Alltwen-Pontardawe Combined Sewer River Crossing

a collaborative approach to find an innovative solution for a new combined sewer river crossing to reduce CSO pollution and property flooding

by Darran Waters BEng MSc CEng MICE

The Alltwen to Pontardawe Combined Sewer River Crossing project involved replacing an existing, deficient combined sewer inverted siphon crossing of the River Tawe in South Wales, with an innovative above ground pipebridge solution. The project was necessary to transfer flows from the Alltwen catchment to a newly constructed CSO at Pontardawe on the opposite north-west side of the river, thereby allowing the decommissioning of an existing problematic CSO on the south-east bank. The existing CSO had poor access, was unscreened and produced unsatisfactory discharges to the river. The existing 225mm diameter siphonic river crossing which carried pass forward flows from this CSO was under capacity, restricting flows to the new CSO, and contributing to the flooding of a number of properties in the upstream Alltwen catchment, as well as presenting significant maintenance issues for Welsh Water. This article describes the collaborative approach to develop an optimal solution and mitigate numerous design, planning and construction risks.

Completed pipebridge from South East side of river - Courtesy of Arup

Background

This scheme was originally Phase 2 of a CSO scheme which started in AMP4. However; the upstream sewerage and the river crossing were not completed in AMP4 due to a number of identified risks and technical difficulties with the river crossing itself. A decision was made to defer the scheme to AMP5 and this is when Morgan Sindall and Arup's involvement started.

The driver for the original AMP4 scheme was pollution caused by the unsatisfactory unscreened CSO on the south east bank of the River Tawe combined with nine flooding properties- six Serious External Flooding (SEF) and three Other Flooding (OF) - in the upstream catchment resulting from insufficient capacity in the collector sewers to transfer the flows to the CSO.

The original solution comprised new upstream sewerage including a trunk road crossing, a bifurcation in the upstream network and a new 600mm diameter siphon to operate alongside the existing siphon to provide the additional capacity required. This solution met the drivers for the scheme.

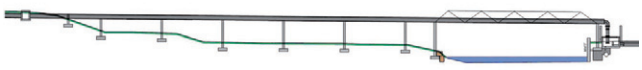
The brief was to take the AMP4 design for Phase 2 and deliver it to allow the new CSO to receive the full flows from the Alltwen side of the river and therefore allow the unsatisfactory CSO to be decommissioned.

This would also provide sufficient capacity downstream to allow the upstream sewer capacity to be increased, relieving the pressure in the local network that was leading to flooding in Alltwen.

North West river bank retaining wall - Courtesy of Arup

Virtual reality pipebridge visualisation - Courtesy of Arup

Completed pipebridge from North West side of river - Courtesy Arup



Pipebridge sketch - Courtesy of Arup

Pipebridge and above ground pipework in construction
Courtesy of Morgan Sindall

Approach

Our approach was to identify and fully understand the problems and constraints of the existing upstream sewerage and river crossing, before developing a solution working together with Morgan Sindall and Welsh Water. We held meetings with the operators and walked the route of the proposed works with them. It soon became clear that the existing siphon had experienced problems in the past and any scheme to duplicate the siphon would need to address those problems. From a construction point of view we worked with Morgan Sindall to identify and assess the risks associated with tunnelling under the river. These risks related to the lack of visible footings to the retaining wall on the north-west river bank and cobbles in the ground adjacent to the river that could cause problems for any form of tunnelling.

Challenge

The challenge was to come up with a solution which removed the risks associated with going under the river and excavating at depth behind the retaining wall. The only way to achieve this was to go above the river rather than below it; this would cause significant visual impact, would be in the flood plain and would sterilise the existing land. Further investigation was required in order to come up with a design that would be acceptable to the Natural Resources Wales (NRW), Neath Port Talbot County Borough Council (NPTCBC) and the land owner.

Following consultation with the NRW and the submission of a Flood Consequence Assessment, it was agreed that the pipebridge would be acceptable providing it had no detrimental effect on the 1 in 1,000 year flood level. It was also agreed that the invert of the pipe should be a minimum of 1m higher than the 1 in 1,000 year flood level. This level was critical and meant that the sewer would need to be above ground from this point all the way to the river. This presented a new risk that this would be unlikely to be acceptable to the land owner, the planning authority as well as local councillors.

