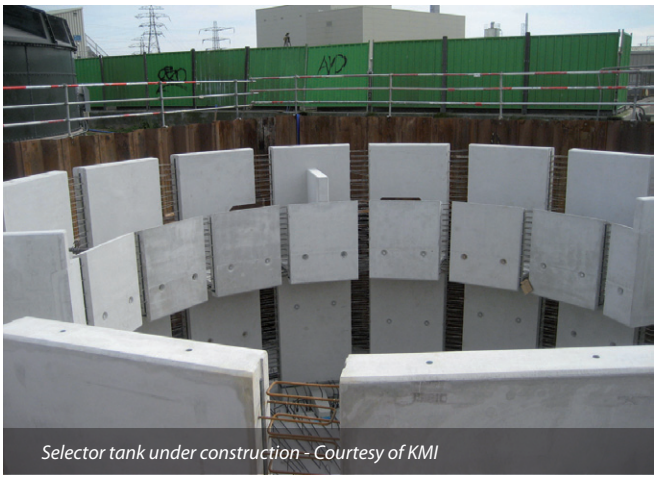
Aerial view of Barrow WwTW - Courtesy of KMI


Detention tanks under construction - Courtesy of KMI


Placing selector tank wall panels - Courtesy of KMI


Selector tank under construction - Courtesy of KMI

Detention tanks

The first phase of the project was the detention tanks and associated infrastructure. There were 4 (No.) above ground circular tanks of 42m diameter providing a total of 33,000m^3 of additional stormwater storage. The tanks were pump feed and gravity return due to the available land and the site topography. Due to planning constraints the tanks required covers and an odour control system.

The detention tanks fill and empty in series and are fed by a submersible pumping station comprising a 10.5m shaft housing 3 (No.) 215kW pumps in a duty/assist/standby arrangement with each pump capable of delivering 780l/s. Each tank has a dual scour jet mixing system and the stormwater return is controlled by actuated valves releasing enough flow to make up the deficit between measured FTFT and maximum FTFT.

The bases of the new detention tanks were founded on CFA bearing piles with traditionally constructed RC bases, walls and central support columns. Segmental GRP roofs were installed spanning between the external walls and central support columns onto which odour extraction ducting was fixed to draw odours to a dry carbon scrubber unit. The regulatory output for the tanks in use was achieved on time with the installation of the roofs and odour control plant being undertaken in the following months.

Inlet works modifications

The upgrade in the existing treatment works included enhancements to the inlet works, installing a new static screen in the inlet screw wet well, replacing the flow to works flume and formula A overflow weirs, replacement FTFT weirs, new detritor isolation penstocks and a new maintenance penstock to the channel feeding two of the 6 (No.) PSTs. These works were required to bring minimum freeboards in line with current UU specifications. The majority of these works required extensive temporary over pumping works to facilitate safe access into the main process channel.

Activated sludge process upgrade

The upgrade to the activated sludge system included the construction of a second selector tank to effectively split the primary treatment zone into two streams and increase hydraulic capacity. With this were replacement RAS pumps, replacement RAS rising mains and a new RAS and SAS distribution chamber.

A decision was made to move away from traditional RC construction for the new selector tank and instead Carlow Precast was contracted to design and manufacture precast wall panels. The benefits of this type of construction were quickly realised as there was less work at height, fewer lifting operations, less plant and vehicle movements, a shorter construction duration and less disruption to the client's operators.

In addition to the new selector tank a new RAS and SAS control and distribution system was installed. This involved diverting the RAS from the FSTs to a new distribution chamber through the new RAS pumps to increase the hydraulic capacity of the RAS transfer system.

Owing to the site layout and hydraulic constraints, this chamber had to be built on the footprint of the existing SAS control chamber; therefore a temporary SAS control facility had to be installed and commissioned elsewhere within the works to enable construction whilst maintaining process requirements.

This new chamber would divide the RAS equally between the 2 (No.) selector tanks and from where SAS is drawn off to be returned to the head of the primary tanks. Upon commissioning the new RAS system, the mixed liquor suspended solids (MLSS) will be increased from 1,800mg/l to 1,900mg/l to increase the biological solids headroom in the FSTs and introduce a level of redundancy to take an FST out of service in the future for maintenance.

How much of your infrastructure budget becomes infrastructure

Key Participants	
Client	United Utilities
Contractor	KMI
Civil & Structural Design	Mouchel
MEICA Design	GHA Livigunn
CFA Piling	Cementation Skanska
Tank Roofs	Production Glassfibre
Precast Wall Panels	Carlow Precast Concrete Engineering
Electrical Installation	Boulting Group
Mechanical Installation Phase 1	North West Total Solutions
Mechanical Installation Phase 2	Compass Mechanical Services
Odour Control	Air Technology Systems
Overpumping Systems	Xylem Water Solutions

Detention tank feed pumping station - Courtesy of KMI

Replacement flow to works flume - Courtesy of KMI

New RAS distribution chamber - Courtesy of KMI

A complex sequence of pipeline diversions, valve insertion, and overpumping is required to introduce the new selector tank and RAS/SAS system into the process requiring careful planning and close liaison with United Utilities' Wastewater Technical Officer. At this time these assets are ready to connect into the process and preparations are being made for the flow diversion works.

Modifications to final settlement tanks

Four of the five FST will be taken off line in turn to raise the launder weirs and central diffuser drums to increase the available freeboard on the launder channels at full flow. The reason that there is inadequate freeboard is because when these tanks were originally constructed, the hydraulic design of the launder channels was based on a FTFT which was only two thirds of what it is today.

This increase in freeboard will reduce the risk of sludge blanket carry-over under maintenance conditions, which has historically caused compliance issues when the rapid gravity filters become blinded.

Due to the FST inlet distribution chamber having no separate internal feed compartments to the individual FSTs, temporary bulkheads were installed inside the chamber to artificially raise the upstream water level to provide sufficient head to feed each FST after coming back on line with raised launder weirs. At the time of writing this article, the first FST has yet to be taken off line for modification.

Replacement transfer main

During the course of the project an instruction was received from United Utilities to replace the Barrow Transfer Main. This was originally a GRP main which suffered a series of catastrophic ruptures, not related to the work KMI was undertaking, but as KMI was established on site they were able to react quickly. This main was 300m long 700mm diameter and transferred a maximum flow of 800l/s of raw sewage from the low lying areas of Barrow and Walney Island to the inlet works.

Immediately following the initial rupture United Utilities installed a temporary overland pipeline to maintain this flow whilst the replacement ductile iron pipeline was procured and installed by KMI. Part of the enabling works for this transfer main replacement will be the diversion of 2 (No.) HV cables feeding the transfer and tidal pumping stations.

Collaborative working between United Utilities and KMI was a great success for this emergency work enabling flows to be maintained and consent to be met. At the time of writing this article (May 2014), the temporary pipeline remains in service and the installation of the replacement transfer main is 40% complete.

Conclusion

The successes to date at Barrow WwTW can be attributed to the close working relationship that was developed between United Utilities and KMI throughout the course of the project. Many challenges have been overcome in terms of maintaining process security whilst overcoming the many complex asset interfaces required to deliver the project. KMI wishes to thank United Utilities for their continuing support.

At the time of writing the article, the detention tanks are fully in service with the odour control system under commissioning, the inlet works modifications are fully complete, the new RAS system is ready to undergo wet testing and the FSTs modifications are imminent. The project is scheduled for practical completion in August 2014.

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