Evolving our approach to manage surface water

Managing surface water differently provides an opportunity to enhance our urban areas, says Dr Chris Digman of MWH and Jonathan Glerum of CIRIA

Retrofitting urban areas, whether it is to replace aging infrastructure, major regeneration work or minor improvements, is not new. Even in times of austerity there is a need to continually maintain, improve and enhance urban areas. Given the current economic climate it is more important than ever to realise the opportunities available and maximise the benefits when retrofitting urban areas. This should include how we manage surface water.

Out of sight, out of mind

Managing surface water has traditionally taken place below ground, using pipes, culverts and tanks to convey and attenuate surface water. However, points in the drainage network such as combined sewer overflows can pollute watercourses and if, and when, this infrastructure fails it can lead to flooding. Retrofitting surface water management measures (SWMM) still recognises the need to use traditional approaches where appropriate. However, these measures should be considered with a new suite of alternative measures to manage surface water both above and below ground, such as sustainable drainage systems (SuDS). Adopting a 'mix and match' approach with a wider range of SWMM will be vital for successful retrofitting and creating multiple benefits.

Realising the opportunities for change

Current regulation and legislation, including the Flood and Water Management Act (2010) and the EU Water Framework Directive will continue to create the need for improvements to our drainage network. The recent extended dry and wet weather periods causing the extremes of drought and flooding demonstrate that the UK must carefully consider how we make best use of and manage surface water.

Work to address these needs is likely to continue for many years and should create opportunities for surface water to be managed using a range of measures. For example, Figure 1 shows a typical suburban semi-detached housing estate. Recent work replaced many of the grassed verges with hard-standing for parking (Figure 2). This was a missed opportunity to retrofit such a street to manage surface water resulting in the use of both green and blue infrastructure (Figure 3) and retaining the below ground infrastructure for an enhanced level of performance.

Figure 1 *A typical UK suburban street, in need of local enhancement*

Figure 2 *The same street where recent resurfacing works have taken place and a missed opportunity to manage the surface water*

Figure 3 *A sketch of the same street showing how opportunities to retrofit could be realised*

Delivery of a retrofit programme

There are two key approaches to retrofitting SWMM in urban areas:

1 In an **opportunistic way**, where gradual improvements to the urban realm are carried out step-by-step, picking off opportunities as and when they occur, and;

2 By taking a more **strategic approach** where a specific need is addressed, such as reducing combined sewer overflow spills, pollution from surface water outfalls or risk of flooding. This will look for and create the opportunities to retrofit measures.

Surface water management plans offer an opportunity across a large area to create a strategic approach that can lead to greater co-ordination when opportunities arise. This however requires all departments within the local authority and other key stakeholders such as Water and Sewerage Companies to sign up to and recognise these opportunities.

Ideally these approaches should use a selection of SWMM that combine both above and below ground solutions, and ideally SuDS. Where possible any work should be aligned with other urban improvement works, providing far greater benefits to the community and environment.

Creating benefits beyond drainage

Selecting the correct SWMM will depend on the local conditions and context where retrofitting is taking place. For example, if it is possible to infiltrate water into the ground, and this does not create other consequences, then this should be done. This has successfully been carried out in the United States in places such as Portland, Oregon (see Figure 4). In places where this is not possible then there are many other measures that can be used that will attenuate water, slow it down, and convey it to another place. Wherever possible, this should be done on the surface. However, even in areas with low permeability, some infiltration will still be possible, as demonstrated by the retrofit rain garden at Ashby Grove, in Islington, London (Figure 5).

Figure 4 *A recently constructed stormwater planter taking highway and footpath surface water on a street in Portland, Oregon*

Figure 5 *Rain garden built in Ashby Grove, London to collect roof water and infiltrate into the ground*

When using a wide range of SWMM, especially those that are above ground, a far wider range of benefits (than pollution and flood risk management) become possible, which are often not seen when traditional below ground measures (such as pipes) are used. These benefits can include:

- reducing the financial and carbon costs of wastewater treatment and pumping
- increasing property values through an enhanced urban area
- greater replenishing of water resources and reducing water use
- reducing air and noise pollution
- enhancing biodiversity by creating new or improved habitats
- better health through increasing levels of exercise and outdoor activity from improved urban spaces
- mitigating the urban heat island effect
- creating greater awareness and understanding of water by involving society.

It is now possible to start valuing these extra benefits, which is important given the current emphasis being placed on demonstrating the benefit and cost of solutions to manage surface water. Work overseas, particularly in Australia and the USA, has shown that these benefits can be quantified on large infrastructure projects. For example, in Philadelphia, USA, a combined surface water management approach of a tunnel and above ground (green infrastructure) features will create an estimated $3bn of benefits over a 40 year lifetime. The green values calculator from the Center for Neighborhood Technology (CNT, 2010) was used, which includes a range of multi-value extra benefits, such as reductions in energy use, the heat island effect and noise pollution, and increases in community cohesion, recreational opportunity and habitat.

