Why We Need Urban Drainage Intelligence

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In the UK, we have over 250,000 miles of sewer networks, carrying 10 billion litres/day, representing one of the largest lengths of sewer systems within the European Union. Investment in those networks over last 25 years has exceeded £125 billion. Even with those levels of investment, for us as a nation to continue to have a sewerage infrastructure that meets or exceeds the required levels of service at an acceptable level of risk and that is affordable, will require us to increase the use we make of Urban Drainage intelligence significantly.

Intelligence means many things to many people. Intelligence is defined by the Oxford Dictionary as the ability to acquire and apply knowledge and skills. In relation to the sewerage infrastructure, that intelligence exists in many different shapes and forms, and covers from the long to the short term, and from whole regions down to components of assets.

The historical focus of urban drainage intelligence has centred on understanding the performance of networks in relation to sewer flooding and CSO operation, and how best to resolve unacceptable impacts, particularly within financial and time constraints. To provide that intelligence, our ability to monitor sewer networks has progressed from simple level monitors to those capable of measuring flow, including under reverse flow conditions. At the same time, the cost of monitoring has come down in real terms, both because of increased self-checking capabilities of instruments, and the effective life of batteries. Complimenting an increased ability to monitor the sewerage system is the ability to model its performance. This began with models having 100 nodes or less, and a simplified network. Now, the size of the network we can model is effectively unlimited, with use being made of models that can run simultaneously on multiple 64 bit machines. Other advances mean that we can connect together sewer and pluvial flooding, make use of terrain data collected using low cost drones, allow for spatially varying rainfall measured using radar, visualise that information in various forms, including 3-D animations, whilst collaborating remotely using cloud based servers.

Furthermore, over the last fifteen years, we have also improved our ability to contextualise the impact of the sewerage network on the environment, through the implementation of the Urban Pollution Management manual. Alongside this, by improving our fundamental intelligence on how to effectively screen CSO discharges, gained through projects such as the Wigan test rig, and how we survey for aesthetically deficient overflows, as a sector we have made a significant reduction in the number of overflows that discharge solids related debris.

Looking at the long term performance of our sewerage systems, we need to better understand the pressures from population growth and climate change, as well as other factors reducing capacity, such as urban creep and inflow & infiltration. To achieve this, and identify the intervention strategies required, we need to improve our intelligence on the available capacity in our networks at a regional scale, over the next 25 to 50 years. By doing so, this will assist understanding the balance between local solutions, financeable over a short time period, and more holistic long term interventions, that may well require different financing arrangements to those that currently exist. Similarly, by understanding better where most available future capacity exists, this provides the basis for a more pro-active partnership with local planning authorities. In some countries, such as Germany and the United States, management of available capacity already exists, related to long term flow monitoring at key points in the sewerage system.

In the medium term, over the next five years, we will need to apply our intelligence consistently, to ensure that we properly understand the problems we are trying to fix. Increasingly this involves bringing disparate sets of data. This can include such measures as source apportionment of microbial sources, to understand the root causes of bathing beach failures, and examining the interplay of pumping stations under a range of conditions to understand the root causes of flooding.

Whilst as a sector we have developed a range of tools and techniques centred on the normal behaviour of the sewerage network, we are less clear on how our networks deteriorate, and the associated impacts. This includes both gradual deterioration, and various forms of malfunction and abuse of the system, and how resilient it is to those occurrences. As a sector, we need to improve our understanding of where, why and over what timescales our networks deteriorate, and how this impacts on levels of service provided. An emerging form of deterioration, which is likely to become more prevalent in the future as more separate systems are built, is the loss of integrity between foul and storm water systems, resulting in either loss of capacity in separate systems, or contamination of storm water systems and attendant adverse environmental impacts.

Allied to this is the need to improve our understanding of how parts of the system could fail, and how to prevent or mitigate the associated impacts. In the case of mechanical parts of our network – pumping stations and rising mains, this will involve improving our understanding of the reliability of equipment, both at a component and a site level, and the root causes of failure. We will also need better means of evaluating the potential consequent impacts on the environment, and understanding the best intervention mechanisms to prevent or mitigate against such occurrences.

On the question of asset failure, we need to have a better appreciation of where failure of our systems could have an impact on other critical infrastructures, such as transport networks. Conversely, we also need to have the ability to understand where the activities of others, including other utilities, could have the most detrimental consequences to the normal functioning of the sewerage infrastructure, and take steps to mitigate accordingly. As part of understanding risks to our networks, or risks posed by our networks, we need to be able to categorise this accurately in terms of probability and consequence, including being able to monetise the total consequences of failure.

Intelligence also plays a key role in managing the short term performance of the network, be that under normal or abnormal conditions. As the importance of energy and carbon becomes ever more important in the operation of systems, so this is likely to lead to a greater need to optimise the performance of the network on an ongoing basis, particularly to reduce pumping costs. This could include making better use of available network storage, or reducing of inflow and infiltration to the network. In some instances, better active management of systems could prove to be a viable alternative to further construction work.

Intelligence also plays key roles in the day to day running of networks. This can include use of sets of monitors to detect either abnormal operation of overflows, or precursors to abnormal operation. In this area, artificial intelligence, including neural networks, are already being used to make such inferences on a routine basis, and consequently make significant reductions in both the number and severity of pollution incidents from sewer networks.

Other preventative intelligence includes understanding where fats, oils and greases have a history of building up in systems, and undertaking pro-active cleansing accordingly. Similarly, understanding where sewer sediments build up and the associated consequences can assist in developing a pro-active sewer cleaning and jetting programme. Plotting of 'other causes' pollution incidents and sewer flooding helps establish key vulnerable areas of the network, and this can then often be related to characteristics of the network. With the recent adoption of private sewers, understanding the overall performance of those small bore networks in this context is a key piece of new intelligence to be gained. It should be remembered though that not all intelligence is high technology. For some of the above problems, a person on the ground lifting manholes can often yield that vital piece of information.

Just as intelligence benefits those who need to operate, maintain and invest in our sewerage infrastructure, so it will also benefit other stakeholders in the system. Over the next five years, the majority of the overflows in the UK will have event duration monitoring fitted. This is partly in response to pressures from both third parties and Europe, to improve the visibility of overflow performance to all. Such an increase in publically available information is bound to bring challenges, and it is up to the sector to be pro-active in both making the information available and, importantly, being able to explain the reasons for the performance, including any intended improvement measures. In a related context, as part of the revised bathing water Directive, a number of companies are making information available on overflow operation available in near real time, to allow beach users to make informed decisions about which beaches they visit, and the activities they undertake.

In terms of sharing information, with the advent of lead local flood authorities and a greater awareness of the benefits of partnership working, information on predicted sewer flooding is now increasingly being shared with local authorities as part of developing integrated flood management plans, leading to better overall solutions being implemented. Looking to the future, particularly with the advent of Environmental Information Regulations, it is likely that predicted sewer flooding maps will become available in a similar manner to that which happened for predicted river flooding maps. Whilst the increased visibility of information will bring justifiable concerns, it also has the potential to bring a longer term benefit, which is to increase public confidence that we understand our systems and are managing them effectively.

In reviewing the myriad of intelligence that applies to our sewerage networks, it is perhaps easy to focus on the technological, and miss out on the intelligence, knowledge and experience we have gained as individuals, particularly as much of it is tacit, rather than codified. Of all the types of intelligence we have, this is one that we may not appreciate exists until it is lost, and we need to take steps to ensure that that our knowledge and intelligence is suitably captured and passed on.