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The Warrington Test Facility

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Background.

In October 2000 United Utilities (UU) with the assistance of Montgomery Watson Harza (MWH) undertook to construct and operate a screen test facility at its Warrington WwTW.

Prior to this test facility it had been intended to assess the performance of screens based on results from the National Screen Test facility at Wigan and to install screens considered suitable in live network situations at selected sites. The performance of these would then be monitored and enable UU to reach a judgement on the suitability of the trialled screens before rolling these out into the rest of the AMP3 programme.

A number of non-powered screens had been installed in live network situations but various issues made meaningful data collection difficult due to:

- Lack of suitable rainfall events.
- The timing of these rainfall events.
- Network configuration.
- Difficulty of access and safety considerations within the chambers.
- Difficulty in collecting sufficient meaningful data, forcing large extrapolations between data points.

All of which makes it difficult in these in situ installations to separate out the impact of the various variables.

Live network installations together with the National Test Facility focus on the retention of screening solids rather than long term performance of the screens led UU to the view that the approach to date was not going to provide all the information they required.

Why build a Test Facility?

The simple answer is that the facility was built to reduce the risk that UU faced in delivering a huge UID programme where screen and screen chambers would form an important component of that programme. It was estimated that UU would install 500 screens on the network during AMP3. 300 of these would be powered and 200 non-powered.

The risk faced was large due to:

- Lack of operational knowledge of screens in the UK.
- Lack of confidence in AMP2 Screen Performance.
- Lack of knowledge of:

- Chamber performance
- Screen Sizing
- Screen Flow rates
- Screen hydraulics

Because of the size of the AMP3 investment it was important that UU got it right first time. During AMP2 approximately 70 screens had been installed in network situations and a number had experienced some design and operational difficulties and it was important that the current programme learned from this history.

As part of its approach to the AMP3 programme UU intended to embrace a standardised approach to the solutions that it adopted by employing generic designs. To establish these generic designs it was important that the complete system, including the screen, the chamber, the weir, the position of the screen in the chamber, the point where screenings are returned to the continuation flow, the continuation flow, the overflow from the chamber, the means of access, and the means of operation and maintenance of the screen should be standardised as far as possible and would be included in a generic design. The generic design(s) would then be rolled out across the programme.

A chamber designed to the WaPUG code of Practice was to be used incorporating a screen. This would allow UU to move away from the construction of unnecessarily large chambers as per FR0488 which as a chamber had the design intention of retaining the solids within the continuation flow without the use of a screen.

In order to reduce the risk to the UID programme the fundamental objectives of the Test Facility were:

- To obtain operational proof of the hydraulic performance of the screens being considered, particularly with respect to the interaction between screen chamber geometry and screen performance.

- To obtain operational proof of screenings handling and management.

- To determine the overall operational reliability of the screens in terms of maintenance and robustness by accelerated life cycle testing.

In addition the test rig would be used to demonstrate to the Environmental Regulator the effort UU was expending ensuring that it had the correct screening solutions for AMP3 and to obtain the input from UU operators and maintenance staff into the layout and maintainability of the generic designs.

This paper reports on the learning from constructing the test facility and ensuring that the test facility geometry presents flows to the selected screens in a manner that allows the screens themselves to function to their optimum. In short it is the first part of the process that allows for an effective whole. Bringing together the chamber, the screen, the sewage the continuation flow and the overflow ensures that we are examining the system that we intend to employ in the field and not looking at a single component of this system in isolation.

I believe that the investment in the test facility has already paid for itself many times over, with improvements to the design of the system being undertaken once on the test facility prior to implementation across the programme.

The remainder of this paper will concentrate on getting the chamber design correct.

CSO Design Guide:

WaPUG published a new design guide in June 2000 for CSO incorporating screens. The test facility was constructed in accordance with the new guide. The basis of the new guide was:

- Old Formula
- New Coefficients
- New dimensional relationships for CSO layout

UU and MWH were unclear as to the combined effect of these changes. For example there had been no practical testing of the changes. Additionally a variety of screen types might be employed on a CSO, would they all work equally well in the same chamber or are particular chamber modifications required for particular types of screens.

Proposals for the Facility:

- Most powered screens will have a capacity of up to 1500 l/s
- A test facility capable of spilling 500 l/s would be representative
- Build rig to WaPUG June 2000
- Pump the inflows and gravity the outflows to ensure we had consistent conditions
- Protocols developed for the benchmarking of the test facility before any screens are installed
- Protocols for screen testing of three powered screens
- Made of Steel to enable ease of amendment
  (for different weir lengths etc dictated by the screens)

Initial Set Up

- Flow taken from inlet channel to Warrington WwTW
- Inlet Pipe 525 mm diameter
- Spill Pipe 600 mm diameter
- Inflow 600 l/s
- Pumped Inflow (3 No. 200 l/s pumps) - Gravity Outflow
- Chamber 6.5 m long by 3.5 m wide
- Longitudinal Gradient 1 in 100

- Channel 300 mm diameter
- Eccentric flanges fitted to inlet to permit easy changing of inlet pipe to 600 mm diameter
- Weir height fixed at 420 mm (0.8 D)

Monitoring:

Based on the experience of in situ CSO monitoring it was determined that extensive monitoring and data gathering should take place. The monitoring included:

- 3 Ultrasonic Level Sensors - 2 in main channel , 1 in spill channel
- 2 magflow meters - 1 on inlet pipework, 1 on continuation pipework
- Manual recording of all data every fifteen minutes
- Data recording of all data every minute
- Photographs taken every fifteen minutes
- Video recording of general flow conditions and abnormal incidents
- Observational recordings
- Monitoring of WwTW inlet channel conditions.

Benchmarking:

The facility was set up and flows switched on to determine that the flow conditions within the CSO were acceptable and suitable for the installation of a screen. The following observations were made on the flow as presented to the weir and the flow conditions within the CSO.

- The flow conditions were not acceptable for any powered screen
- A hydraulic jump was forming in main channel
- The spill flows could not get away from the spill chamber into the outfall pipe
- The flow conditions deteriorated when inlet flows exceeded 350 l/s

Potential reasons for these poor flow conditions might have included:

- Bend on inlet pipework 4 m upstream of the inlet
- Benching profile - changed too quickly from 600 mm dia to 300 mm dia
- Weir cut for Huber Rotamat screen including cut out for screenings return
- Outfall pipe too small

Observation on the test facility of the poor flow conditions suggested strongly that none of these was the sole cause and this lead to the following chamber amendments.

Chamber Amendments

- Inlet Pipe increased to 600 mm diameter

- Spill Pipe twinned (2 No. 600 mm dia) with weir inlets
- Invert Channel reformed to 600 mm diameter to beyond end of weir then tapered to outlet
- Adjustable weir plate fitted
- All ultrasonics moved to above main channel

Some of the chamber amendments were made to eliminate the potential effects that they may have on the flow conditions with an intention of getting the chamber design right for the flow conditions and screens.

Test Facility Conclusions:

- A diameter to flow relationship for CSO design is too simple
- Enough data had been collected to develop a detailed design method
- Acceptable flow conditions for testing screens could be created
- Getting spill flows into outfall pipes is critical to CSO/Screen performance
- UU could have confidence in CSOs proposed for AMP3

OUTCOME :

- Confidence in design of the CSO Chambers

- WaPUG Guide amended (Figure 1 replaced simple formula)

- Move on to the next stage of testing, testing of screen performance in an effective chamber.