Tackling other causes flooding through proactive maintenance

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BACKGROUND

Property and area flooding is becoming an increasing priority for customers and OFWAT and therefore for water companies. This includes concern about flooding due to blockages and collapses.

The national picture for England and Wales is set out in the report on levels of service produced by OFWAT [OFWAT 2002]. In 2001-02 there were just under 5000 properties that suffered internal flooding with sewage. 57% of these incidents were due to causes other than overloaded sewers. These causes are principally blockages, collapses and equipment failures. In addition there were an unreported number of flooding incidents affecting outbuildings, gardens, roads and public spaces. These incidents of external flooding are now recognised as having an impact almost as great as internal flooding.

Sewerage providers incur significant costs in dealing with these incidents including payment of compensation, cleanup costs, emergency maintenance and management and public relations costs.

In addition to flooding, blockages and collapses also cause pollution incidents. In total there were 2200 sewerage related pollution incidents in the same year. As well as involving costs for cleanup and emergency response these pollution incidents also bring a risk of prosecution.

There is likely to be an even larger hidden problem of partial collapses or blockages that go unnoticed because they do not cause a complete failure of the system, but do cause an increased risk of flooding or overflow spill during rainfall. These are causing unnecessary flooding or spill but may go unrecorded for years.

THE PROGRAMME

Objective

Earth Tech is managing a programme for one water company to use targeted maintenance to reduce the occurrence of blockages and collapses and therefore reduce the number of flooding incidents due to “other causes”. This paper presents some of the findings.

The study first looked at the distribution of incidents across the region to identify which catchments to target. In each chosen catchment risk areas were identified based on past incidents. Maintenance was then targeted at these risk areas. Work is now commencing to implement an improved risk based assessment that will allow new risk areas to be identified and to refine the selection of maintenance techniques.

Method

The method being adopted uses GIS to collate information on failures of levels of service (blockages, collapses, flooding) and the risk factors that may have contributed to them (fats and grease, soil conditions, traffic load). This analysis is then used to identify those areas where maintenance action will prevent future problems.

There are two ways in which action can be targeted.

The first is to identify hotspots where problems have happened repeatedly and are continuing to happen. To achieve immediate benefits here it is not too important to understand the underlying causes leading to the problem; it is only necessary to intervene with cleansing or rehabilitation to prevent future occurrences. We could class this as semi reactive action. In the longer term, for blockage hotspots an understanding of the causes may allow them to be addressed so that regular cleansing is no longer needed.

The second is to identify areas that do not have a clear history of problems but that are at risk of future problems. This does require an understanding of the underlying causes of problems throughout the system so that other areas where the same causes occur can be identified. This proactive action is obviously more complex than the semi-reactive action described above.

As time goes on the first method becomes less useful. Because we are preventing blockages and collapses we have less and less data from which to identify hotspots. The cause of the problem may have gone but we could continue to intervene forever. There are therefore benefits in moving to the second method.

Both methods of assessment involve the analysis of a large amount of data, not all of which is readily available. To make sure that the work is cost effective the principle that 80% of the results can be obtained for 20% of the effort is adopted. Where a small part of the data cannot readily be used it is ignored until it can be shown to be essential.

