REDUCING THE NUMBER OF DG5 FLOODING INCIDENTS

by

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Background.

One of the most distressing service failures that water and sewerage customers can experience is flooding from blocked or overloaded sewers. Despite recent successes by water companies at reducing the number of properties on the DG5 register, urban flooding remains a challenge for the rest of AMP3 and is likely to play a significant role in AMP4. Approx 7,000 properties are affected by internal sewer flooding each year, and it is accepted that targeting properties known to be at risk of frequent flooding will not eliminate the problem. Likewise asset management can be utilised to reduce 'other causes' incidents, but significant reductions in numbers are not guaranteed. As a result of performance being measured by the number of properties at risk , companies are incentivised to give priority to projects with low unit costs. In the next AMP period the focus may change towards addressing the problems with greater impact on the customer and highest frequency of occurrence.

Introduction.

Problem understanding is key to arriving at the right solution and enables effective and efficient asset and risk management to be undertaken.

Throughout AMP3 MWH has been working with YWS on projects to resolve both hydraulic and 'other causes' flooding. As a result innovative methodologies for dealing with the problems have been developed that achieve a balance between the level of protection given and reactive and proactive investment.

Problem understanding.

It is widely accepted that there are proportionally three times as many cellared properties in the Yorkshire region as there are in other water company regions, and that this increases the company's vulnerability to internal flooding incidents. This fact has proved a major driver to YWS and has led them to vigorously address flooding problems in the region.

DG5 flooding falls into two categories, incidents caused by hydraulic incapacity (overloaded sewer flooding), and incidents caused by transient network problems and structural and service deficiencies (other causes flooding). Understanding the problem is critical to solution development and good incident and catchment data should underpin the investigation of incidents.

It is easy to overlook the importance of understanding the cause of individual flooding incidents. Historically the collection of information about incidents has been poor and 'ad hoc' but there have been significant improvements in the data collected over the last decade. YWS are continually striving to improve their understanding of flooding incidents and as a result now have a well-defined procedure for recording data which is used to facilitate prioritisation of expenditure.

By interpreting incident data, hydraulic data, structural and service condition data it usually possible to identify the flooding mechanism. In more complex cases however there may be multiple causes and these can be harder to identify and resolve. In some areas of persistent ‘other causes’ flooding it has subsequently been found that there are underlying hydraulic deficiencies and the synergistic effects of the two causes have increased the frequency of events. In such cases problem understanding allows the identification of solutions which give the optimum balance between increasing network capacity and works to improve structural or service condition.

Hydraulic flooding problems.

Traditionally dedicated network models have been used to resolve flooding resulting from hydraulic incapacity. However this can be a time consuming and costly way of delivering solutions. The indiscriminate use of sewer modelling is ill suited to the constraints of a five-year delivery programme. By understanding the flooding mechanism and using structured reasoning and risk assessment it is possible to identify situations where a modelled solution may not be required. MWH have written a protocol that can be used with clients to allow schemes to be reviewed so that the most appropriate solutions strategy can be adopted. In some cases this may involve detailed modelling, in others it may not.

Abbey Road North, Shepley is an example where such alternatives have been successfully used. Three properties in the local catchment suffered internal cellar flooding, and it was widely accepted that the sewer network was overloaded. Historic feasibility studies had identified that large volumes of storage would be required to lower surcharge to such a level that flooding of the cellars would not occur. The estimated cost of the proposal was £1.2m.

After reviewing all the data and talking to the affected customers it became obvious that flooding emanated from direct connections to the sewer at cellar level and the volumes escaping were small. Assessment was made of the relative levels and vulnerability of adjacent properties and it was agreed that removal of the connections would not cause flooding at new locations. With agreement from the customers the cellar connections were abandoned and a small sump pump installed with the discharge hose connected at high level. This solution still allowed effective cellar drainage, e.g. to handle ground water ingress, but prevents backflow from the surcharged sewer system. The work was completed within two weeks of the instruction being received at a cost of £5,000 per property, and the properties have subsequently been removed from the flooding register.

Fig.1. An example of cellar flooding.

‘Other causes’ flooding problems.

