A PLACE FOR SuDS?

ASSESSING THE EFFECTIVENESS OF DELIVERING MULTIFUNCTIONAL SUSTAINABLE DRAINAGE

CIWEM Chartered Institution of Water and Environmental Management

Woodberry Wetlands, London, courtesy Laura Grant

A PLACE FOR SuDS?

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Well-designed SuDS can be built affordably and without delay in nearly all kinds of development as well as retrofitted in established development

Bridget Joyce Square, London

Richard Knight House, London

Ashford, courtesy Sue Illman

Contents

Executive summary:
A place for SuDS?

The landmark Housing and Planning Act 2016 will help deliver the ambition of tackling the housing crisis by supporting the building of one million homes over the course of this Parliament. But the urgent need to deal with the housing shortage must also be linked with the connected crises of flood risk, water scarcity, water quality, public health and wellbeing and biodiversity loss. Every time housing provision is considered, it should be remembered that one in six homes is at risk of flooding and up to £1 billion of flood damage is incurred every year[1]. It is vital that in building new homes we do not build more risk, we must build, but build well.

Surface water flooding is a growing problem, intensified by urbanisation and changing weather patterns delivering more intense rain storms. An estimated four million properties are already at risk of surface water flooding in the UK[2], and unlike other sources of flooding which may be more predictable, it can affect many other properties that are not identified on flood risk maps. This kind of flooding, can devastate people's lives, their homes and businesses and make the buying and selling of property difficult.

Flooding, water quality, access to greenspace, and biodiversity, are all affected by the way homes and communities are planned and delivered. There is extensive evidence to demonstrate how healthy local environments drive healthier people and healthier economies.

So in aspiring to solve one crisis, we have an opportunity to solve many more and deliver multiple benefits for little or no additional cost. The answer is to adapt the way we build to incorporate more natural features and provide resilience measures on a range of scales.

CIWEM and its partners consider that incorporating sustainable drainage systems (SuDS) into developments can support the holistic approach needed to maintain local water balances and treat water pollution, whilst also supporting wildlife, providing alternative water resources and delivering attractive community spaces. Crucially, we know this can be done quickly and affordably if planned properly.

Incorporating SuDS into developments can maintain local water balances and treat water pollution, whilst also supporting wildlife and delivering attractive community spaces

Green roof at Richard Knight House, London

Purpose

The Government is reviewing the law and policy in England that requires SuDS to be included in new developments. This is an important step as we believe the policy around SuDS is not working as well as intended. This report has been written to inform this review and propose a practical way forward.

We set out the findings of the Big SuDS Survey, which is believed to be the largest independent survey on SuDS in the UK to date. Through analysis of the data and research from across the sector we investigate the physical, financial and policy constraints, and recommend priorities for change.

To inform the review, this report focusses on the situation in England, but has drawn on experience from across the UK. The appendix details how Scotland, Wales and Northern Ireland are approaching SuDS and what we may be able to learn from them.

Report findings

The report sets out to address the key barriers to delivering SuDS as cited in the survey: land take and site constraints, delays to planning, health and safety, costs, planning policy, planning guidance and advice, adoption and maintenance and SuDS standards. By considering each of these, our analysis shows that the main obstacles to high-quality and widely implemented SuDS are political and institutional rather than technical or financial.

We have found that well-designed SuDS can be built affordably and without delay in nearly all kinds of development as well as retrofitted in established developments. Arguments for not delivering SuDS on the basis of site constraints may be overstated and the range of options available means it is nearly always possible to incorporate some measures. SuDS are a cost effective alternative to conventional drainage when included early in the planning process and it is the failure to consider SuDS from the very start of a development's design that is a significant barrier to efficient delivery. They are far from the brake on development they may be portrayed as a result of the diversity of options and techniques available.

SuDS are enablers of climate resilience and support healthy and economically vibrant communities. The value of these benefits is considerable. However, because the benefits accrue to local communities and are not valued by conventional markets, with the costs are borne initially by one party (typically the developer), they require effective policy to correct the market externalities involved. Unfortunately the vast majority of those involved in delivering sustainable drainage consider that current policy is not achieving this sufficiently and only eight per cent believe that the current standards are driving high quality and effective SuDS in England.

Our analysis, underpinned by the findings from the survey, provides a clear indication that:

1. At the majority of sites, the costs and particularly the benefits of implementing SuDS, are not being assessed.
2. Physical site constraints are cited frequently as reasons to 'opt-out' of delivering SuDS in new housing and commercial developments, when the range of options available means this is commonly unjustified.
3. In many areas planning authorities do not have the capacity to judge the merits of applications properly, leading to more opt-outs than necessary on the grounds of price and practicality as many go unchallenged.
4. Where SuDS have been delivered, they often miss opportunities to provide multiple benefits as they follow the very narrow non-statutory standards that exist presently.
5. The adoption and future maintenance of SuDS are the greatest barriers to be resolved.

This represents a real opportunity for improved practice, which strengthens policy and standards.

Knowledge gaps

The survey identifies that there is scant information about the extent and quality of sustainable drainage in new developments with very little monitoring of actual delivery taking place. **Therefore, the Government's forthcoming review should examine and seek to address the following areas:**

1. The scale and extent of SuDS deployment and monitoring across the country.
2. The quality of SuDS delivery, relating to the non-statutory SuDS standards, designing to an adoptable standard and other recognised benefits like water quality, biodiversity and amenity.
3. The effectiveness of planning policy in driving the delivery, quality and adoption of SuDS.
4. The capacity of local planning officers and Lead Local Flood Authorities to assess the merits of SuDS proposals and the viability of applications.
5. The impact of the ten home threshold excluding minor developments from requiring SuDS.
6. Improved recording and reporting of SuDS implementation.

Policy proposals

Given the number of new homes planned by the Government, many of which are in areas that are already water stressed, and given the implications of such development for flooding, water quality, biodiversity and amenity, the review should set out a process for strengthening law and policy. We recommend several policy changes to enable wider SuDS implementation, affordably and quickly.

We propose that:

1. Discharge of surface water to the sewer system should be conditional on the inclusion first of high-quality SuDS in new developments.
2. A clear decision must be taken with regard to the adoption and allocation of maintenance responsibilities for SuDS. This should have a clear and established mechanism for raising funds to ensure the continued effective maintenance and eventual replacement of all SuDS they adopt.
3. New standards are developed aimed at optimising opportunity to achieve amenity, biodiversity and water quality benefits as well as flood risk reduction. These should reflect the needs of the adopting authority so that they can set out an approval process and adopt with confidence.
4. The Government should undertake a follow up review of the barriers to retrofitting SuDS in existing developments and make proposals on how retrofitting might be incentivised.

The Government's review is a crucial opportunity to ensure we reach our goals for delivering housing without increasing flood risk, water pollution, biodiversity loss, or compromising quality of life. It provides the opportunity to build healthier, more prosperous and resilient communities. We hope our findings can inform the debate and provide a way forward, achieving the many benefits of sustainable drainage before many more unsustainable developments are built.

We propose that discharge of surface water to the sewer system should be conditional on the inclusion of high-quality SuDS in new developments

Portland, courtesy Sue Illman

Why sustainable drainage?

Flooding already poses a significant threat to people, communities and buildings in the UK and climate change is expected to increase the frequency, severity and extent of flooding. The exceptional rain and resulting floods in the summer of 2007 killed 13 people and cost an estimated £3.2 billion with two thirds of this attributed to surface water flooding[3]. The ***2017 Climate Change Risk Assessment*** predicts that annual flood damage to residential properties could rise by 22–78 per cent in the 2050s and 47–160 per cent in the 2080s. At the same time lawns are giving way to driveways, road verges are replaced by tarmac and even the smallest gaps in urban areas are often in-filled with new developments. Climate and concrete-creep are slowly combining to prime a 'surface water time bomb'.

Surface water flooding happens when too much water arrives too quickly and there is nowhere for water to be discharged to (whether soaking into the ground, draining into a watercourse or another drainage system). Any new "hard" development can increase the risk not just locally but in other catchments and communities downstream. It is also exacerbated by many of our sewers being designed to deal with both the surface water and foul water from our homes and businesses. With these either discharging in a controlled manner into our rivers and streams or uncontrollably surcharging manholes. Rain flowing across impermeable surfaces accumulates pollution from transport and urban waste, which then contaminate watercourses, especially when so many sewers are operating close to or at their maximum capacity.

The Victorians pioneered the drainage system that we take for granted today but, as we build more developments, this approach needs to be used alongside modern, more sustainable options that work with nature. Ofwat estimates that about half of average annual flooding incidents are a result of the capacity of the drainage system being exceeded.[4] And as pressure on our water resources increases, surface water should be seen as a resource to be used, rather than a problem to be buried and disposed of.

