

# Bransholme Surface Water Pumping Station

## flood protection for the Bransholme and Kingswood catchment

by Stephanie Dye CEng MIMechE, Quentin Williams & Ray Kelly

The Bransholme and Kingswood catchment in north west Hull serves around 15,000 homes with separate foul and surface water sewerage systems. Flows from the two (north and south) surface water sewers combine in the pumping station wet well and are discharged to the tidal River Hull. The pumping station, discharge culvert and storage lagoon currently in use were all constructed in the 1960s as part of a larger Yorkshire Water treatment facility at the site. Most flows are discharged straight to the river via the culvert; however when river levels are high, water can be directed to the storage lagoon. When the tide falls and river levels subside the lagoon is drained by gravity to the river. With the wastewater treatment facility relocated to the main works at Hedon and only a transfer pumping station left, the surface water pumping station and lagoon are now enclosed by residential development, a leisure complex and the river.



Wet well and screw pump channels viewed from the tower crane - Courtesy of Arup

### Site history

The existing Bransholme Surface Water Pumping Station (SWPS) consists of a single submersible electric pump for dry weather flows and four diesel driven pumps operated duty/assist/assist/standby with a maximum capacity of 5.4m<sup>3</sup>/s for higher rainfall events. At over 45 years old the diesel pumps are nearing the end of their operational life.

In June 2007 Hull experienced heavy flooding and around a thousand homes in the Bransholme catchment were affected. It was identified that an upgrade would be required to provide greater protection for the expanding catchment and to reduce the risk of future flooding. Sewer network modelling confirmed that both the replacement pumping station and existing lagoon required increased capacity and plans were put in place to deliver both of these schemes.

In 2008, for flood risk reduction while designs for a replacement pumping station were developed, Yorkshire Water installed 2 (No.) additional pumps in a new dry well adjacent to the existing building to provide 100% back-up for the diesel units, an additional 5.4m<sup>3</sup>/s. In 2010 Black & Veatch completed a scheme to raise the walls of the lagoon and more than double the storage volume available to over 100,000m<sup>3</sup>.

### New surface water pumping station

It was imperative to replace the existing pumping station with one that could provide day to day protection for the catchment, but also had sufficient capacity to handle the high flows predicted to be delivered in major storm events. The overall capacity of the new station will be over four times that of the original installation, taking it from 5.4m<sup>3</sup>/s to 22.9m<sup>3</sup>/s to allow for peak flows and future connections of planned developments.



With a very low base flow and the potential for infrequent larger events, Archimedes screw pumps emerged as the most reliable option. The main advantage of this solution is that all the pumps, including the large storm pumps, can be run and tested dry to keep them in good working order for the moments when they are most needed.

Eight Archimedes screw pumps will be supplied by Spaans Babcock. Six storm pumps, each 3.75m diameter and capable of pumping 3.94m<sup>3</sup>/s, will operate as duty and five assists. Two smaller dry weather flow screws will each deliver up to 600l/s and operate as duty and standby.

The new pumping station will deliver flows to the river as before, via the same collection channel and discharge culvert. When the river is high, or the pumped flows exceed the culvert capacity, water will pass over a weir into the lagoon for storage.

The size and form of the pumping station is dictated by the screw pumps themselves and the electrical equipment required to power them. With Environment Agency requirements to keep all critical equipment above a potential flood level the motors and gearboxes, switchgear, transformers and control panels are all incorporated into the main body of the building and raised above the ground.

Additional architectural design and planning applications were provided by Arup, including new elements for Yorkshire Water pumping stations, with solar PV on the west side and a sedum and wildflower green roof system for the sloping screw pump covers. All these technical challenges were required to make a building in a very public location more appropriate for the setting.

#### The location

Early on in the feasibility studies it was identified that regardless of the pump type selected for the new station, to provide enough space for the new SWPS part of the lagoon footprint would have to be utilised. When the lagoon was raised, additional capacity was included to allow for a corner of the site to be given over to the new station at a later date and still retain the required storage volume.