Other causes flooding is typically caused by:

- Random blockages
- Recurrent blockages
- Structural and service defects
- Asset failures

Data analysis has shown that blockages in small diameter sewers are a major cause of internal flooding and an understanding of solids settlement, structural and service defects, flow volumes and effluent composition can help identify areas that are particularly liable to blockages.

For a number of years MWH and YWS have been working together to reduce the number of ‘other causes’ incidents across the Yorkshire region. For ‘other causes’ flooding problems, innovative and cost-effective ways of dealing with the deficiencies of an ageing sewer network and transient problems e.g. blockages, need to be identified and implemented. Again the first step in tackling the issue is understanding the problem. Early work was aimed at developing strategies and procedures for pro-active cleansing and maintenance. Sewer investigation work was undertaken by CCTV and also visual inspection of ancillaries and this information was utilised to initiate a cleansing and maintenance programme.

The conclusion of the study was that pro-active cleansing and maintenance successfully reduced incidents in the targeted areas, and it was proposed that information from the sample areas should be used to classify future incident risk. The CCTV results for one of the specific target areas are shown in Table 1. The survey covered all sewers in the targeted areas. A greater number of defects were found in the lengths of Section 24 sewers. These included broken pipes, open joints and obstructions.

More recently MWH and YWS have worked together to undertake Section 24 sewer investigation in a particular catchment and then later to identify innovative solutions to flooding from S24 sewers. In November 2002 MWH was appointed to manage the CCTV survey of all of the Ex Section 24 (Ex S24) sewers in one quarter of an OS grid square. The results were then categorised using Examiner software and the results are shown below in Table 2. Only 1% of the sewers were graded with an ICG of 5, and this score related to a specific location where a fence post had pierced a pipe. However over a third of the sewers were graded at condition grade 3 or 4, and the number of backfalls and pipes with poor gradients were identified. It should be noted that the area investigated is part of the pro-active cleansing and maintenance programme, which may explain the absence of blockages in the sewers with poor or negative gradients.

Solids movement within the sewerage system is very complex and linked to a number of variable parameters. Swaffield and Wakelin (1976) identified during solid transport tests that a solid will generally become vulnerable to being deposited when the velocity of the solid reduces to 0.2 m/s, for example at the back end of a flush from a WC. The study also identified that solids passing over a rough joint would become stranded due to the structural defect. Littlewood (2001) confirmed this during laboratory trials of solids movement in smooth Perspex pipes where the velocity of the solid significantly reduced when a solid passed over a joint. Even relatively smooth joints with less than 1-mm step could affect the progress of the solid. For completely smooth pipes with no joints, solids will be deposited at the location where the flushwaters pass over them and leave them stranded.

Numerous laboratory studies have been undertaken to understand further the mechanisms for solid deposition. Swaffield and McDougall (1996) identified that solids will move progressively through building drainage carried by water discharged from household appliances, and also that different solids are transported at different rates and distances from a WC flush.

The structural condition of the sewerage system is therefore likely to be the most significant factor that causes the initial deposition of solids that can lead to blockages occurring. With this in mind, consideration of the CCTV results itemised in Table 2 supported by data analysis which shows that blockages are the major cause of internal flooding incidents, up to 60% of Section 24 sewers in the studied area are in a condition that predisposes them to blockage formation.

It is possible that in areas such as this blockages will continue to occur. Although proactive cleansing can reduce their frequency it is unlikely to entirely eliminate them. A more targeted approach to maintenance and rehabilitation may be necessary if further improvements to service levels are to be sustained.

Table 1. CCTV summary report for SE1423. DG5 Other Causes. Pilot Study

Description		Measure	Diameter Range (mm)			
			<200 (Ex s24)	200-350	351-500	>500
Length Surveyed		Metre	6123	5464.2	1458.4	954.1
Pipes Broken (All)		No	103	34	7	5
Debris/Silt	<10% area	Metre	865.1	867.5	408.6	20
	>10% area	Metre	463.6	1170.3	154.3	0
Debris/Grease	<10% area	Metre	1065.1	761.4	225.2	154.7
	>10% area	Metre	30.4	0	0	0
Defective/Intruding Connections		No	23	150	30	13
Joint Displacement (Large)		No	40	12	1	0
Camera Under Water		No	9	0	1	0
Obstructions		No	17	4	0	0

Table 2. Results of Sewer Investigation Project.

