Paper 11

Title: **wrccso: Rethinking the CSO for the 21st Century**

Presenters/Authors: Petros Tzinaetis, WRc, petros.tzinaetis@wrcplc.co.uk, 01793 865162
Frank Moy, WRc, frank.moy@wrcplc.co.uk, 01793 865108

Summary

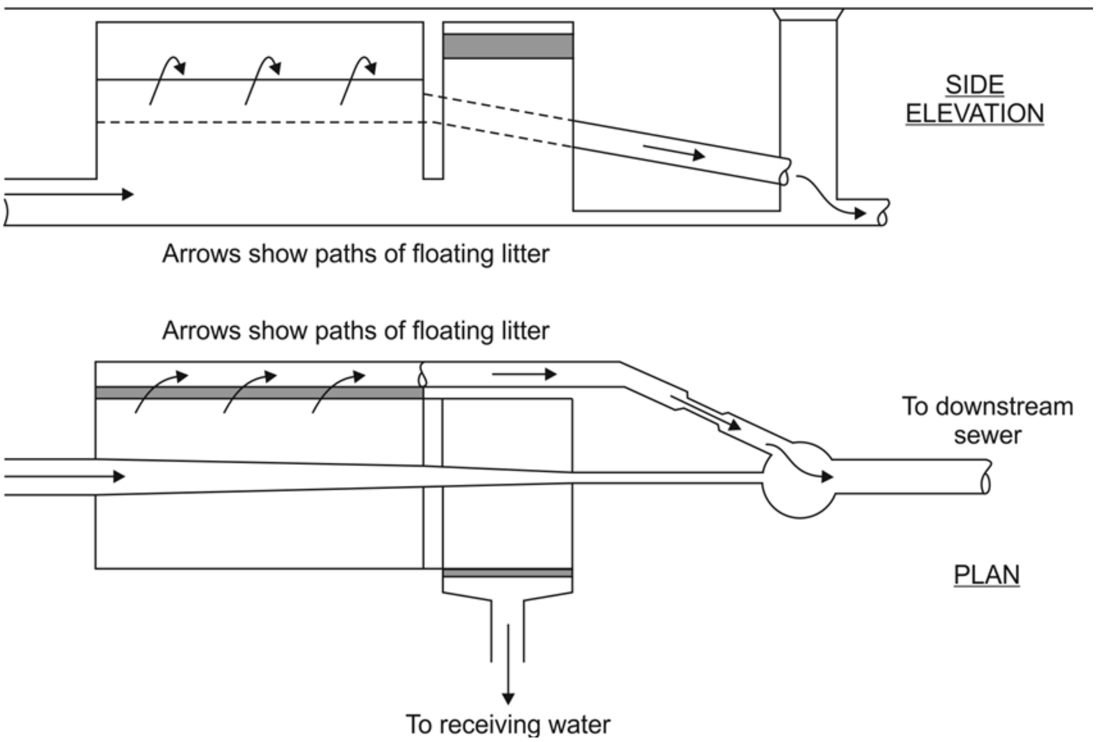
The design of combined sewer overflows have largely remained the same for over 50 years, though more recently, additional storage and methods of screening solids have been added to traditional CSO designs.

To address/reduce pollution from CSO spills and the associated costs of maintaining these assets, WRc has developed an innovative patented CSO design which, according to models, reduces the floating solids presented to the screen by over 80%.

The design principle

The design principle is to separate floating sewage litter, (panty liners, wipes, paper debris, plastics and organic material) and continuously return this to the sewer downstream of the CSO chamber. By bypassing the floating debris, it allows relatively debris free sewage to be presented to the CSO screens during high flows and spills. Blinding of the screen is minimised and there is no need for mechanical raking or brushing to keep the screen clear.

The new design is based on an on-line, in series, double (large and small) chamber with a throttle downstream of each chamber and weirs set at different levels in each chamber. Spill from the first chamber is unscreened and is connected to the downstream sewer system via a bypass pipe. Spill from the second chamber is to the receiving watercourse and is passed through a static screen.



This second weir is set at a higher level than the weir in the first chamber allowing preferential flow from the first chamber, carrying the floating debris, via the bypass pipe to the downstream sewer. The design pass forward flow is achieved by a combination of flow via the bypass pipe from the first chamber and continuation flow from the downstream chamber.

