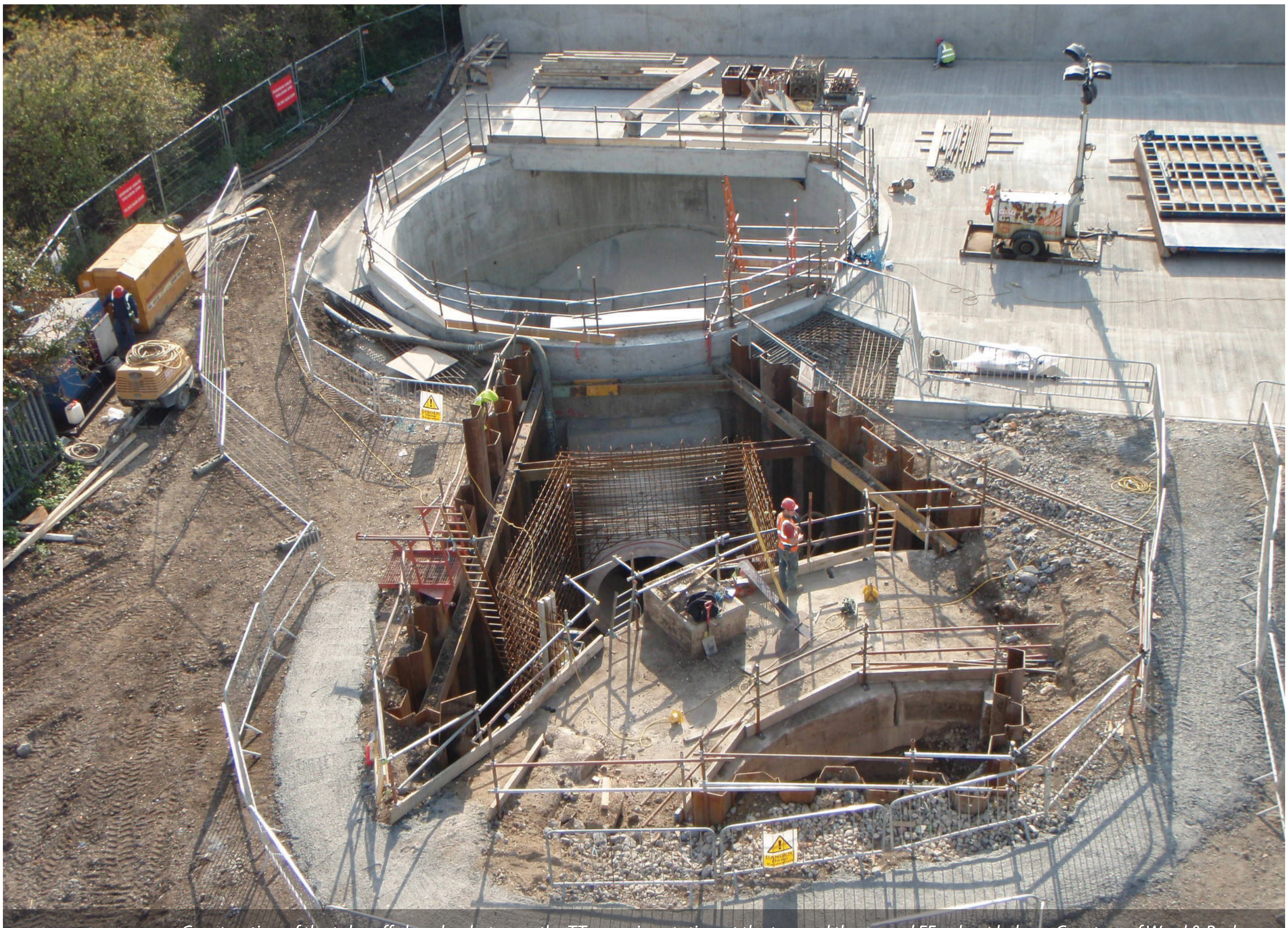
Deephams STW

phosphorous removal to a consent standard of 1mg/l under the Urban Waste Water Treatment Directive

by John Harte BSc

Deephams Sewage Treatment Works is one of the capital's largest waste water treatment works, located off Picketts Lock Lane, adjacent to the William Girling Reservoir in Edmonton, North London. The main body of the works are over half a century old and nearing the end of their life span, built during a period of rapid population growth in Greater London. The works receive flows from all of Enfield, Waltham Abbey, Northaw & Cuffley and parts of Haringey, Waltham Forest and Broxbourne. The works serves a population equivalent of 885,000 with dry weather flow of 2,693l/s.