The advantages of the above ground solution to DCWW were that the troublesome siphon could be abandoned and that no additional siphon was required. It was considered that the downside of having the pipework above ground and above the river were minor in comparison. In the past, Welsh Water Operations have had to dig down to the siphon upstream of the river for it to be unblocked.

There is currently no access to the downstream upward leg of the siphon where there are two 90º bends. Operations therefore requested that, if the siphon option went ahead, access to the downstream upward flow leg would need to be provided. This presented a further risk due to the required location of a chamber immediately next to a retaining wall of suspect integrity.

Design Issues

The pipebridge solution comprised 65m of above ground pipwork supported on piers and a 28m section of pipebrige to span the river and a dissipation chamber on the downstream side of the river to bring the pipe back underground where it connected into the pipework upstream of the CSO.

There was a risk of potential subsidence with the presence of shallow mine workings along the route. For this reason additional ground investigation (GI) was specified for the foundation design of the above ground pipework and pipebridge. Following this further GI we managed to design out the need for piled foundations.

To reduce the number of pier and footing details to a minimum, it was necessary to span as far as possible with the pipework. This meant using a Class K9 cleanwater pipe with a bending moment of 348 kN.m which allowed a10.5m spacing between the piers.

Shallow pipework downstream of the river meant that the dissipation chamber would either be above ground adjacent to the

river or below ground in the grass sloping towards the CSO, with the pipe crossing above a cycleway. The solution agreed during the site meeting with the councillor and planners was for the above ground chamber to be clad full height with recycled stone from an existing abandoned shelter that needed to be demolished and which then retained some of its period features.

This solution allowed the building of an above ground chamber in a sensitive area and provided gated access to the chamber for maintenance. A virtual reality visualisation helped to demonstrate how the structure would look and enabled an acceptable solution to all parties to be agreed on site.

The adjacent Tesco Superstore had a pumped discharge into the below ground sewer upstream of the existing siphon. However, with the above ground solution this pipe was raised from 28.84 to 32.48m AOD increasing the static head required for the pump by 3.74m. This was overcome by changing the impellors in the Tesco pumping station to cope with the additional head and so connect into the pipe above ground. There were no other connections in this section of pipework.

The pipebridge truss girder design was required to span 28m between two 2m wide 0.4m thick reinforced concrete supports. The truss girder was galvanised to provide an 85 year design life, design loadings included the self weight of the pipe including an assessment of the maximum volume of sewage, an imposed load for maintenance and wind loading. No river loading was necessary due to the pipe being 1m above the 1 in1,000 year flood level.

Planning Approval

The challenge of having designed a technically viable option was to get planning approval for a substantial above ground pipe and bridge structure adjacent to a well maintained footpath and cycleway. The council was, at the same time, spending money rebuilding natural stone walls and improving the area as an attractive amenity space, and so a before and after virtual reality visualisation was produced to help in discussions with the council and councillors who met on site to consider the proposals.

Successful Delivery

Construction started in August 2013 and was completed on programme in December 2013. This included a 6-week fabrication period for the truss girder which was delivered and installed in a single day using a 400 tonne crane located on the south-east bank of the river and a 40 tonne crane on the north-west bank. The outturn cost of the scheme was £0.973m compared with the target cost estimate of £1.32m for the pipebridge option and an estimated £1.7m for the original siphon option.

The success of this project was due to the persistence and collaborative approach taken by Welsh Water, the delivery team and third party stakeholders. Through engaging with Operations to fully understand the problems with the existing siphon crossing, a more robust solution could be developed. Construction risks were identified early in collaboration with Morgan Sindall, and planning and approval risks were resolved through stakeholder engagement and innovative visualisation tools.

The above ground solution allows the combined sewer flows to get to the screened CSO preventing regular pollution events; it frees up capacity in the upstream network to prevent flooding affecting numerous properties and it will be a maintainable asset removing operation risk. All this would not have been possible without a collaborative approach building on relationships within Welsh Water and other stakeholders.

The Editor & Publishers thank Darran Waters, Senior Engineer with Arup, for preparing the above article. The author thanks Welsh Water, Morgan Sindall plc, and Arup for their input and assistance.

Crane lift of truss girder and pipe - Courtesy of Morgan Sindall