DERBY SEWERAGE IMPROVEMENT STRATEGY

USING BTKNEEC

TO ACHIEVE THE FINAL SOLUTION

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Introduction

A satisfactory method of predicting the impact of combined sewer overflows (CSOs) on receiving waters is provided by the UPM Procedures. The impact can now be assessed in absolute terms and, by examining surface, sewer and river processes, proposals for the rationalisation and improvement of CSOs can now be approached in a classical rather than an empirical manner. This leads to more precise solutions to drainage problems.

The Derby Sewerage Improvement Strategy was the subject of the National UPM Trials where the proposals were modelled in detail and shown to comply with derived quality standards for the main river.

The detailed examination of some key components of the Strategy require information at specific locations which was not provided directly by the UPM study. The basis of consents for the principal CSOs and the predicted impact on two tributaries of the main river which will receive modified discharges are critical elements about which further information was required.

This paper describes how a spill frequency analysis, as an addendum to the UPM modelling, provided the necessary information.

Background

The proposed sewerage improvements for the City incorporate a number of new or modified CSO's and obtaining consents for these discharges is vital to the successful implementation of the strategy.

The detailed UPM procedures have been applied to the waste water and river system as part of the UPM Demonstration Project. This work was mainly undertaken by WRc and involved detailed monitoring of the performance of the systems under both dry and wet weather loading conditions. Detailed simulation models were built for the systems, which were verified with field data. The detailed models were applied to derive critical intermittent water quality standards for the River Derwent for rainfall induced discharges.

A simplified model of the sewerage system was developed which was based upon the proposed upgrading solution at that time. This model was then used with the derived intermittent water quality standards. It was demonstrated satisfactorily that the proposed upgrading solution performed within these standards.

However, one issue centres on the need to control excess storm flows from the Eastern Interceptor trunk sewer to the sewage treatment works at Spondon. A new CSO is planned which would limit carry forward flows to Formula A. Whilst

the principles of this approach are acceptable, there is a potential conflict with a local plan to improve the amenity value of the River downstream of the likely discharge point. The potential for complaints will be raised and the regulator is reluctant to consent a new discharge unless the need is clearly demonstrated. The alternative of pumping excess flows to storm tanks is therefore to be included in an appraisal of options.

Concerns of the Environmental Agency are also focused on the discharges from seven CSOs and their impact upon two tributaries of the river. These are at Mill Fleam and D Cut. There is an expectation by the public that any changes should consistently provide improvement and not bring about any deterioration, whether or not the absolute standards are being met.

It was first suggested that, for the upstream CSO's to perform satisfactorily, carry forward flows in excess of Formula A may be required and/or the inclusion of `Scottish Paper' storage. It was feared that the combination of an increased load and the interception of clean base flows to D cut would severely affect the water quality at this location. The requirement of screens was also noted, particularly for discharges to D Cut.

A detailed assessment of pollution incidents at the two locations did not indicate a water `quality' problem however. Incidents were related to complaints by members of the public about the quantities of sewage derived debris which could be found on the banks, and to accumulations of floating material in D Cut. It was also notable that these incidents were associated with minimal spills rather than high volume discharges from CSOs, and premature discharges are the most likely source.

Full UPM analyses would be prohibitively expensive and it was therefore agreed that an analysis of spill frequency and volume, to confirm that spill frequency was the issue to address and also, to determine the relative changes the proposals would generate, would be a valuable exercise.

Spill Frequency Analysis

The hydraulic model of the sewer system has been used extensively to investigate flooding problems within the catchment. This has proved a significant aid in understanding the performance of sewerage under severe hydraulic loading. The model of the existing system is derived from Drainage Area Studies and is well validated and audited, showing remarkable accuracy in predicting flooding locations.

The model has been modified to represent the proposed sewerage improvements which alleviate flooding and pollution. Two models therefore exist, one of the proposed sewerage system and one of the existing and a `before and after' hydraulic assessment was provided at reasonable cost. To carry out the analysis, annual time series rainfall (ATSR) was applied to both models. The first 5 of the series and every subsequent fifth event were used in the analysis, to reduce computational time.

The total event volume of each computed ATSR event, for each individual CSO was assessed. These were then grouped into receiving waters so that the relative change for the proposed schemes could be assessed.

Discharges to Mill Fleam

Discussions with the EA concluded that the aesthetic problems to this watercourse are aggravated by the high amenity value of the Mill Fleam through the city centre and very frequent spills from CSOs which discharge to it. One existing overflow structure at this location is a leaping weir arrangement with very poor solids separation.

Storage in accordance with Scottish paper recommendations had been suggested but finding sufficient room for construction is a serious problem. Figure 1 shows that an improvement has been made with respect to spill volumes although it is not very significant without storage. To clarify the illustration, the volumes for each spill event are accumulated to give the total annual spill at the right-hand vertical axis.

Discharges to D Cut

Fourteen CSO's currently discharge into the Southern Surface Water Sewer (SSWS) which in turn outfalls into D cut. Five of the CSO's have been nominated for improvement. The conversion of the SSWS into a combined sewer with an overflow structure will intercept all of the CSO discharges and convert these into internal control structures.

The analysis results for all CSO's discharging into D cut is shown in figure 2. The existing system produces spills from at least one of the contributing fourteen CSO's for all rainfall events that have been simulated. This plot demonstrates a significant improvement to the annual storm load, which is reduced by a factor of two.

For each ATSR event the volume of all CSO's discharging to D Cut is significantly reduced. The most damaging spills with respect to receiving water quality and amenity standards are the higher frequency spills, which will be eliminated by the proposed scheme.