Numbers of incidents

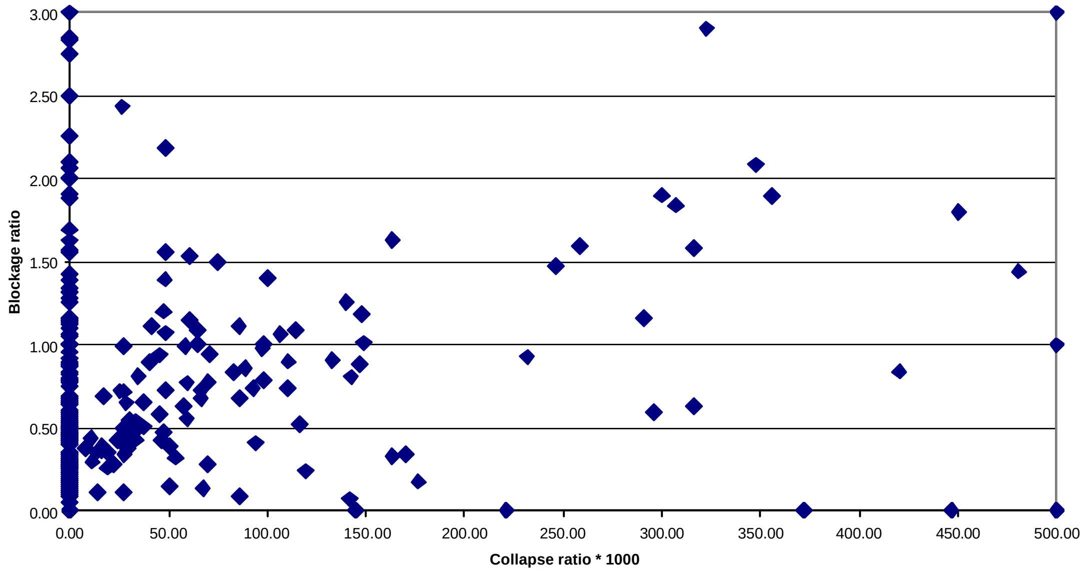
The study looked at the number of blockage and collapse incidents in each catchment in one typical recent year. For this purpose collapses are defined as complete collapse of a section of sewer preventing flow; blockages are defined as those severe enough to require emergency response.

The average number of incidents across the region over the two years was 590 blockages per 1000 km of sewer and 35 collapses per 1000 km. The industry average is about 500 and 20 respectively.

Although in percentage terms the performance is most adrift on collapses, in absolute terms there are greater gains that can be achieved by targeting blockages.

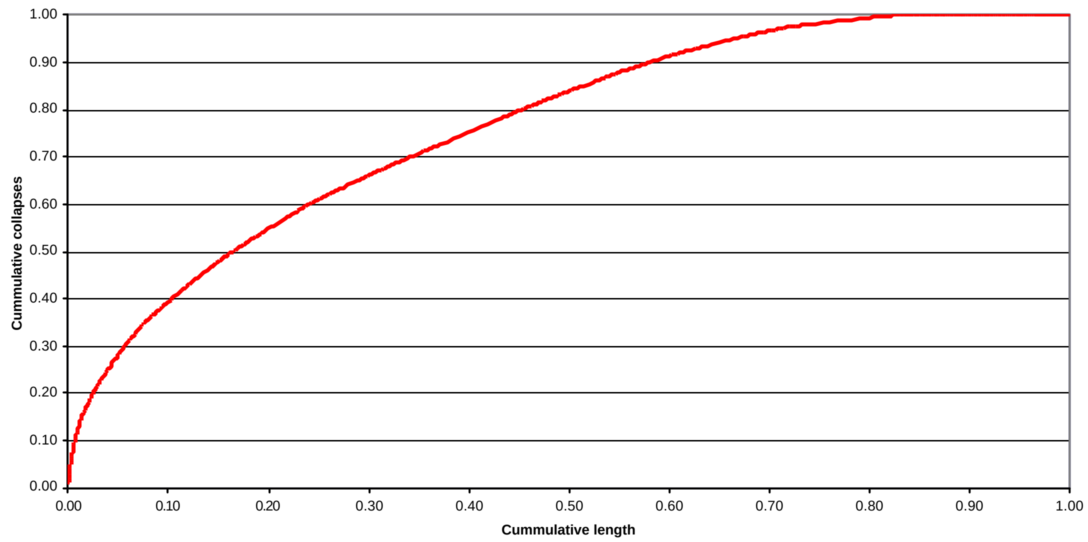
There was some correlation between number of blockages and collapses in each catchment although this was not universal.

