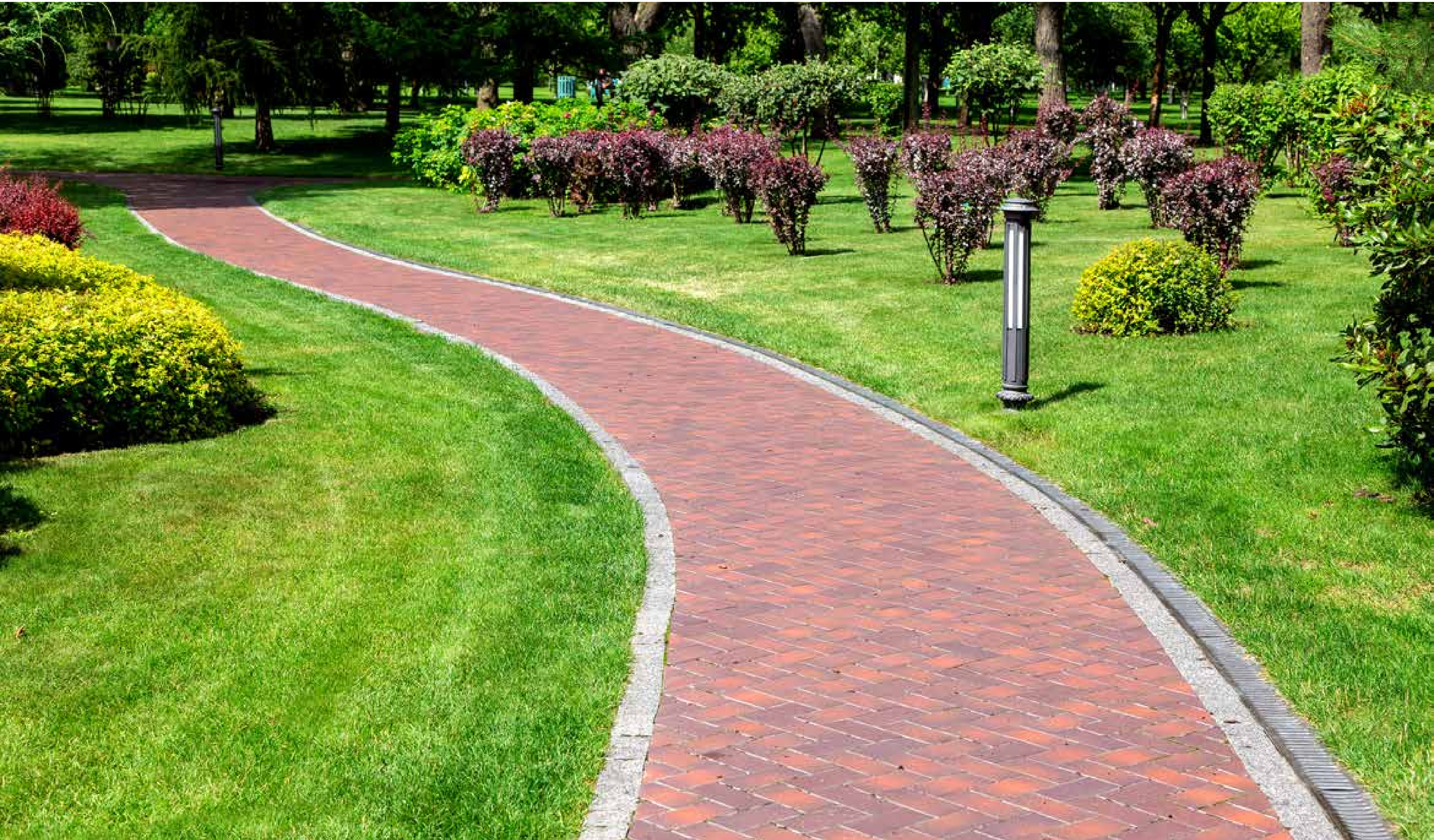
WWT EXPLAINS

THE PRACTICAL REALITIES OF SUDS

in association with Innovyze® Empowering water experts



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SUDS ADD VALUE TO DEVELOPMENT PROJECTS

SuDS require a special way of thinking. They're arguably more sophisticated than conventional drainage. SuDS ask engineers to learn to use a new range of design, installation and maintenance skills. A successful SuDS is designed to mimic and work with the natural behaviour of water on a site. They slow the flow and replicate processes that existed before development.

A SuDS system could comprise a series of small SuDS installed plot by plot, such as rainwater harvesting and green roofs. They could be applied across a site in the form of tree pits, planters or porous paving — depending on the outcome of the hydraulic model and other site considerations. And, of course, the medium- and larger-scale SuDS structures, including swales, dry ponds and wetlands, may be appropriate in certain circumstances.