General Results

Figure 3 shows, for completeness, the annual spill volumes for all of the major discharges from the sewer system. Some comparisons are notable and may best indicate where limited resources should be directed. It would be unreasonable for instance to provide expensive improvements to minor discharges and to `economise' on major ones. This may be a basis for discussions on the further application of the principles of BTKNEEC which would otherwise be conjectural.

Acknowledgements;

Severn Trent Water Ltd.,
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Richard Long Associates,
Charles Haswell & Partners Ltd.

Further Information for WaPUG Members

If you require more information or exchange views about the contents of this paper, please contact Andy or Alastair on 0121 717 7744.

MILL FLEAM SPILL VOLUMES FOR HYDROWORKS ATSR EVENTS

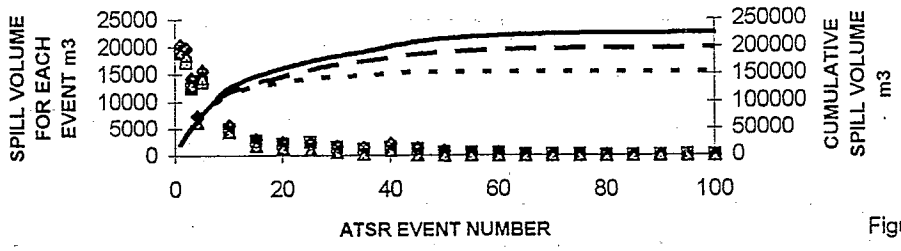


Figure 1

D Cut SPILL VOLUMES FOR HYDROWORKS ATSR EVENTS

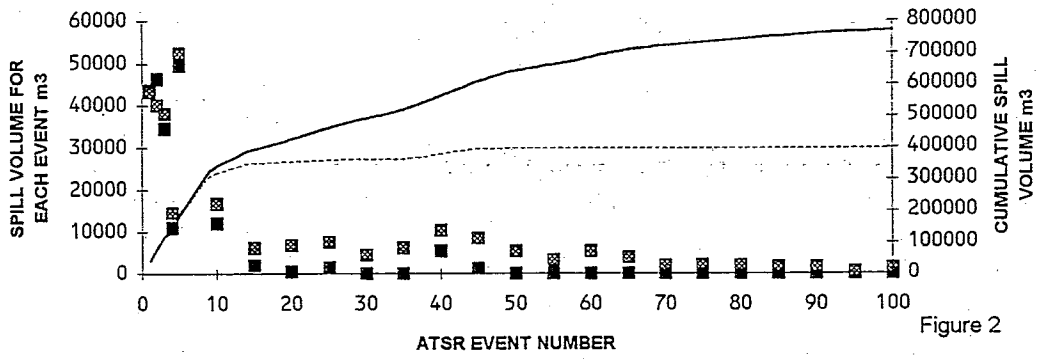
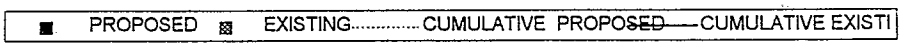


Figure 2



TOTAL SPILL VOLUMES FOR ATSR EVENTS GROUPED FOR RECEIVING WATERS

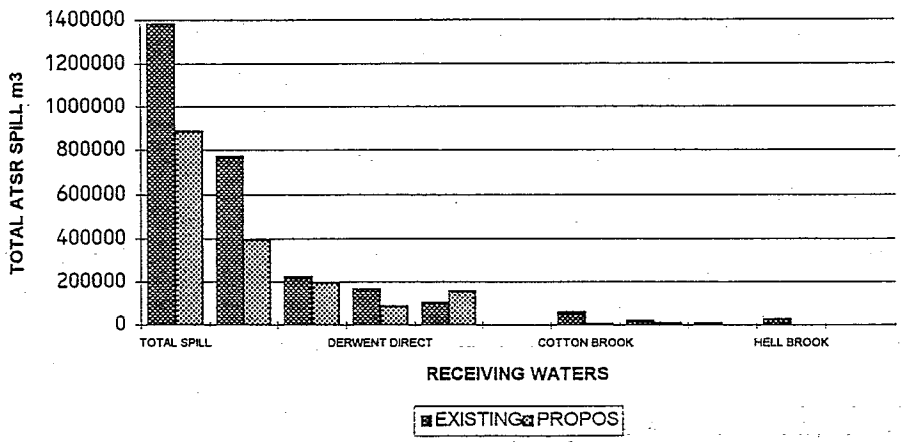


Figure 3

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Question Peter Whalley Environment Agency

Your cumulative curves are a new thing to me in terms of frequency of spill. How does Formula A fit into all this?

Also there are other things to be considered for river standards such as screening requirements for aesthetics ?

Answer

Formula A was taken as the baseline pass forward for all the options. Screens will also be considered for all the options considered.

Question Richard Marshall Design and Building Services

Are cumulative curves meaningful on what is essentially a frequency issue ?

Answer

Yes the curves are useful in demonstrating what has been achieved , and very useful in consultations with the EA.

The curves are meaningful in that they give a clear indication of the reduction in impact that a CSO has on its receiving water course in terms of frequency of spill and volume over the year, although admittedly the area under the graph is not truly representative of volume. They are therefore useful in demonstrating what has been achieved, or indeed can be achieved and as such are invaluable in negotiations with the EA.

Comment Richard Kellagher IHS

I believe the curves are very useful particularly when you look at the change in the direction of the lines. The before shows a gradual gradient indicating a lot of small spills of very concentrated pollutant. The after curve is much steeper indicating that only the big spilling dilute storms are left. The curve gives some good indicators on water quality issues.