Morecambe WwTW Catchment Strategy

£72m project to improve bathing waters and the environment, future-proof wastewater treatment assets, and optimise operation and maintenance

The Morecambe sewerage system collects at Schola Green Wastewater Pumping Station (WwPS) located in the west end of the town. From there, flows for treatment are pumped via a 6km long pipeline to Morecambe Wastewater Treatment Works (WwTW), which is situated to the south, near to the village of Middleton. Both sites have outfall pipelines which discharge effluent into Morecambe Bay. The Schola Green outfall is a storm overflow (which operates intermittently when the system is overloaded) and the Middleton outfall discharges treated effluent from the WwTW. The project is required to comply with tighter permit conditions that will be imposed on the number of storm water spills into Morecambe Bay from Schola Green WwPS from 31 July 2019.



Project needs

The storm overflow at Schola Green WwPS has been identified by the Environment Agency (EA) in NEP4 as needing to comply with the requirements of both the Shellfish Waters and Bathing Waters Directives, which will limit spills to no more than two per bathing season (15 May - 30 September) and ten per annum.

Additionally, as a secondary objective, the existing wastewater treatment process at Morecambe WwTW is obsolete and needs to be replaced. The population is predicted to grow and Morecambe WwTW needs to be capable of meeting its regulatory discharge requirements for the increased flows and loads up to a 2036 design horizon.

Furthermore, at low tide the four diffusers at the end of the Morecambe WwTW outfall pipeline are not submerged and therefore the EA has also required a solution to ensure effective dilution of the final effluent.

This will require the introduction of a tidal pumping system at the treatment works: final effluent tidal storage and tidal pumping station to discharge treated effluent at sea, only when the outfall diffusers are fully submerged at high tide. This is required to be implemented by March 2020.

Project summary

The backbone of the solution is to increase the pass forward flow at Schola Green WwPS by upsizing the pumping station capacity and laying an additional transfer main to Morecambe WwTW, and to upsize the Morecambe WwTW treatment capacity. At Schola Green WwPS, additional storm storage is also required.

The solution involves five main elements, as follows:

 The construction of two new storm water detention tanks at Schola Green WwPS, in order to increase capacity and reduce the number of spills to the outfall.



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- The installation of a second pumped transfer pipeline between Schola Green and Morecambe (Middleton) WwTW, in order to increase the flows to treatment. The new pipeline will generally follow the route of the existing main. However, there are some deviations where new developments have been built since the original pipeline was laid.
- Replacement of the obsolete treatment process at Morecambe (Middleton) WwTW, in order to provide a full upgrade to the latest technology and also to cater for the increased flow transfer from Schola Green.
- Provision of approximately 10,000m³ of tidal storage at Morecambe WwTW, achieved partially through conversion of the existing civils assets once the existing treatment process has been decommissioned.
- Upsizing of the land-section of the existing outfall pipeline from Morecambe (Middleton) WwTW, to cater for the increased treated effluent flows. The 2.5km long marine section of the outfall pipeline does not need to be upsized, but some improvement works are required at the discharge ports to address problems that have occurred as a result of beach/sea bed movement.

The main construction contract was awarded to United Utilities' Construction Delivery Partner C2V+, a joint venture between VolkerStevin and CH2M (now Jacobs), in February 2017 and the project is now halfway through its implementation phase.

Design

The four main elements of the project, (1) Schola Green WwPS, (2) transfer main, (3) WwTW and (4) outfall works, presented significant challenges which required innovative approaches.

To establish the best TOTEX solution a robust optioneering process was carried out during pricing. This looked at the balance between

storage of storm water at Schola Green WwPS and pass forward flow for full treatment at the treatment works located 6.5km away. The key constraints were:

- Available space at the WwPS located within Morecambe.
- Reuse of existing stormwater storage within the assets.
- Working with a 19th century dry well pumping station and existing 20 year old transfer main.
- Available space at the WwTW which is surrounded by environmentally designated areas.
- Contamination.
- Reuse of the existing outfall main.

These constraints were interdependent requiring an iterative approach which drove construction methodology and, fundamentally, the selection of the NeredaTM process.

The Nereda™ granular activated sludge process is a highly compact approach for the treatment of wastewater. Compared to conventional activated sludge it does not require final settlement tanks. In collaboration with the client it was established that primary settlement could also be omitted. This allowed the pass forward from Schola Green WwPS to be increased from 350l/s to 580l/s while maintaining all new works within the existing site boundary. The pass forward flow (PFF) defines the storage required at Schola Green WwPS which decreases exponentially as PFF increases.

The selected PFF also allows the reuse of the existing 2.5km long offshore, 800mm diameter outfall. When constructed the outfall diffusers discharged in the deep channel within Morecambe Bay. However, over the past 20 years since construction of the outfall, this channel has moved resulting in the diffusers being buried beneath 6m of sediment. United Utilities had implemented an interim solution to ensure the current discharge could continue and carried out a comprehensive review of alternative outfall locations.



