Western Valleys CSO Study

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Introduction

This paper describes a study carried out by Binnie Black & Veatch on behalf of the Southeast Sewerage Scheme Alliance (SSS Alliance) part of Dwr Cymru Welsh Water Alliance. The study is currently being implemented as part of the AMP3 combined sewer overflow (CSO) improvement programme. The study is noteworthy in so much that it demonstrates how a pragmatic planning strategy, which does not adhere rigidly to predetermined rules when they are demonstrated to be inappropriate, can result in a solution which is of benefit to all stakeholders.

Study Area Description

Western Valleys comprises the three valleys of the Rivers Sirhowy, Ebbw Fawr and Ebbw Fach which lie to the north west of Newport, South East Wales. The conurbations within the catchment include Abertillery, Ebbw Vale, Tredegar, Newbridge and Crosskeys. The downstream boundary of the study area ends approximately at the M4 motorway, although the sewer system continues downstream and the flows eventually contribute to the new Cardiff East sewage treatment works. Figure 1 shows the general configuration of the study area catchment.

The area is serviced by a combined sewer system which has a total contributing population of some 150,000 persons. The system incorporates a total of 121 CSOs, of which 57 were identified as unsatisfactory (uCSOs) on the spreadsheet of intermittent discharges for improvement in AMP3 (AMP3 list). All 57 were deemed to be unsatisfactory for reasons of aesthetic pollution, with a small number also considered to cause water quality problems. The topography of the catchment comprises river valleys that are generally very narrow and steep sided. Consequently the urban development and all services; roads, railways, utilities and sewers, tend to be congested into the bottom of the valleys. It is not uncommon for the sewers to run along the bed of the rivers and the CSO sites are frequently awkward and confined. The rivers are fast flowing and well oxygenated.

Environmental Standards & Perceived Environmental Problems

The river quality objectives for the watercourses in the Western Valleys catchments are generally River Ecosystem Class 2 (RE2) with some lengths of RE1 in the upper reaches and one culverted length of river near the steelworks at Ebbw Vale which has a target of Class 3. For the most part these objectives are currently achieved and, where this is not the case, the cause is known, or strongly suspected, by the Environment Agency to be other than the CSO discharges.

Hence, the principal environmental issue in the catchment is aesthetic pollution from both sewer derived debris and other sources. The Amenity Use classification for the rivers has historically varied from low to moderate throughout the catchment. However, the Environment Agency now consider that an objective of Moderate Amenity Value throughout the catchment is appropriate.