Figure 1Correlation between blockages and collapses



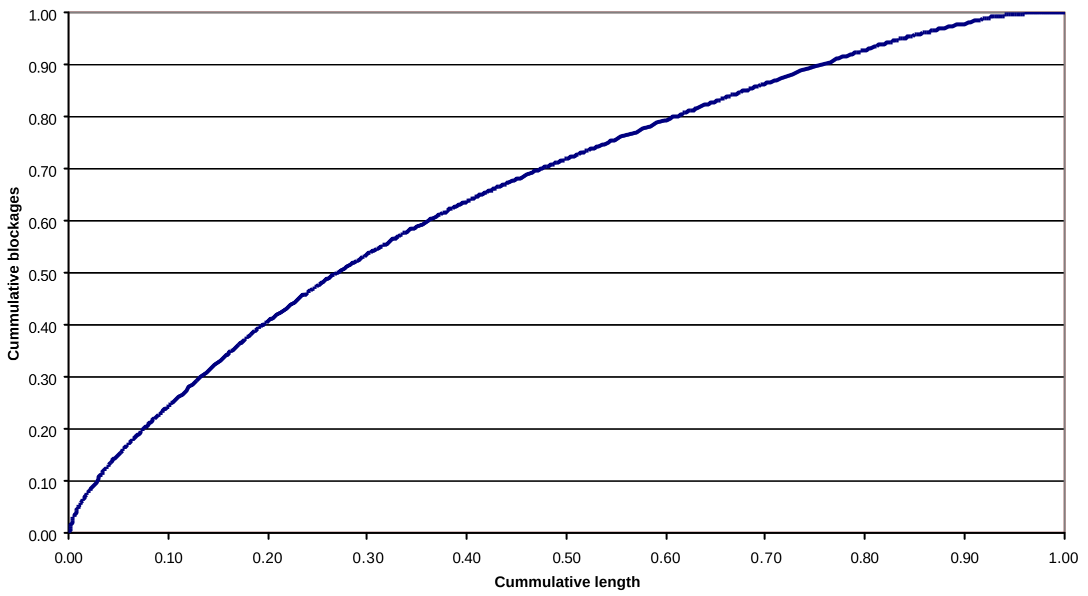
However the rates were not uniform across the region with some catchments showing very high rates. Figure 1 shows the cumulative number of collapses against the cumulative length of sewers in the catchments. This indicates that catchments containing only 40% of the sewer length had over 70% of the collapse incidents.

Figure 2 Distribution of collapses



The situation is less marked for blockages although catchments with 60% of the sewer length have over 75% of the blockages (Figure 2).

Figure 3 Distribution of blockages



Targeting catchments

The first year of the programme assessed target sewers catchment by catchment. This obviously has a significant cost. The first step is therefore to identify those catchments that will show the most cost effective results from such a study.

A cost model was developed of the cost of doing an assessment and of managing and carrying out cleaning and renovation work of the target sewers that the study identified. The benefit was estimated by assuming that a catchment could be brought to a target performance of blockages per kilometre per year and collapses per kilometre per year. The reduction in incidents from a sample year could therefore be calculated.

The estimated cost per avoided incident could therefore be calculated for each catchment and ranked to tackle the cheapest catchments first.

It perhaps comes as no surprise that it is cheaper to use jetting to prevent a blockage than to use repair or replacement to prevent a collapse. When looking for quick wins therefore it is inevitable that the programme will focus on blockage prevention.

Cluster analysis

For the selected catchments, we then looked at longer records to identify the distribution of incidents within the catchment. This showed that many of the blockages were clustered in small areas that suffered from repeated incidents. These clusters were often associated with collapses as well.

Catchment A - Collapses

This catchment had a total sewer length of 726 km and typically suffered 21 collapses a year. Over a ten year period only 8.5 km (1.2%) of sewers suffered any collapses and 40% of the collapses were on just 34 sewers totalling just 1.7 km (0.2%) of the sewer length.

Of these 34 sewers only 8 had a structural grade allocated

Grade	No of sewers
1	3
2	2
3	1
4	2
5	0

Only 3 collapses in the whole 10-year period were on Category A sewers. This perhaps indicates that the strategy of taking preventive action on these sewers, which cost most to repair, is achieving its aims although not addressing the overall problem of collapses.