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Reg. No. 1650049. V.A.T. Reg. No. 369 6295 96 Reg. Office: Unit 44, Coneygree Industrial Estate, Tipton, West Midlands DY4 8XP This concluded, after a collaborative effort with the delivery team, that the existing location was the only feasible solution if it could be adapted to allow safe and economic future modification should further beach encroachment or retreat occur.

The solution developed involved the placing of a segmented steel canister on top of the existing four diffuser ports within the temporary concrete caissons which had been installed to allow current operation. The four diffuser heads will have eight Tideflex valves, each of which discharge at a relatively high velocity at low flows promoting scouring local to the ports and mitigating against blockage.

The other key challenge to address at the WwTW was construction on a tight site with high groundwater and historical contamination issues. The existing works was constructed in two phases; mid-1990s and mid-2000s. The initial works gravitated from primary tanks through to the outfall pumping station. Tertiary filtration and UV treatment were added in the second stage and interstage pumping was incorporated to feed these processes. Only the tertiary filters are reused in the new process. The new hydraulic profile allows flow to gravity through from new inlet screens to a new outfall PS.

This allows the construction of the new process units with minimal excavation, reduces material off site and below ground temporary support with a small construction footprint. This introduces additional operation challenges, particularly for the 6mm inlet screens which needed to be raised 12m above ground level.

The design was delivered to BIM Level 2 standard with a strong focus on maximising the benefits of 3D modelling for optimum solution development, constructability reviews and Access, Lifting and Maintenance reviews with the client. The ability to holistically develop the design mitigated the risk of a more traditional 2D approach. It also has great opportunities for direct import of supplier designed elements into the model and for suppliers, where the delivery platform allows, to work directly with the main design model. Though significant progress has been made on this single model design development approach there are fundamental barriers to smooth delivery between different modelling platforms and capabilities.

Process

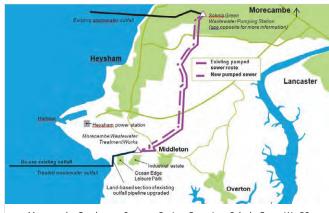
 $Nereda^{TM}$: Due to the space constraints of the site, it was agreed at tender stage that the NeredaTM process, developed by Royal HaskoningDHV (RHDHV) in the Netherlands, provided the optimal balance of treatment capacity and OPEX in a compact footprint that allowed the new process units to be constructed whilst maintaining treatment in the existing process.

Utilising an innovative hydraulic design and precise batching control, this revolutionary process promotes the selection and growth of fast-settling sludge granules to remove the requirement for separate clarifiers. Providing the oxygen necessary for effective treatment requires 4 (No.) 75kW hybrid screw compressors feeding the 2,636 (No.) 9" diameter membranes in each aeration grid.

Each reactor requires up to 5,200Nm³ of air per hour, the equivalent of two hot air balloons, while the total process reactor volume is 12,000m³ (almost five Olympic swimming pools).

In conjunction with the RHDHV process designers in the Netherlands and the expert fabricators at Suprafilt, C2V+ and United Utilities have refined the design to minimise the number of fixings and support steelwork required inside the tank. Hinged grids and multiple drain sumps maximise access and maintenance provision for the end user during reactor maintenance.

Utilising fast-acting pneumatic valve and penstock actuators for precision process control, the control algorithm uses the process



Morecambe Catchment Strategy Project Overview: Schola Green WwPS, transfer main, Morecambe WwTW and outfall pipeline



Morecambe WwT W: Rotary drum thickener area BIM model snapshot Courtesy of United Utilities



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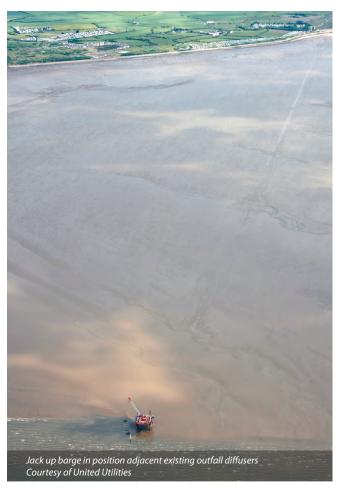