Working within a Category A reservoir under the Reservoirs Act 1975 was not an easy option but the limitations of the site and sewer network made constructing the pumping station outside the lagoon extremely difficult. In addition to space constraints, although use of the storage capacity is infrequent, to provide continuous protection in case of a rainfall event the lagoon was required to remain in continuous service during construction.

The principle contractor for this design and build contract, Black & Veatch, developed a solution that permitted construction of the new wet well, pumps and building within the boundary of the existing lagoon. This will enable Yorkshire Water to maintain the lagoon as a working storage facility throughout the scheme.

#### Construction

Work began on site in March 2014. The first phase of construction was excavation of the 40m by 35m cofferdam within the lagoon boundary. Sheet Piling (UK) and MGF provided the cofferdam piles and support frames which allowed the 8m deep wet well excavation to be opened by TKL. With excavation at full depth, the construction of the wet well and channels to house the Archimedes screw pumps was commenced in stages by sub-contractor BBC. Removal of the final frame in May 2015 has allowed Black & Veatch to begin bringing the structure up above ground level for eventual connection to the building structure.

With 22m long screw pumps to support, the potential for differential settlement between the top and bottom bearings was another design question to be resolved. The solution agreed was for the eastern section of the building to be cantilevered off the below



Existing SWPS diesel pumps - Courtesy of Arup



Existing SWPS building - Courtesy of Arup



View of existing SWPS - Courtesy of Arup



View of the pumping station building from the west lagoon boundary - Courtesy of Arup



ground structure so that if settlement occurred both bearings would move together. The remainder of the steel framed, brick clad building would be supported on piles through the lagoon base.

These precast concrete piles were installed through a piling mat in the base of the lagoon. To protect against seepage paths through the clay lining, each pile was driven through a plug of bentonite pellets which will absorb moisture and form a barrier to further water movement. The building steel frame is being installed in sections by SCS, with the first stage completed in May 2015 and ready for installation of the internal blockwork and brick façade to begin.

Following completion of the new water tight boundary, a lagoon test will be required to prove the works are satisfactory before removal of the corner section of the existing to allow re-landscaping and construction of a crane pad. A further excavation will then be made to install a culvert from the North Sewer to the wet well which will remain isolated until commissioning is complete.

#### Pumping station fit out

Once the building exterior is in place, the mechanical and electrical installation will commence. The screw pumps will be delivered from Spaans Babcock in the Netherlands and installed using a 500t crane. This will also be used to lift 4 (No.) Winders transformers into place in the back of the building. Three transformers will connect into the Igranic 3.3kV MCC for the supplying the storm pumps, and one to the Lintott LV MCC to supply the smaller pumps and site wide services.

Due to the proximity of the neighbouring properties, the building fabric is designed to provide enhanced noise reduction from the motors and gearboxes while the green roof panels reduce the transmission of noise from the movement of water in the screws themselves.

The green roof is designed in precast panels and will be planted by specialist green roof supplier Optigreen to require minimal irrigation and maintenance. These panels will be supported on columns and precast concrete beams over the screw channels.

#### Commissioning

Without a guaranteed storm event to test the new large capacity pumps, off-line testing and dry runs will be completed before the new pumping station can be connected into the sewer network. An agreed programme of testing and commissioning is due to take place in the autumn, to provide confidence that the system works as designed before it is connected into the sewers. The break in to the North Sewer and diversion of flows from the South Sewer to the new culvert will then be completed.

#### Demolition

With the new pumping station live and taking all the flows from the catchment, the 1960s pumping station will be demolished. Some of the pumps and electrical equipment, including the two emergency pumps installed in 2008 and associated generators and starters will be retained for use on other sites. The pumping station building will be completely levelled, the wet well back-filled and the area re-landscaped with trees, shrubs and wildflowers to provide some visual shielding of the pumping station from the local properties.

