Seaham Sewage Pumping Station

upgrade of storm screening facility

by Matt Agar BSc CEng MICE

Seaham is a small town in County Durham situated approximately 6 miles south of Sunderland and 13 miles east of Durham. Seaham Sewage Pumping Station (SPS) is part of the sewage treatment works (STW) constructed and commissioned in phases between 1996 and 2001 to enable raw sewage from Seaham and the surrounding area to receive treatment to meet the 1996 bathing water standards, before being discharged to sea. The STW serves a population equivalent of approximately 36,000; dry weather flow, flow to full treatment (FFT) and Formula A flows are 165, 330 and 750 litres per second respectively.

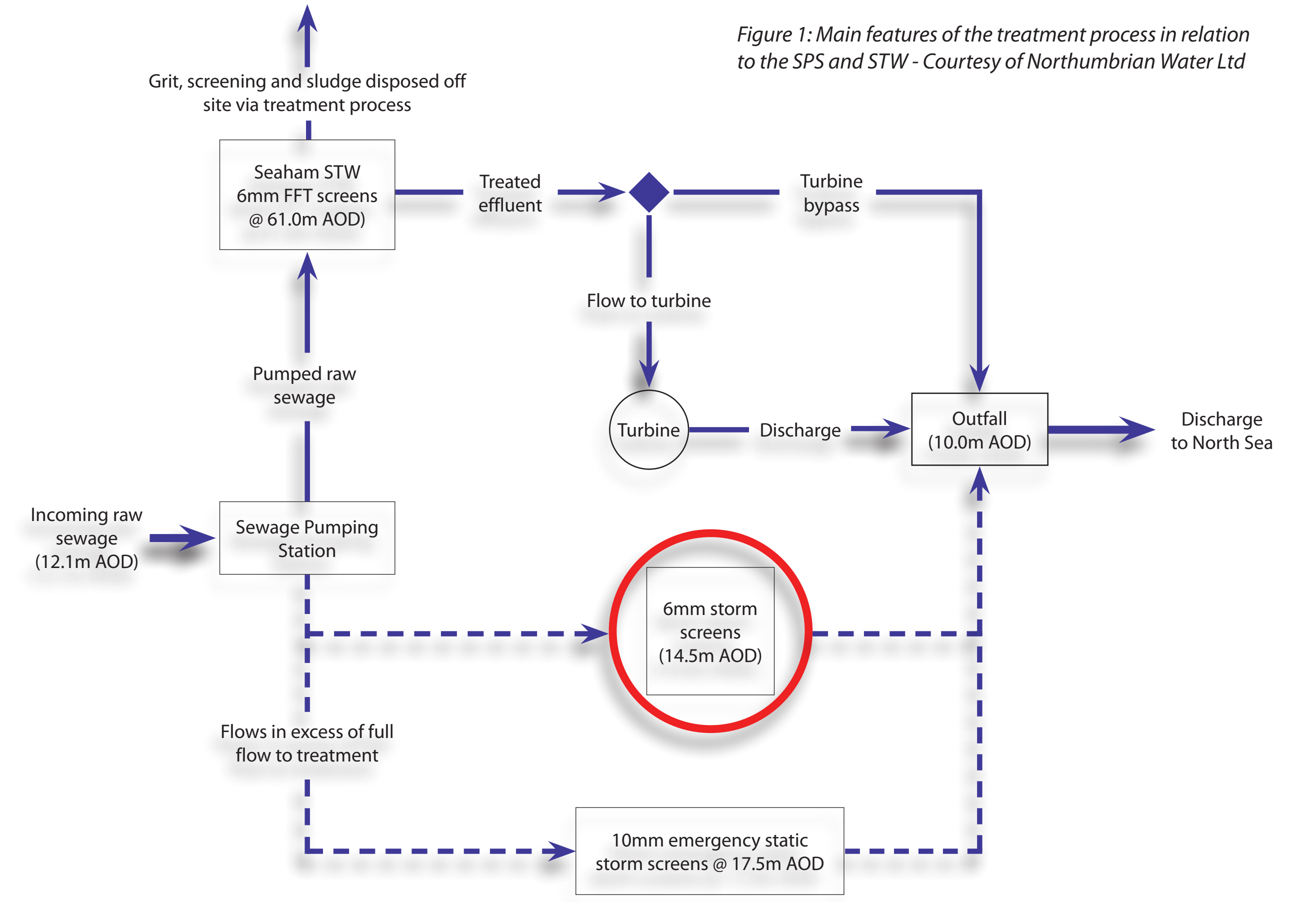

Figure 1: Main features of the treatment process in relation to the SPS and STW - Courtesy of Northumbrian Water Ltd

Figure 1 (above) depicts the main features of the treatment process in relation to the SPS and the treatment works. Fine screens, for FFT were designed to take a flow of 330 litres per second and the 2 (No.) duty storm screens, for flows in excess of full flow to treatment, were designed for 900 litres per second each.

The most relevant part of the discharge consent, so far as storm flow at the SPS is concerned, is to the effect that discharge shall only occur when the rate of flow at the overflow is in excess of 330 litres per second and that such discharge shall not contain matter greater than 6mm in two dimensions.

The STW itself is located at the end of a 1.8m diameter, 2km long, interceptor sewer on the coastline to the south of Seaham and the SPS is situated at the lower end of the site built over a deep excavated shaft to accommodate the very low invert level of the incoming interceptor. The shaft is approximately 20m in diameter and 40m deep and is divided at the base to form the station's wet and dry wells (see figure 3). The inlet works fed by the SPS is located approximately 100m to the east and 55m above the pumping station wet well.

Reason for the work

As part of the original installation, 2 (No.) storm screens comprising horizontal bars with 4mm gaps and a reciprocating comb removal mechanism had been installed. They were difficult to maintain; the main problem being blinding due to trapped, compacted, screenings ultimately causing the screens to fail with the risk to Northumbrian Water (NW) breaching discharge consent.

Design development

