Realising resilience through a retrofit revolution

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Abstract

The water sector continues to face significant challenges, notably the need to deliver high quality and resilient outcomes for society, the economy and the environment, both today and critically for the future. We all recognize that traditional, or business-as-usual (of old), approaches will be insufficient to deliver these outcomes sustainably or cost-effectively.

Approaches, increasingly based on green and blue infrastructure and in particular sustainable drainage that deliver multiple benefits are being proposed, trialled, scaled up and implemented across the UK and around the world. These are generally used in new or re-development situations, but are also, albeit slowly, being used for retrofit. At the same time, the policy, regulatory, economic, societal and technical landscape is aligning in support of these approaches.

The time is now right for a retrofit revolution, moving green and blue infrastructure into the mainstream and scaling it up. Not only can this achieve significant cost savings, but it can also deliver wider societal and environmental benefits, and resilient outcomes that will create a positive legacy for future generations. There are a number of enablers now in place that will help realise a significant increase in retrofitting, from the English and Welsh Water Company recent business plan proposals through to the formation of strong partnerships realising sustainable solutions on the ground.

Learning from the journey to successfully retrofit sustainable drainage in the UK and globally, combined with these enablers means the future is exciting, and perhaps finally, the revolution will be realised, to the benefit of our communities.

The challenge and opportunity to address multiple drivers and create resilient systems

OFWAT's approach to the 2019 price review (PR19) is likely to lead to falling bills and closer scrutiny of water company performance. This will challenge the water industry to reduce capital spend, find more sustainable solutions and focus more strongly on TOTEX than ever before. This is tied in with the need for significant performance improvement to reduce flood risk and pollution, a substantial "Water Industry National Environmental Programme", action on high spilling overflows and a general need to increase capacity and resilience (key drivers for the Drainage and Wastewater Management Plans).

Meanwhile the reality of climate change, ageing infrastructure and the constraints in our modern urban environments which continue to grow and become more densely populated require future solutions to be more resilient. For water companies, the Water Act (2014) added a new duty to further the resilience objective. Greater resilience is about the ability to cope positively with change, which may be adapting to climate change in the future, performing outside of design parameters in extreme events or flexibility in ownership. Integration of a range of sustainable drainage (SuDS) or blue-green infrastructure (BGI) can contribute to a resilient system as:

- They can perform in a wider range of conditions than conventional drainage;
- They mimic natural processes such as absorption, evaporation, evapotranspiration, and infiltration; and
- They are flexible to adapt to future uncertainties (e.g. Gersonius et al, 2013) such as climate change and create redundancy within the system
- They can contribute to a reduction in water demand

Furthermore, water companies and other service providers now recognise the impact their activities have on communities and the environment and seek solutions that provide wider benefits. There is increasing recognition across the industry that SuDS or BGI play a major role in this. Whilst these are interventions are similar, the paper refers to both, rather than a single type.

BGI refers to a network of water bodies, green spaces and other naturalistic features which are managed as a system to service our societal needs. In the context of drainage and surface water flood risk management, BGI may take the form of:

- Existing natural features such as rivers and historic manmade structures such as canals that currently manage surface water;
- Sustainable drainage systems (SuDS) which recreate natural water cycles as an alternative to conventional drainage;
- Surface water management measures such as swales and bunds;
- Natural flood management e.g. using leaky dams to mimic when large sections of trees fall into rivers slowing the movement of water during high flow events; and
- Rural SuDS e.g. to tackle agricultural diffuse pollution.

Blue and green spaces within our urban environments are important habitats for wildlife, provide amenity and recreational value to communities and have health benefits (Ashley et al, 2013, Eunomia, 2015). The inclusion of these systems, either from new, in a redevelopment or retrofit could not just manage water, but help reshape our urban places and spaces.

Policy and regulatory drivers demonstrate recognition of the growing appetite in the industry for sustainable solutions.

Changing policy and regulatory drivers demonstrate the growing appetite for more sustainable solutions. SuDS are now mandatory on new developments in Wales[1], with local authorities acting as SABs (SuDS Approval Bodies), whilst legislation in Scotland means that SuDS are required on new development and Scottish Water has, for some time, been responsible for SuDS that deal with the run-off from roofs and any paved ground surface within the property boundary.

