Hendon STW Sludge Dewatering

delivering Northumbrian Water's updated sludge strategy

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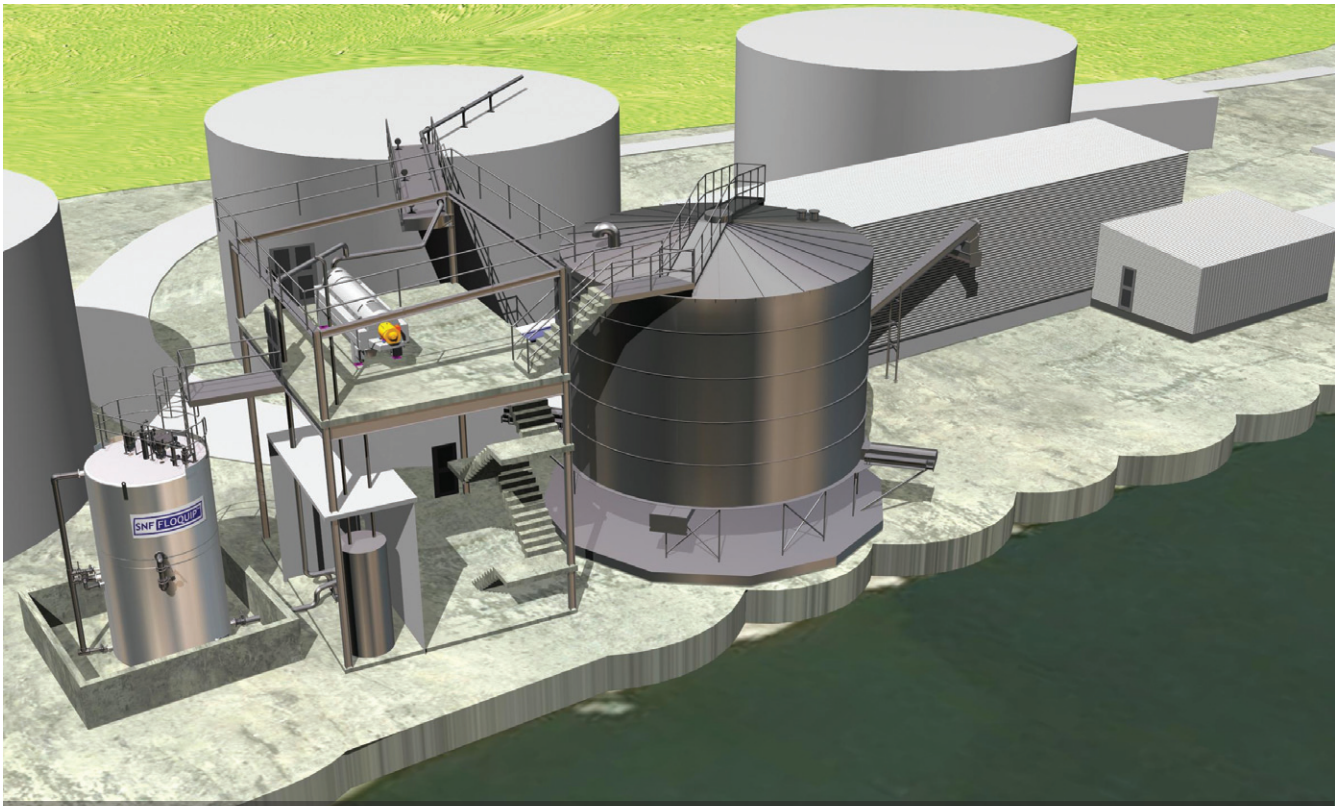
Located near Hendon in Sunderland in the North East of England, Hendon Sludge Dewatering Facility is situated on a long, narrow site which is part of Hendon Docks in the Port of Sunderland. The site is capable of treating up to 160 million litres of wastewater per day, serving a population of around 250,000 people. As one of Northumbrian Water's key regional sludge dewatering sites, Hendon produces around 9,000 tonnes dry solids of sludge cake every year. The facility reduces the water content of the sludge to create sludge cake with over 25% solids content. The cake then gets transferred by vehicle to Bran Sands Treatment works, on Teesside, where it goes through an advanced anaerobic digestion process.



