Ivybridge Bathing Waters

attenuation and screening of combined sewer overflows and UV disinfection of treated effluent, to meet the rBWD for Mothecombe bathing waters

by Sally Walters MEng (Hons) CEng MICE MIET & Mike Crisp BEng (Hons) CEng MICE

Ivybridge is a small town, lying on the edge of Dartmoor in South Devon set on the River Erme. It lies about nine miles east of Plymouth and seven miles from Mothecombe beach and was once known as one of the fastest growing towns in Britain. With a population of almost 12,500 it is the largest town in the South Hams district. Improvements to the storm storage and sewerage system at Ivybridge were required to achieve the new European revised Bathing Water Directive (rBWD) 'sufficient' classification at Mothecombe bathing water, as part of South West Water's *Even Cleaner Seas* project.

Tunnel boring machine 'Hannah' lining up for the 150m journey to commence - Courtesy of H5O

Project need

The improvements to the storm sewerage system will reduce the volume of storm discharges to the River Erme by 75%, reduce combined sewer overflow (CSO) discharges to less than three significant discharges (50m^3) per bathing season, provide aesthetic improvements through the provision of screening on all CSOs, and disinfection of the final effluent at the sewage treatment works (STW). Monitoring systems have also been added to facilitate measurement of performance and compliance.

Background

The European Union's revised Bathing Water Directive came into force in March 2006 and replaces the current Bathing Water Directive. The overall objective is the protection of public health, but it also offers an opportunity to improve management practices at bathing waters and to standardise the information offered to bathers across Europe.

The directive introduces a new classification system with more stringent water quality standards. The water quality standards for the new classifications are much higher than those of the original bathing waters directive. The Government's target under the new directive will be 'sufficient', which is approximately twice as stringent as the current 'good' (mandatory) standard. South West Water's *Even Cleaner Seas* project was established to ensure that South West Water's infrastructure did not prevent bathing waters from meeting this standard.

Even Cleaner Seas

A total of 13 major improvements were identified at nine bathing waters within the region. The town of Ivybridge was the key site identified for the Mothecombe bathing water as the biggest contributor of storm spills to the River Erme, and hence having the greatest impact on Mothecombe Bay.

Project management

This scheme was delivered by H5O, South West Water's Engineering Alliance. The project was delivered early and below budget due to a number of innovative approaches facilitated by the collaborative approach taken by all partners including the client, designers, main contractor and specialist subcontractors. This included remodelling and verification to minimise the required storage volumes, an additional auger bored low level link pipe to the existing storm tank, and selection of an earth pressure balanced tunnel boring

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The 15m diameter storm tank whilst tunnel boring was under way. The TBM was launched from the tank - Courtesy of H5O

'Hannah' the TBM at launch - Courtesy of H5O

View down the 1.2m tunnel under construction beneath the A38 dual carriageway - Courtesy of H5O

The screen installation into the 3m dia shaft at Keaton Rd. A combined H5O effort produced a solution for a tight space - Courtesy of H5O

machine which required a smaller reception shaft and thus less disruption to local residents at the constricted end of the tunnel and associated cost savings.

The scheme has also won South West Water Pure Environment Awards and more recently won the United Kingdom Society for Trenchless Technology (UKSTT) Awards in the New Installation category.

Detailed design and construction

The works comprised the following key elements at several different sites:

- Reconfiguration: A new screen and event duration monitoring (EDM) at the existing Erme Road CSO.
- EDM installation at the existing Station Road CSO.
- 3m diameter, 7m deep storm storage and screen chamber at Keaton Road, constructed using jacked caisson shaft.
- 1.2m diameter, 165m long storm sewer under the A38 from Keaton Road to Ivybridge STW, constructed using micro-tunnel boring machine.
- 15m diameter, 10m deep, 1,500m^3 storm storage tank at Ivybridge STW, constructed using segmental jacked caisson shaft.
- 2 (No.) automatic siphon actuated Hydrok flushing bells in the new storm tank.
- Low level 500mm diameter interconnecting sewer between existing and new storm tanks at the STW, constructed using auger bore.
- New settled storm overflow outfall and EDM monitoring at the STW.
- UV treatment on the FE at Ivybridge STW.

During the feasibility phase, one of the biggest issues that became quickly apparent was the lack of capacity within the existing sewerage system just upstream of the STW and how to get increased flows from Keaton Road on the north side of the A38 dual carriageway, to the STW on the south side. Many options were explored including pipe bursting and upsizing of the existing sewer, an option to install a new pumping station at Keaton Road to pump flows to the STW, as well as varying options of splitting the catchment flows and providing offline storage north of the A38.

The final solution was derived following detailed modelling and feasibility assessments with early ground investigation (GI) undertaken to inform the ultimate design solution. Using the GI H5O was able to engage the Highways Agency (HA) early in the feasibility stage to seek agreement to construct a 1.2m diameter tunnel under the A38. Agreement was reached quickly on an appropriate tunnelling methodology to minimise the risks from surface settlement. Minimal overcut, face loss and post construction grouting specifications were confirmed as achievable and gave confidence in minimal to no surface settlement of the highway.

The machine chosen was an earth pressure balanced tunnel boring machine; this was shorter than the slurry equivalent and resulted in a smaller reception shaft. The boring machine also allowed the team to monitor the ground conditions closely and at times change the teeth from spades to points, which turned out to be critical due to the variation between soft slates and very hard white quartz.