To futureproof our housing and enable it to be more adaptable, we need to consider new ways of making our homes both resilient and attractive. Sustainable drainage complements more catchment-wide thinking that promotes diffuse "networks" of flood response, rather than single large flood defence schemes. SuDS can reduce the pressure on conventional drainage systems that are often over-stretched, reducing sewer overflows (where surface water and sewer systems are combined) and additional costs.

Sustainable drainage mimics natural processes and reduces flooding by managing rainfall close to its source and wherever possible at, or near the surface. By building in permeable paving, channels, green roofs, swales, soakaways or ponds, sustainable drainage becomes a "city circulatory system", slowing, storing and treating water that could cause damage (figure 1). Well-designed SuDS should incorporate the four elements of water quantity, water quality, amenity and biodiversity wherever possible.

SuDS can be delivered in a variety of urban and rural contexts including housing, schools, community buildings, parks, public open spaces and highways. Incorporating natural processes help make communities greener, more attractive places to live.

Half of average annual flooding incidents are a result of the capacity of the drainage system being exceeded

Woodberry Wetlands, London, courtesy Susdrain

The benefits of SuDS

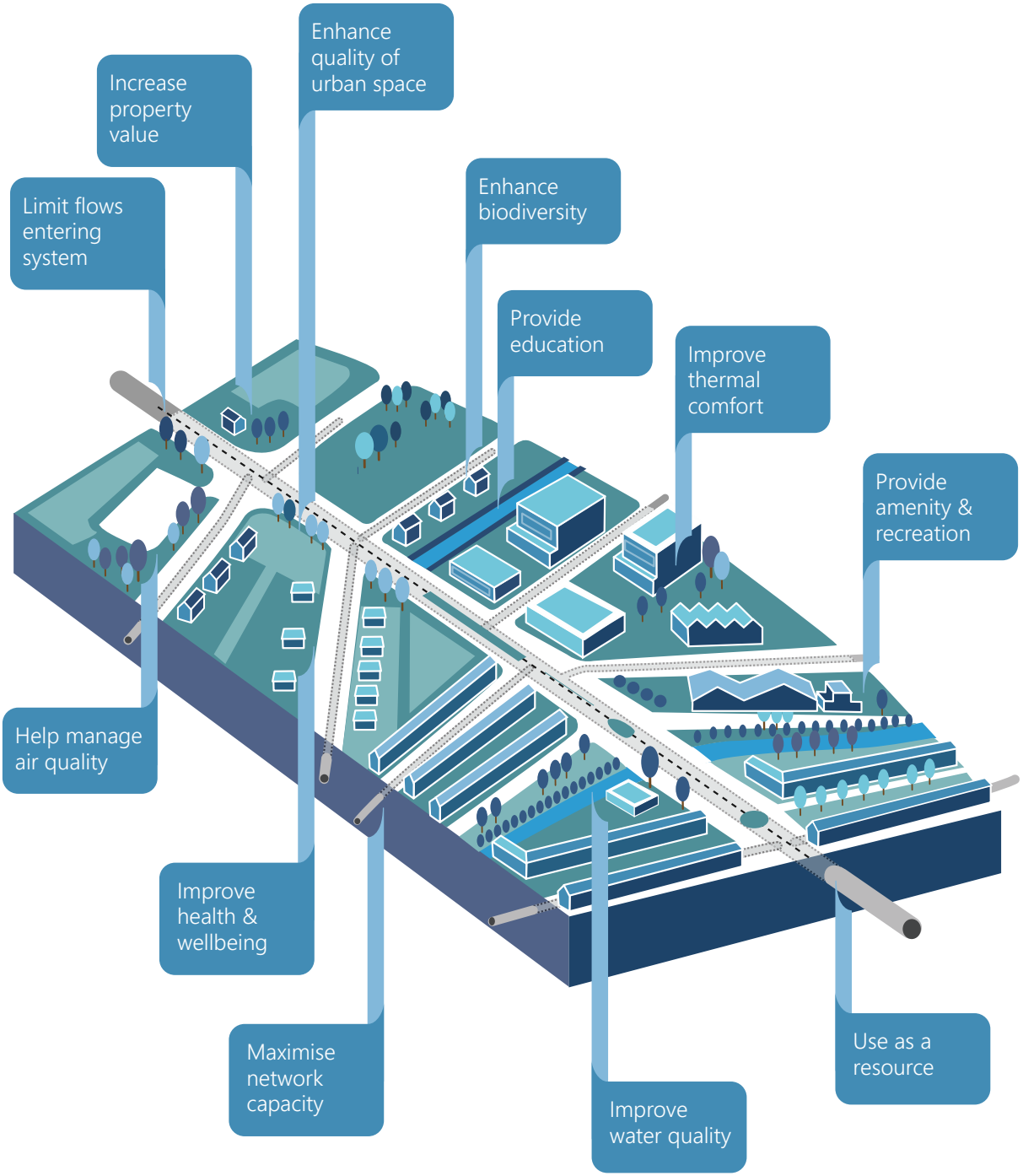


Figure 1. The benefits of SuDS, adapted from CIRIA. Features include pervious paving, trees, swales, green roofs, soakaways and ponds. They also include solutions such as attenutation storage tanks, oversized pipes and vortex flow devices, but these do not deliver all of the wider benefits denoted. Further description of the benefits of different SuDS components are detailed in figure 8 and in the SuDS Manual.

Gathering the evidence

Following the Pitt Review's[5] recommendation from 2008, a legal requirement for SuDS in new developments was recognised in the Flood and Water Management Act 2010. The Government decided not to bring the law on SuDS into force because of concerns about bureaucracy and costs associated with its requirements, deciding instead to rely on the National Planning Policy Framework updated in April 2015 to drive uptake.

Under current planning rules, planning applications relating to major developments (those of ten dwellings or more; or equivalent non-residential or mixed development) should ensure that sustainable drainage systems are put in place, unless demonstrated to be inappropriate. Instead of full national standards to facilitate change, brief non-statutory guidance has been published.

Data on the effectiveness of current planning policy has been sparse as there is no requirement for local authorities to report on SuDS uptake, nor monitor whether they are actually implemented or effective. Worryingly the Committee on Climate Change found that just 15 per cent of planning applications in areas of flood risk contained the phrase 'sustainable drainage' in 2015.

Responding to growing concerns about the low delivery and poor quality of SuDS that have been delivered, Parliament legislated again in the Housing and Planning Act 2016 to require a review of law and policy in England[6]. This is a chance for the Government to give the policy push needed to make the most of SuDS.

The Big SuDS Survey

To help build a stronger evidence base, CIWEM launched the Big SuDS Survey to collate experiences from across the industry on the effectiveness of the current planning policy for SuDS. The survey was supported by professional bodies and organisations from across the sector including the Institution of Civil Engineers (ICE), the Royal Town Planning Institute (RTPI), the Royal Institute of British Architects (RIBA), the Institution of Environmental Sciences (IES) the Landscape Institute, Susdrain, the University of Exeter's Centre for Water Systems and the Wildfowl and Wetlands Trust (WWT).

The results of the survey are described and analysed in the following chapters of this report. The results also highlight where there are still gaps in evidence, which the Government's own review should seek to fill. The full results of the survey stratified by respondent type will be available in a separate peer-review paper by University of Exeter's Centre for Water Systems.

Data was collected over the month of July 2016 via an online survey with 539 responses. This is believed to be the largest independent survey on SuDS in the UK to date. Analysis by the University of Exeter shows that:

- there are a broad range of job roles, with at least ten responses from ten different roles in relation to SuDS. The public and private sectors are both well represented, although a high percentage are consultant engineers
- there is a good geographical spread throughout England and there are also responses from the rest of the UK and the world
- there is a clear call for national consistency in approach
- there is a need to define SuDS, they mean different things to different stakeholders

SuDS can be integrated into almost any site at no additional cost from land take to the developer.

Queen Caroline Estate, London

Physical constraints: easy answers

Land take and site constraints

Whilst policy requires the use of SuDS in major development, developers may 'opt out' of the requirement on the basis of practicability and affordability. Our survey showed that one of the most commonly cited reasons for not implementing SuDS in planning applications was site constraints (including both a perception of land take and physical constraints such as ground conditions (figure 2)).

Certainly, incorporating SuDS in new developments can pose practical challenges for planners and developers, but most of these obstacles can be overcome relatively easily in most cases, if the necessary engagement, robust planning and design is undertaken from the outset.