The choice of which SuDS to use, their number, combination and where to site them, all form part of the new challenge for drainage engineers. At the design stage, a hydraulic model can demonstrate the effects that different SuDS might have on a given site, including at times of peak flow. Additional to understanding the hydraulics, a SuDS expert will want to know about the local authority mindset and will be keeping an eye to the future maintenance of the SuDS features. It's definitely a new way of working and a different type of challenge for drainage engineers.

But there's an upside for engineers who get good at SuDS. They'll be able to demonstrate that their SuDS expertise adds value to a development project. SuDS save space and improve amenity, at the same time as providing drainage on a site. That's a valuable combination of potential wins for a developer. And the versatility of SuDS make them well suited to retrofit and brownfield projects, as well as to greenfield developments.

With new Design and Construction Guidance coming from Water UK in 2020 and Wales having already set up a network of SuDS Approving Bodies, the momentum in support of SuDS is building. Questions remain about where it's best for adoption and maintenance responsibility for SuDS to reside, but the multiple benefits that SuDS offer suggest that these queries will be resolved. The engineers that get out in front and develop their mindset to work effectively with SuDS will surely benefit from the competitive edge.

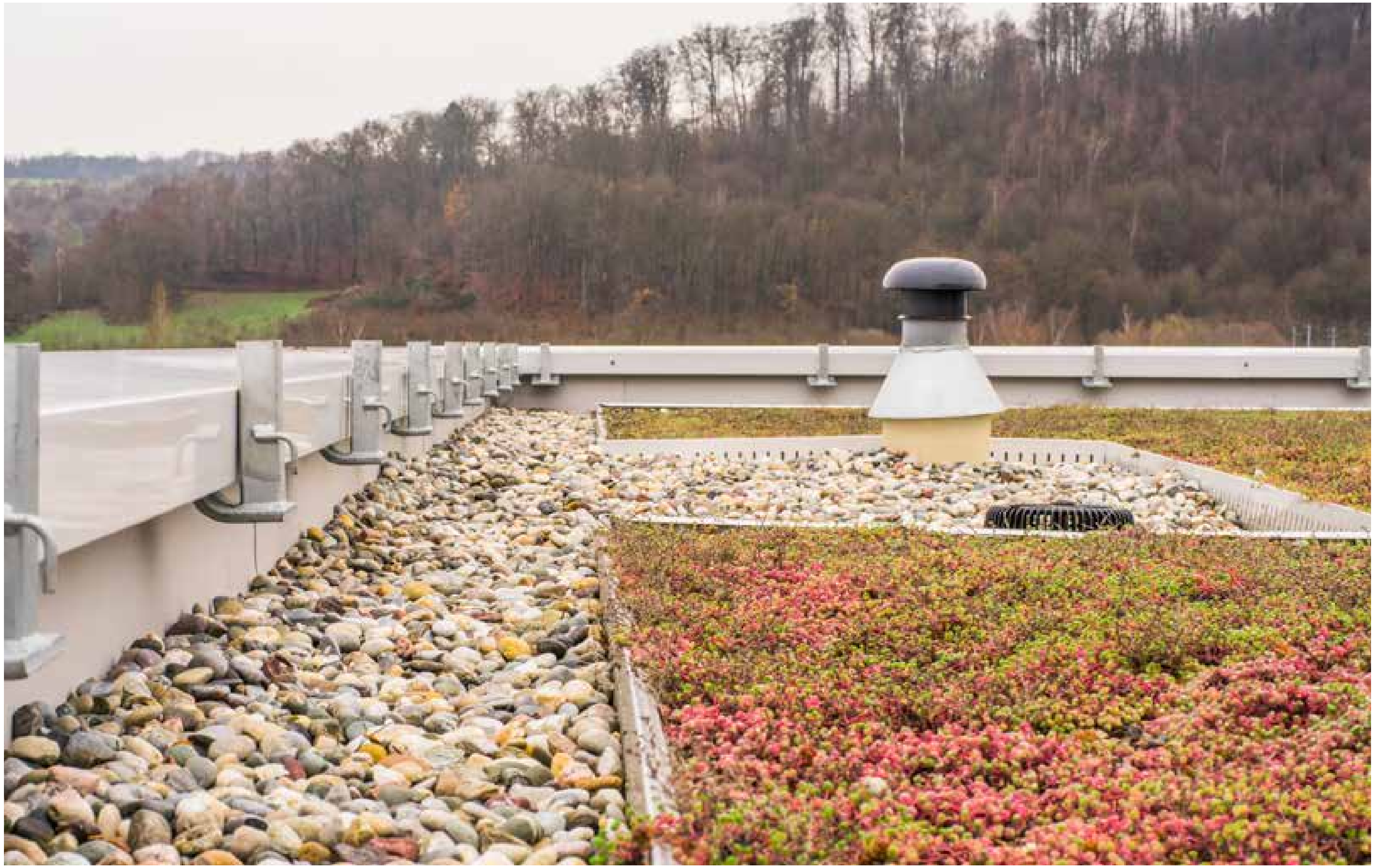
1. WHAT ARE THE MAIN CONSIDERATIONS WHEN LOOKING AT INSTALLING SUDS?