Total length of S24 Sewers at Grade 1	700 m	29%
Total length of S24 Sewers at Grade 2	480 m	20%
Total length of S24 Sewers at Grade 3	388 m	16%
Total length of S24 Sewers at Grade 4	511 m	21%
Total length of S24 Sewers at Grade 5	28 m	1%
Total length of S24 Sewers not surveyed	157 m	7%
Total length of S24 Sewers “none existent”	28 m	6%

Complex inter-relationships contributing to flooding.

It is important not to assume that all internal flooding incidents are the sole responsibility of water companies. There are many examples where the actions or omissions of other parties cause or exacerbate sewer flooding. In particular Local Authorities, the Environment Agency, Local Drainage Boards and customers can all play a part in helping to reduce flooding problems, both by good housekeeping and where necessary capital investment.

The photograph below is indicative of the problem caused when highway gullies are not maintained correctly. In this case the gully no longer drains the surface waters off the carriageway into a watercourse but allows overland flows to enter the sewer network causing increased surcharge.

Similarly in the Honley catchment a number of properties suffer external and internal flooding and problem understanding has highlighted that structural defects in an adjacent watercourse restrict discharge of the downstream combined sewer overflow exacerbating the flooding.

In situations where such inter-relationships exist collaboration between all the affected parties is important but can be difficult. Understanding where shared responsibilities are a factor can help decision making for the party with the most pressing driver. Managing the customers expectations and understanding of responsibilities can be even more challenging. Water companies and local authorities are often the first points of contact for flooding problems and good working relationships between these and other bodies is essential.

The future.

Increased customer awareness and expectation of ever-higher levels of service from the water companies may lead to more incidents being reported in the future. In addition increased development will have an impact, but this could be managed by legislative changes, and in any case water companies are expected to tackle this issue by using the funding allocated for sewerage growth.

It is likely that there are latent problems that are not yet fully understood, and it is impossible to predict what impact these will have without further information.

However there is much talk about how rainfall events are changing, and becoming more intense which may influence flooding. The UKWIR Climate Change project has identified that certain parts of the UK may be subjected to a 40% increase in rainfall amount. This and other climate change issues are more likely to be considered in the longer term rather than the next AMP period, but companies may wish to consider the increased business risks such predictions may present.

When considering external flooding, unaudited Ofwat data suggests that there are around three times more external incidents than internal incidents. Understanding the customer and environmental impacts of these external problems will be fundamental to prioritisation of future investment, and the management of flooding in AMP4 and beyond.

Conclusion

The authors have demonstrated that problem understanding is critical to determining both the appropriate method of solution development and in assessing the relative risk of alternative proposals. In particular, that building a sewer network model is not necessary in all circumstances.

When tackling 'other causes' flooding, asset condition has been shown to be an important factor. Targeted cleansing and maintenance can do much to reduce the occurrence of blockages which subsequently lead to flooding, but because of the randomness of such events, will not entirely address the problem.

Property and external flooding may also arise from other sources such as river or ground water flooding, often in concert with sewer flooding. In such cases problem understanding and liaison between responsible bodies is particularly important.

References:

UKWIR Project CL/10*, Climate change and the hydraulic design of sewerage systems.*

Digman, C.J. (2003) *Aesthetic Pollutant Loadings in Combined Sewerage System*, PhD Thesis, Sheffield Hallam University.

Littlewood, K. (2000*)* Movement *of Gross Solids in Small Diameter Sewers,* PhD Thesis, University of London.

May, R.W.P., Martin, P., Price, N.J., (1998) *"Low-cost options for prevention of flooding from sewers"* CIRIA C506

Swaffield, J.A. and McDougall, J.A. (1996) *Modelling Solid Transport in Building Drainage Systems,* Wat, Sci, Tech, Vol 33, No. 9, pp 9-16.

Swaffield J.A. and Wakelin R.H.M`*Observation and analysis of the parameters affecting the transport of waste solids in internal drainage systems'.* Public Health Engineer,Vol 4, No 6, pp165-171, November 1976.