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Morecambe WwTW Catchment Strategy Key participants	
C2V+	Main construction contractor
Royal Haskoning DHV	Nereda™ process design and consultancy
Eric Wright Water	General MEICA Installation
VolkerBrooks	Access steelwork
Huber Technology	Inlet screens and compactors
Invicta	Penstocks and stoplogs
MeasurIT Technologies	Tideflex valves
Andritz	Rotary drum thickeners
NPS	Polyelectrolyte storage and dosing
Suprafilt	Nereda™ internals
Aerzen	Aeration blowers
Cooper Freer	Pneumatic compressors
Pneumatic Valve Islands	Metalwork
Powerrun	Inter-process above-ground pipework
Xylem Wedeco	UV disinfection system
Grundfos Pumps	Washwater booster system
Sulzer Pumps	Outfall and transfer pumps
Siemens	Electromagnetic flowmeters
MGA Controls	Transfer main non-return valves
Xylem Flygt	Centrifugal and submersible pumps
Seepex	Progressive cavity pumps
Goodwin Tanks	Glass-coated steel tanks
Utile Engineering	RDT buffer tank air mixing
Hidrostal	Thickened sludge tank mixing
TCS	Systems integration
Lloyd Morris Electrical	MCCs
ESE	Transformers
Schneider Electric	RMUs and HV switchgear
Mantis	Pedestrian cranes



monitoring and flow instrumentation to vary the treatment 'recipe' to reflect the prevailing weather and load conditions and ensure a high quality effluent is discharged to the RGF and UV disinfection plant. Continuous remote monitoring from the Netherlands will allow site-specific trends to be identified and recommendations for optimisation to be provided to the operator, utilising the process data from NeredaTM installations worldwide.

The construction process has utilised the DfMA (Designed for Manufacture and Assembly) approach to prefabricate and assemble as much of the installation as possible to minimise the site installation time.

Pre-assembled modules are delivered to site and unloaded directly to the installation location in the NeredaTM tank using pedestrian cranes from Mantis. The cranes provide 1100kg lifting capacity at over 40m with a very small footprint (4.5m x 4.5m), providing an ideal solution for the limited space available on site.

UV disinfection

Due to the sensitive nature of the receiving waters in Morecambe Bay, the Morecambe treatment works discharge consent requires that all process flows are subject to UV disinfection prior to discharge. For AMP6 UV projects, the EA has moved away from the US Environmental Protection Agency (EPA) approach to setting target UV dose. This requires the measurement and assessment of site-specific dose-response relationships in conjunction with equipment validated using biodosimetry in the setting of the target dose, to ensure the final installation achieves the water quality objectives while controlling TOTEX.

Due to the requirement to present performance data for the new process, use of an innovative technology like Nereda[™] made the process of agreeing the validated dose parameters for the new UV system a real challenge for the project team and United Utilities.

After acquiring 12 months of process sampling data, it became evident that using the performance of the existing treatment works both in terms of UV transmissivity (UVT) and log reduction value (LRV) would result in an oversized plant, both in terms of space available on site and TOTEX. Following further sampling of NeredaTM plants in the Netherlands, it quickly became evident that there would be insufficient evidence to support the case for an improvement on the existing UVT and LRV values.

Consulting extensively with RHDHV, Xylem Wedeco and the United Utilities Process and Dispersion modelling team, the dilution effect of the new tidal storage and discharge solution, including redesigned outfall diffusers, was used to significantly increase the downstream LRV.

By redesigning the upstream pipework and flow measurement system, the design team was able to ensure that the redesigned plant would still fit into the footprint available and meet the discharge conditions, even utilising the performance data from the existing plant for upstream LRV.

The project team commenced detailed design with Xylem Wedeco in June 2018 with a target for commissioning in June 2019. The new plant will be able to treat up to 725l/s, with 560 lamps installed and a duty of over 260kW at FTFT. Each lamp module has an electrical wiper system and motorised lifting system to ensure ease of access for operation and maintenance.

The system will be optimised to ensure the system minimises power consumption under low flow conditions with banks dimmed and switched off as required using real-time feed-forward control from Schola Green WwPS and on-site instrumentation. Actuated downward-opening penstocks modulate to ensure that the lamps are kept submerged under all flow scenarios.



Progress to date

- Schola Green WwPS: Works on site commenced April 2017. At the time of writing (July 2018) the construction of the new south storage tank is substantially complete, with only the final wall pour and roof to complete on the north storage tank. Installation of the new transfer pumps within the existing pumping station is planned for commencement in the last quarter of 2018.
- Transfer Main: The route of the transfer main contains numerous environmental and third party challenges and constraints, by passing under a railway line, through a caravan park, around Morecambe FC, along highways and agricultural land. Works on site commenced January 2018 and the full 6km length is planned for completion in the first quarter of 2019.
- Morecambe WwTW: Works on site commenced July 2017.
 As of July 2018 civil construction of the main Nereda™ and inlet works structures is complete, with the civil construction of the three MCC structures and the outfall



pumping station shaft substantially complete. Mechanical installation has commenced with main electrical installation planned to commence in the last quarter of 2018.

 Outfall diffusers: Works on site commenced at the end of April 2018 and are planned for completion by the end of July 2018.

At the time of writing (July 2018) the first phase of the project is currently on programme to meet the new permit conditions by the end of July 2019. Following completion of Phase 1, construction works for Phase 2 Tidal Storage will commence with completion in the second quarter of 2020.

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