# Blackburn UID Scheme

## detailed design and construction of extensive modification works to an existing CSO chamber to resolve an unsatisfactory intermittent discharge

by Katie Eyton BEng

Blackburn combined sewer overflow (CSO) had been categorised as an unsatisfactory intermittent discharge (UID) with an aesthetic driver because it was failing to adequately screen the storm spills to the required criteria. The purpose of the project was to resolve the UID from the combined sewer network to ensure that flows up to and including a 1 in 5 year return period are screened to the required standard of 6mm in two directions before spilling to the river. The dry weather flow in the CSO is 400l/s with a 1 in 5 year peak inflow of 6941l/s. The peak storm flow to be screened is 5844l/s.


*Removal of the concrete roof sections to CSO chamber - Courtesy of JN Bentley Ltd*

### Background

The existing CSO, which covers a region of approximately 34km$^2$ and serves a population of around 130k residents, had 2 (No.) powered screens to provide screening of flows during storm conditions. During dry weather flow conditions, flows enter the CSO chamber through the 2.1m diameter incoming sewer and pass unrestricted through the chamber to the downstream sewer.

During storm conditions the pass forward flow is controlled by the twin 900mm diameter outlet pipes at the downstream end of the CSO chamber. These twin pipes restrict the pass forward flow and in times of storm this causes the level to rise in the CSO chamber. As the level continues to rise and overflow the weirs, the 2 (No.) mechanical screens operate screening the flows prior to them entering the spill channel and discharging into the River Blakewater to the north of the site.

### Scope of works

The contract was awarded to JN Bentley Ltd by United Utilities as part of its AMP5 Capital works Programme. The scope of work was the detailed design and construction of extensive modification works to the existing CSO chamber in order to install new powered screens.

The 2 (No.) existing powered screens were to be replaced by 4 (No.) Longwood 'StormGuard' 650 model screens. Both existing screens spilled in to a single 2.6m wide spill channel on one side of the main 5m wide through-flow channel. The 4 (No.) new screens were to be configured as two pairs of two such that a secondary spill channel was required on the opposite side of the through flow channel. Some modifications to the existing chamber walls and weirs were also required.

In order to replace the screens, the roof of the existing chamber needed to be removed. A new roof would be provided with access arrangements specifically suited to the operation and maintenance requirements for the new screens.

New outfall structure and masonry walls were also to be provided for the new spill channel.

A control kiosk was to be provided to house the control panel and associated electrical and telemetry equipment for monitoring and control of the screens.

### Constraints and challenges

One of the challenges throughout the scheme was the limited site access and physical boundary constraints. The CSO is situated in Blackburn within a residential area at the end of a cul-de-sac, which is the only vehicular access route to the working area. It is also sandwiched between semi-detached housing and a hospital. The River Blakewater forms the northern boundary of the site. The psychiatric rehabilitation hospital is located at the end of the cul-de-sac and required 24hr access to be maintained.

The access route was restrictive due to the narrow residential roads and sharp corners; HGV vehicle movements were difficult with parked cars being present. Turning and manoeuvring of articulated vehicles was difficult due to the physical constraints of the cul-de-sac. No parking or waiting by construction vehicles was allowed outside the working area at any time.

Essentially, the site was tightly bound on all four sides by the hospital, housing, the road and the river. A separate area of land remote from the working area had been made available by United Utilities for the site welfare compound area.

Flow had to be maintained through the existing CSO chamber throughout the construction period. This included storm flows that would interfere with any construction activities and temporary works within the chamber.

The ability to screen the storm flows had to be maintained at all times. This presented health issues associated with working with sewage and safety issues with working over the flow, as well as ensuring that no construction debris could block the sewer causing premature discharge or debris to be washed into the river via the spill channel.

It was clear to JN Bentley that by far the greatest challenge was to carry out the work in a manner which would, as far as possible, limit the work carried out inside the chamber which was considered a highly hazardous confined space environment. This would not only minimise the health, safety and environmental risks, but also limit potential delays to the programme, costly overruns and disruption to the residents associated with excessive down-time during wet weather periods.

### Removal of the existing roof

The existing reinforced concrete roof structure comprised two slabs – an original 410 mm thick roof slab, and, a secondary 350mm (in some places 450 mm thick) slab on top of the original. The upper slab had been constructed after sections of the original roof slab were removed to allow installation of the screens. Reinforced concrete beams had also been added at the same time to trim the new openings and to strengthen the roof structure. Both the upper and lower slabs were one-way spanning (across the width of the chamber).

As there was no as-built information available on the older, lower slab; cores were undertaken to establish the reinforcement and the joint between the two slabs. The cores indicated that the top and bottom slabs were not structurally bonded to each other.

The two existing screens were to be maintained in full working order whilst removing the existing roof slabs. Extensive temporary works were required for the removal of the existing roof slab, in order to carry out the works safely and maintain the structural integrity.

A phased removal of the roof was very carefully planned and utilised a 55T mobile crane for each stage.