Catchment B - Blockages

This had a total sewer length of 370 km and typically suffered from 94 blockages a year. Over a five year period only 15 km (4%) of the sewers suffered any blockages and 25% of the blockages occurred on just 875 m (0.2%) of the sewers.

These results indicate that there is obvious scope for targeting sewer cleaning and renovation at those sewers that are likely to suffer from problems and ignoring the rest. The trick of course is to correctly identify those at-risk sewers.

We did not categorise these incidents on the severity of the flooding caused, but it appears that collapses are slightly more likely to result in internal flooding of properties than are blockages. The reasons for this have not yet been investigated.

Results

To date we have investigated 7 catchments for blockages and 3 collapses for collapses.

For the 7 catchments analysed for blockages. Jetting has been carried out on sewers that had a history of blockage problems and in all cases significant deposits of silt or fat or significant masses of roots were removed. For one of these catchments the local operating staff maintained a list of sewers that they identified as having a risk of blockage and that were jetted at intervals. None of the sewers that we identified from the blockage history were on their list.

In total in the first year we identified 71 km of sewer that required period cleansing (perhaps once a year). Of these we actually cleansed 54 km (1636 sewer lengths) the rest is underway now. Interestingly we have since had blockages on 26 of those sewers. This suggests that for a few of the sewers suffering from repeated blockages there is an underlying problem that cannot be solved by jetting. For one of the sewers we have already identified a partial collapse.

We looked at three catchments for collapses. In these we identified 6.5 km of sewers that had a history of problems. We carried out a CCTV inspection of 5.5 km of these (access was too difficult for the other 1km). Of the sewers inspected 72% were grade 4 or grade 5. We have identified renovation schemes for 1.7 km of grade 5 sewers and these are being constructed.

One catchment had a significant problem of collapses where we identified 20 sewer lengths with a history of repeat collapses. These have been inspected by cctv and almost all were found to have other fractures or partial collapses that should be repaired. None of these would have been identified during a normal drainage area study, as they were not critical sewers.

Results so far show that it is significantly cheaper to analyse and address problems of repeated blockages than it is to analyse and address problems of collapses. The cost ratio is at least 1:10. Jetting to clear blockages will need to be repeated each year so that in the long term the cost builds up but to get quick improvements in performance for limited cost it is obviously better to focus on blockage removal with jetting rather than renovation.

A significant number of problems were found in pitch fibre pipes where jetting is considered too risky and where renovation is the only real option.

THIS YEAR

Proactive sewer cleansing

For the present we are continuing with the same strategy for proactive sewer cleansing as there is still a backlog of historic data to analyse. However in the longer term we see the need to develop improved assessment techniques. These are described later.

A desirable extension is to identify the risk of flooding of properties and other areas if a blockage occurred. There are techniques to automate this but it will always require some judgement as to the behaviour of the flows when the blockage occurs.

Proactive sewer rehabilitation

Because collapses occur less frequently than blockages there is less historical data available on clusters of problems. We therefore think that within a year we will have exhausted this technique for finding sewers at risk of collapse and will need to develop new techniques. We are already developing these procedures and will trial them later this year.

The concept of critical sewers to identify those for which it is worthwhile carrying out regular CCTV inspections to identify the need for rehabilitation is not new. It is a cornerstone of the Sewerage Rehabilitation Manual. However knowledge and drivers have moved on since the development of the original derivation and the identified need for this project indicates that it no longer meets all of the needs of water companies.

The majority of public sewers (around 80%) are in category C and so are not assessed for proactive rehabilitation under the SRM procedure. However collapses on these sewers still cause problems and should be avoided.

There are three components to the assessment of sewer failure. The first is the risk of collapse due to the structural condition of the sewer. This is assessed from cctv inspection.

The second is the risk of collapse due to the external ground and loading conditions. This is assessed from soil condition information, surcharge frequency and location.

The third is the cost of the damage should the sewer fail. In the SRM this is assessed as the sewer criticality, based on the likely repair costs.

The most expensive of these to assess is the first, as it requires cctv inspection.

