Improvement Programme for Combined Sewer Overflows (CSO) and other Intermittent Discharges

RISK AND SUSTAINABILITY IN DRAINAGE SYSTEMS

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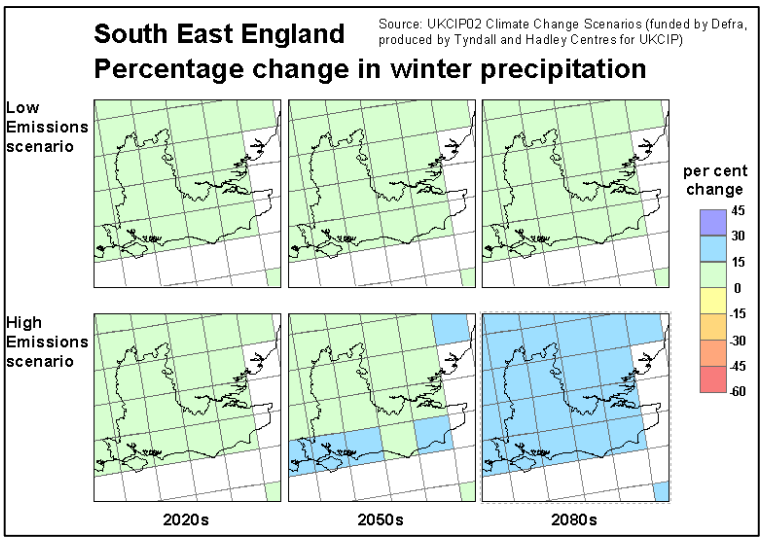
1.0 Introduction

Risk and Sustainability are two important subjects to occupy the thoughts of the Water Companies. Risk is something that all companies are concerned with and its management ultimately determines the confidence levels that company executives feel in the day-to-day running of the business.
Sustainability is concerned with managing existing assets or resources and forecasting how they can be best utilised in future. This paper features some of the main risks in Asset Management and how they can be managed and also how sustainability is currently approached and ways it might be improved in the future.

2.0 Risks

A key component in managing risk is determining clearly what is known with the benefit of experience/hindsight and what is merely forecasted. How can we improve the confidence in the risk assessment by using resources available to us in technology?

From the perspective of AMP3 one of the greatest uncertainties in which we face risk is how to respond to climate change. We are no longer discussing whether climate change will take place, there is sufficient evidence to conclude that it is happening and as engineers and approvers we need to modify our designs to cope with future needs.



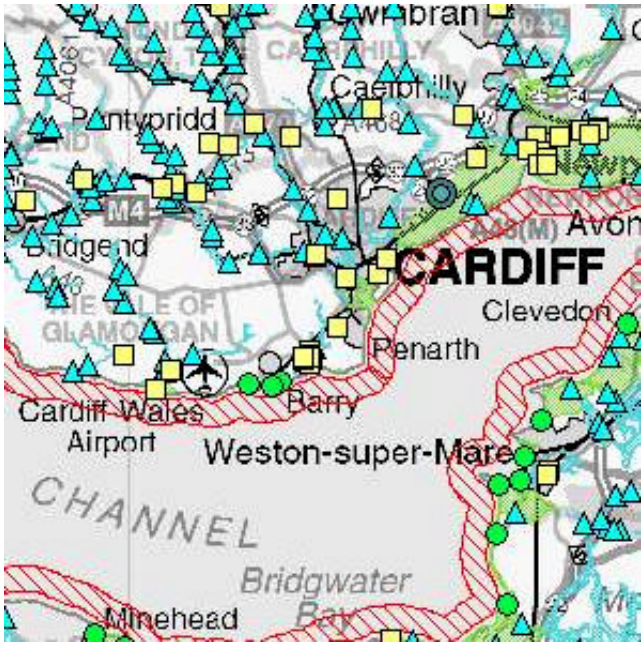
The biggest question is how and by how much? Do we have sufficient evidence to allow us to prescribe new standards to design principles? The activities of UKCIP and the Met Office are providing us with more data in respect to rainfall. Learned professionals have stated that a 100-year Return Period storm may be equivalent to a 1 in 10 year storm in 10 years time. If we continue to design solutions using current guidelines we face the prospect of these solutions being redundant sooner than expected. If we take the option of drastically increasing the design principles then we have the prospect of failing to have sufficient funds available. Perhaps the smarter option is to better assess the risk?