The most effective way to work with SuDS is to consider them as part of the whole-site design of a development from the outset. The strategic flood risk assessment for a project, in relation to SuDS, looks to identify the existing water corridors and flow routes that water takes through the site. SuDS mimic those natural processes where possible and can be used to reduce the quantity of water to the level that would have come off the pre-developed, or naturalised, site. This may mean siting buildings to allow for natural flows and maintaining the natural levels.

Developers sometimes start with the view that installing SuDS structures will add cost to a project. This mindset is a challenge for engineers whose job it is to demonstrate the value of SuDS to the scheme. Modelling the site can be an effective way to do this. Software systems can identify the natural green-blue corridors on the site and support design of the SuDS to work with the natural water flows and site topology. This includes optimising SuDS' effectiveness during times of peak flow.

The optimal SuDS design will vary from site to site. The design responds to the site, the developer's aims and takes account of the local authority's approach to SuDS including what the authority may adopt and be likely to approve. Modelling SuDS enables such discussions by providing reliable insight into what SuDS are able to deliver as part of the project. When SuDS models are included as part of the planning submission, the whole project is easier for the planning authority to understand and accept.

The general rule with SuDS is to try to deal with the water as close to the source, and to use as small a



solution, as possible. For a site with a large number of detached properties, plot-based features may be appropriate, such as water reuse rainwater harvesting tanks or rain gardens. At a street level it could be a larger-scale SuDS feature such as a swale. Finally, a bio-retention area or a natural wetland may be suitable for the development. The aim is to identify how SuDS can deliver the greatest cost benefit. This may include helping to reduce earthworks and development costs and influencing where the green space goes.

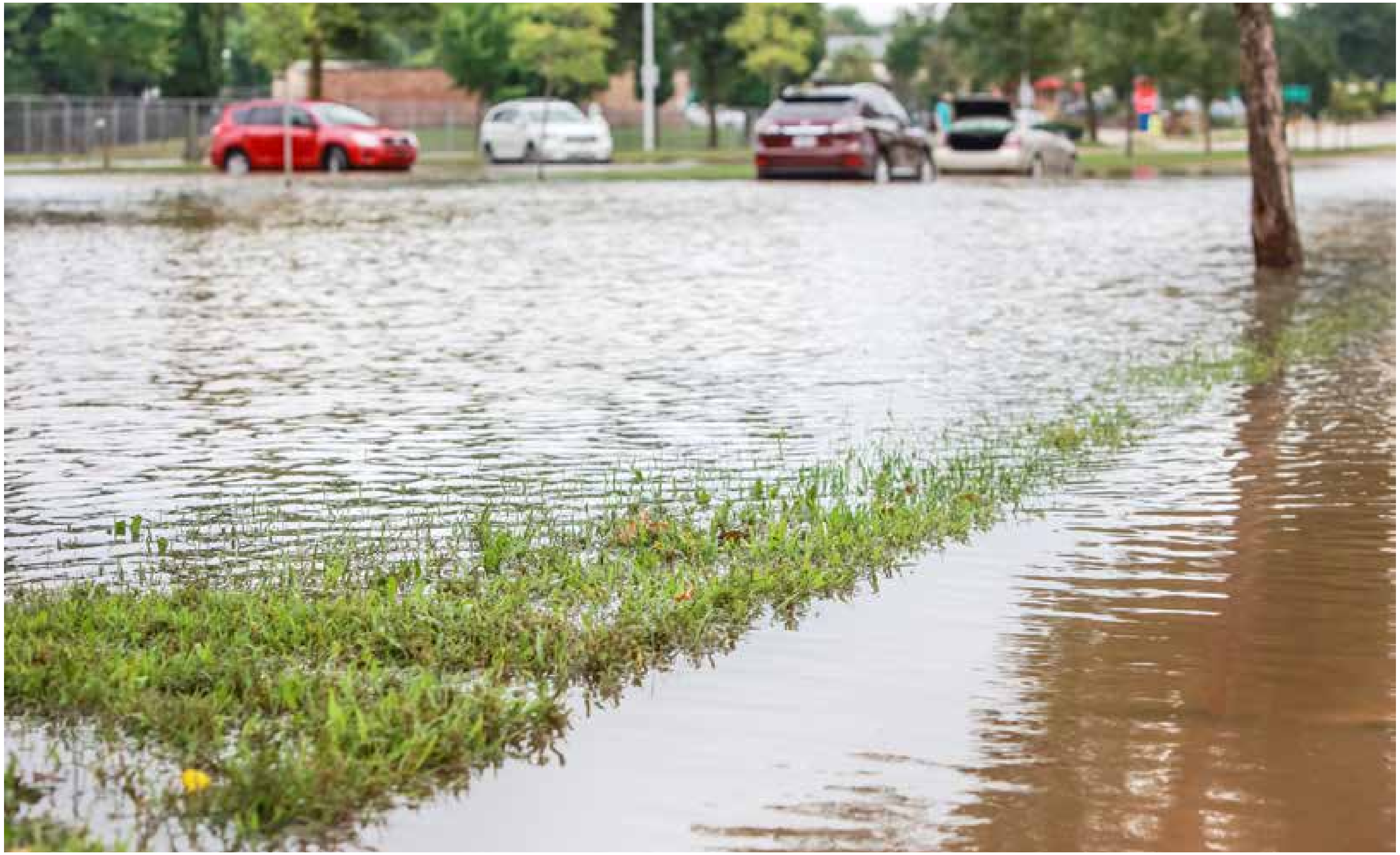
Specialist technical solutions enable designers to configure integrated SuDS structures that combine individual features into an optimal whole. The software supports potentially complex SuDS designs by providing insight about the impact of the whole system. The multiple benefits of SuDS - quality, quantity, amenity and biodiversity - as outlined by the Construction Industry Research and Information Association (CIRIA), are more clearly demonstrable in the context of a whole system design.