Northumbrian Water appointed MWH to prepare a feasibility study to identify options to improve the reliability and maintainability of the storm screening facility at the pumping station. Particular problems associated with determining the optimum solution included:

- Difficult location of the screens (inside deep pumping station wet well shaft) and the requirement to include a facility to maintain the screens.
- Selection of screens that, under emergency flow conditions when submerged under three metres head of water (difference between emergency and storm spill levels) will continue to remove screenings that will have been compressed onto the screening mechanism.
- Selection of screens that can structurally resist the head differential referred to under the foregoing bullet.

Screens provided by a number of suppliers were investigated with the final choice being 2 (No.) Hydrok 'MecMex' screens. Hydrok worked with MWH to devise an innovative solution that minimised demolition and construction work within the live wet well. The screens were installed at the bottom of bespoke, prefabricated, stainless steel shafts complete with integral guiderail system facilitating raising of the screens to first landing level of the pumping station for ease of cleaning and maintenance. The screens consist of wedge wire baskets with 6mm x 6mm apertures cleaned by opposing hydraulically driven brushes on each side of the screening surface. The brush arrangement prevents the tendency for screenings to become hair pinned and facilitates screenings removal even when there is no flow away from the screen.

Hydrok also designed, manufactured and installed stainless steel baffle walls to create shafts to prevent unscreened and screened effluent mixing as the level within the well rises and therefore extend above the emergency screen overflow level; they also prevent the storm screen guiderails from becoming clogged as they would otherwise be exposed to unscreened sewage.

They further installed a bespoke overhead lifting system mounted to the underside of the chamber roof to enable all component parts to be lowered into position via the existing restricted manhole opening. This was necessary as any modifications to the chamber roof structure were prohibited.

The control panel and power packs for the hydraulically operated cleaning mechanism are located outside the wet well with level detection instrumentation being the only electrical equipment associated with the screen present in the well.