One of the ways we can do this is by using the improvements in latest technology. One example is the use of Radar storm information. If we can improve our extreme rainfall predictions as well as improving our computer models it will enable us to predict the consequences. In addition by combining 3D terrain modelling with dynamic hydraulic modelling we can identify where water will route to and consequently assess the risk of failure. There is of course nothing new in modelling flooding, we are just getting better at doing it. This will give an increased confidence in risk assessment and plan accordingly.

Whilst we engineers like to deal in numbers and results, the solutions predicted are sometimes misinterpreted. For instance, insurance companies are off expecting a 100-year protection (200 years in some cases). But how many realise that the analysis is based on a limited data set and it would be questionable whether the statistics are sufficiently robust to enable us to grow the data to provide protection measures to this extent. Add to this combination effects of rivers or tidal effects and the results become more and more tenuous. However, by considering the failure condition we are better prepared for the event and can "manage the risk" more effectively rather than trying to engineer out the failure condition against statistics, which may be unreliable. For a person whose house is under water it matters not that the storm exceeded the Design Return Period!

How can we do this?

Utilising the latest statistics from UKCIP we can anticipate the growth of storms expected in various parts of the country. By creating the failure condition we can determine where the water will pond and hence create protection measures to accommodate the risk i.e. we manage the risk.



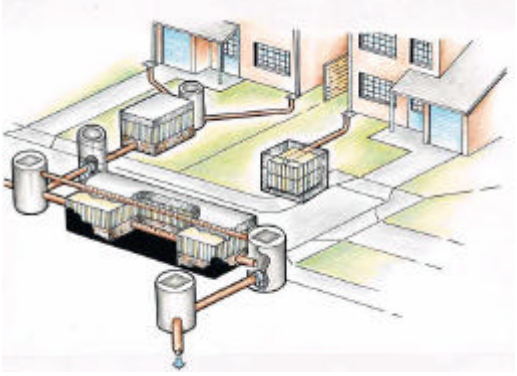
An example of this type of approach is the Cardiff East Catchment. This is a complex network with major interlinking of large diameter sewers. It also includes a large valley trunk sewer. A program has been set up of long term flow monitoring. By comparing this with known hydrological conditions it enables us to make a much better assessment of risk. Of course this data is also used to enhance our sewer models but this is way beyond our normal verification checks. The results also have a bearing on the Severn Estuary Coastal Model which monitors the effects of CSO discharges to the Barry Bathing Waters.

If we tried to use conventional methods in applying design criteria to this model the result would be enormous capital cost. By using a risk-based approach it allows us to better understand the fundamental operation of the system and to apply the capital spend in a more effective manner. This is just one example but there are numerous others, particularly in regard to bathing water analyses that have been used in "critical catchment analysis" of the Cardiff/Barry area.

3.0 Sustainability

3.1 New Systems

Sustainability when directed at new systems is normally referred to by us as SuDS.
SuDS are a wide-ranging subject and can mean a variety of different things to different people and organisations. It can be as narrow as a house soakaway to complex combinations of infiltration devices, flow attenuation techniques and detention basins and ponds.

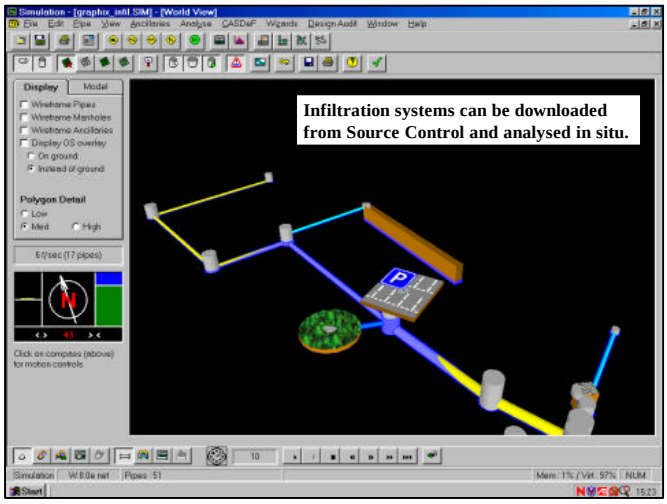


I prefer to think of it as the latter and any type of structure or flow attenuation system, which improves the run-off characteristics of a new drainage system, is to my mind SuDS.