2. HOW CAN SUDS HELP TO IMPROVE WATER QUALITY?

SuDS mimic natural settling and filtration processes by slowing the flow of water. This helps to filter water of pollutants or suspended solids such as sediments and micro-plastics. When it rains, the dirtiest bits off a site are picked up and carried off, typically into drains and down into the water course. The roadsides get a lot of build up of debris including tyre rubber, metals from exhaust emissions, oil and rubbish thrown from vehicles. Therefore the first rainfall is the most highly loaded with pollutants.

Modelling enables drainage designers to assess the effects of such events on the quality of water in the watercourse and to work out how best to mitigate the impact. SuDS have features that collect and filter pollutants cleaning out the water before they move it off. With permeable paving, for example, water passes through a number of different filter layers that help to keep pollutants out of the natural watercourse.

In residential sites with fairly low risk, low pollution run-off, bio-retention areas, which have sand and other filter media below a vegetated surface, filter the water. Even a simple detention basement allows for settlement that improves the quality of run-off from a site.



SuDS slow the flow and prevent run-off from rushing to the lowest point

3. HOW CAN THE SUDS APPROACH IMPACT WATER QUANTITY?

SuDS store and then slowly release surface water run-off. If a carpark suffers a sudden downpour lasting 20 minutes a large volume of runoff would typically move quickly to a main point of discharge, such as a watercourse or main sewer. The network would need a lot of storage to slow the peak and avoid flooding.

SuDS slow stormwater runoff so that it moves slowly through the network for up to an hour or more after the event. They reduce the risk of flash flooding and result in lower storage requirements. When used in a series, individual SuDS structures have a cumulative effect that can be significant. SuDS structures cause water to travel slowly through vegetation and filter media; a grassy channel or a swale presents surface friction that the water must overcome. And many SuDS provide storage as well, such as porous paving that can include cellular storage underneath, and detention basins.

A hydraulic model shows where flooding could happen on a site. By modelling the routes that water takes through the site during times of peak flow, engineers can design SuDS to optimise their effects in reducing water quantity. Software can be used to help specify SuDS, including which to choose, how many, in which configuration and where to site them for best effect.

Tree pits provide drainage and storage, prevent pavement heave and help to reduce carbon levels

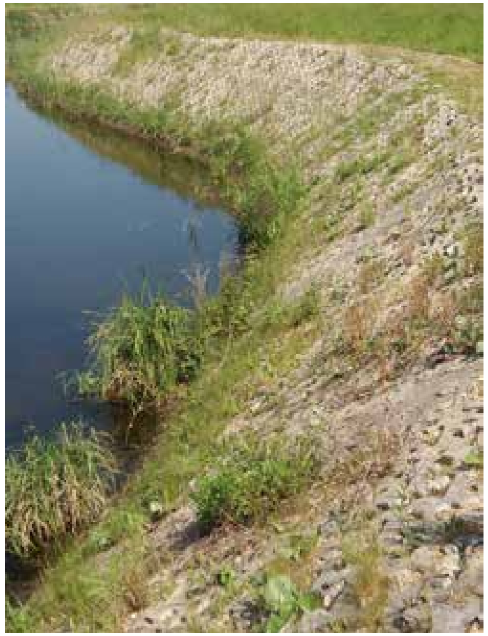
4. WHAT CONTRIBUTION CAN SUDS MAKE TO AMENITY?

Water quantity and flooding are at the forefront of the industry's mind and remain the big focus of the UK's planning and legislative agendas. This has contributed to a way of thinking about SuDS that tends to downplay their additional beneficial features and opportunities. Such downgrading of SuDS' multiple benefits occurs more when they are not considered early in the project.

The redevelopment of Sheffield City Centre is a real-world example of how good SuDS can be at delivering amenity. The SuDS design used there provides an attractive planting feature together with additional drainage through a staggered series of weirs, or rain gardens, that hold back the water. At first glance, members of the public may not recognise the vegetation as part of a drainage system at all.