In England, the government's recent 25 year Environment Plan (HM Government, 2018) sets goals for improving the environment including reducing risks from flooding and coastal erosion. There is specific mention of use of natural flood management solutions and support for "increasing the uptake of sustainable drainage systems". The Government (HMSO, 2018) anticipates that the Revised National Planning Policy Framework (NPPF) will ensure that the planning system aligns with the Plan, influencing developers to deliver more quality, well-designed homes and stronger protection for the environment. The NPPF requires developments to be appropriately flood resistant and resilient, and to incorporate SuDS (unless clear evidence can be provided otherwise). Whilst this could be strengthened to become mandatory, Local Plans appear to be taking a tougher line with SuDS Policies (House of Commons Environmental Audit Committee, 2018).

Historically, there has been a shift in the expenditure by water companies related to working in catchments (urban and rural) cementing this shift in direction. Comparing AMP4 and AMP5, the Green Alliance (2018) recently reported a near four-fold increase spend in catchment management between the AMPs as shown in Figure 1.

This commitment has recently been both reaffirmed and increased by Water Companies. Surface water management, SuDS and green infrastructure feature in all of the recently submitted PR19 business plans. Table 1 summarises some of the key aspects of this that have been put forward in draft Business Plans.

[1] https://gov.wales/topics/environmentcountryside/epq/flooding/drainage/?lang=en

Overall, this shows clear and unambiguous direction of travel, towards new approaches for managing stormwater using SuDS and blue / green infrastructure.

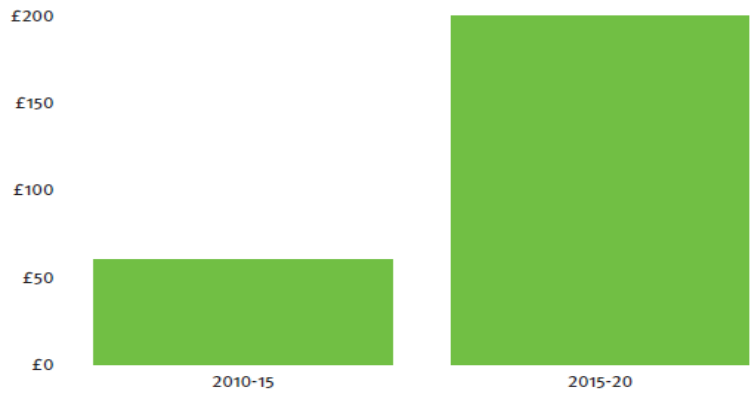

Figure 1 – Increase in spend on catchment management (£millions) over AMP4 and AMP5 (source, Green Alliance, 2018)

Table 1 – Examples from the English and Welsh Water Company Draft Business Plan Submissions (2018) with regard to managing surface water

Water Company	Example of the direction outlined within draft business plan
Anglian Water	Proposing significant investment in Surface Water Management focused on reducing the volume of surface water entering sewerage catchments for 20 prioritised catchments.
Northumbrian Water	Rainwise will continue (that has already contributed to reducing flood risk to more than 4,000 properties) and SuDS will be used wherever possible.
Severn Trent Water	Move to innovate and adopt sustainable drainage solutions. Consider a wider range of solutions including customer incentives. Proposed Green Communities performance commitment to increase natural capital while tackling flood risks.
Southern Water	Sustainable Drainage 2030 will unlock capacity for future growth by making better use of our existing networks and greater uptake of sustainable drainage methods.
South West Water	Extend the Downstream Thinking (SuDS) programme to develop non-end of pipe solutions for sewer flooding management, and in doing so increases opportunities for biodiversity net gain
Thames Water	Disconnecting 65 hectares of surface water from our combined sewer network by 2025 and a scheme to work with local authorities to contribute to improved surface water management.
United Utilities	Introduce sustainable drainage schemes to provide protection and mitigation to around 1400 homes.
Wessex Water	Maximise opportunities to work with partners in sustainable drainage systems and the separation of surface water from combined sewerage systems.
Welsh Water	Targeting the surface water removal of 400,000 roof equivalents by 2050. A continued commitment to Rainscape programme.
Yorkshire Water	Disconnect 40 hectares of surface water from sewers by 2025. Living With Water in Hull will retrofit SuDS to reduce flood risk.