SuDS are without doubt an emotive issue. Almost everybody seems to have an opinion on it. The Framework for SuDS document that has had its publication date once again delayed seemed to address a lot of issues where barriers had previously been encountered. The new SuDS Code of practice and the latest CIRIA documents are certainly a way forward.

Unfortunately, negativity seems to be "by word" when undertaking discussions on SuDS. There are notable exceptions around the country but on the whole it seems to be treated with scepticism and suspicion. How often do you hear a statement such as "Oh yes! Everyone agrees that SuDS is a good thing, but we don't use them because of….." or "Oh yes! We'd like to use them but there are Adoption and Maintenance issues so we don't use them because of……."

The SuDS working party for Wales was set up by Welsh Water (DCWW) who fund it. This rather explodes the myth the Water Companies are opposed to their use. What Welsh Water can not do is adopt structures or systems which they are legally precluded from owning. This does not mean that nobody can adopt them. It means that they can only adopt those systems, which they are allowed to adopt. The framework for SuDS presented a matrix which gave a breakdown of SuDS devices and their relationship to each stakeholder, be they: - Water Company, Highway Authority, Local Authority etc. This is a very good idea except it was probably not sufficiently detailed. Nevertheless the SuDS Working Party for Wales has embraced the matrix as a framework for future development. Each stakeholder is approaching the matrix from the point of view of which elements would be acceptable to him or her and under what conditions.



This is a considerable improvement since it gives direct guidance to developers (and organisations acting for them), on what is and what is not acceptable. Allied to this is a series of diagrams to indicate the way in which devices can be used and how and who would be expected to own and manage them. Hopefully this will clear a lot of logjams that are encountered. In addition to the above a SuDS flyer has been produced which will be circulated through every local and Highway Authority in the country and will raise awareness of its use in the Principality.

The Environment Agency for Wales has also funded a web site which will be online shortly. This will include databases of sites and be both informative and educational.

Whilst the take up of SuDS systems has been slow I believe we are definitely making progress and sites are growing.

3.2 Existing Systems

The traditional approach to solving unsatisfactory CSO discharges has been to limit forward flows (usually to Formula A) and spill the rest within the current guidelines to either achieve river quality objectives (RQO) or bathing water objectives. If the spill/frequency fails to meet these criteria then it is usually enhanced by storage. Where flooding problems are encountered then the traditional approach is to either pass more flow forward or provide attenuation storage.

The difficulties with these approaches are twofold:

1. If you pass more flow forward you may be removing the local problem but you generally pass this on downstream in the catchment e.g. to another CSO or ultimately the treatment works. The cost of downstream upsizing can be major and of course the situation over time has a tendency to get steadily worse.

2. If we store the water then we may be able to reduce the peak flow but we don't do anything about the overall volume. In addition what we see with major trunk sewers is that they are so heavily attenuated by the time they get a considerable way down the system there is less of a discernible peak to the flow hydrograph.

   What we see in storage to this type of scenario is that it might have an effect on short duration peaky summer storms but long duration winter storms or even periods of extended wet weather can fill them up and they fail to empty for weeks or even months.

   When this happens the ammonia levels in the stored water start to get very high. By the time that they do empty you find that a lot of screening material can settle into large chunks the size of footballs and when they are released into flows, which can be many cumecs, they act like cannon balls and can cause considerable damage to the screens at the works. Add that to the Ammonia levels that you have to treat and you certainly wonder if the storage is worth the hassle. I am not saying that storage does not work and on new storm water systems it is highly effective. However we do have to carefully consider its use on large long trunk mains.

   We also have some curious equations to satisfy such as 2 hours storage at 3 DWF. This is a fairly easy calculation to make but I have reservations on its usefulness. For example in a recent case this storage represented thousands of cubic metres and it changed the annual spill frequency by very little i.e. you would have had to provide a very large tank for virtually minuscule effect. Fortunately I should add that we have good relations with the Environment Agency in Wales and they are supportive when we are able to present clear cost/benefit arguments towards solutions.

How do we improve these situations?

The answer is quite simple – we remove the storm water from the systems! That is quite an easy statement to make but unfortunately it is not so easy to implement. I am not as naive to think that in an urban congested highly developed area we should start to dig up all the roads of the major cities and start laying storm sewers. However there are ways in which we can improve:

Inflow/Infiltration (I/I)

In some systems this represents a major contributor to the flow. In our aging sewer systems there are frequent occurrences of inflow from other sources such as rivers and streams or infiltration from ground water. Tackling this problem unless it is fairly obvious can be difficult to track down. There are specialist companies who are becoming very skilled and the results from I/I surveys can be very helpful.