Other SuDS that provide amenity benefits include a playing field that's allowed to fill up to a low level when it rains, before draining to provide the sports space again. And tree pits that both store water and offer shade and promote healthier lifestyles by creating an enjoyable environment for people to walk or cycle in. Tree pits also reduce carbon emissions and lower the so-called 'urban heat island' effect that can occur nearby to highways.

The kind of schemes that make optimal use of SuDS amenity potential often result from collaboration between drainage engineers and landscape experts. By combining strong engineering skills with landscape design, project engineers can maximise the multiple benefits that SuDS promise ..



5. HOW CAN USING SUDS IMPROVE BIODIVERSITY?

Amenity and biodiversity are linked, because with more vegetation the site is likely to attract wildlife. Creatures may flourish above ground such as butterflies and bees or below ground in stone-filled trenches that contain a variety of wildlife. Some development sites may have habitats, such as those containing specific pollens, that are protected in order to preserve wildlife species that depend upon them. Specific SuDS features and designs can be used in these circumstances to deliver the site's biodiversity requirements.

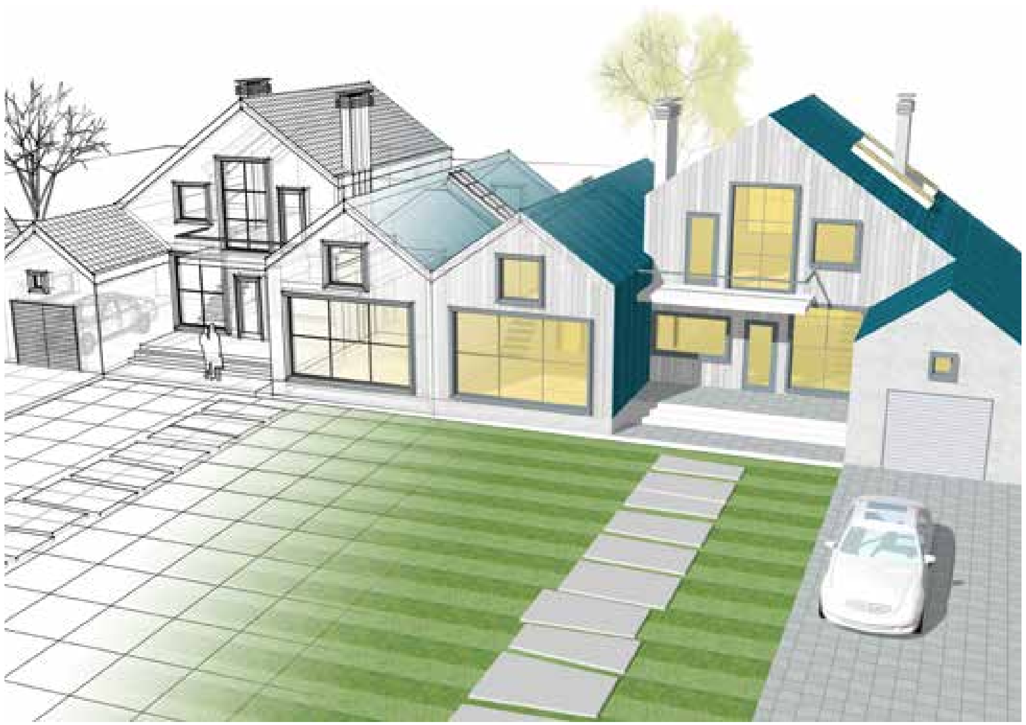
6. WHAT ARE THE PRACTICAL USES OF SUDS IN BROWNFIELD SITES?

SuDS's multiple benefits are arguably even more relevant in the case of brownfield sites that are often very tight on space. They do multiple jobs at once from a single piece of land. SuDS can help to meet planning requirements in brownfield projects because they provide more than one function to maximise every square metre of the site.

SuDS can be applied at a very small scale if needed, including plot by plot, to improve on current practices. Their scalability makes them particularly suitable for brownfield and retrofit projects, because they can be deployed on a site to alleviate existing problems. Multiple small SuDS and specific combinations of SuDS can have a cumulative effective that results in a much lower storage requirement compared to a traditional end-of-pipe solution.

SuDS that work well on brownfield sites specifically include porous paving, tree pits, green roofs, rain gardens and planters. Porous paving can be used to maintain car-parking space on the surface while providing storage underneath. Tree pits encourage water to drain naturally to the tree, may provide storage underneath and reduce pavement heave by allowing roots to grow. Green roofs slow the flow or take out elements of flow and rain gardens could reduce the need for a series of gullies at a low point that might be subject to flooding.

It may even be possible to disconnect a property or series of properties completely from the traditional drainage system, in certain circumstances. This can help to reduce connected space and it frees up drainage capacity potentially resulting in lower charges from the water company.



The scalability and flexibility of SuDS are especially beneficial in retrofits where there is older infrastructure that was designed to support lower levels of urbanisation than is needed now, or where the site has already been redeveloped once before. They offer developers a wider range of solutions to address flooding issues compared to traditional drainage. An added benefit is that SuDS' adaptability to brownfield sites supports minimal use of pristine greenfield land.