Operation

During dry weather flow, the sewage passes uninterrupted through both chambers to continuation as in a conventional CSO.

With increased flows during rainfall, the throttle downstream of the second chamber becomes surcharged and flow is retained in the chambers.

With progressively increasing flows, the orifice between the two chambers will be surcharged creating separate bodies of water in the two chambers.

The chambers fill with the water level in the two chambers rising together due to the U-tube effect through the interconnecting orifice. (The filling process is quicker than in a conventional chamber as the throttle on the continuation pipe is smaller than on a conventional CSO).

The first chamber, the larger of the two, acts as a stilling pond separation chamber where bed load will settle and light material will float to the surface.

A weir level in the first chamber is set at a level to maximise the volume of the chamber but lower than the weir level in the second chamber. As the first chamber spills floating litter will be drawn from the surface and passed to the bypass pipe. The bypass pipe is sized so that the combined bypass flow plus the continuation flow from the second chamber is equal to the design pass forward flow of the sewer. This is achieved by orifice size or downstream pipe throttling.

If the flow continues to rise, the weir in the second chamber will start to operate. If this is a replacement for an existing CSO this is usually set at the current spill setting level for a CSO. The body of water in the second chamber will be relatively undisturbed by the incoming flow to the CSO which is baffled by the wall separating the two chambers and the body of water in the first chamber. As the orifice between the two chambers is at the invert, floating debris is retained in the first chamber and bed load passes through the second chamber with little turbulence to re-suspend it. The body of water in the second chamber therefore remains relatively free of floating debris and it is this flow that passes through the screen to the receiving water course.

Separation will continue as the spill from the first chamber to the downstream sewer continues via the bypass pipe to provide capacity for separation and also prevents the build-up of floating debris and pass forward of concentrated litter at the end of the event.

A high level spill between the two chambers provides relief from the first chamber in the event of exceptional flow conditions. A vortex flow control device is an option for small diameter continuation pipes to reduce the risk of blockages.

CFD Modelling

The characteristics of each CSO are different; different inflows, pass forward flows, weir heights, chamber depths etc. WRc have developed a CFD model with CHAM, a CFD software consultancy, that can accommodate dimensional and hydraulic changes and following design of a chamber for a specific location, allows refinements of the design to improve effectiveness. For example reduction of the bypass weir length and positioning of a baffle significantly improved the flow of litter over the bypass weir.

Selsey case study

A trial is being undertaken by Southern Water, through their delivery partner MGJV, at a site in Selsey, West Sussex. The traditional solution would have been a mechanically raked screen but this was not a suitable solution because of the CSO's location giving limited access for maintenance. Static screens alone were unsuitable due to the speed with which they blind. An alternative solution was needed.
MGJV / WRc worked closely in adapting the design to address on-site construction aspects, such as fabricating in two sections to avoid services, demonstrating the 'flexibility' in this solution. Normally the two chambers would be in a single unit.
The chambers were manufactured off site by Asset International in high density polyethylene (HDPE), delivered to site and placed in a pre-prepared excavation straight from the lorry. Installation of the chambers took c. 5 hours.

The performance of the CSO is being monitored by WRc for 10 events, to include events that generate operation of the bypass weir as well as spill events.

Depth data monitors and the cameras triggered by the depth in the chamber are being installed to provide real time data of the performance of the CSO and to validate physical and CFD modelling that predicts > 90 % litter separation. In the interim MGJV also continue to visit the site to monitor performance and WRc have visited on two of these occasions, one with the water level still high but below the bypass weir level and the second where the water level had dropped to DWF conditions.

Inspection of the bypass weir and bypass channel, and the spill screen indicate the CSO is operating as intended with evidence of wipes and other floating debris in the bypass weir but little floating debris in the second chamber and no litter on the screen.

Design benefits

The overall benefits of the design are:

- Reduction of debris on the screens, and therefore there is no need for mechanically raked screen reducing the capital and maintenance costs and improving reliability.
- There is also a reduction in the need to visit the site to clear screens;
- If screen overtops in extreme events, as there is minimal floating litter in the spill chamber, the aesthetic pollution and cost of litter picking is reduced;
- Monitoring of bypass spill gives early warning of imminent dry weather discharges before they occur;

- CFD modelling shows litter separation of greater than 90% by optimising chamber sizes and relative weir heights; and
- The chambers can be retrofitted or installed as a new build.