3D CAD drawing of the new facility, including cut-out of two-storey centrifuge and poly-dosing building *Courtesy of Agrivert Ltd*

The ongoing development of advanced anaerobic digestion facilities, as part of Northumbrian Water's updated sludge strategy, is enabling them to use larger volumes of waste sludge to generate methane, fuelling gas engines to produce significantly more renewable energy for use at various sites, including Bran Sands. Northumbrian Water's previous sludge strategy comprised transporting liquid sludge by ship and then by road tankers from Hendon to Bran Sands. In 2008 however, the strategy was updated and Northumbrian Water discontinued their use of the ship, the MV Northumbrian Water.

The sludge dewatering upgrade works at Hendon is a key part of Northumbrian Water's updated sludge strategy, which aims to substantially reduce Northumbrian Water's operating costs and environmental impact, by reducing the need for the transport of voluminous liquids around the region.

Project scope

The current scheme will provide a permanent dewatering facility to replace hired equipment, and must be delivered as quickly and practically as possible in order to reduce the duration of current hire costs.

The £3m contract is design and build, with the design ongoing whilst construction commences, and is procured through NEC 2 Option C (Target Cost).

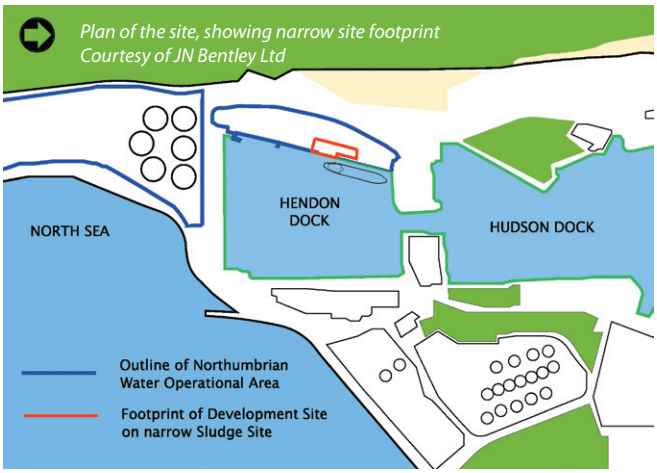
JN Bentley is Principal Contractor and Lead Designer for the Civils, MCC and Systems Integration elements of the project. Agrivert is providing subcontract services for the design and build of the dewatering equipment, and the associated steel framed building elements of the works.

Collaborative planning process

Due to the fast-track design and build approach, plus the large elements of subcontractor design, and restrictive nature of the site footprint, JN Bentley proposed the adoption of the CLIP (Construction Lean Improvement Programme) planning approach, facilitated by the Building Research Establishment. The process, designed to improve programme and financial performance, and

minimise waste through collaborative planning (involving the client, designer and sub-contractors), has already enabled the project team to bring forward some key project milestones ahead of schedule. This process will continue throughout the project, to best identify and mitigate any potential risks, by drawing on experience from all members of the project team.

As part of the planning process, the team has also been liaising closely with the Port of Sunderland regarding the programmed construction phases. JN Bentley produced detailed planning drawings for submission to the local planning authority, including measures for odour abatement and the diversion of surface water drainage, in order to ensure accidental spillages of sludge or oils could not contaminate the adjacent dock.



Plan of the site, showing narrow site footprint
Courtesy of JN Bentley Ltd

Key challenges

Perhaps the most significant challenge, for both the design and build stages, is the site footprint. The work area is very narrow and sandwiched between Hendon Dock and three large, 14m high, concrete sludge storage tanks.

The site itself comprises the original dock and masonry dock wall, plus a series of circular caissons used to extend the dock in 2000. The existing structures and multiple underground services had to be negotiated when designing and constructing the foundations for the new dewatering plant. Most significantly, due to space restrictions, the new buildings are located to straddle from behind the original dock wall and over the caisson wall, which was not designed to take any additional loads.

The centrifuge and building will not only exert vertical loads but also dynamic horizontal loads. A grid of piles through the caisson wall was therefore designed to carry the additional loads down to the underlying ground. Ground beams were then constructed to link the piles together, with integral slabs forming the ground floor of the new buildings. A compressible separation was placed beneath the ground beams and slabs, again to minimise the risk of any additional loads being transferred onto the caisson construction. Because the possible location of the piles did not permit them to be placed directly below the building columns, column loads were off-set from the piles, and considerable heavy steel reinforcement was required in the ground beams. In addition some of the ground beams had to be 'cranked' to fit below adjacent structures. Most concrete had to be pumped due to the narrow scheme footprint.