By modelling the hydraulic processes on a site, engineers have a way to demonstrate to developers the effects that SuDS could have. The model can look at the current level of run-off and compare it with what would happen after installing SuDS. This type of modelling is particularly applicable where planning requires that run-off from the redeveloped site must compare to that of the existing site. To demonstrate this, modelling software can make use of existing data from the site.

Analysing new and existing infrastructure means that it's important to understand clashes with other utilities operating across the site. Therefore, for well-considered design, it's important to ensure that SuDS modelling tools can interact with other applications such as computer aided design (CAD) and building information modelling (BIM) systems.

> "Computer models enable engineers to compare the before and after hydraulic processes on a site ahead of the planning application"

7. WHAT ARE THE MAIN BARRIERS TO ADOPTING SUDS?

The Chartered Institution of Water and Environmental Management (CIWEM)'s 2016 study, 'A Place for SuDS?' identified planning, adoption and maintenance as the biggest barriers to adoption. Three years on, planning legislation still allows a get-out if developers can demonstrate that SuDS don't work on a site. And there is no designated adoption and maintenance body. Therefore SuDS have been adopted variously by water companies, local authorities and private companies paid for by residents' fees.

The conversation about SuDS adoption is closely linked to questions about who pays to maintain them. A 2019 study published by Landscape and Urban Planning Journal, 'Residents' perceptions of sustainable drainage systems as highly functional blue green infrastructure,' found that "at three sites residents were charged management fees which were not well understood and caused concern." The perception is that ongoing maintenance costs aren't well known or well documented, which has resulted in organisations shying away from taking on SuDS as an adoption responsibility.

8. WHOSE RESPONSIBILITY IS IT TO LOOK AFTER SUDS ONCE THEY ARE INSTALLED?

The responsibility for maintaining installed SuDS is likely to vary according to the circumstances of each scheme. Water companies will be in a position to adopt SuDS acting as sewers, as part of the surface water system, when the new Design and Construction Guidance (DCG) on foul and surface water sewers is published by Water UK, expectedly in 2020. Water UK and Ofwat have clarified that a SuDS feature performing the function of a sewer is a sewer. Water utilities already have a legal obligation to adopt sewers and SuDS can now be treated as a part of that system. The DCG is expected to focus on water quantity and will supersede the standards formerly known as Sewers for Adoption guidance (SfA).

Water companies are arguably well-placed to assume the role of maintaining SuDS, because they're skilled in managing risk-based maintenance programmes and can access a lot of information about the assets in their networks. They've developed a lot of asset management expertise and infrastructure over a number of decades with oversight from the regulator.

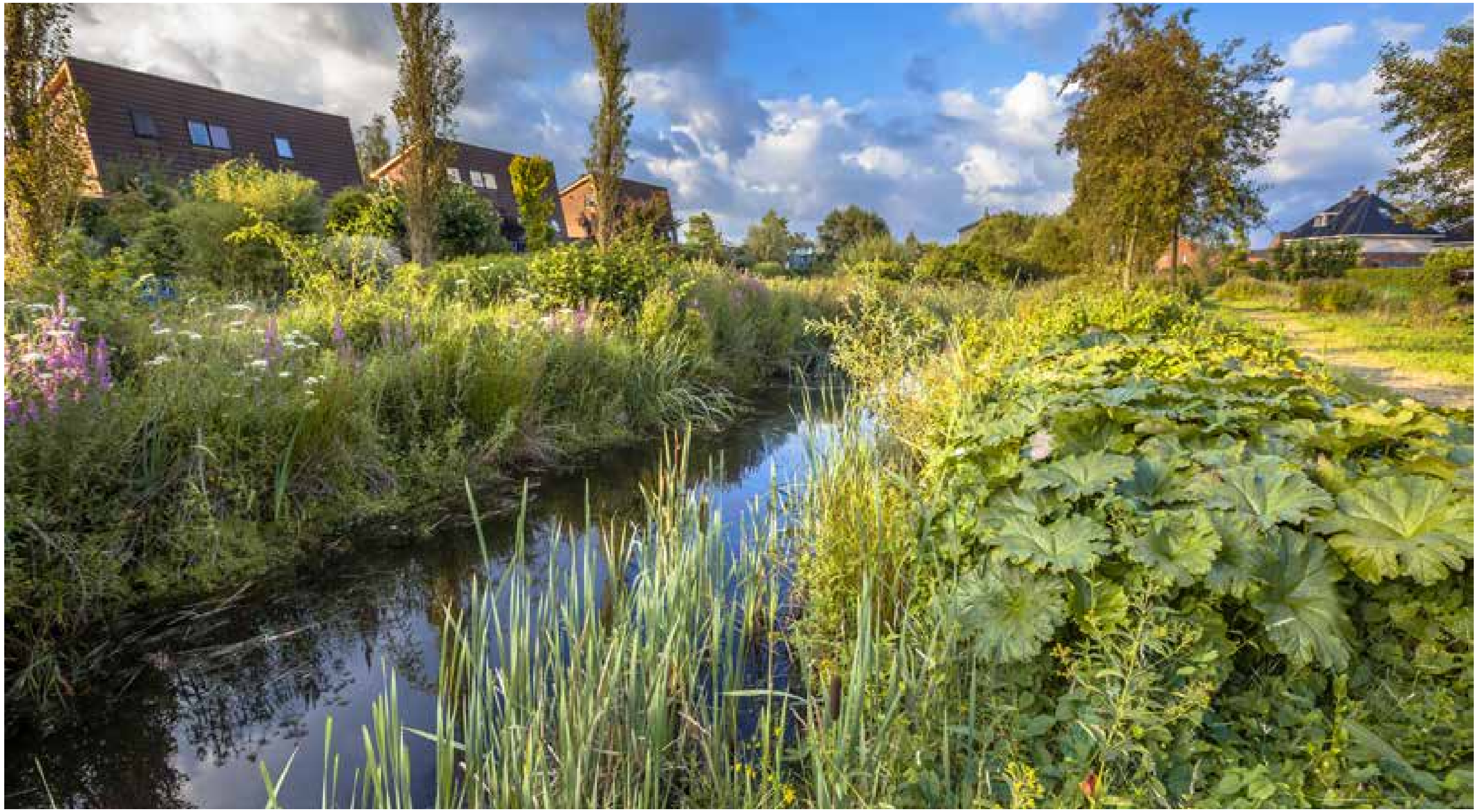
On the local authority side, Schedule 3 of the Flood and Water Management Act 2010 looked to set up SuDS Approving Bodies (SABs) that would potentially take on adoption responsibility. The legislation was never enacted in England, but it was adopted in Wales. Wales established a network of SABs within its local authorities starting from January 2019. It's anticipated that this SABs network will add to the industry's body of knowledge about best practice in SuDS adoption and help to dispel some myths.