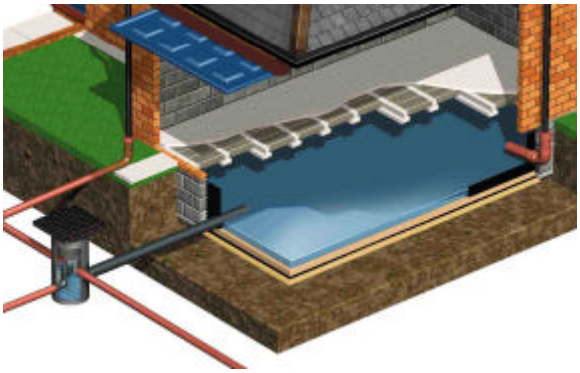
One thing is for sure – the situation will not get better and merely further deteriorates with time. I believe we need to become more ingenious in how we find it. There are many useful processes for solving it once we find it such as relining, sealing with resins, renovation etc. My experience is that the best time to go on an "Infiltration Hunt" is at night. You have to be very systematic in the procedure and not randomly lift manholes; it needs to be planned carefully. Most domestic systems are at their lowest flows at around 3 a.m. and although inspecting at this time means working at anti-social hours it can yield very positive results.

Another traditional way of finding I/I is of course flow monitoring – this can give good results and point you in the right direction but unfortunately you tend to have to know where the problem is before you monitor it, which is where local knowledge is invaluable.

Removal of Storm Water arising from Properties

Removing the storm water in our combined systems that is present from housing or industry (or misconnections) is not easy. For the reasons given previously separation is largely unfeasible but there are occasions when it may be possible and it should not be ruled out altogether.

Local infiltrations systems can sometimes be used if the ground conditions permit it. There are objections to these type of techniques mainly on the grounds of adoption, maintenance and what happens when it exceeds its life cycle. But these issues are not insurmountable and with the right legal agreements can be overcome. Another technique that has been used successfully recently is boreholes. In some cases these can take a lot of rainwater to an accepting strata and are comparatively inexpensive. Independent tanks for Rainwater Harvesting is another excellent method as they not only reduce storm runoff but also reduce the cost of a household or business potable water supply.



There are undoubted difficulties to overcome but with a positive approach they can be mitigated. Every little helps and the more practical measures we come up with certainly beats pouring tons of concrete into the ground. This is a challenge to us as Engineers and Environmentalists to become more innovative.

An approximate area of 1000 square metres represents a storm flow for a 1 in 1 year return period of 1 l/s. This is equivalent to adding a large population for foul flow. Hence the removal of storm water not only relieves the downstream condition but also aids future development. For every small amount removed allows head room for future development. For instance, Barry Island (near Cardiff) used to be a famous Butlin's Holiday Camp. It has now been re developed with housing which has its own separate system. This development has resulted in an increase in capacity of the local system, which can be used in a beneficial way. This is just one example of how the situation can be improved.

Most of the scenarios detailed above need support from local residents or businesses. In order to effect the principles outlined the general public has to offer their little bit of help. In order to do this they need to be educated so that the sustainability argument is seen in a context which enables a potential reduction in spend and consequent savings which are reflected in the Water Rates.

This has happened in Malmo, Sweden where the population are helping greatly. Unfortunately there tends to be a NIMBY principle where if an individual's property is not in danger then they don't see how it affects them. But it does – in their Water Rates! In Welsh Water area, they offer a discount to customers who remove their storm water from the combined sewer system. (this may occur in other Water Companies as well). This fact is little known and perhaps if it was more attractive we might see a greater take-up.

4.0 SUMMARY

Finally the more sustainable we make our drainage systems by whatever method we use so we reduce the risk. Any risk strategy is based on its management. My opinion is that managing the risk is the way forward and not trying to over engineer solutions that may be unachievable and may even make things worse. Recognise the failure condition and take engineering steps to mitigate it.
This paper is not intended to be comprehensive. Many of the issues contained within it are worthy of papers in their own right and there is current research progressing. Hopefully it is thought provoking and can stimulate us to find a more "sustainable" way forward.

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The views expressed in this paper do not represent any organisation or company other than myself.