Construction of the take-off chamber between the TT pumping station at the top and the curved FE culvert below - Courtesy of Ward & Burke

Description of the site

Raw sewage arrives at the works via three trunk sewers and is raised through three inlet pumping stations, all currently undergoing upgrade works for reception of storm flow under a separate contract. The site is split into three separate streams A, B & C; streams A & B were on the whole constructed in the mid 1950s then increased in capacity, and an additional stream C was added in the mid 1960s. Flow is split into 35% to stream A, 35% to stream B and 30% stream C.

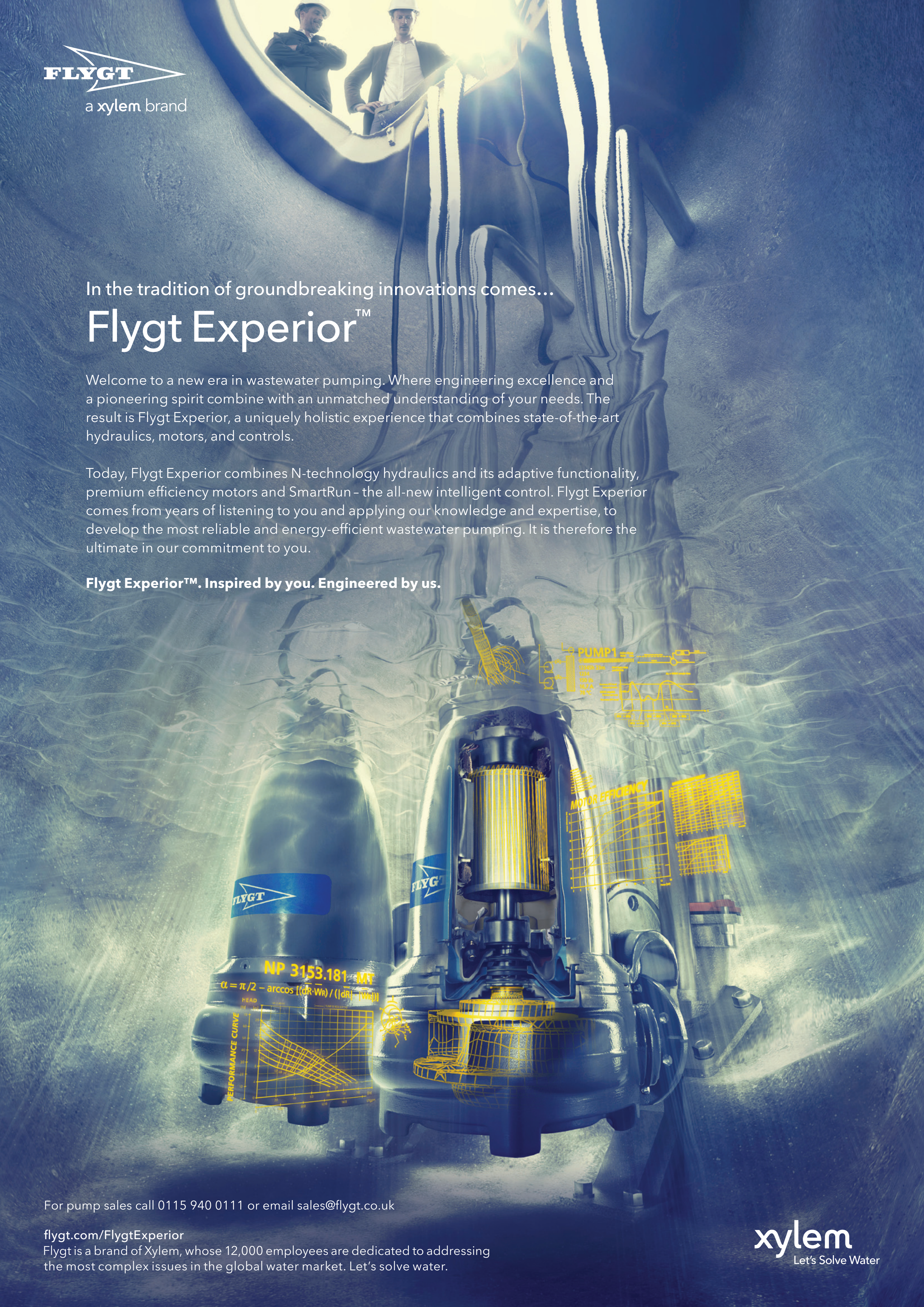
Primary settlement is achieved via 16 (No.) rectangular horizontal flow tanks, 6 (No.) in each of streams A & B and 4 (No.) in stream C. Secondary treatment is through 12 (No.) fine bubble diffuser aeration lanes; 4 (No.) four-pass lanes in each of streams A & B and 4 (No.) two-lane tanks in stream C. Final settlement is through 48 (No.) radial flow tanks, 16 (No.) tanks in each stream.