Water UK (2018) has published a pre-implementation version of Sewers for Adoption 8 (SfA8). This is expected to come into effect by mid-2019 as part of the sector's implementation of the Ofwat Code on Adoption Agreements. When the new guidance comes into effect, it will be the only guide to the standards that sewers must meet if they are to be adoptable by water and sewerage companies in England. Within this, SuDS now play a prominent role and provide a clearer path for the design and adoption of certain types of SuDS. Discussions will still be needed, particularly in the retrofit situation

where for example, combined sewers currently drain a highway, but the document is a significant step forward in providing a common platform for the construction, ownership and adoption.

Many Local Authorities, despite not becoming SuDS Approval Bodies in England from the Flood and Water Management Act are pushing and promoting for the greater use of SuDS, and being of good quality. Many Local Authorities now provide guidance to encourage and support the inclusion of SUDS, such as in Peterborough who offer guidance to homeowners and developers (http://www.peterborough-suds.org/). Durham County Council have taken the next step of offering a SuDS adoption and maintenance service to new developments and published adoption guidance (Durham County Council, 2016), thus recognising the importance of long term security of assets for sustainable and resilient solutions. There are also practical schemes on the ground delivering high quality retrofit SuDS, such as Sheffield City Council's Grey to Green Phase 1 scheme (susdrain, 2018a). Through this support and work, there is clear momentum at the local authority level to see a growth in SuDS.

Building the evidence: sustainable solution costs are typically lower than conventional solutions and they can deliver wider benefits

The key challenge is whether SuDS cost more than conventional solutions. The evidence can be varied, but critically it is very context dependent. Firstly, new development, redevelopment, regeneration and retrofit offer differing contexts. Secondly, timing is very important. The cost may often be higher for example in new development, if no thought is given to SuDS from the outset and only considered as a last resort. In the same way, seizing the opportunity of when to retrofit, aligning with other work can significantly reduce the costs. Thirdly, when multiple benefits are taken into account, and so typically recognising that SuDS can resolve multiple drivers, the balance of the cost scales change.

Considering new development first, the Welsh Government has published an assessment of the costs and benefits (Welsh Government, 2017). This shows that SuDS are generally cheaper and have greater benefits than conventional alternatives. Figure 2 shows the capital costs of SuDS solutions on new (small, medium and large scale) developments. Whilst there is uncertainty around these estimates and it is hard to find clear comparisons, this indicates the potential for significant savings in the cost of building new homes.

Whilst recognising that drainage can be complex and the local context is important (e.g. ground conditions or a sloping site), the general body of evidence indicates SuDS will be comparative or typically lower cost for new development. Work undertaken for Defra (Kellagher et al, 2013) indicated that costs are typically lower or neutral for SuDS compared with conventional drainage depending on the size of the site and the context. Other evidence collated for Defra when working on the Flood and Water Management Act in 2011 indicates across a range of sites, costs are lower (e.g. susdrain, 2018b, Stevens, 2012).

When considering the retrofit context, the cost comparisons typically become more difficult. Gill et al (2011) found that "retrofit SuDS can offer a viable alternative to traditional drainage solutions in some circumstances" and that where benefits become valued and properly accounted for, the cost benefit ratio will rise. A case study of an evaluation in Leeds, Roundhay demonstrated that SuDS solutions become cost beneficial when multiple drivers and benefits are included (susdrain, 2015). However, if only a single driver is included, then they cost more, and may not be cost beneficial in monetised terms.

Through evaluating the costs and benefits of multiple schemes, as part of the development of B£ST (Horton et al, 2016), there is a significant correlation between the costs and benefits and the local context. For example, permeable ground leads to lower costs whilst dense urban areas cost more to retrofit within, unless combined with other programmes of work. Similarly our experience indicates that when solving surface water 'problems', i.e. related to the surface water sewer, the costs will be lower than solving 'combined sewer problems' due to the nature of how water is drained and managed.

However, it is possible to create cost beneficial and low cost schemes that resolve issues related to the combined sewers (e.g. McLarnon and Groark, 2017, Lewis, 2018).