Whether local authority or water company, both have their benefits when it comes to SuDS adoption.

Water companies have much experience managing assets and offer a robust maintenance structure. Local authorities are well placed to take the big picture, multiple benefit point-of-view, because they grant planning permission and can, therefore, more easily assess the entire development for amenity and biodiversity value. And local authorities manage highways, through which they have a proven ability in asset management.

"Adoption varies by project and may depend on whether the SuDS is fulfilling a sewer-like function"

Adoption need not be thought of as mutually exclusive and it could depend on the SuDS' primary function — which may be permeable paving or a carpark, or have a more sewer-like function. Water companies and local authorities each know how to manage assets. And in both cases, maintaining SuDS will represent a new activity.



SuDS maintenance ensures that quantity and quality standards hold up over time

9. WHAT ARE THE ADVANTAGES OF REGULAR MAINTENANCE?

The design stage uses a rigorous process to conduct proof of concept and to demonstrate that the design satisfies requirements. If not maintained, SuDS decay away from those initially demonstrated standards of water quality improvement and water quantity reduction.

A pair of discarded trainers blocking a swale outlet will prevent the SuDS from behaving to the standard in the approved design resulting in a lower level of certainty and understanding about the flood risk.

SuDS upkeep can be scheduled using existing maintenance systems in the same way as traditional maintenance such as running a closed circuit television (CCTV) survey along a pipe. Certain of the SuDS maintenance jobs might be required only once every few years. The type of maintenance that SuDS require includes emptying sediment traps, cutting the grass on a swale and clearing debris from permeable paving with a water jet. Such tasks can be completed with minimal disruption because SuDS are used on or close to the surface. A cracked pipe, by comparison, can be a significant problem to fix involving stoppages in service or the expense of opening up a carriageway. Software systems can help to achieve the most cost-effective SuDS maintenance programmes. They use design data to create risk-based schedules to prevent asset failure and optimise use of resources.

Local authorities are the lead flood authority

10. SHOULD SUDS BE INCLUDED IN THE LOCAL AUTHORITY'S ASSET REGISTER?

To have the SuDS included in a local authority asset register might offer the best outcome in terms of advancing SuDS adoption. There is an argument that the local authority, as the lead flood authority, is the appropriate body to manage things that pose a significant flood risk. Section 21 of the Flood and Water Management Act 2010 outlines the responsibility of the local authority to keep a register of all structures or features that "are likely to have a significant effect on flood risk in the area."

While local authorities may not wish to register smaller, plot-by-plot SuDS features, certainly there is an argument that they should include larger, strategic SuDS elements, particularly if that element is the final point before outfall. The main issue here is that well-maintained SuDS will keep on performing at their required level in order to prevent floods and that, as the lead flood authority, the local authority ought to have oversight of that maintenance.