Sites in urban areas are often confined with restricted space so planning and design constraints may be tighter than at other sites. However, SuDS can be integrated into a development without impacting negatively on the primary function of the urban space, particularly if they are integrated into the overall landscaping of a development and are multi-beneficial, i.e. pervious paving, public realm space.[7]

- SuDS can be integrated into almost any site. Many solutions can be implemented within the footprint of a development or the fabric of the building, for example, pervious paving, tree pits, bioretention and other vegetated components, green roofs and rainwater storage.[8] In Belgium, rainwater harvesting is compulsory for new buildings with more than 100m² roof as it is recognised as an excellent approach at this scale.
- A review of available evidence by the Committee on Climate Change suggests that any additional space for SuDS can usually be accommodated within existing open space requirements, resulting in no additional cost from land take to the developer.[9]
- Opportunities for the creation of SuDS can be found in the smallest of spaces. They can even go on steeply sloping sites and very flat sites. The London Plan requires major developments to have roof, wall or site planting that deliver a number of objectives including SuDS, energy efficiency and growing food.
- The use of SuDS is not limited by the ability of soil to infiltrate (for example on clay sites), as all SuDS can be designed to attenuate (or hold back water) as well as infiltrate. The use of attenuation is standard practice, with infiltration being seen as a bonus. SuDS can even be used on contaminated sites with (lined) attenuation usually being the preferred option in these locations.[10],[11],[12] Queen Mary's walk in Llanelli is built with an impermeable membrane under it that achieves an 80 per cent reduction in runoff into the sewer by evaporation.

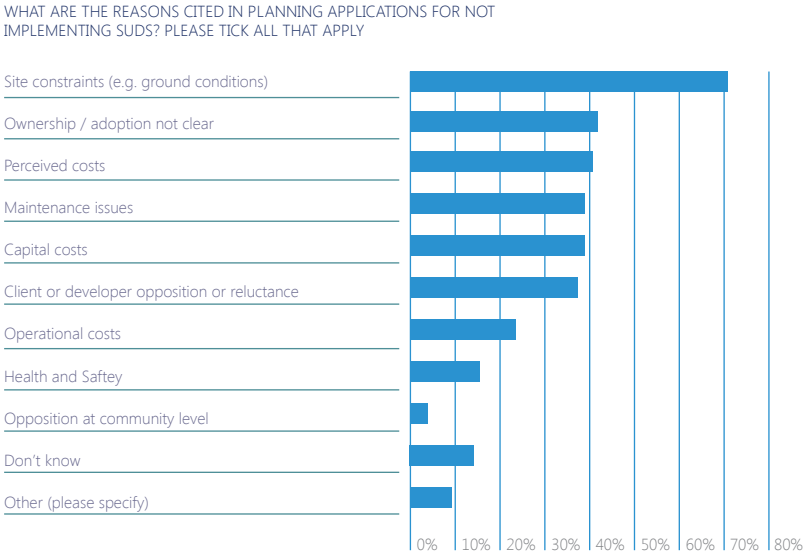


Figure 2. Big SuDS Survey question 15 "What are the reasons cited in planning applications for not implementing SuDS? Please tick all that apply"

Opportunities

- Underutilised land often falls along the interface between public and private land, such as grass verges and other small pockets of vegetation or paving. Reviewing this land and discussing potential opportunities with landowners and the community can unlock small pockets that can be used to enhance the streetscape as a whole as well as supporting SuDS strategies.[13] See Dŵr Cymru Welsh Water's RainScape project in the appendix.
- Where space is limited on site, sub-surface options such as tanks or blue roofs may prove more efficient and can attenuate peak flows. These should also include rainwater or stormwater harvesting technologies to provide wider benefits. [14]
- There are substantial opportunities to retrofit existing communities and integrate SuDS whenever works are proposed in the urban environment. From the reroofing of buildings (green roofs or rainwater harvesting), to highways works, for resurfacing, road widening or creation of cycle lanes; all of these provide the opportunity to incorporate SuDS as bioretention systems or through SuDS in tree trenches. In these circumstances SuDS become much cheaper, as they are an 'extra-over' cost to the planned works.

We consider that arguments for not delivering SuDS on the basis of site constraints may be overstated and the range of options available means it is nearly always possible to incorporate some measures. Our findings suggest that with good planning there may be no additional requirement for land or that the additional land needed for SuDS can be small and affordable.

Delays to planning

We were interested in whether the requirement to consider SuDS in developments of over ten homes or in commercial developments causes any delay to the planning process, such that it might act as a disincentive to give SuDS options the full consideration they deserve.

There was limited evidence of this in the survey and it was certainly not identified as a barrier to development. Where delays occur, they are often the result of uncertainty over the on-going maintenance of the systems, rather than construction of the SuDS themselves. We therefore consider that providing certainty on 'adoption' of SuDS would help to speed up the planning process and this needs to be considered in the Government review.

Figure 3. Somerset, a missed opportunity for SuDS. Photo courtesy of Peter Melville Shreeve. The 'lake' on this housing estate of 200 homes is always empty and unsightly. The lake will only fill during a one in 100-year storm event. This could easily have been designed with higher amenity value, as useable space, but the plans already had decided on the pond before drainage consultants were engaged on the design.

In order to minimise any delays, the SuDS design process should begin in the feasibility stages of any development and should be a consideration before land is actually purchased. Respondents noted that all too often SuDS are an afterthought and an argument used that as the site has already been designed, there is no space left to include SuDS. Pre-application discussions between planners and developers (or their consultants) is normally a requirement of the planning and/ or drainage approval process for larger sites. Encouraging developers to ask the Lead Local Flood Authority for pre-application advice is essential so that SuDS are not an afterthought and are integrated fully into the site.

Early consideration of SuDS will inform the site layout around the drainage requirements, rather than the other way around (Figure 3). This will allow potential opportunities and constraints to be identified and addressed at an early stage and ensure that the space is used as cost effectively and efficiently as possible and maximise the benefits that can be achieved.[15] In the survey all sectors called clearly for SuDS to be introduced early in the design process.

We believe that failure to consider SuDS from the very start of a development's design is a significant barrier to efficient delivery efficient delivery. There is a real opportunity to address this through stronger policy and standards.

Health and safety

The survey found that 15 per cent of respondents viewed health and safety as a reason why a scheme may not be accepted. The design of a SuDS scheme should ensure that it is safe for those living near or visiting the system, and for those involved in its operation and maintenance.[16]

- A preliminary Health and Safety assessment (in accordance with the SuDS Manual) should be developed at the outline design stage, early in the Construction, Design and Management planning process.
- Well-designed SuDS components includes features that are no more hazardous than those found in the existing urban landscape, for example ponds in parks or footpaths alongside canals. This view is supported by The Royal Society for the Prevention of Accidents (RoSPA)[17].

In many cases, safety concerns result from misunderstanding and lack of information, rather than actual risk. Schemes that manage water on the surface would only have a small amount of water in them and only following heavy rainfall events. Those that are on the surface provide the best means of seeing when water levels are starting to rise and the capacity of the system is exceeded, giving residents and other users more time to take action should they need to in areas of flood risk. Many SuDS components and schemes are now installed safely in schools, providing opportunities for education about water in the environment (case study 1).

We do not consider health and safety to be a significant barrier to SuDS implementation and risk can be designed out readily.