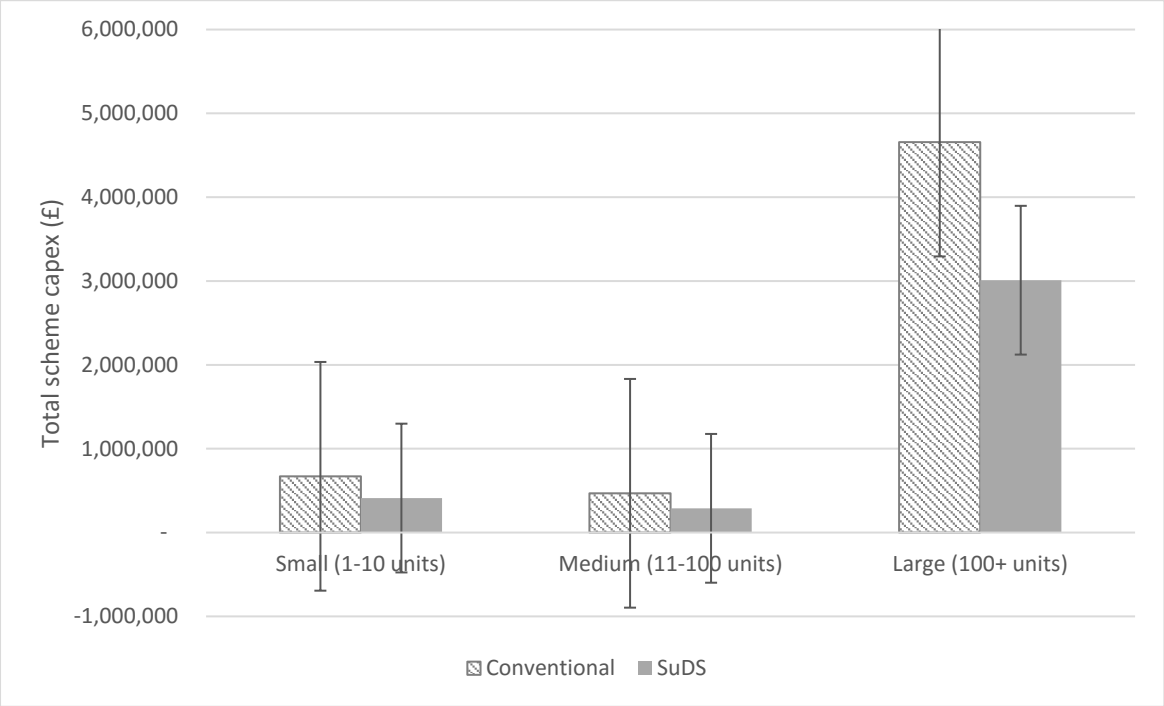

Figure 2- Comparison of costs for new development using convention and sustainable drainage, with the potential error bands indicated (source, Welsh Government, 2017).

There is a growing body of evidence 'on the ground' that supports that SuDS offer a cost effective way to address multiple issues. Examples where major retrofit programmes and projects have taken place globally (such as Philadelphia, Callahan (2018)) and now in the UK (such as by Northumbrian Water and Welsh Water) where SuDS solutions reduce the overall costs compared with conventional approaches (e.g. Ng, R. and Thomas, M. (2017), McLarnon, C. and Groark, D. (2017), McLarnon et al, 2016). Furthermore, programmes of work, such as that of Thames Water's 20 for 20 in AMP6 demonstrates that retrofit and redevelopment can make use of sustainable drainage to manage surface water and increase resilience (Thames Water, 2017).

Enablers that are leading to a growth in sustainable solutions

Stantec has delivered many successful SuDS schemes with numerous stakeholders across the UK and globally. A qualitative analysis of this work undertaken identified the following common enablers or success factors:

- leadership - setting a clear vision and sustainability goals where SuDS become the first choice;
- Strong and trusting partnerships with key local partners who share responsibility for surface water management or who are affected by surface water or drainage issues;
- Effective management of stakeholders and community engagement;
- Delivery of a wide range of benefits over and above the scheme drivers or drainage characteristics, e.g. extended flood risk, water quality, amenity, biodiversity, education;
- Use of alternative funding streams and private contributions, often secured through partnering;
- Timing of interventions – if they align with other stakeholders programmes, the costs tend to reduce and critically enable the intervention to be built in some cases; and
- Supporting guidance and specialist input for the design and delivery of measures.

Many of the UK water company's vision statements relate to sustainable and resilient provision of services and most have built in goals to their business plans for delivering SuDS (as highlighted earlier with the most recent business plans). Going further, Northumbrian Water, Newcastle City Council and other organisations have signed up to the Blue Green Infrastructure Pledge. This pledge aligns aims of providing sustainable flood risk reduction through the implementation of blue green solutions and sets a challenge to incorporate these principles into all work. Though SuDS may not be business as usual yet, observations from successful schemes show these commitments are driving a change in attitudes towards SuDS, where they become the first option on the table – not the last.