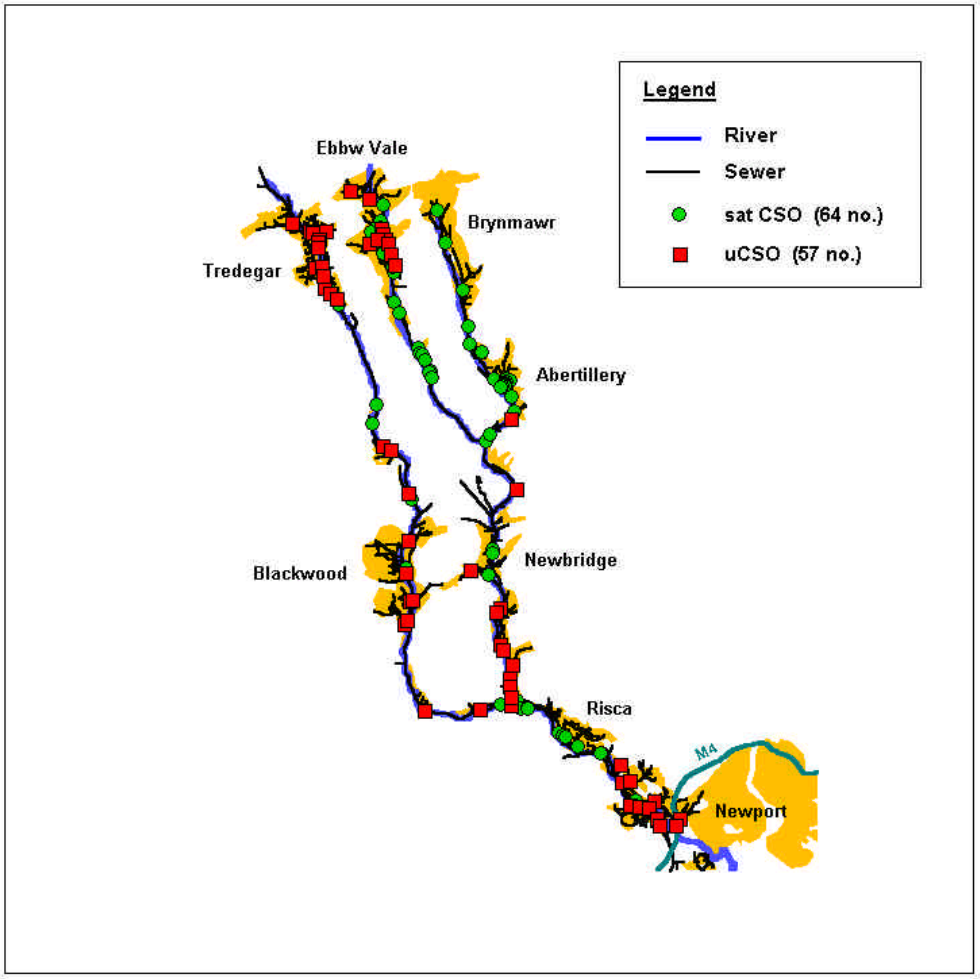

Figure 1 : General Arrangement Plan for Western Valleys

Previous Investigations and Modelling Studies

As with many other catchments, hydraulic simulation models for the Western Valleys areas have been developed in several stages over a considerable period starting in the early 1990's using, initially, WALLRUS software and finishing up with HydroWorks. By 1999, a reasonably comprehensive verified HydroWorks model of the complete Western Valleys study area was available for planning CSO improvements. The model included in excess of 3000 nodes and all 121 CSOs in the catchment. A version of the model was also available which included future urban development up to the year 2010.

This model had been used in an earlier study to develop a proposed solution to meet the upgrading needs of the catchment. The planning criteria employed for this purpose were the standard suite of criteria developed during AMP2 for application throughout Wales, *viz*:

- Aesthetic Performance. i.e. Provision of solids separation, as set out in the AMP2 Planning Guidelines and elsewhere, appropriate to the Amenity Use classification of the watercourse.
- Hydraulic Performance. i.e. CSOs to pass forward no less than Formula A flow (or equivalent) prior to first spill.

- Environmental Performance. i.e. Compliance with the 99 percentile in-river BOD and ammonia standards appropriate to the river quality objective and the Environment Agency's "no deterioration" policy.

All CSOs on the unsatisfactory list were required to comply with all of these criteria.

The result of this planning exercise was a catchment scheme which addressed the shortcomings of the 57 uCSOs in the catchment at a total cost of some £9.3 millions at current prices. The principal features of the scheme were:

- Reconstruction of numerous overflow chambers to meet current good design practice (i.e. design to FR 0488);
- Provision of screens, either static, self cleaning or mechanically raked, at the majority of the UCSOs;
- Relatively small storage tanks at selected locations to reduce spill frequencies and volumes equivalent to Formula A performance; and
- Two major "integrated" schemes, each addressing three uCSOs, which involved major upsizing of sewers and the provision of large volumes of detention storage (circa 10,000 m^3 in total).

Together the two major "integrated" schemes accounted for some 62% of the total scheme capital cost.

AMP3 Planning Strategy

At the commencement of the AMP3 planning process, the earlier plans were reviewed to see if it was feasible to identify a more cost effective overall catchment solution. The high cost of the two integrated schemes was noted and more detailed consideration of these schemes showed that the principal cost driver in each case was the requirement for the CSOs in question to pass forward Formula A flows (or equivalent) prior to spill occurring. The previous planning results also showed that, despite passing forward less than Formula A flow rate, the existing CSOs did not spill excessively frequently, nor was the in-river impact of the CSOs in terms of the 99 percentile standards (assessed using the Environment Agency's QUALSIM software routine) unacceptable. It therefore seemed questionable whether the proposed schemes could be considered to represent good value for money in environmental terms.

This conclusion suggested that it would be worth re-examining the performance of all 121 CSOs in the catchment. Hence, the HydroWorks model was used to assess the spill frequency and annual spill volumes for each CSO for a typical year of rainfall events, and the current setting and the Formula A flow for each CSO were calculated. These data were then analysed to evaluate the relationships between the CSO setting, discharges and environmental impact. An extract from a typical table of results is shown in Figure 2.

The major conclusions which were derived from the exercise were that:

- Formula A is not a strong indicator of CSO performance in terms of either spill frequency or volume. Location within the catchment and the local sewerage configuration is just as important in determining how often and how much a CSO spills.
- The 57 identified uCSOs on the AMP3 list were by no means the worst performers out of the total 121 CSOs in the catchment, judged on the basis of either spill frequency or volume. The analysis suggested that the selection might almost be random, whether the CSOs were ranked in priority order against either

spill frequency or volume criteria. This conclusion was also extended to include environmental impact, assessed against the 99 percentile BOD and ammonia criteria using the EA's SPIRIT software.