Case Study 1: SuDS for schools

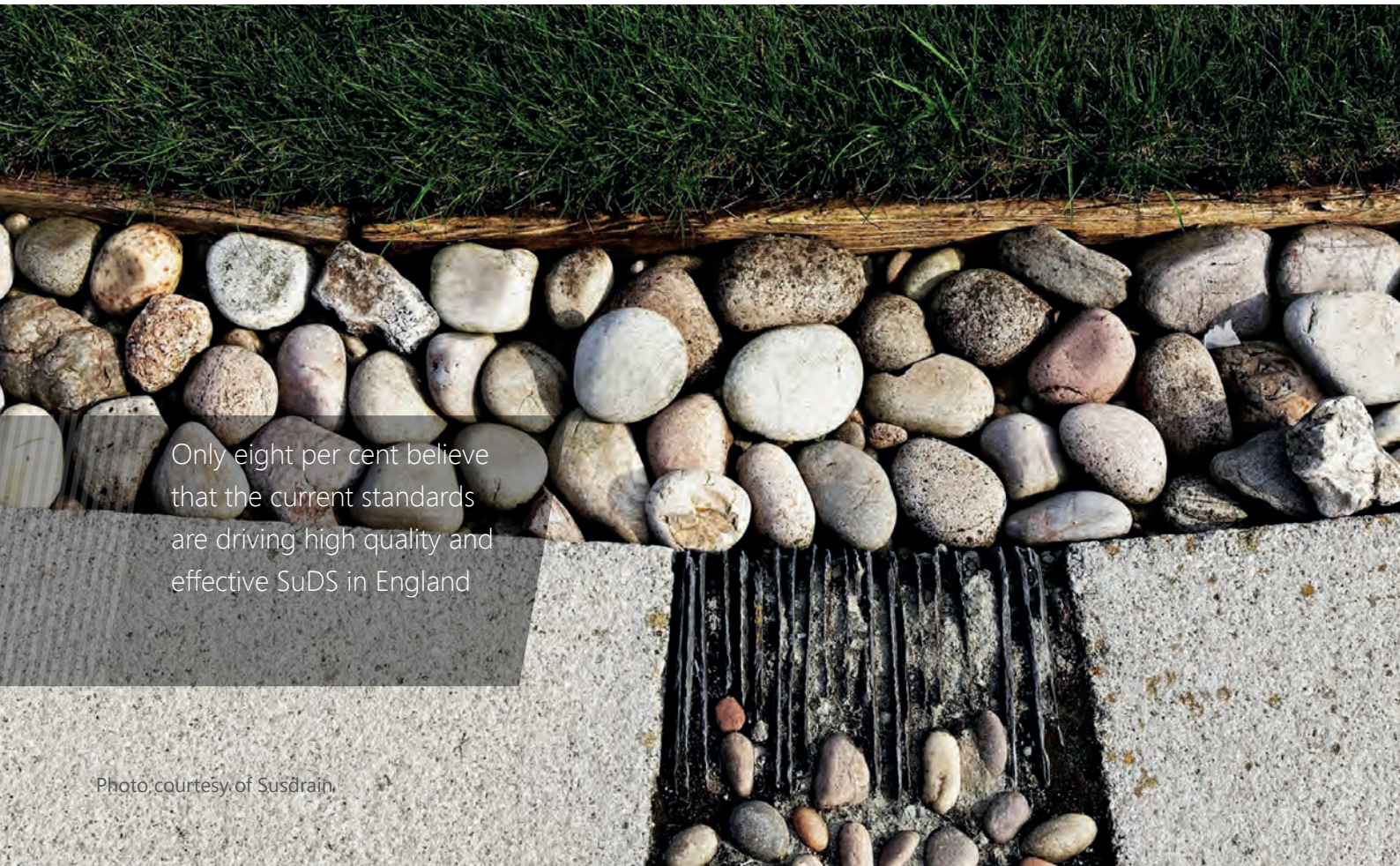
SuDS for Schools is a WWT project, supported by the Environment Agency and Thames Water, retrofitting SuDS at ten schools in the Pymmes Brook catchment in London.[18] The project was used to demonstrate that creating SuDS in several schools in a single catchment can deliver diverse benefits, from cleaner water and flood risk management, to education and improved places for children to play and learn without compromising health and safety.

For example, at Hollickwood Primary School, the aim was to reduce flooding of fields and playgrounds, improve water quality, and create a learning and play space. The SuDS components used were swales, detention and retention areas and all were designed with safety and the needs of children and teachers in mind. The scheme uses source control components (rainfall diverted from downpipes into a raised bog garden), site control (the so-called "boggy corner") and conveyance components (grass and "biodiverse" swales designed and planted to mimic a natural river system). The SuDS were designed to manage 100 per cent of the run-off from a one in ten-year rainfall event and 50 per cent of a one in 100 year event.

The 'boggy corner' at Hollickwood School, image from the Environment Agency [20]

See also the case study of Stebonheath primary school, Llanelli in the appendix, the first school in the UK to have a sustainable surface water scheme retrofitted.

Children at the school are now much more aware of the need to manage rainfall sustainably and of the value of wetlands for people and wildlife. Added to that, they have fun, new places to play in.[19]



Only eight per cent believe that the current standards are driving high quality and effective SuDS in England

Photo courtesy of Susdrain

Financial constraints: potential savings

Are SuDS more expensive than conventional drainage?

Increasing pressure for housing and development means that land is extremely valuable, so it is understandable that developers may view SuDS as having the potential to reduce their margins. Economic viability is often cited as a reason not to include SuDS in schemes, and our survey revealed that this was perceived largely to be associated with the opportunity cost of the land.

If SuDS can be incorporated without affecting land take[21], is there evidence that they may reduce profitability because they cost more than conventional drainage? There is a lack of clarity on costs as the recording of SuDS implementation within the industry has in the past been poor and there has been considerable spin on both sides of the debate. The most compelling figure identified in the survey was that almost 75 per cent of respondents do not assess the costs and benefits of SuDS schemes.

- Costs will be entirely dependent on the site, the type of scheme to be developed and the timing of the intervention in the design. It will also depend on what is trying to be achieved whether merely the minimum standards for flood risk management or if the scheme will go further, to pursue multiple benefits from SuDS. It is also difficult to compare schemes; SuDS have significant water quality benefits, while to achieve the same water quality benefits in a conventional system would double or treble the cost.
- The Government has sought to improve understanding on costs. Defra[22] found that SuDS may be up to 30 per cent cheaper to construct, although for challenging sites they could be five per cent more expensive to construct than conventional drainage.
- Defra-commissioned independent research found that maintenance costs are on average no higher than those for conventional piped surface water drainage. Through discussions with developers and service managing agents the actual figures for maintenance of some SuDS within managed open spaces can be much lower (a typical example was around £6 per property per year).[23] For more evidence on the costs and benefits of SuDS, see the case study of Lamb Drove, Cambridge, in the appendix.

This evidence suggests that capital and maintenance cost differences are usually marginal, and from anecdotal evidence in the survey, it was found that SuDS should cost less than conventional drainage if schemes are well-designed.

More London, courtesy of Sue Illman

Costs and benefits

Under current planning policy a developer can 'opt-out' from implementing SuDS if an economic test demonstrates it is not viable. Defra guidance states that the construction cost and opportunity cost of the land can be taken into account, alongside the design costs and maintenance and operation requirements. Yet there is no requirement to factor in the benefits SuDS provide, nor does the test account for long term environmental and social costs of conventional drainage (figure 4).

- Good SuDS schemes will have multiple functions providing multiple benefits, which in turn reveal better cost benefit analyses. There are also intangible benefits that may not be considered and could be assigned monetary values, such as amenity, biodiversity and improved social cohesion, which can be difficult to assess.[24]
- The survey revealed that schemes are more cost effective when SuDS are designed in from the outset, so providing clarity on requirements for developers and planners would help them to be integrated at an earlier stage in the design. If considered from the start there should also be savings for the developer resulting from reduced excavation, use of the soil onsite and reduced construction waste disposal.

Given that almost 75 per cent of survey respondents are not quantifying the costs and benefits of SuDS and the amount of benefits that SuDS can bring, it is necessary for these to be taken into account to ensure that the optimum decisions are made.

The Impact Assessment monetises costs and benefits over a 50 year period. This scenario shows the results if all new major and minor developments install

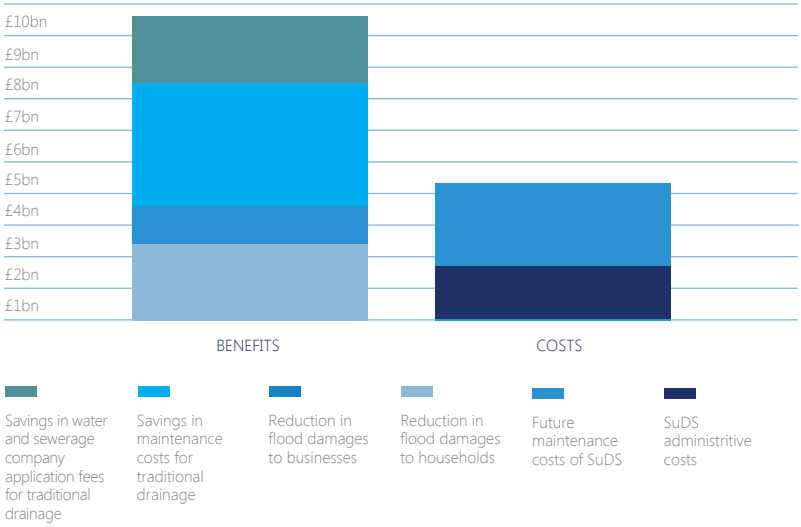


Figure 4. Present value costs and benefits of incorporating SuDS schemes for all new developments across England. Committee on Climate Change[25], data sourced from Defra impact assessment[26].

SuDS. The benefit and cost numbers show the total values for England based on assumptions of flood damage reduction. The assessment assumes capital costs are the same for SuDS and conventional drainage, which is why those costs are not presented here.

This graph does not include the wider benefits from improved water quality, amenity and biodiversity.

When the wider benefits are taken into account, the case for SuDS is typically compelling (case study 2). However, these benefits are often public goods and do not accrue to the developer, reducing their attractiveness. Where there are larger cost savings or where the benefits are valued truly it is likely that developments will include them. This can be considered a market failure (as the benefits are not counted but the costs are), suggesting the need for better accounting or incentives.

Another potential blocker is that as developers do not pay for the maintenance of conventional drainage and may be put off including SuDS by a future liability. There may be the opportunity to develop more innovative funding approaches, similar to partnership funding for flood risk management, where those who benefit from a scheme can then contribute towards its costs. This could be adopted more easily for retrofit schemes or for contributions towards long term maintenance. Ultimately, there is a pressing need to clarify the future adoption and allocation of maintenance responsibilities for SuDS.