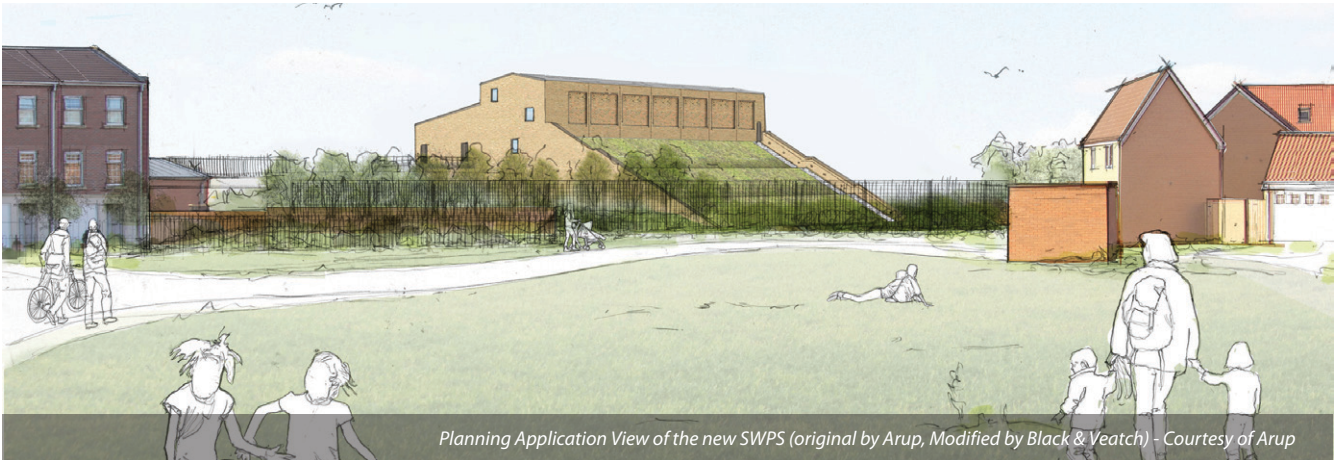
#### Community engagement

Since 2007 the site around the lagoon and SWPS has been surrounded by new homes. With neighbours so close, a huge effort was needed to engage with the local community, many of whom were unaware of the historical flooding.

A bespoke communications plan was implemented from the investigation and the pre-planning stage which included several customer events in the local area. Since planning approval was received, further events have been held and regular newsletters



Archimedes screw pumps - Courtesy of Spaans Babcock



Planning Application View of the new SWPS (original by Arup, Modified by Black & Veatch) - Courtesy of Arup

issued to properties in the surrounding area. Local interest in the project has been very high and communication with the council, local drainage boards and the MP for Hull has been on-going throughout the development of the scheme.

Yorkshire Water has taken the high profile nature of the work as an opportunity to engage with the local community through schools, running an outreach programme trial unique to the area. The company runs two education centres at Headingley WTW (Leeds) and Esholt WwTW (Bradford), designed to support Key Stage 2 learning, which have around 8,000 visitors annually. However, due to the distance from Bransholme to these facilities the education guides were taken on the road.

Six primary schools took up the opportunity and welcomed guides to talk about the pumping station scheme, the role and importance of water in the environment and provide safety advice about construction sites. On the back of this success, one school is working

with Yorkshire Water to run a competition for the children over the summer holidays to name the eight screw pumps and produce a poster. Children with the winning suggestions will receive a prize and have their names etched on a plaque within the building. They will also be given the chance to see their plaque unveiled when the SWPS is opened by MP Diana Johnson.

#### Contract delivery

Yorkshire Water have employed Black & Veatch as principle contractor, with Arup providing technical consultancy and site supervision services throughout the design and construction. Turner and Townsend are providing cost consultancy services. Overall project completion is forecast for early 2016.

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