CSO Ref	Frequency Spills/yr	Volume Spills/yr (m^3)	Existing CSO Setting (l/s)	Existing SOC "A" (l/s)
105	65	157855		487.3
51	95	131628	56	83.1
119	49	79852		1425.0
24	95	72855	32	32.6
111	31	71784		2534.8
19	34	49410	910	692.4
29	95	46250	6	69.8
18	85	37168	40	31.0
7	90	36458	68	44.3
72	60	35261		0.0
61	44	33356		376.3
115	42	25613		2.2
109	95	23401		69.4
21	37	21091	968	901.3
42	42	21087	>34	7.0
36	15	19632	1534	1414.4
16	60	19199	76	39.9
27	95	16092	12	48.9
92	16	16028		329.5
52	27	15180	1117	1994.6
17	85	14474	28	56.0
55	70	13584		54.7
114	42	12901		3.9
48	70	10938	61	34.5
75	90	10729		15.4
1	39	10586	51	38.9

N.B. Yellow highlight indicates CSO on AMP3 list

Figure 2 : Summary Table showing Spill Frequencies and Volumes (Extract)

Based on this knowledge an alternative planning strategy was proposed and agreed by all parties. The revised strategy may be summarised as follows:

- All CSOs, whether on the AMP3 list or not, which were shown by a SPIRIT analysis to be a potential cause of water quality problems were to be upgraded to alleviate the problem.
- Solids separation was to be provided in accordance with the requirements for Moderate Amenity Use at all CSOs on the AMP3 list.

- No requirement for CSOs to pass forward Formula A flows, if they do not cause a water quality problem.
- Solids separation to be provided at selected additional CSOs not on the AMP3 list which modelling shows to be big and frequent spillers.

This strategy offers the following benefits compared to the previous approach.

- All water quality problems in the catchment associated with CSO discharges will be resolved. Previously, this was not the case, because two out of four CSOs shown by modelling to be the source of potential water quality problems were not on the AMP3 list of uCSOs and, hence, were not addressed under the earlier strategy.
- The Environment Agency's wish that the whole of the Western Valleys catchment should have an Amenity Use quality objective of Moderate can be accommodated. Previously, approximately 50% of the uCSOs were planned to be upgraded to meet only Low Amenity requirements.
- Solids separation will be provided at several CSOs which are likely to have significant aesthetic environmental impact which would not otherwise have been addressed.
- The upgrading requirements can be provided within the budget available in the AMP3 programme.

Implementation of the Solution

The original implementation plan for the Western Valleys catchment called for the following schedule of deliverables:

Year 2 – 10 CSOs
Year 3 – 18 CSOs
Year 4 – 29 CSOs

Adoption of the revised strategy has allowed the SSS Alliance to accelerate this programme and the delivery schedule is now anticipated to be:

Year 2 – 15 CSOs
Year 3 – 22 CSOs
Year 4 – 20 CSOs

The Year 2 deliverables were selected to be (a) relatively simple and quick to construct and (b) independent of the more strategic aspects of the planning strategy. They have, of course, already been constructed at the time of writing and, for the most part, comprise static (manually cleaned) screens retro-fitted in existing CSO chambers. In a few cases, it has been agreed that no new works are required to comply with the agreed guidelines.

For Years 3 and 4, the proposed works are generally more extensive. Year 3 construction works have now commenced and detailed designs for Year 4 are being finalised. The solutions will comprise a mixture of static screens where spill frequencies are sufficiently low to justify it; self-powered screens where the hydraulic head to drive them is available and electrically driven, mechanically cleaned screens for the remainder. Some innovative hydraulically powered screens are also to be trialed at remote locations where power is not available and there is insufficient hydraulic head for conventional self powered screens. The total storage volume to overcome water quality problems is still to be finalised, but is anticipated to be approximately 5,000 cubic metres distributed around three locations within the catchment.

Conclusion

The Western Valleys CSO Study represents an excellent example of the benefits that can accrue from the stakeholders in a project working together in a spirit of partnership and with the desire to achieve the best environmental value for the available resources. Had the original proposals developed in accordance with standardised procedures been implemented without further investigation, very substantial amounts of money would have been invested for little, or no, additional environmental benefit. Adopting an approach tailored specifically to the characteristics and environmental needs to the catchment has allowed a solution to be developed which is advantageous to all parties. The Environment Agency gains a solution which provides an higher standard of environmental protection in terms of both water quality in the rivers and aesthetic pollution over a greater geographical area, whilst still obtaining the designated standards at the uCSOs identified within the AMP3 programme. The SSS Alliance, and hence Dwr Cymru Welsh Water, is able to deliver the solution within the budgetry and time constraints imposed upon them by Ofwat for delivery of the AMP3 programme. The residents of the study area will benefit from living in an area of improved environmental quality compared to that which would have been the case if this scheme had not been implemented.

Acknowledgements

This paper has been produced with the permission of the directors of Binnie Black & Veatch, AMEC Civil Engineering Ltd. and of Dwr Cymru Welsh Water and the Environment Agency. The views expressed are those of the authors and not necessarily of these organisations.

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