As it was not feasible to install a large access above each screen to facilitate removal, core drilled holes were provided allowing the screens to be lifted using the existing SPS overhead radial crane and be maintained within the wet well. A Hydrok provided lifting beam is lowered into the wet well using the overhead radial crane. It is then picked up using low level lifting device, manoeuvred to the screen position onto a mesh walkway above the screen from where it is re-slung to the radial crane using lifting tackle through the core drilled holes over the screen. The screens can then be lifted to a clear height. Re-installation is the reverse process to the foregoing.

The screens are started by rising level in the wet well sewer chamber sensed by an ultrasonic sensor. On cessation of the storm event the ultrasonic gives off a signal that cues a timer to provide 30 seconds continued cleaning before the screen deactivates. The screens then switch just before the next out-stroke, when the cylinder and brushes are parked. A short, daily, exercise routine irrespective of the level in the wet well enabled by a programmable timing device occurs.

A 3D survey of the pumping station shaft and the wet well was obtained to reduce risk of dimensional related errors (see figure 2).

Construction

An NEC3 Option A contract was let on 16 August 2011 to MWHT for the construction of the works including elements of detailed design for the storm screens and associated equipment. The starting date

*Hydrok stainless steel wedge wire profiles utilised in all Hydrok CSO screens

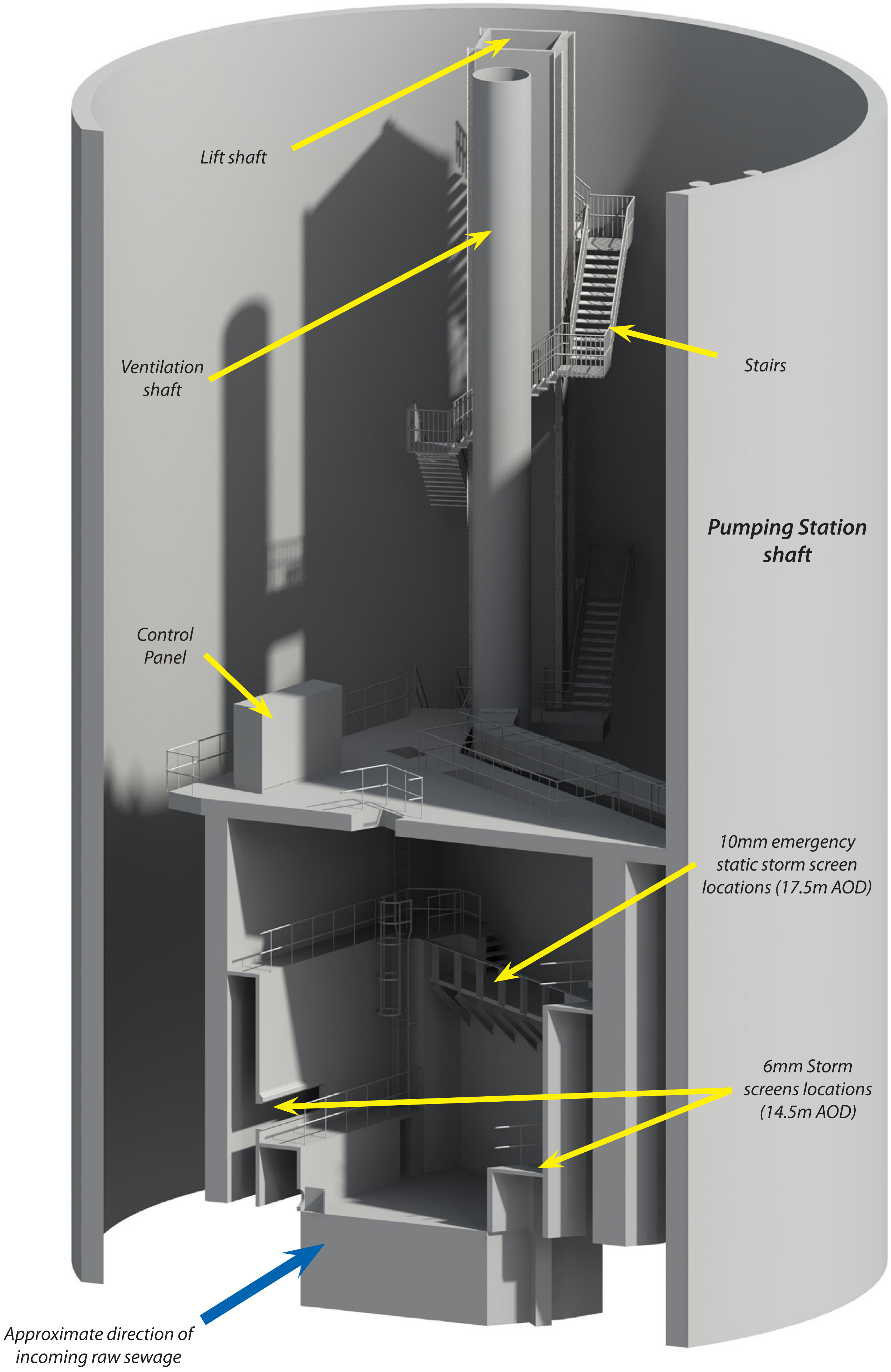

Figure 2: 3D image of SPS - Courtesy of Northumbrian Water Ltd

was 22 August 2011 and the contractor inserted completion date was 1 February 2012. Option C had been considered but discounted largely because it was decided to maximise the contractor's incentive to complete work in the wet well as quickly as possible. Rates for costing standing time due to storms (defined by levels exceeding a specified point) or employer instructed stoppages (for maintenance) were included in the contract facilitating easier assessment of compensation events.

To accommodate each of the two new screens it was necessary to cut out and re-profile sections of existing reinforced concrete at the locations of the redundant screens. This was to ensure uninhibited flow, with minimal risk of ragging at the underside of the new screens. Each of these sections to be removed and profiled was approximately 1.1m wide x 1.5m deep by 3.5m long (triangular in cross-section).