The chamber at Keaton Road served as the reception chamber for the tunnel boring machine as well as forming a screening chamber at the head of the storm storage tunnel and shaft at the STW. The site proved particularly challenging due to a number of constraints. The chamber was located at the end of two very narrow residential roads, constrained by the A38, the River Erme and residential housing. There were a number of service conflicts, including medium pressure gas mains. The space available limited the size of the chamber, presenting a challenge to the screen and

M&E contractors to install a mechanically cleaned 375l/s screen in a 3m diameter chamber. H5O worked together to design and install a Huber ROK1 auger brushed horizontal basket screen mounted on a Hydrok stainless steel frame with a Hydrok lifting system.

H5O used a hydraulic model to develop a solution with minimal storm storage construction in the town centre area by making maximum use of existing available sewerage volume. Additional storage totalling 300m^3 was achieved by adjustment of overflow weir levels and the use of a Hydrok MecMex screen with minimal headlosses at Erme Road CSO, mobilising available sewer capacity whilst maintaining acceptable sewer surcharge levels and flood risk. This eliminated the need to provide any storm storage and potentially disruptive pipe upgrades in and around the town centre and war memorial areas.

Erme Road CSO chamber is located in the middle of a one-way road system, making any proposed construction work on the chamber potentially very disruptive. Due to seasonal constraints and working in and around the war memorial, H5O was only able to agree a one-week road closure for completing the work at the beginning of December. The time constraints, minimal design information on the chamber and confined space working meant that close working with the contractor was required to ensure that the existing cover slab could be broken out, the screen installed and a new cover slab installed in less than a week. This was all successfully achieved.

At the STW a solution to link the existing storm tank and new tank provided a simple cost saving alternative to extensive pipework upgrades and provided a simpler solution to returning the storm flow. Using a trenchless, auger bore solution allowed the existing storm tank to drain to the new tank thus utilising one set of pumps for both tanks. It also allowed the pipeline to take a direct route beneath the existing inlet works, various works pipelines and sludge tanker access road.

The 15m diameter storm tank at the STW was constructed as a jacked caisson shaft. The ground investigation showed that below a 3m band of granite cobbles, boulders and sand there was a weak Devonian slate with veins of quartz. The caisson worked well and provided support through the upper granite boulders cobbles and sands, but at around 10m it became difficult to jack within the tolerances, and the shaft had to be completed using an underpinning method. This was due most likely to large granite boulders acting like cam locks behind the upper rings and jamming them in place. The shaft at Keaton Road was constructed in the same way.

The ground conditions also presented challenges to the auger bore probe for the 500mm diameter storm tank connecting sewer, which frequently came up against quartz veins which could not be penetrated by the displacement head. H5O overcame this issue by retracting and removing the probe head and replacing it with a bespoke rock drill head to get through the quartz. Although laborious it proved to be effective.

Alongside other improvement work planned in Ermington, Modbury and Holbeton, this represented a £7m investment in river and bathing water quality in South Devon, with up to £20m being spent in 2014/15 to improve bathing waters across Dorset, Devon and Cornwall.

Sustainability

The project team identified an opportunity to process the concrete demolition material on site to generate hardcore for use in temporary roads and hard standings. This not only avoided the use of primary aggregates but reduced the volume of traffic to and from the site.

The location chosen within the existing sewage treatment works for the 15m diameter shaft was effectively a brown-field site and

required the removal of previously abandoned and backfilled concrete settlement tanks. The tanks were pre-1950s and very little was known about the construction including the size and quantity of reinforcement. Investigations showed that the tanks were predominantly mass concrete with very little reinforcement, making them highly suitable for small scale aggregate recycling.

Sustainability benefits:

- Quarrying and transportation of 500 tonnes of primary aggregate avoided.
- Transport of 500 tonnes of demolition waste away from site avoided and associated landfill implications.
- One excavator used for all activities again avoiding transportation implications.
- Associated reductions in carbon generated and reduction in impact on the local residents.

Community liaison

While the work was taking place, weekly progress and look-ahead posters were displayed to keep the local public informed. Residents were informed with letter drops prior to changing the traffic management arrangements and when it was necessary to work the occasional weekend.

A guided site visit was arranged for interested members of the public, and they were invited to see the tunnel boring machine break through to Keaton Road. Over a four-week period 130 engineering students from Plymouth University visited the site during construction.

The team approached Devon & Somerset Fire & Rescue Service to offer the site as a training ground for a rescue scenario. A dummy was placed at the bottom of the storm tank at the 10m deep storm tank at the STW and using rope and a lifting frame two teams worked together to enter the tank and recover the casualty. The Fire & Rescue service were grateful for the opportunity to exercise their line rescue techniques.

The site team also visited the local primary school to introduce the scheme and facilitated some group activities such as hazard spotting, word searches and a poster competition. They introduced Considerate Constructors' mascot 'Ivor Goodsite' to hand out fun packs. A few days later the children visited the site and were shown around by the site manager. The results of the poster competition were impressive and the prizes included a family admission to the National Marine Aquarium and £10 book vouchers.

Completion

The works were successfully completed in January 2015. All of the scheme initiatives achieved wider sustainable benefits exceeding expectations in protecting the environment, improving on existing best practice and supporting the local community. In achieving this level of customer service, the team themselves have had the opportunity for personal development and considerable job satisfaction, and working with the stakeholders to make sustainability a central part of day- to-day work.

The main purpose of the *Even Cleaner Seas* scheme will bring direct benefits to this area which is heavily dependent economically on the tourist trade.

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Aerial view of the tunnelling in progress - Courtesy of H5O