Defra's Surface Water Management Plan Guidance (Defra, 2010) encourages different organisations to "work together and develop a shared understanding of the most suitable solutions to surface water flooding problems". Grant in Aid funding is provided by Defra to the Environment Agency to invest in flood risk management schemes and is available to any flood risk project. To qualify for FDGiA a flood scheme must have a matching contribution of private funding. Northumbrian Water have successfully delivered schemes in partnership with local authorities and the Environmental Agency, notably at Killingworth and Longbenton (Northumbrian Water, 2018) and Fellgate (McLarnon et al, 2016).

These partnerships deliver more sustainable solutions as they allow organisations to share costs, agree responsibility for adoption and maintenance and open up new funding streams. Sharing the problem and delivering a combined solution (with multi-stakeholder funding) is cheaper than could be delivered by individual organisations and provides a more comprehensive solution for the community. These multi layered solutions where drainage and surface water measures work together also offer more resilient solutions in terms of hydraulic performance, whole life maintenance and security of the asset. A great example of this is in the North-East where The Northumbria Integrated Drainage Partnership realised the value of partnering in AMP5 and were recently recognised in the 2018 Flood and Coastal Project Excellence Awards (https://www.floodandcoast.com/project-excellence/2018-shortlisted-entries/).

The timing of when the interventions are built can be important. Lewis (2018) highlights that a retrofit basin to manage exceedance flows was built during the redevelopment of the local school. The construction of the basin was accelerated compared with other parts of the scheme to realise the opportunity. Many similar opportunities exist, when stakeholders work together, such as highway renewal programmes or regeneration schemes.

Critical to the success is the underpinning guidance available. CIRIA (Construction Industry Research and Information Association) and susdrain, a community supported by cross-sector group of organisations, provide a range of resources for those involved in delivering SuDS. The susdrain site is free to access and hosts case studies from successful SuDS schemes across the UK, along with wide ranging design and construction guidance for SuDS whether in new development or retrofit. CIRIA has also developed a free tool and guidance, B£ST (Benefits of SuDS Tool) for evaluating the multiple benefits of SuDS (Horton et al, 2016), supporting funding applications and conversations with stakeholders.

The success factors noted above can be seen further afield. In the city of Philadelphia, the Philadelphia Water Department (PWD) has undertaken a program to address CSOs in order to meet federal and state water quality requirements. The Green City, Clean Waters program uses green infrastructure to take full advantage of the economic, social and environmental benefits associated with introducing green space into a highly urbanized environment, and supports PWD's plan for a more sustainable city.

Funding is raised through revenue and specific arrangements including levy on new developments and commercial properties. Goals in terms of "greened acres" allow the PWD to measure implementation progress. Several outreach programs have been launched to encourage participation and a sense of ownership from both residents and civic leaders in the Green City. Through this program, civic groups can obtain a small grant from the PWD to monitor and beautify green infrastructure sites. This encourages engagement, ownership and mobilises a free workforce, thus building in resilience on a

number of levels. The project team have a well-established design and build methodology, supported by a Green Infrastructure toolbox.

Conclusions

The broad UK water industry is now in a far better position to create resilience through a retrofit revolution than ever before. Whilst there will always be some barriers and challenges to overcome, significant steps have been taken recently that have created a number of enablers including:

- The recent Periodic Review Submissions by English and Welsh Water Companies demonstrate a substantial increase in appetite and commitment to implement sustainable drainage over the next 5 year price control – and beyond.
- The development of Drainage and Wastewater Management Plans will focus on realising greater capacity and long term resilience.
- The recent development of Sewers for Adoption to include sustainable drainage helps to provide a common technical foundation and guidance.
- The ability to value and monetise the wider benefits through industry standard tools
- There is growing evidence that cost comparisons to grey infrastructure are favourable and, when multiple benefits are considered and solutions address more than a single issue, the overall economic case is compelling.
- Partnership working is yielding fantastic results in retrofitting that are not only contributing to water related objectives, but also social and environmental benefits.
- There is greater influence and participation from communities on the design and management of solutions that will support their longevity and create resilience for the future.

Through these enablers, the future for retrofitting should be positive, that by the end of AMP7, SuDS and BGI should become more common place within our urban and rural areas, creating multiple benefits. Partnerships and aligning different partner's goals and targets will be key to achieving this.

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