The cost of SuDS—perceived or real—is likely to remain a source of debate. Whilst the wider benefits of SuDS remain largely unpriced, objective assessment of the viability of schemes will remain difficult. If we are to build climate resilient developments, we must address these costs and benefits more carefully.

Case study 2: Increasing social return on investment, retrofitting social housing in Hammersmith, London

Groundwork and the London Borough of Hammersmith and Fulham have been working together to demonstrate how retrofitting open spaces on housing estates can be a cost effective solution to improving London's resilience to climate change[28]. The estates were chosen to showcase many climate proofing options while also providing benefits such as biodiversity, play areas, improved amenity and better air quality.

Works began in 2014 on three housing estates with extensive landscaping to incorporate SuDS features such as swales, raingardens and bio-retention basins. A large scale green roof was also installed on one, which was incorporated into planned maintenance to the roof to increase efficiency.

The sites are roughly 'maintenance-neutral', so where impermeable surfaces (asphalt, concrete etc.) have been replaced by gardens that require maintenance, they have been offset by turning grass areas to meadow. Simple low-maintenance plant mixes that suit the conditions and provide colour for residents were also used. Contractors and council officers are being trained so they can replicate these measures elsewhere.[29]

The improvements to be delivered across the three sites are:

- 2,500m^2 of enhanced green infrastructure
- 25% increase in permeable surfaces
- 20,000m^3 of water retention capacity
- 600 trees planted
- 600m^2 of green roofs
- 400m^2 of food growing capacity
- 10 rainwater harvesting systems[30]

Social benefits of £4.50 are accrued for every £1 invested[31]. The calculation of social return on investment was based on Cabinet Office procedures. Susdrain provides sources of information on benefit cost assessment and guidance to help assess intangible benefits.[32]

Climate proofing social housing estates, before and after, Queen Caroline Estate, Hammersmith. Courtesy of London Borough of Hammersmith and Fulham[27]

Over 70 per cent of respondents stated that they do not think current planning policies encourage SuDS sufficiently

Upton, Northampton, courtesy of Susdrain

Policy constraints: the real roadblock

So far, we have shown that the barriers presented by physical and financial constraints are often overcome easily, with clear benefits for communities. Nevertheless, cost and practicality continue to be cited as reasons for developers opting out of SuDS provision. Our evidence points to policy failings as the main reason for limited uptake of high-quality SuDS.

The survey identified four policy and institutional barriers that need to be addressed: weak planning policy, local authorities not having sufficient resource to drive and enforce good quality SuDS, a lack of clarity around SuDS 'adoption' and weak standards creating poor quality schemes.

Planning policy

We have already noted that it is possible to 'opt out' of the requirement to implement SuDS fairly easily. But there are other concerns around planning, as before SuDS need only be considered on major developments and in areas at risk of flooding. They also rely on planning officers and Lead Local Flood Authority (LLFA) officers having the skills and resources to be able to assess applications and enforce decisions.

Snapshot: SuDS planning policy in England

- New development should only be considered appropriate in areas at risk of flooding if priority has been given to the use of sustainable drainage systems.
- Local planning policies and decisions on applications for major development[1] (ten homes or more) and major commercial development to ensure SuDS are put in place unless demonstrated to be inappropriate.[33]
- When determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere [... following the sequential, and if required the exception, test]
- Local planning authorities are expected to consult the Lead Local Flood Authority on the management of surface water and ensure through the use of planning conditions or obligations (such as Section 106 agreements) that there are clear arrangements for ongoing maintenance.
- The decision on whether a sustainable drainage system would be inappropriate in relation to a particular development proposal is a matter of judgement for the local planning authority. In making this judgement the local planning authority will seek advice from the relevant flood risk management bodies, principally the Lead Local Flood Authority, including on what sort of sustainable drainage system they would consider to be reasonably-practicable.
- The judgement of what is reasonably-practicable should be by reference to the technical standards published by Defra and take into account design and construction costs.

[1] Major development are developments of ten dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010).

Although there is limited data on how SuDS have been implemented since April 2015, the survey shows that there is limited confidence that SuDS are being incorporated effectively into new developments under current planning policies (figures 5 and 6).

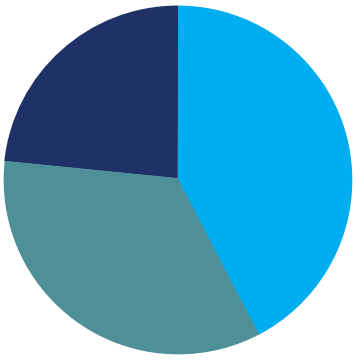
Over 70 per cent of respondents stated that they do not think current planning policies encourage SuDS sufficiently.

- Current planning policy misses the opportunity to integrate SuDS into minor developments (between one and nine dwellings) which make up over 90 per cent of planning applications.[34] Defra's own impact assessment found that if planning policy targeted minor development it would have much stronger benefits around reducing surface water flooding, as a good proportion of this will be infill development that would otherwise connect to heavily-constrained urban drainage systems.
- The current policy also does not address the impact of urban creep from developments that do not require planning permission (permitted development), nor does it deal with retrofitting SuDS into existing developments.

At the heart of the problem in England and Wales is the automatic right to connect surface water run-off in new developments to existing sewer systems, reducing the need for developers to consider implementing SuDS. This right to connect was established in Section 106 of the Water Industry Act 1991[35] 25 years ago, during which time pressures on drainage infrastructure have increased significantly. Water and sewerage companies are not statutory consultees for new developments, which hampers their involvement in issues relating to water quality and surface water management systems.

Normal planning procedures could be improved by ending the presumption that new developments can connect automatically to the sewerage system and by making the right conditional on the inclusion of SuDS. To connect, developers would need to demonstrate that they have met national standards and any additional standards adopted formally by local authorities.

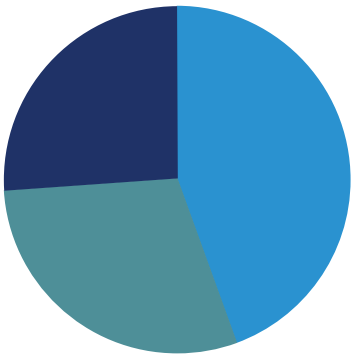
IN YOUR EXPERIENCE ARE SUDS INCORPORATED INTO THE MAJORITY OF HOUSING SCHEMES ABOVE TEN DWELLINGS?



42% YES
34% NO
25% DON'T KNOW

Figure 5. Questions 8 (response 335)

IN YOUR EXPERIENCE ARE SUDS INCORPORATED INTO MAJOR COMMERCIAL SCHEMES? (AS DEFINED BY PLANNING POLICY)



44% YES
30% NO
26% DON'T KNOW

Figure 6. Question 9 (response 336)

How does planning policy and advice vary across England?

The weakness of current planning requirements is exacerbated by a lack of resourcing and guidance for local planning authorities, which rarely have the wherewithal to assess the merits of an application in any detail or argue a case with a major developer.

Skills and resources in local authorities across England vary considerably and so too does pre-application advice and the occurrence of pre-application discussions. Responses suggest that there is an issue with capacity and resources in LLFAs and Local Planning Authorities (LPAs) to assess planning applications. Seventy-five per cent considered that planning authorities did not have adequate in-house expertise to consider the merits of proposals and opt-out applications. This this included a high percentage of responses from local authority staff (see box).

Question 24: Do you consider Local Planning Authorities have the expertise in-house to check and advise on quality SuDS deployment and challenge inappropriate planning proposals?

"As a Head of Planning I have no in house expertise to refer to, and the Lead Local Flood Authority have no capacity to assist."

"We very much depend on the advice of the Lead Local Flood Authority who are not resourced to provide this service as they do not receive any planning fee."

"Further advice is needed to be provided to LPA's to enable them to understand the importance of consulting with the LLFA undertaking the Technical Assessments. The Technical Assessment should not be undertaken by the LPA but by the LLFA, this needs to be clearly stated, they are two separate functions."

There is an important distinction to be made as to where the Local Planning Authority (LPA) 'sits' within the local government arrangements when SuDS are considered for residential and commercial development. 'Single tier' (Unitary) authorities[2] and upper tier authorities (County Councils) assume the role of the LLFA, which has the lead responsibility for managing the risk of flooding from surface water. But in District or Borough Councils, the LPA should consult with the LLFA at the County Council that it sits within on surface water drainage when considering major development[36]. The survey suggests that in some lower tier authorities there is a lack of awareness that they should consult with the LLFA and in others that the LLFA does not have enough capacity to assist.

Experience tends to vary across the country with some authorities producing and strictly implementing their own adopted guidance and others achieving the bare minimum. Some authorities have developed good local SuDS guidance through supplementary guidance documents (e.g. Cambridgeshire, Staffordshire, Bristol, Birmingham and Shropshire). This can make it considerably more difficult for developers and consultants that work across different parts of the country; a more consistent national approach could alleviate this, as could LPAs formally-adopting policy and guidance on SuDS.