Sludge is treated on site; primary sludges being thickened by 3 (No.) belt thickeners, and SAS through 4 (No.) belt thickeners, which is then mixed and treated through 9 (No.) digesters, prior to secondary digestion, and finally being dewatered through 6 (No.) belt dewaterers. Finished sludge cake is stored on the site cake pad before exporting off site.

Improvement works

The main driver for the upgrade of the works is to ensure compliance for phosphate removal to a consent standard of 1mg/l under the Urban Waste Water Treatment Directive. The upgrade also provided the opportunity to improve reliability and performance of the aging assets by carrying out further upgrade and refurbishment work.

Improved phosphate removal will be achieved by chemical dosing to promote solids production. In brief, the works comprised:



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- Pre-precipitation dosing prior to the primary tanks, followed by simultaneous or top-up dosing before the final settling tanks if required.
- Scraper bridges refurbishment in 9 (No.) of the existing 16 (No.) primary tanks.
- Increased capacity of both the sludge thickening and sludge dewatering plant.
- Refurbishment of 4 (No.) of the 9 (No.) existing digesters.
- Tertiary treatment of the final effluent through 6 (No.) disc filters.

Scope of works

The challenge that met the GBM management, design and construction team was for practical completion of the main elements of work in an extremely challenging timescale.

Innovative design that called for as much off-site construction as possible, coupled with a design that allowed flexibility to cope with developing design and discussion with subcontract elements were essential. Many of the elements of work were record breaking in size or capacity for different sub-contractors and suppliers.

Chemical dosing

Chemical dosing, both precipitous and top-up, was proposed to be via containerised units. This element was undertaken by Gee & Company, developing the largest combination of containerised units they have designed.

This simplified on-site works removing the need for in-situ bunded tank areas. The final arrangement for the ferric sulphate precipitous dosing was for 4 (No.) hydraulically balanced containers, each with 2 (No.) 24m^3 tanks inside, providing a total capacity of 192m^3. The BIFLOC top-up dosing was through 2 (No.) containers with a total capacity of 96m^3.

The pre-precipitous dosing was required in two different inlet flow streams due to the multiple inlet configuration of the works, each requiring "flash" mixing at the point of dosing, achieved with static mixers by Statiflo, lowered into the two inlet channels. The larger of the mixers for flows up to 3,800l/s, was the biggest non-ragging mixer of this type Statiflo have made.

Each mixer was designed to be lifted and installed in one piece, which was achieved overnight during low flows with temporary bypassing arrangements.

Increased sludge capacity

To increase the plant's sludge capacity, work was required on the scraper bridges, gravity belt thickeners (GBTs), centrifuge dewaterers and the digesters.

Refurbish PST bridges and desludging control system: 9 (No.) of the primary tank scraper bridges, 3 (No.) from each process stream, were systematically taken off site for a mechanical overhaul while new guide tracks were re-laid on-site. New scum beaches and control systems were all installed by MWH.

Primary sludge gravity belt thickeners: Space being at a premium on the congested urban Deephams site, there was a need to make better use of what was there. Space was created by removing a redundant sludge import tank in order to add two new gravity belt thickeners to supplement the existing three GBTs. The new GBTs, complete with sludge delivery pumps and poly-dosing were installed by Ashbrook Simon-Hartley.

Centrifuge dewaterers: During the tender process, centrifuges were seen as the preferred method for dewatering the digested sludges, supplementing the existing belt dewaterers. The centrifuges were installed on raised steel platforms, simplifying and speeding the pipework installation.

The centrifuges, complementary poly-dosing system and sludge delivery pumps were all installed by Ashbrook Simon-Hartley.

Digesters: Typical of the teamwork shown on this challenging project; drain-down, purging and systematic takeovers of the digesters between client operators and contractor ran smoothly. Inspection and lining material choice was validated on the first digester.