The methodology in the SRM is first to assess the criticality based on repair costs. For sewers with high repair and disruption cost (Category A and B) a cctv inspection is then carried out to assess structural condition. This is then modified by an assessment of external risk factors.

There are two problems with this approach. Firstly it does not take into account the increasing cost of disruption and compensation when a collapse occurs. Repair cost is therefore no longer a good measure of the real cost to the company. Secondly it carries out the expensive cctv inspection before identifying all of the other factors.

We therefore propose the development of a revised methodology particularly for category C sewers.

This would first identify the external factors that could influence the risk of collapse. These would be similar to those identified in the SRM including soil conditions, surcharge and traffic loading. The occurrence of previous collapses in adjacent sewers would also be identified as a risk factor.

The damage and disruption cost of a collapse would then be assessed. This would use many of the factors from the SRM criticality assessment but would also incorporate some crude assessment of the number of properties at risk of flooding.

These two factors would then be combined to identify those sewers where poor structural condition would give a high risk of failure and damage. These sewers would be targeted for cctv inspection to identify if pre-emptive action was worthwhile.

THE FUTURE

Cost model

A further development of the cost model would be to assign a financial benefit to the prevention of incidents and so produce a cost benefit model. This could take into account the number of properties likely to be affected by an incident, the additional cost of emergency response to the incident etc. It was decided that this extra step was too complex at this stage and that a cost effective approach was more appropriate.

Blockage risk assessment

In the longer term we will develop improved methods of assessing sewer cleaning strategies. There are two ways to do this. The first is to identify underlying causes of blockages so that the alternative of capital solutions, which will remove the need for ongoing maintenance, can be assessed. The second is to identify risk factors for sewers across the network so that other problems can be identified before they develop.

Identifying causes

Some of the contributory causes of blockage are obvious and can be readily identified. Areas with food outlets will suffer from fat build up. Coastal areas will suffer from wind and wave driven sand. Sewers with flat gradients will suffer from sedimentation. Sewers upstream of pumping stations or overflows may suffer backup. Roots can be identified when cleansing.

For any problems that do not show any of these obvious causes it is worthwhile carrying out a cctv survey to identify structural causes such as intruding laterals or partial collapses.

Once the cause of the problem is identified the cost benefit of a capital solution rather than ongoing maintenance can be reviewed.

Identifying risks

With the knowledge of these risk factors it is possible to identify other sewers in the catchment that are at risk of blockage even if they do not have a history of repeat blockages. This can be considered as a crude form of "blockage criticality". These sewers can then be targeted for occasional cleansing to prevent problems occurring. Identifying the risk of root blockage from readily available information is likely to be a challenge for the foreseeable future.

LONG TERM

From the data analysis carried out for this project we have been able to estimate the long term costs of dealing with blockages and collapses. These are rough estimates, but we estimate that to deal with blockage problems in at risk sewers it is probably necessary to have a jetting programme equivalent to a spend of £60 for every km of sewer in the system.

To deal with the backlog of sewers at risk of collapse we estimate that it requires a spend equivalent to £8 000 for every km of sewer in the system. Bearing in mind that the asset value of those sewers is of the order of £3 m per km the investment would seem to be worthwhile.

CONCLUSIONS

As the capacity of our sewer systems is improved so reducing the occurrence of flooding due to incapacity, other causes flooding becomes a higher priority. There is also a hidden problem of blockages and collapses in our sewer systems causing degradation in performance that increases flood risk but not sufficiently to give risk to remedial action.

Blockages and collapses do not occur uniformly throughout sewer catchments but are clustered in areas with identifiable risk factors. Proactive cleansing and renovation in these areas can be cost effective in preventing flooding.

The tools developed under this project have allowed us to identify the risk areas and plan the proactive interventions.

Further developments are already underway to assess the risk factors leading to blockages and to develop an improved risk assessment tool for sewer criticality.

REFERENCES

OFWAT 2002. Levels of service for the water industry in England & Wales 2001-2002 report. OFWAT 2002 www.ofwat.gov.uk.

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