SuDS will work best when integrated into Local Plans and considered alongside communities' other needs.

Local Authorities have the overview for public open space and green infrastructure, but they need access to expertise and resources to ensure that they are created and maintained. In practise the flexibility of the LPA towards allowing SuDS to form part of an open space of a scheme often relates to the political desire for a development.

Furthermore, once planning approval has been granted, there are few resources to monitor if the development progresses as approved. Many respondents believed that enforcement of planning decisions was failing. Almost 40 per cent of respondents thought stronger planning enforcement would improve the uptake of SuDS. There are instances in the survey where local authority staff knew of schemes that they had approved but did not know whether they had actually been delivered. It was also noted that schemes are often 'value engineered' out by developers and their consultants with the knowledge that enforcement by the LPA is unlikely.

There are also issues with planners not taking on board the advice of the LLFA, and as the LLFA is not the final voice on using SuDS, the planners can reject LLFA recommendations and treat the inclusion of SuDS as 'just another factor in the planning balance'. Allowing non-specialist advice to override specialists with flood risk management experience when making decisions about critical drainage infrastructure is a fundamental flaw that exists because Schedule 3 of the Flood and Water Management Act was not implemented.

We are concerned that local authorities (which may be either LPA or LLFA, or both) do not have sufficient resource to drive and enforce delivery of good quality SuDS. This is resulting in sub-optimal new developments and should be addressed.

Adoption and maintenance

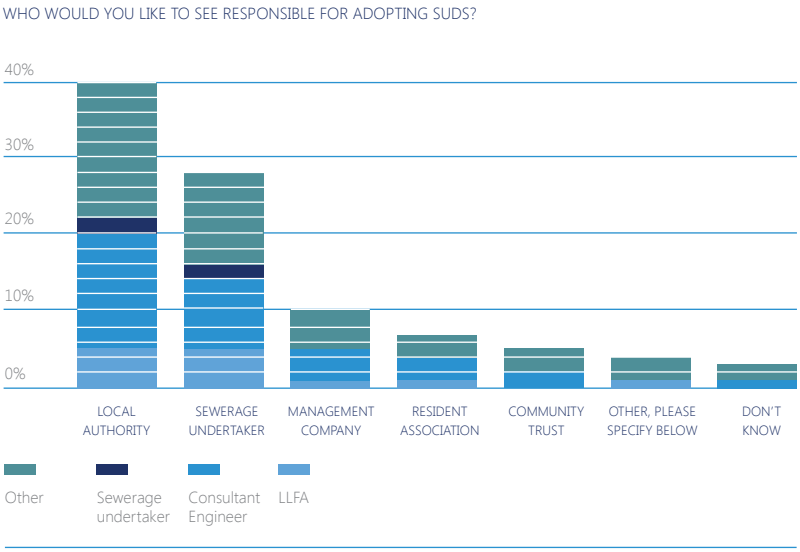


Figure 7. Question 5. Who would you like to see responsible for adopting SuDS? Colours show answers by main respondent type. Survey size 376.

The person or organisation that takes ownership and responsibility for the management and maintenance of SuDS components is said to "adopt" the system. Maintenance of conventional drainage is paid for by the sewerage undertaker, whereas in the absence of any formal framework SuDS maintenance can fall to a maintenance company, local residents, the local authority or another undertaker. The difficulty of agreeing adoption on a case-by-case basis has contributed to poor uptake of SuDS schemes, as uncertainty can cause delays in the planning process.

Measures to clarify this situation were produced under Schedule 3 of the Flood and Water Management Act. However this schedule was not actually implemented, so a clear mechanism for adoption has not been resolved. There is no guidance on where the responsibility for maintenance lies, how income streams may be developed, or how a robust approval process may be created.

Without a clear mechanism for defining the appropriate adopting authority we will continue to have the pick and mix approach and the negative affect this has on the sustainability of designs, as developments are often built to the option that is easiest to maintain, not necessarily taking into account the widest benefits (as not all of these can be monetarised into profit for the developer).

For SuDS to be most effective, the arrangements for adoption and future maintenance of the system should be considered during the early stages of design. This is likely to influence the design just as much as technical considerations and the adopting organisation will most likely want to approve the design before construction.[37]

The planned benefits of SuDS can be lost if they are not maintained properly. This has happened in some cases because of a lack of responsibility and in others because responsibility has been handed over to maintenance companies, which have ceased to operate after just a few years, leading to "orphan SuDS", which fall into disrepair.

Money provided by developers to local authorities towards the long term (or ten year) maintenance cost, cannot be ring-fenced, and are therefore 'lost' within general budgets. At the same time, in the current period of major cuts to local authority budgets, many authorities have no wish to take on any additional long-term financial obligations.

Establishing responsibility and a robust source of income for the organisations adopting SuDS is essential both to avoid delays in the planning process and to ensure that they continue to deliver the designed benefits once they are in place. Consideration therefore needs to be given to the ways in which long-term funding can be secured, and an appropriate body or mechanism for doing so.

Unsurprisingly, resolving the adoption and maintenance of SuDS was highlighted as the top priority for the Government's review, although there was some division about who should adopt SuDS (figure 7): 40 per cent favoured a local authority and 28 per cent opted for the sewerage undertaker. Interestingly, the answer to this question from those at LLFAs, LAs and sewerage undertakers showed a 50:50 split between LA adoption and sewerage undertaker adoption within each group. The results are clear that it should be undertaken by a publically accountable statutory body, either the local authority or sewerage undertaker. They could then, if necessary, contract maintenance out to another organisation.

Opportunities

- Adoption by the local authority centralises responsibility and enforcement. They are already responsible for drainage, spatial planning, urban design matters and green infrastructure delivery. As a public body they may be more democratic and reliable to ensure maintenance in the future. Lead Local Flood Authorities receive a local levy from grants from central Government and business rates for managing the risk of flooding from surface water. In some areas local authorities charge developers the Community Infrastructure Levy, in others Section 106 (of the Town and Country Planning Act) contributions or Commuted Sums are used to maintain SuDS schemes.
- Sewerage undertakers have a range of relevant skills and already manage several aspects of the water cycle. They have practical drainage experience as well as charging infrastructure that could help to support long-term maintenance, for example through surface water drainage rates. SuDS are in effect an extension of the drainage network and they can benefit from reduced loads on their network capacity, additional assets and the removal of pollutants at source.[38]

The Government's review should seek to resolve the current lack of certainty on the adoption and long term maintenance of SuDS and this should be combined with clarity of revenues. In making this decision, we recommend the Government takes into account: (1) relevant experience and skills (2) interaction with other responsibilities (3) who is responsible for additional pressures on the system (with reference to the polluter pays principle) (4) who would benefit from reducing pressures on the system (5) whether the adopting organisation has the resources available.

We consider that the lack of clarity regarding the adoption and allocation of maintenance responsibilities of SuDS is arguably the greatest single barrier to widespread implementation. Resolving this should be an urgent priority for the Government.

Are standards delivering high quality SuDS schemes?

The concept of sustainable drainage covers many different components and approaches, as such there is no simple "right" type of scheme. A conventionally piped surface water system with attenuation via oversize pipes and a restricted discharge may be defined as sustainable drainage under the current non-statutory guidance, but is vastly different from green, "soft" engineering components which can deliver a wider range of additional benefits. Where SuDS are delivered, they are often pipe-to-pond systems that offer few such benefits and can be problematic to manage.

The most effective SuDS schemes combine source control—as close to where the rain lands on the ground—with successive stages of a SuDS management train that can include other storage and filtration components. Managing rainfall at source ensures silt and pollution do not flow freely into watercourses, controlling the flow and quality of water for use further downstream.

Components downstream in the management train can include detention and retention basins and urban ponds, providing temporary storage of water and to trap and treat pollutants. However, some of these components are frequently designed poorly; many existing examples resemble neglected bomb-craters, rather than realising their potential as attractive and biodiverse wetlands for communities to enjoy (e.g. figure 3).

Our evidence emphasised how effective SuDS policy could contribute to a variety of cross-Government objectives. For example: there is potential for SuDS to contribute to the provision of high-quality greenspace close to people's homes and respond to the growing problem of chronic physical and mental health conditions in the UK. Strengthening the requirement for SuDS to deliver added benefits can help to create the pockets of quality environment that can be invaluable to communities and wildlife.

Only eight per cent of survey respondents believe that the current non-statutory SuDS standards are driving installation of high quality and effective SuDS in England. Non-statutory technical standards[39] for SuDS are intended to ensure that SuDS match greenfield run-off rates for new build developments but do not mention any requirement to implement the wider benefits of SuDS. As the standards are non-statutory they have no legal basis and cannot be enforced.

What type of SuDS are being delivered?