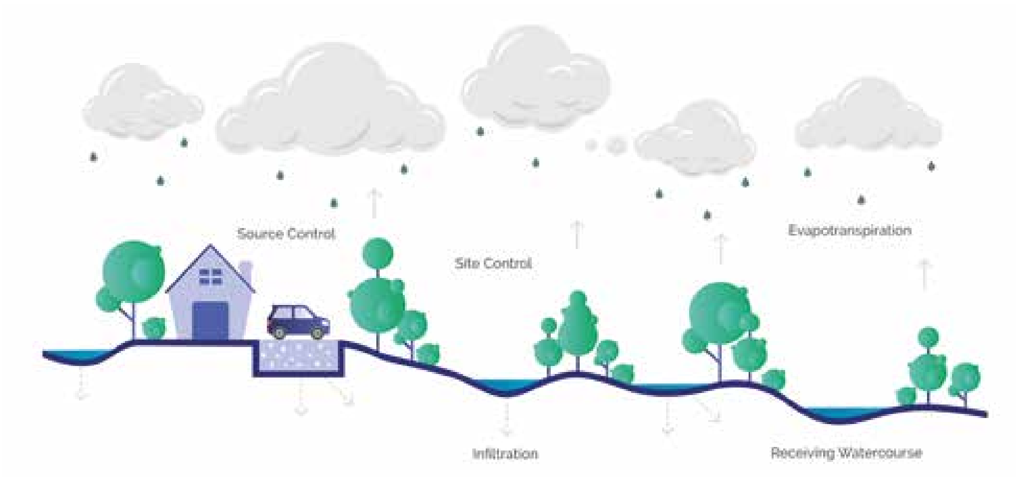
CASE STUDY: MAKING SUDS A PRACTICAL REALITY – THE APPROVER'S STORY

Technology from Innovyze helps Caerphilly County Borough Council meet environmental engineering standards, changing standard thinking about managing surface water.

As SuDS differ from traditional drainage techniques, SuDS Advisory Bodies (SABs) are instrumental in encouraging developers and drainage designers to think differently about how to manage surface water. This can be a challenge for people who are used to doing things in a certain way. They now need to consider:

- How SuDS mimic natural drainage
- Ways to manage runoff at the surface and close to the source
  - Employing a series of drainage components in a 'management train'
  - Meeting defined parameters of flow rates and runoff volumes
  - Protecting water quality, and encouraging biodiversity and amenity

Driving the change in thinking is a focus for Caerphilly County Borough Council's SAB, headed up by principal flood risk management engineer Michelle Johnson and Rhodri Powell, senior flood risk management engineer. "One of the biggest changes since January 2019 is that drainage approvals are handled independently from overall planning permission," Michelle explains. "We have spoken with everyone who has submitted an application. By talking with them we can show them the need to think differently about managing water on site."



A combination of SuDS can be used in sequence to form a treatment train

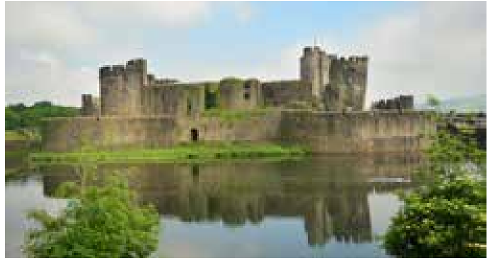
Even before development plans are submitted, a discussion with the Caerphilly team can open up new ways of planning how to make best use of the site. MDSuDS from Innovyze is a design tool that enables developers to design SuDS to take advantage of the space available, while minimising land take – a criticism often used to argue against installing SuDS. Using MDSuDS to evaluate the performance of different SuDS structures in a sequence can reduce the amount of land required for sustainable drainage. Known as a treatment train, the various structures slow down the flow and reduce the volume of water that has to be handled.

High-level concepting using MDSuDS helps developers open discussions with the SAB, which then goes on to design and build SuDS with greater accuracy. It removes the guess work that can lead to oversizing and overengineering – ultimately saving construction costs.

Features within the software, such as deluge mapping, allows the Caerphilly team to run a speedy analysis of the main flow path and ponding areas on a site, before any drainage design is added to the topography. This presents a picture of what happens to rainfall naturally on the site.

The team regularly uses this feature in desktop studies. It helps determine where runoff naturally accumulates and water pathways across the surface of the existing site. This makes it easier for a developer to plan where drainage structures are needed and shows where blue/green corridors occur creating a better habitat for wildlife and natural planting.

In this way, Caerphilly County Borough Council is making best use of technology to sure that the benefits of SuDS are delivered in line with legislation and, importantly, in line with the four pillars of water quality, water quantity, biodiversity and amenity.



- Caerphilly County Borough Council uses MicroDrainage MDSuDS to help advise, assess and approve SuDS schemes
- In January 2019 the Welsh Government made SuDS a requirement for all new developments over a certain size
- SuDS have to be designed and built to meet Statutory Standards
- The SAB uses technology from Innovyze to identify blue/green corridors and improve drainage, biodiversity and amenity on a site
- The reduced workload for SuDS approvals mean that more can become a reality