In the UK, these approaches have also started to be used on a small scale. For example, at Halewood Primary School in Merseyside, retrofit SuDS have been built to reduce the risk of flooding to the school playing field. The Green Infrastructure North West Valuation Toolkit was used to assess a total of 12 different benefits. This resulted in a net present value of £80 000 over a 50 year period, and although there is some sensitivity in the monetised benefits, they provide a helpful indication to the likely scale of the benefits that will be created from such work.

The importance of good urban design

Where possible, retrofit SWMM should be integrated into an urban area in an appropriate way. Understanding the views of the local community is extremely important. Their views can influence what SWMM will look like as well as be influenced by how they look once they are constructed. Engaging with local communities can take time. Experience shows that the early involvement of local communities, understanding what is important to them and explaining problems some time before delivering solutions can lead to successful retrofitting of a range of measures. Identifying a range of key issues that are important to the local communities helps to capture their attention, giving them a stronger reason to be involved.

To ensure that measures are appropriate for an area (beyond the key drainage considerations), the context in which retrofitting occurs must be understood. This includes understanding each place's characteristics, building typology, layout and orientation, ecology, and the views of the local community. The Spaceshaper toolkit by CABE (2007) can help to measure the quality of the existing space.

To ensure that any retrofit measures are successfully integrated, an understanding of the scale of the retrofit will also be required. Depending on whether the measures are to be incorporated on a single plot, across a street, throughout a neighbourhood or within the whole catchment will influence the choice of measures used and their design. Different places suit different measures and different designs therefore it is important to consider when to introduce hard and soft features and how to mix them.

People need to be able to move around safely and freely. Therefore the design should cater for people first by identifying measures that can best

support their needs. Considering micro-climates and the correct planting can create positive impacts. Ecological and pedestrian connections will already exist, but considering how they can be improved will enhance the local amenity and biodiversity.

Planning ahead is important. Any space that has an ambiguous function will most likely fall into disrepair. Retrofitted SWMM should have a clear function and where possible measures should have more than one use. For example, an auditorium in a school playground in Malmo, Sweden (Figure 6) also functions as a surface water storage area during heavy rainfall. Good places are never finished; they evolve, so places should be designed to have the ability to adapt to changes in the future.

Figure 6 *An auditorium in a Swedish school playground that also acts as a detention basin during heavy rains (courtesy Dick Fenner)*

How to retrofit SWMM

In the UK, a wider range of SWMM are starting to be considered and used to manage suface water. To date there have been a number of projects such as Ashby Grove (Figure 5) and The Dings Bristol (Figure 7). Many of these have come about due to local champions making it happen and proving that retrofitting non-traditional SWMM can be achieved in the UK. However, it is also clear that examples from a business as usual approach are emerging. Organisations, such as Ofwat recognise that using a wider range of measures will be important and have asked Water and Sewerage Companies to consider using them in designs during the current asset management period (AMP) (2010-2015).

To help UK stakeholders successfully retrofit SWMM, CIRIA worked with MWH, the University of Sheffield and Susturb to develop and write guidance that was published in April 2012. The guidance is written to support a diverse range of stakeholders and practitioners across the many disciplines needed to successfully retrofit measures.

Figure 7 *The Dings, Bristol where permeable pavement was retrofitted during the creation of the 'Homezones' area (courtesy of Sustrans).*

The guidance provides a framework (Figure 8) to facilitate more effective retrofitting of surface water management measures. It outlines how to take a strategic or opportunistic retrofit approach depending upon the drivers and the scale of the retrofit. Urban design is firmly at the heart of the guidance and its framework, with examples shown of how retrofit measures could be implemented into different urban areas (like Figure 3). Having practitioners thinking differently will be vital to successfully change our surface water management approach.

The guidance follows a structured project delivery approach, enabling practitioners to follow or dip in and out as required. The preparation phase outlines the key steps to consider at the start of a project and is applicable to opportunistic (also known as nibbling) or larger scale projects and will help ensure the wider opportunities are not missed. It recognises the importance of engagement with stakeholders and communities

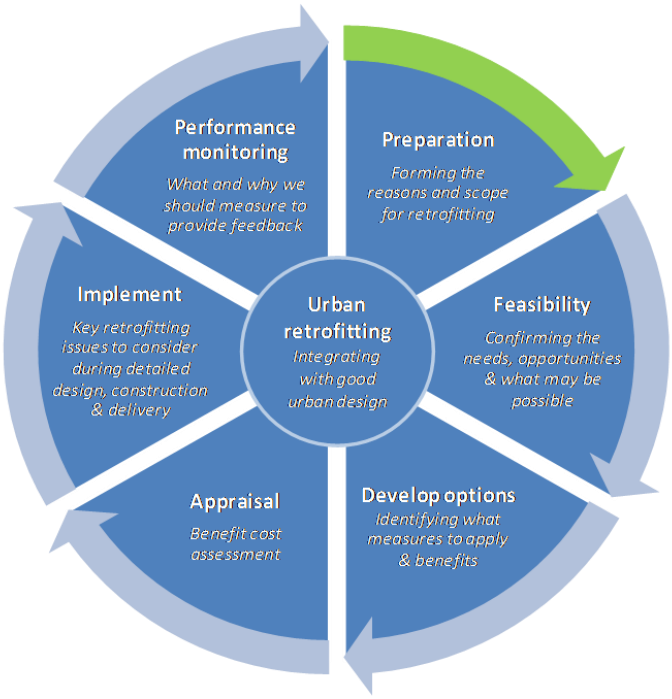

Figure 8 *The six phases of the Retrofitting Framework is underpinned by urban design principles*

to successfully achieve retrofitting and generate multiple benefits.