SUDS APPROACH	Water Quantity			Water Quality	Amenity	Biodiversity	Large Sites *(survey results)*	Small Sites *(survey results)*
	Peak run off rate	Small events (interception)	Large events					
Water Sensitive Urban Design	●	●	●	●	●	●	1.3%	0.6%
Swale	●	●	●	●	●	●	0.2%	0.2%
Bioretention system (shallow landscape depressions) (includes raingardens)	●	●	●	●	●	●	4.1%	4.8%
Infiltration system (includes soakaways, infiltration trenches, infiltration blankets, infiltration basins)	●	●	●	●	●	●	17.1%	22.6%
Pervious paving	●	●	●	●	◐	◐	8.2%	10.5%
Trees	●	●		●	●	●	3.2%	4.6%
Detention basin (includes designing for exceedance)	●	●		●	●	●	11.7%	4.9%
Ponds and wetlands	●			●	●	●	12.4%	4.5%
Green roofs	◐	●		●	●	●	3.0%	3.8%
Rainwater harvesting		●	●		●		3.3%	10.3%
Filter strips		●		●	◐	◐	2.7%	3.0%
Filter drains	●	◐		●	◐	◐	3.1%	2.9%
Proprietary treatment systems (includes vortex flow devices)				●			7.7%	7.1%
Attenuation storage tanks (includes geocellular storage systems, oversized pipes, GRP, concrete)	●						22.1%	20%

● likely valuable contribution to delivery of design criterion

◐ some potential delivery of design criterion, if specifically included in the design

Rows added showing the percentage of respondents to the SuDS Survey answering the questions: "In your experience what form do SuDS schemes commonly take on small/large sites? Please tick all that apply." Response rate 350.

Figure 8. Multifunctional aspects of SuDS approaches and the percentage being implemented on large and small sites. Adapted from SuDS component delivery of design criteria from the SuDS Manual.

Question 23: Do you consider that the present Defra non-statutory technical standards are effective at driving installation of high quality and effective SuDS in England?

"permeable paving may feature or underground tanks, but opportunities are missed for landscaped SuDS on nearly all projects."

"Yes, but only in the sense that they meet the national standards (flood risk only)."

"The standards generally result in piped or tanked attenuation systems, which will be poorly maintained and could result in increased flood risk."

The non-statutory technical standards are likely to encourage more hard, 'grey' solutions. The standards can actually be implemented with conventional drainage as they only focus on volume control, rather than quality, amenity or biodiversity. They are dominated by attention to the quantity of water attenuated because it is calculable, whereas water quality, amenity and biodiversity are ignored perhaps because they are less easy to quantify. In this way, the standards neglect the key aspects of SuDS, multi-functional and cost-sharing benefits and their important role in successful place-making.

We have compared the different types of SuDS approaches and their potential benefits alongside the survey results of which are the most commonly implemented on large and small sites (figure 8).

Although figure 8 shows a good percentage of infiltration systems being used (that in some circumstances provide multiple benefits), there is also a similar proportion of attenuation storage tanks that only reduce peak runoff rate. The use of sub-surface or underground SuDS components such as geocellular storage systems, oversized pipes, glass reinforced plastic, storage tanks and concrete pipes, should be used as a last resort, with those that provide multiple benefits considered first. In this respect, a comprehensive rainwater harvesting and recycling system, which does use tanks, would be acceptable, through the benefits it provides through its sustainable reuse of water.

There should be more incentive to design SuDS that provide wider benefits. New standards should be developed aimed at optimising opportunity to achieve amenity, biodiversity and water quality benefits, as well as flood risk reduction. The Welsh non-statutory SuDS standards, which are in line with the SuDS Manual would be a good model to consider. The standards should be produced to reflect the needs of the adopting authority so that they can establish an approval process and adopt with confidence. They should also be understood easily and followed by developers and their consultants.

New standards should be produced with more considered detail and robustness on priorities to assist the Lead Local Flood Authority in promoting the uptake of high quality SuDS systems and provide greater confidence for the adopter.

Is policy driving retrofit?

New development only comprises one per cent of land use change within urban areas each year (ASC, 2012)[40]. Current planning policy is only focussed on new build and re-build developments, even though renovations and permitted development are where SuDS are needed most, given that these account for most development in existing towns and cities.

Retrofitting established developments with SuDS is a great opportunity to make them more resilient to surface water flood risk. SuDS can be retrofitted when paved areas are replaced, when buildings are refurbished, during drainage improvement works, or by disconnecting roof or driveway run-off from the public drainage system.

The main barrier to wide-scale retrofit of SuDS schemes is institutional rather than technical. Retrofitting has worked well overseas in Portland, Malmo and Tokyo. Here single agencies have been responsible for urban planning, highways, urban parks and surface water management, with input from local 'SuDS champions'.

- Retrofitting SuDS into urban streets as a standalone project may not always be cost-beneficial. It is often easier and more cost effective to introduce SuDS if they are included as part of other works to improve an area, such as constructing traffic calming measures or highway maintenance improvements. This opportunistic approach is being referred to increasingly as 'nibbling', where elements of the urban fabric are made more permeable.

- Taking opportunities to capture and store run off (particularly from roofs), can produce a supply of non-potable water that can be harvested and stored, reducing demand for non-potable water, saving on supply costs and increasing resilience to climate change.[41] Customers that have removed their property from the public sewer can apply for a small rebate on their surface water drainage from their water company. Water companies could further incentivise high 'surface water dischargers' to capture, reuse or infiltrate rainwater runoff in critical drainage areas.

The focus of the Government's review is on new developments but as these only account for a small percentage of housing stock, we recommend that a further review should seek to improve the requirements of planning policy for redevelopment and SuDS retrofit to enhance the reduction of flood risk.

A clear decision must be taken with regard to the adoption and allocation of maintenance responsibilities

Bridget Joyce Square, London, courtesy Laura Grant

Conclusions and recommendations

In England the law and statutory policies relating to sustainable drainage have remained in a fluid state since the Flood and Water Management Act 2010[42]. The Government chose not to commence Schedule 3 of the Act to avoid what it perceived to be a surfeit of bureaucracy; unfortunately, this has created a void of effective policy.

We know that trees and other natural features in our urban spaces help increase mental wellbeing, promote physical activity and health, create attractive, higher value locations, clean the air we breathe, absorb carbon dioxide, provide shade and cooling in summer and help water infiltrate into the ground rather than overloading drainage networks causing flooding at the surface. The value of these benefits is considerable, however, because the benefits accrue to many but the costs are borne initially by one party (a developer in the case of new build for example or a water company or local authority with retrofit), they require effective policy to correct the market externalities involved.

Our evidence indicates that the vast majority involved in delivering SuDS consider current policy ineffective, with many new homes built without the full benefit of SuDS. Minor developments and permitted development (particularly changes to front gardens) are not considered by planning authorities even though they make up the vast majority of developments. The issues of weak planning policy, lack of clarity around SuDS adoption and weak SuDS standards need addressing by the Government's review if we are to defuse the ticking surface water 'time bomb'.

We assert that a policy that demands SuDS to be considered from the outset would ensure that they are well-designed and implemented, delivering cost savings and so much more: amenity, biodiversity and water quantity and quality benefits. These all combine to contribute to cost effective developments, places and communities that deliver higher levels of health, productivity and vitality.

The greatest single barrier identified to improve widespread update of SuDS is securing a mechanism of adoption. We accept that the Government is unwilling to unleash the bureaucracy proposed in the *Flood and Water Management Act,* such as SuDS Approval Boards. But we propose that if there were stricter policy and better SuDS standards in place, then uncertainty and inconsistency would be reduced and the SuDS that organisations were asked to adopt would be better designed and built and the mechanisms to ensure maintenance could be made more robust.

There are policy options available that would integrate quality SuDS into new homes and developments without delay to house-building. These are (1) repealing the automatic right to connect to conventional drainage systems and to require SuDS in all new developments; (2) publishing new statutory standards aimed at achieving added benefits; and (3) clarifying approaches to adoption of SuDS. The experiences in Wales, Scotland and Northern Ireland (as highlighted in the appendix) show that all of these policy options need to be addressed in order to make real progress. The Government's review is an important opportunity to fill the data gaps but—crucially—to develop the legal and policy push necessary to deliver the benefits offered by SuDS.

In short, we consider that significantly greater effort should be invested in delivering sustainable drainage and green infrastructure both in new and existing developments than is currently the case. With so many more homes planned for the next few years, we have a real opportunity to ensure that everyone can benefit from the protection and amenity offered by SuDS.

Report findings

Our analysis, underpinned by the findings from our survey, provides a clear indication that:

1. At the majority of sites, the costs and particularly the benefits of implementing SuDS are not being assessed.
2. Physical site constraints are cited frequently as reasons to 'opt-out' of delivering SuDS in new housing and commercial developments, when the range of options available means this is commonly unjustified.
3. In many areas planning authorities do not have the capacity to judge the merits of applications properly, leading to more opt-outs than necessary on the grounds of price and practicality as many go unchallenged.
4. Where SuDS have been delivered, they often miss opportunities to provide multiple benefits as they follow the very narrow official standards that exist presently.
5. The adoption and future maintenance of SuDS are the greatest barrier that needs resolving.