*New screens to CSO chamber - Courtesy of JN Bentley Ltd*

*Highly constrained site - Courtesy of JN Bentley Ltd*


*Stage 1 - Upper Slab Removal - Courtesy of JN Bentley Ltd*

*Stage 2 - Lower Slab Removal - Courtesy of JN Bentley Ltd*


Stage 3 - Beam Removal - Courtesy of JN Bentley Ltd


New PCC roof beams being lifted into place - Courtesy of JN Bentley Ltd


Existing outfall - Courtesy of JN Bentley Ltd


New outfall, adjacent to the existing outfall - Courtesy of JN Bentley Ltd

***Stage 1: Removal of the upper slab***: Calculations, following the information determined by the cores, had revealed that the lower slab could not support the combined weight of both slabs. Therefore, additional dowels were installed adjacent to the up-stand beam to tie the lower slab to the beam, which would allow the lower slab to take the weight of both slabs. Epoxy resin anchors were pre-installed ready for the lifting plates. The upper roof slab was then cut into sections approximately 10T in weight. Longitudinal cuts, i.e. in the direction of the span, were completed first. Transverse cuts were then completed in stages with the crane lifting each slab section away after it was cut.

***Stage 2: R emoval of the lower slab***: Removal of the lower slab was more complicated. The lower slab now spanned from beam to wall and was to be removed by cutting it into 4.2m by 1.6m sections, weighing approximately 7T each. Whilst it was cut, the weight of each slab was temporarily supported by effectively hanging it from a bespoke steel H-frame, which was designed also to span from beam to wall. The H-frame was fixed to the slabs using epoxy resin anchors. The end cuts were then completed, requiring the H-frame then to take the full weight of the slab. The crane could then lift the slab sections out complete with the H-frame attached. This method did not require any work inside the chamber and also prevented any shock loading of the crane.

***Stage 3: Removal of the supporting beams***: This required underpropping to support the beams during cutting and removal. This required some work inside the chamber, but with the roof slab removed, the chamber was now open, allowing adequate ventilation and also affording much safer means of access and egress. The existing mechanical screens were isolated during removal of the beams, reducing the risks of working in the chamber to an acceptable level. When wet weather required the screens to operate the work was stopped and the screens re-energised.

Weather forecasts were checked daily prior to work commencing and a decision made whether to commence work or not to maintain the on-going safety of the site team.

JN Bentley and subcontractor Holemasters, who carried out all the saw cutting work, collaborated closely together. The complete removal of the roof took ten weeks. In total, 360T of concrete was removed from the roof in 75 sections and sent for recycling.

### New spill channel and roof

The new spill channel was constructed once the removal of the roof was complete. Because it was such a tight site, the crane for the roof removal had been sited where the new spill channel was to be constructed.

Before the excavation could begin the existing kiosk and associated power equipment had to be relocated, and permanent sheet piling installed along the boundary with the highway.

It was originally planned that a 6mm perforated plate would be installed over the full length of the weirs to provide temporary screening after the existing screens were removed. However, JN Bentley proposed an alternative sequence of works which would prevent the need for this. Two of the new screens were installed first. The screw augers to the existing screens were then removed, but the perforated drum retained to act as a temporary static screen on the downstream side of the weir. The second two new screens could then be installed.

Given the access constraints, continuous flow of sewage, and confined space issues, a PCC solution was adopted for the new roof. It was constructed from eleven 12m long precast beams and 55 (No.) precast slab sections. Initially the roof slab was designed to HA loading requirements but was redesigned to suit HB loading requirements to reduce project costs due to the fact that no vehicle

will be driving over the CSO. The construction of the new roof slab was aimed at avoiding confined space working where possible, without compromising live flows, and causing the least amount of disruption to nearby residents and hospital.

The PCC solution adopted reduced the amount of confined space working and avoided temporary propping support work within the CSO, which in turn reduce project costs.

### Construction of the new overflow

Works were required in and adjacent to the River Blakewater in order to construct the new overflow and outfall from the CSO chamber. The new outfall was adjacent to the CSO structure, immediately downstream of the existing outfall. Construction involved the removal of the existing dry stone river wall and excavation below the watercourse channel over approximately a 10m length. The twin 900mm diameter continuation sewers were very close to the back of the river wall.

Construction of the new headwall therefore involved excavation work in a very sensitive area. To limit the amount of disturbance to the river channel, existing headwall and to maintain the integrity of the adjacent sewers a delicate approach and method was required.

The more usual method of driving sheet piles into the river bed along the edge of the concrete channel was considered likely to cause undue vibration and disturbance. A less intrusive option was developed which involved the placement of 1T sandbags to form a barrier along the edge of the river channel, and sequencing excavation work in short sections at a time so as minimise impact on the river bed.

During periods of prolonged wet weather and high river levels, all work had to cease within the watercourse. Regular monitoring of weather forecasts was maintained throughout these works.

### Public interface issues

The site was immediately adjacent to both the hospital and residential housing. Security, out of hours safety, site traffic movements, noise, vibration and odour were important considerations in the site set up and method of work. Mitigation measures included:

- Acoustic screens to reduce noise, particularly from the cutting works.
- Noise and vibration monitoring.
- Daily washing down and disinfection so to minimise odour issues from the CSO after the roof removal.
- Letter drops to keep residents informed.
- Timber hoarding and CCTV.

### Conclusion

Due to the tight physical constraints of the site and the extremely hazardous environment, it was vital that the method of work was very thoroughly planned and sequenced. The high level of detail in the risk assessments and method statements made construction possible. For each stage of work, these were prepared, discussed with the client and communicated to the site team.

The cost of the scheme was approximately £0.95m, with work starting on site in May 2013 and was completed in January 2014. The improvements made to the existing asset will help preserve the quality of the river Blakewater for years to come.

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