Tertiary treatment

The greatest test for the design and construction team was the large amount of civil works required in the construction of the tertiary treatment (TT) plant, but needed to be confined into a small space. The task was further complicated by the need to intercept flow in the final effluent culvert to treat flows up to 3,150l/s, whilst allowing flows greater than this to bypass the plant and at the same time not creating any hydraulic head loss into the works and flooding the final settling tank weirs.

Civil work: It was decided early on to create a design that allowed civil work to commence quickly from the outset whilst detail design could develop. All the disc filters, supplied and commissioned by Veolia, were elevated to enable all the connecting pipework to be above ground and developed later.

The civil work was split into smaller packages to enable the detail design of the bulkier work to commence sooner. The first civil phase was the deeper shaft of the main tertiary treatment pumping station, along with the more difficult connection to the existing final effluent (FE) culvert.

The second phase was the pre-filter screen-chamber, filter distribution chamber and disc filter area, all constructed off a ground level piled slab minimising differential settlement and simplifying pipe connection details later. Detailed design and construction was carried out by specialist civil contractor Ward & Burke.

TT Pumping station: The tertiary treatment pumping station was an 11.5m shaft which Ward & Burke initially sheet piled into the lower level clay to seal the excavation area and provide jacking points to guide the shaft down. The bottom section was cast at ground level, and sunk by excavating internally. Two more sections were cast on top and sunk further, making the shaft a total of 7.5m deep.

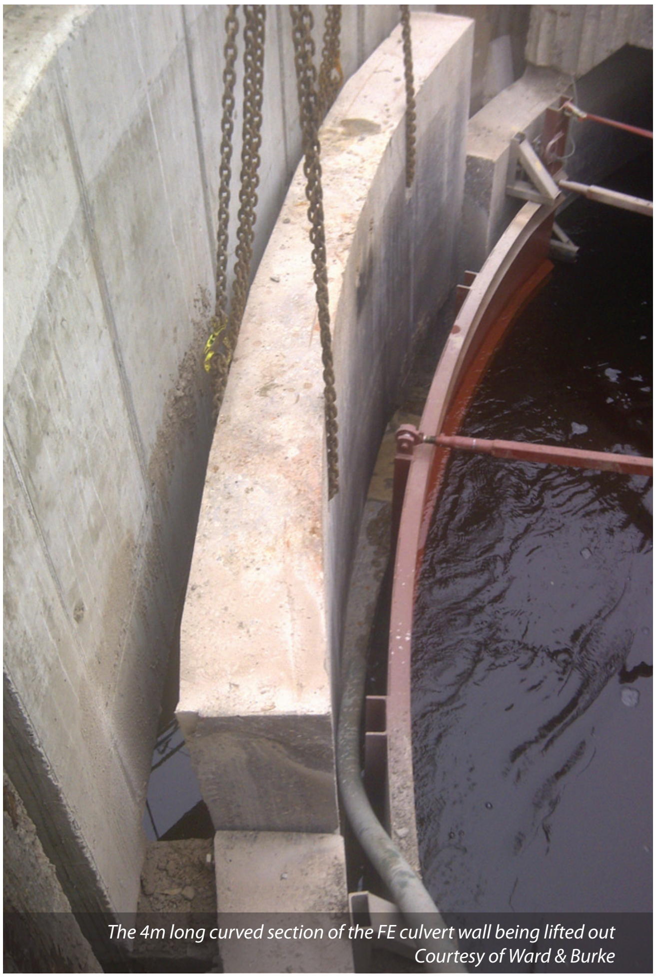
Above the lower level clay was a layer of peat, and settlement of the shaft was a concern, particularly as the confined footprint of the plant area left the pump shaft within 5m of the existing piled FE culvert where the connection had to be made. The decision was taken to support the shaft on a ring of piles to minimise differential settlement against the existing FE culvert.

FE Culvert: From the outset there was concern about how the team were going to create a method to abstract and return flow to the 3m wide by 2.4m deep concrete FE culvert without hydraulic head loss and how this could be constructed at minimum risk to the works process. Over-pumping flows of this magnitude would be expensive and carried the risk of either flooding the FST weirs or the construction work if it failed.