Working inside the confined space of the wet well and without allowing debris to fall into the well where major pump damage could easily occur was a major, and difficult, task. The contractor's plan was to erect a fixed platform from which to work and break out the reinforced concrete walkways in circa 200mm wide by 50mm deep segments using air operated tools.

Debris was to be collected in small skip buckets and lifted to the surface using the SPS's overhead cranes. Following concrete excavation the new screed would be formed by attaching formwork to the concrete walls. Netting was attached beneath the platform and tools were tied off within the well to minimise risk of pump damage.

Flows had to be carefully monitored throughout the works as, in the event of a storm, levels could rise quickly within the well. This was achieved by closely monitoring the weather forecast and if there was a threat of a storm event no work would be carried out inside the wet well. An upstream CSO feeding the SPS was also monitored; communication via a two-way radio being key to the safety of the operation.

A further complication was the ongoing operation of the STW. In the event of failure at the inlet works it was necessary to inhibit the pumps within the wet well and this was managed by monitoring the on-site SCADA system with messages relayed to site personnel within the wet well to leave the working area if necessary.

The labour intensive method of breaking out concrete proved to be time consuming and was abandoned in favour of wire sawing; tests on concrete samples from sections of the aprons to be excavated returned values in the range of 72 to 75kN.

Conclusion

The use of the revised wire sawing method contributed to the recovery of delays associated with the former method and the completion date was revised from 1 February to 21 February 2012 as a consequence of various delaying events. Completion was ultimately achieved on 10 February 2012. The key project participants were:

Client	Northumbrian Water
Principal contractor	MWHT
Storm screens designer/supplier/installer	Hydrok (UK) Ltd
Technical Consultant	MWH
Commercial Consultant	Faithful and Gould