Construction of the permanent facilities has had to be carried out with minimal disruption to operation of the existing site. Because of limited available space, the new facility will be located in the area previously occupied by the temporary dewatering plant. During construction, the temporary facility has been replaced with

a mobile dewatering unit located on another part of the site. As a result of the narrow site, the decommissioning of the temporary silo was logistically difficult but, with careful planning, Agrivert managed to dismantle it in sections and load directly onto wagons for removal from site.

Upgraded dewatering process

The process side of the works consists of conversion of a redundant ship loading pumping station to feed sludge to the new system, centrifuge, poly batching and dosing, sludge cake screw feed conveyor system, lorry loading building and odour control ducting.

Indigenous and imported sludges are currently screened through two strainpresses, previously installed by JN Bentley under a separate contract, with the screened sludge being stored in a sludge tank, which will feed the new dewatering facility via a single duty progressive cavity pump with variable speed control. The civils works also include construction of a poly tank bund and pipe bridge to connect the sludge feed pipework to the centrifuge building.

The single Alfa Laval centrifuge is designed to support a maximum throughput of 1,300m^3 of liquid sludge per day, over an 11-hour shift, at around 4% dry solids, producing a cake of at least 25% dry solids. Sludge flow to the centrifuge will be measured using electromagnetic flow meters. In order to prevent the need for cake pumping or vertical screw conveyors, the centrifuge is to be mounted at height. In order to install the centrifuge, one of the largest in the country, the roof of the centrifuge building has been designed with a removable section to allow the centrifuge to be craned in and dropped into the first floor.

The poly dosing facility, to be designed and installed by SNF UK Limited, will operate using powdered polyelectrolyte. Therefore a storage facility with physical separation from wet areas is being constructed to reduce the risk of moisture getting into the powder. All poly equipment will be located in this steel-framed building, with architecture to match the existing site buildings. Due to the need to achieve a compact footprint for the new works, the centrifuge room is on the first floor of this building, with the powdered polyelectrolyte storage and preparation room at ground level below.

A 460m^3 silo will provide sufficient capacity to store 270t of sludge cake, with a walking floor to ensure efficient unloading of cake. This silo was constructed in a lay-down area off site using a jacking system. This has enabled the foundations and floor of the tank to be installed on-site whilst the tank is being constructed. The roof and top ring of the silo were constructed at ground level. Heavy jacks were used to jack the roof up to enable the next section of the silo to be installed. The operation continued until the silo was fully constructed. It was then craned into position using a 500t crane.

Sludge dewatering obviously has the potential to release odours. Therefore, part of the planning process involved considering ways to ensure that odour produced by the process did not become a problem. Sludge cake is to be loaded from the silo into 27m^3 articulated trailers using a screw conveyor.

A drive-through lorry loading building with roller shutter doors will enclose vehicle loading and prevent odour emission. This odour enclosure building is orientated to allow vehicles to drive through site and load, without the need to reverse.

An assessment was carried out of the treatment capacity of the existing odour control system, with odour contour modelling to confirm the impact of the new works. The new dewatering facility will be connected to this existing odour abatement system at the jetty, so the existing treatment units are being refurbished to

Construction of cake silo over extended dock *Courtesy of JN Bentley Ltd*

ensure they are capable of operating at their design capability. In addition, a chemical dosing system will be installed to dose Musol MPox into the raw sludge feed, to further counter the possibility of odour emission from the new plant.

The dewatering facility requires both process and washwater. An additional part of the project therefore, is minor works at nearby Hendon STW, to upgrade the final effluent pumping system.

Progress to date

Having commenced this design and construct contract in January 2011, the construction and commissioning of the plant are on target for completion in December 2011.

Outcomes and learnings:

At the time of writing, the civil engineering element of the project is 6 weeks ahead of programme which, on a project of this size, is unprecedented. The project team strongly believes this is due to the implementation of the CLIP process, which has also been instrumental in helping to deal with the challenging narrow footprint of the site and has helped JN Bentley, as Principal Contractor, to better understand subcontractor requirements and vice versa.

As a result, works have been better planned, enabling all contractors to continue simultaneously with clear and consistent coordination between subcontracted and civil elements of the project.

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Installation of metal-framed lorry loading building
Courtesy of JN Bentley Ltd