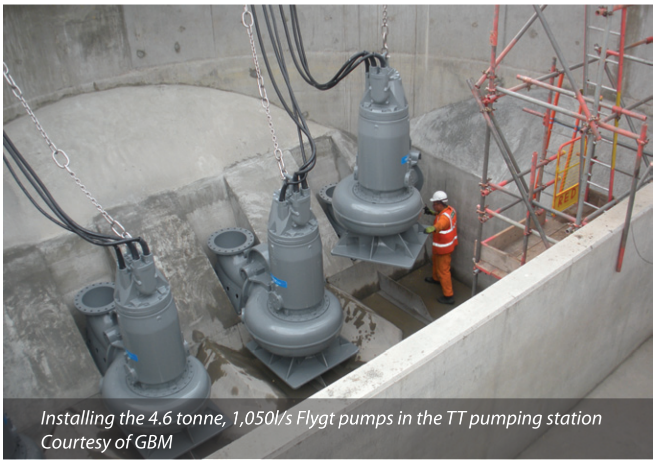
A collaboration between the design team and Ward & Burke brought up a unique and extremely effective solution. It was decided to cut off a section of the FE culvert roof and lift in a purpose made steel channel shaped flume, although there were further complications in that the desired effluent take-off point to cut into the culvert was on a curved 90 degree bend. A new effluent take off chamber and 2.1m diameter connection to the main tertiary pumping station was built first.

The culvert roof was cut and lifted off in one 15 tonne piece, the curved flume was sunk and fixed in position; each end of the flume

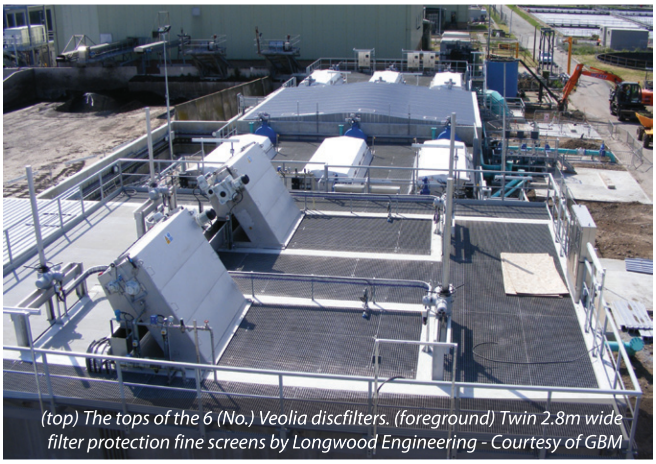
The culvert roof removed with the flume in place
Courtesy of Ward & Burke



The 4m long curved section of the FE culvert wall being lifted out
Courtesy of Ward & Burke



Installing the 4.6 tonne, 1,050l/s Flygt pumps in the TT pumping station Courtesy of GBM



(top) The tops of the 6 (No.) Veolia discfilters. (foreground) Twin 2.8m wide filter protection fine screens by Longwood Engineering - Courtesy of GBM

was sealed against the walls and floor of the culvert with bespoke reinforced inflatable rubber tubes, the efficiency of this exceeded expectations and made a 100% water-tight seal.

With the steel flume sealed in place, a 4m long curved section of the concrete culvert wall was cut out from behind the flume, the bottom was cut level with the floor of the culvert, and the cut edges were made good, all in the dry.

When all the construction work was ready, the flume seals were deflated and the flume lifted out. The culvert roof that had been sawn off in one neat piece was returned and stitched back into the same position over the non-stop FE flow, this also avoided the need to pour a new slab, shutter over running water, confined space working or use permanent formwork.

Pumps: The main tertiary pumping station has 4 (No.) submersible Flygt pumps, installed in rotating duty, of three duty/one standby. Though each 4.6T pump is capable of pumping over a tonne of water every second, the sump design is so effective and the pumps run so quietly that it's difficult to know which pumps are running.

Disc filters

To meet process requirements, 10 micron screens were chosen for the disc filters to treat flow up to 2,700l/s with the capacity to increase to 3,150l/s in the future. Disc filter supplier, Veolia Water Solutions & Technologies, chose to use 6 (No.) of their 2.6m diameter filters, each 8m long, treating 450l/s through each filter.

Although the 2.6m filter had been used before, this was the largest single installation by Veolia, more than double the capacity of previous installations. The main pumping station was designed for 3,150l/s flow and the disc filters arranged, and pipework sized to allow for a future 7th filter.

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Putting the finishing touches on the Tertiary Treatment Pumping Station, with 900mm pump risers and 1400mm rising main - Courtesy GBM

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