Knowledge gaps

The survey identifies that there is scant information about the extent and quality of sustainable drainage in new developments with very little monitoring of actual delivery taking place. **Therefore, the Government's forthcoming review should examine and seek to address the following areas:**

1. The scale and extent of SuDS deployment and monitoring across the country.
2. The quality of SuDS delivery, relating to the non-statutory SuDS standards, designing to an adoptable standard and other recognised benefits like water quality, biodiversity and amenity.
3. The effectiveness of planning policy in driving the delivery, quality and adoption of SuDS.
4. The capacity of local planning officers and Lead Local Flood Authorities to assess the merits of SuDS proposals and the viability of applications.
5. The impact of the ten home threshold excluding minor developments from requiring SuDS.
6. Improved recording and reporting of SuDS implementation.

Policy proposals

Given the number of new homes planned by the Government, many of which are in areas that are already water stressed, and given the implications of such development for flooding, water quality, biodiversity and amenity, the review should set out a process for strengthening law and policy. **We propose that:**

1. Discharge of surface water to the sewer system should be conditional on the inclusion first of high-quality SuDS in new developments.
2. A clear decision must be taken with regard to the adoption and allocation of maintenance responsibilities for SuDS. This should have a clear and established mechanism for raising funds to ensure the continued effective maintenance and eventual replacement of all SuDS they adopt.
3. New standards are developed aimed at optimising opportunity to achieve amenity, biodiversity and water quality benefits as well as flood risk reduction. These should reflect the needs of the adopting authority so that they can set out an approval process and adopt with confidence.
4. The Government should undertake a follow up review of the barriers to retrofitting SuDS in existing developments and make proposals on how retrofitting might be incentivised.

We propose that new standards are developed aimed at optimising opportunity to achieve amenity, biodiversity and water quality benefits as well as flood risk reduction.

Appendix: additional case studies

SuDS in Wales

In Wales the automatic right to connect to a sewer remains, however, its non-statutory SuDS standards[43] are far more ambitious than those in England and include a wider range of benefits such as water quality, amenity and biodiversity, which align with CIRIA's SuDS Manual. There are six standards, dealing with runoff destination, hydraulic control, water quality, amenity, recreation and design. The standards are being trialled as non-statutory with a view to making them statutory in the future.

Responses to the survey noted that there is still reluctance by Dŵr Cymru Welsh Water to adopt schemes, although the company is implementing its own retrofit SuDS schemes. It is planning to invest around £80 million up to 2020 in support of its RainScape project.

Dŵr Cymru Welsh Water, RainScape project

The scheme integrates raingardens, basins and swales, porous paving, filter strips, grass channels and geocelluar storage into new developments or installs systems to be connected to the existing sewer system. Llanelli was targeted by the RainScape project as it sees almost as much storm water in its network as Swansea, despite the fact that Swansea serves three times the number of properties, and covers three times the area [44].

Where space is limited to infiltrate flood water it can be directed into roads. Safe storage zones and conveyance channels for extreme events can be included as part of road or car park designs using raised kerbing or speed bumps as containment features. Civic spaces such as pocket parks, squares and plazas can also be designed to function as exceedance storage zones.[45]

Raingardens are an excellent example of how SuDS components can be integrated into a streetscape with limited impact on the primary purpose of an urban space. They can be combined with a wide range of street features, such as on-street parking, pedestrian crossing points, spaces for cycle storage and seating areas. They can also be used to assist traffic calming measures, including gateways and build-outs (Figure 10).

Figure 10. Examples of bioretention systems providing traffic calming measures, Llanelli, Dwr Cymru Welsh Water [46]
Using SuDS to improve the streetscape, providing multi-functionality by integrating with other street features including tree planting, traffic calming, parking bays, verges and central reservations.

Stebonheath primary school, Llanelli

Also part of the Rainscape project, this playground is the first scheme of its kind in the UK and has been designed to reduce the amount of rainwater entering the local public drainage systems, helping to reduce the risk of sewer flooding and pollution.

The school used to generate 10,000m^3 of storm water annually. That is enough to fill four Olympic sized swimming pools. The transformed playground is anticipated to remove 3,000m^3 from the sewer network, and will instead now put the water back into the natural water cycle through the new plants and trees that have been planted as part of the scheme..

The investment at the school has transformed the playground by incorporating a pond, a swale (a vegetated channel), a range of trees and plants, planters, an outdoor educational area and water-saving water butts. These features help to absorb the surface water that used to run straight off the playground into the sewer network.

The school children were involved in the design of the scheme and participated in a workshop with the engineers where they collaborated on how the playground should look. A pond and an all-weather outdoor classroom were added to the end design as a result of feedback from the pupils.

For more information, see SuDS Wales:
www.sudswales.com/about

SuDS in Scotland

In Scotland the Water Environment (Controlled Activities) Regulations have required SuDS for new developments since 2006, however, opportunities for multi-functional assets are still often missed.[47] SuDS are now installed routinely in new developments across Scotland, however, there are still issues around silo-thinking as there is no clear national surface water management strategy and few SuDS have been adopted by the water authority, Scottish Water.

The system in Scotland enforces the use of SuDS more readily than in England, especially regarding the levels of treatment required, which often forces developers to look at other solutions.

However, many installations do not conform to good practice and there is often an unwillingness to achieve more than just the basic minimum requirements to meet regulatory conditions. Often only Building Standards officers and Scottish Water (where involved) actively check the construction of SuDS. Improvements to regulation, in particular secondary legislation to give local authorities more powers of inspection, may encourage better design and construction practices[48].

SuDS designs have been skewed by Scottish Water's vesting standards and Local Authorities being variously willing to adopt only certain types of SuDS. Maintenance of SuDS within the boundaries or curtilage of a private property, such as a residential driveway or a supermarket car park is the responsibility of the land owner or occupier. Where SuDS are constructed outside the boundaries or curtilage of a private property, SEPA's preference is for them to be adopted by Scottish Water, the local authority or a public body, and here SEPA seeks a guarantee for the long term maintenance of any SuDS implemented.[49]

CIWEM's Scottish Branch has produced a review of SuDS in Scotland[50].

SuDS in Northern Ireland

In Northern Ireland there is no automatic right to connect to a public sewer. This was introduced in the Water and Sewerage Services Act 2016[51]. Section 4 of the Act extends the powers of Northern Ireland Water to adopt sustainable drainage systems and to require construction of SuDS. This is further supported by Section 5 which introduced restrictions on the right to connect new surface water sewers to the public network. The definition of SuDS within the Act is a structure that is designed to receive surface water and reduces the run off rate that is not a sewer or a watercourse, so it does not require benefits wider than flood risk to be considered.

As the Act only came into effect earlier this year it may be too early to assess the impact of the new legislation. The current experience of developers in Northern Ireland is dominated by hard engineered containment of storm water (tanks, oversized pipes, hydro brakes, vortex flow devices). Northern Ireland Water will adopt this type of arrangement but it has been noted that there is some reluctance to develop or adopt 'soft' SuDS. There is still a need for clear guidance on the design, approval and construction of SuDS.[52]

Lamb Drove project, Cambridge

Cambridge County Council together with developers delivered a SuDS scheme in Lamb Drove. Following this Defra established a project to monitor the benefits of a SuDS scheme at a study site (Lamb Drove) and a control site between 2008 and 2011. The results demonstrated the benefits of the development with the SuDS scheme that showed marked differences in runoff volumes and peak flows, pollution concentrations, associated maintenance costs and habitat and biodiversity benefits.

- The Lamb Drove site has attenuated surface water flows, significantly reduced peak flows have been observed when compared to the Control Site.
- Lamb Drove has observed reductions in concentrations of a variety of pollutants and other water quality indicators.
- The number of species has increased at the Lamb Drove site over the monitoring period from 30 to 34 while it has decreased at the Control Site (34 to 21).

"Overall both the capital and the maintenance costs associated with the study site has been much lower when compared to costs associated with conventional pipe drainage systems. Its whole life cost is therefore significantly lower than that of a conventional pipe system."[53]

The estimated cost savings due to SuDS is ten per cent of capital and maintenance costs. In addition, each house has two water butts to collect rainfall from the roof, which can be used for watering gardens and other applications for which rainwater is suitable. Omission of the new surface water sewer connection should give some financial benefits (approximately £30/year/household) to the residents as it avoids the annual payment of storm water disposal changes to the sewerage undertaker. It has been suggested that the savings could have been greater if the SuDS layout had been considered earlier in the development process[54].

For more case studies please visit www.Susdrain.org

Lamb Drove, courtesy of Susdrain

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Western Harbour, Malmo, courtesy of Sue Illman

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