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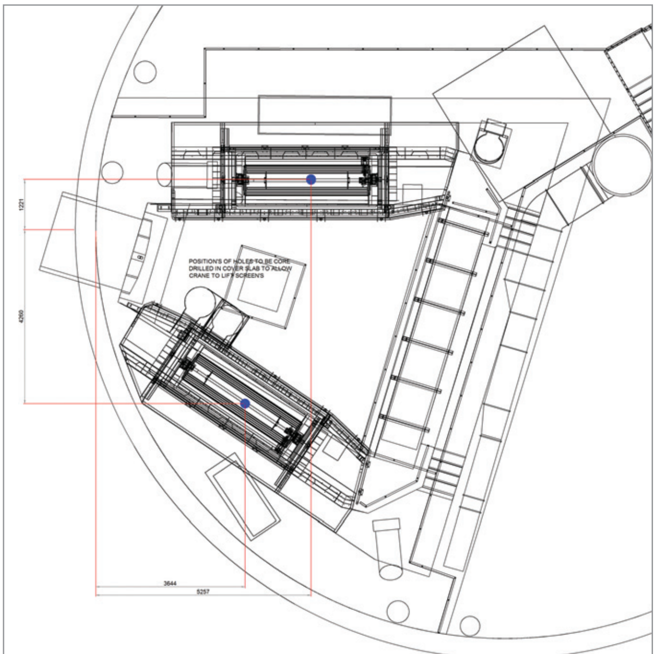
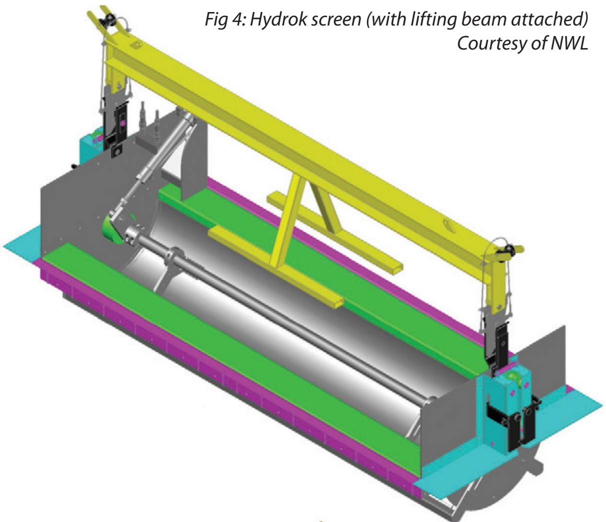


Fig 3: Plan of screens - Courtesy of NWL

Fig 4: Hydrok screen (with lifting beam attached) Courtesy of NWL



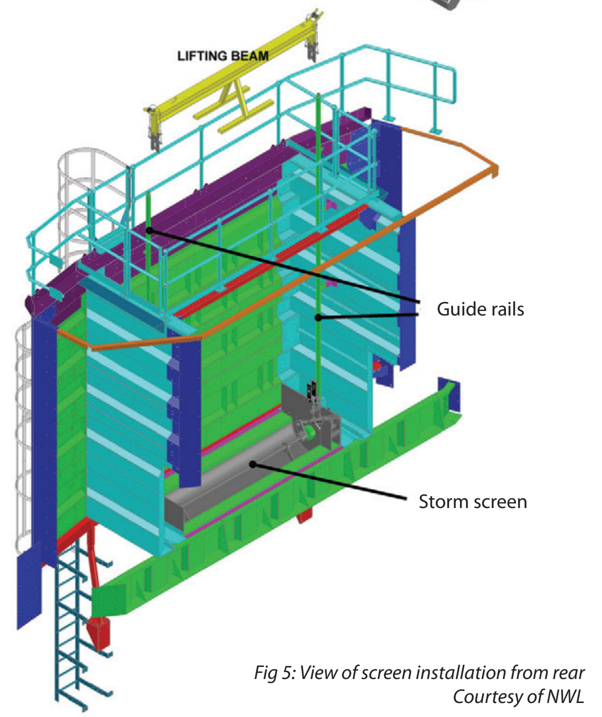


Fig 5: View of screen installation from rear Courtesy of NWL