It is important to 'truly' understand the need, i.e. what is the problem to be addressed (particularly for strategic retrofitting), as this is often not well enough understood. The feasibility phase outlines how to identify the opportunities and locations where it is possible to retrofit measures in a structured way with three categories of opportunities:

1. **Target opportunities**, which may be achieved quickly or provides an easy opportunity to manage surface water (e.g. disconnection of a large area from a drainage system or large open green space).

2. **Common opportunities**, are areas where similar types of measures may be retrofitted and approaches targeted.

3. **Future opportunities**, are where there is opportunity to align programmes of work and potential funding.

The guidance sets out how to overcome the common hurdles to retrofitting SWMM in the UK. It provides a structure to match up the needs with the opportunities to then assess the potential impacts and where you may first look to retrofit and when. Based on the joint understanding of the needs and opportunities, retrofit strategies can be developed considering the wider benefits that may be possible.

The next stage is to develop options. The guidance provides an approach to consider a mix of traditional measures and SuDS. Tables have been developed to support the practitioner to select measures in different locations and the potential benefits they can bring. The guidance identifies the importance of hydraulically modelling the performance of the measures where appropriate. There are emerging software packages to model water quality, and these may be used with greater confidence in the future. Confirming the performance enables different strategies to be tested.

Guidance is given on how to assess the costs and a wide range of benefits that will often go beyond the initial driver for the scheme. The appraisal approaches advocated can go far beyond simple capital, operational and whole life costs. By adopting a wider assessment of the benefits it may help tilt the balance of taking a grey/green approach compared with more conventional approaches. Considering the wider benefits that the work will bring should be undertaken as early as possible to ensure the right appraisal approach is selected. This stage also includes the consideration of incentives and multiple funding

sources, which the formation of strong partnerships across an area will help bring. There are a growing number of calculators to assess the wider benefits (e.g. social and environmental) becoming available. This will be a fast developing arena, therefore look for developments and new work coming out.

Once the options have been selected, the guidance identifies key issues to consider such as confirming the ownership and adoption (which should be discussed as early as possible), health and safety, permissions, detailed design, construction, operation and maintenance. It identifies a wide range of detailed design guidance that is freely available.

Finally the guidance outlines why it is important to consider monitoring either to confirm the performance and when to undertake maintenance activities. This is not only for the hydraulic and water quality performance, but also about how the measures are 'accepted' by the local community. Statutory and other requirements are highlighted for the practitioner to consider and how this should form part of an asset management approach.

The guidance is primarily intended for use by those working with the existing urban environment and who wish to manage surface water in a way that maximises the benefits and tackles the future challenges ahead. It focuses on how to retrofit surface water management measures into the urban environment, either as part of a strategic programme of work or by realising opportunities incrementally as they arise. It is applicable to a wide range of disciplines, professions and stakeholders, deliberately not targeted to one audience.

Fundamental to the guidance is that it complements and should be read in conjunction with other guidance, and relevant national and local legislation. It provides an approach that can be used across the UK, applicable to the local situation and community. It aims to inspire a new way of working and is relevant to a wide range of professionals and organisations.

What is happening?

Several local authorities and sewerage undertakers are seeking and finding the opportunities to retrofit a range of SWMM. Some of these are simply opportunistic, while others are more strategic e.g. Thames Water using SuDS (Figure 9) to resolve surface water sewer flooding in Harlow, Essex (Fulton et al, 2012).

Figure 9 *Retrofitting geo-cellular storage as part of a wider scheme with storage swale in a grass verge to reduce the risk of flooding from the surface water system.*

The drivers and encouragement already exist to retrofit SWMM where there is a risk of flooding or where water quality improvements can be made. Currently, such work is normally carried out when it is deemed to be cost beneficial (using a narrow band of benefits). However, by taking a more comprehensive approach and working closely with the different stakeholders involved in improving the urban realm, it should help to provide greater value for retrofitting as well as leveraging greater funding opportunities. If the benefits are recognised by the multiple stakeholders involved in the delivery of retrofit SWMM, then this could substantially help this approach be embedded as business as normal.

References

CABE (2007) Spaceshaper, Commission for Architecture and the Built Environment, London

CNT (2010) The value of green infrastructure. A Guide to recognizing its economic, environmental and social benefits. Center for Neighborhood Technology, Chicago, USA. Go to: www.cnt.org/repository/gi-values-guide.pdf

Fulton, L., Marples, N.R. and Neal, W. (2012) Sustainable drainage – seizing the opportunity in Harlow, WaPUG Spring Conference, Birmingham, UK, May 2012

Statutes

Flood and Water Management Act 2010 (c.29)

Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive)