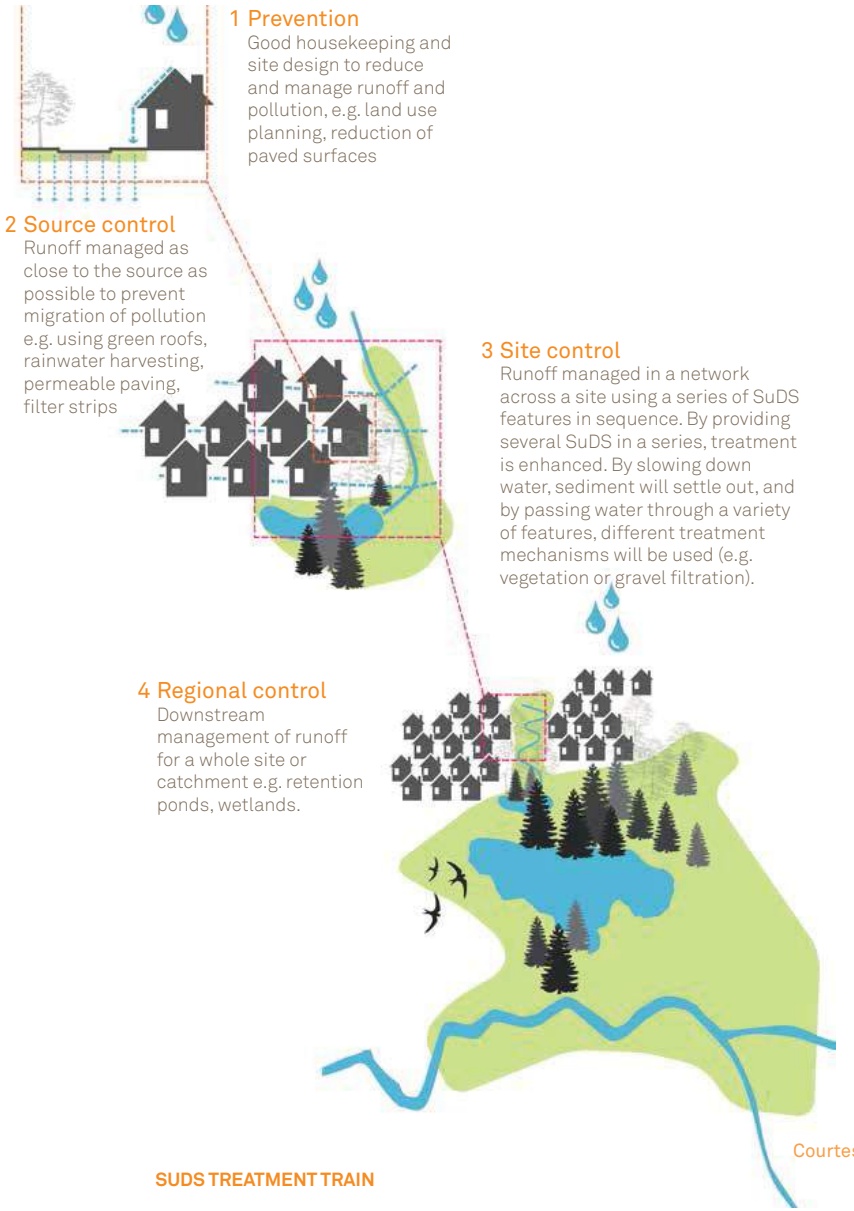
03

DESIGNING SUDS TO DELIVER BENEFITS

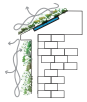
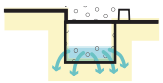
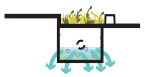
SuDS should not be thought of as individual items, but as an interconnected system, where water slowly flows from where it falls to a soakage area or discharge point through a series of features that help to treat, store, re-use, convey and celebrate water. An important concept for the SuDS designer to follow is known as the 'treatment train'. By passing water through several stages of treatment, sediment and other pollutants will be removed more effectively, and maintenance costs are reduced as this minimises the risk of downstream SuDS features becoming clogged or blocked. The designer can use the treatment train to create green corridors and links, add opportunities for engagement and education and to match delivery of SuDS to phasing of development.

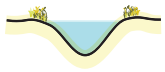
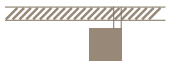
There are a wide variety of sustainable drainage systems which can be linked together in sequence, so that a designer can tailor surface water management to the local context. The following table presents common types of SuDS, their most suitable setting and their typical land take.



Courtesy of CIRIA

SUDS TREATMENT TRAIN

	Description	Setting	Required area
 Green roofs	A planted soil layer is constructed on the roof of a building to create a living surface. Water is stored in the soil layer and absorbed by vegetation.	 Building	Building integrated.
 Rainwater harvesting	Rainwater is collected from the roof of a building or from other paved surfaces and stored in an overground or underground tank for treatment and reuse locally. Water could be used for toilet flushing and irrigation.	 Building	Water storage (underground or above ground).
 Soakaway	A soakaway is designed to allow water to quickly soak into permeable layers of soil. Constructed like a dry well, an underground pit is dug filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to gradually seep into the ground.	 Open space	Dependant on runoff volumes and soils.
 Filter Strip	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and cleansing.	 Open space	Minimum length 5 metres.
Permeable paving	Paving which allows water to soak through. Can be in the form of paving blocks with gaps between solid blocks or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or allowed to infiltrate into ground below.	 Street/open space	Can typically drain double its area.
 Bioretention area	A vegetated area with gravel and sand layers below designed to channel, filter and cleanse water vertically. Water can infiltrate into the ground below or drain to a perforated pipe and be conveyed elsewhere. Bioretention systems can be integrated with tree-pits or gardens.	 Street/open space	Typically surface area is 5-10% of drained area with storage below.

	Description	Setting	Required area
 Swale	Swales are vegetated shallow depressions designed to convey and filter water. These can be 'wet' where water gathers above the surface, or 'dry' where water gathers in a gravel layer beneath. Can be lined or unlined to allow infiltration.	 Street/open space	Account for width to allow safe maintenancce typically 2-3 metres wide.
 Hardscape storage	Hardscape water features can be used to store run-off above ground within a constructed container. Storage features can be integrated into public realm areas with a more urban character.	 Open space	Could be above or below ground and sized to storage need.
 Pond / Basin	Ponds can be used to store and treat water. 'Wet' ponds have a constant body of water and run-off is additional, while 'dry' ponds are empty during periods without rainfall. Ponds can be designed to allow infiltration into the ground or to store water for a period of time before discharge.	 Open space	Dependant on runoff volumes and soils.
 Wetland	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated with a natural or hardscape environment.	 Open space	Typically 5-15% of drainage area to provide good treatment.
 Underground storage	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation.	 Open space	Dependant on runoff volumes and soils.

BIORETENTION AREA

WETLAND

SWALE

GREEN ROOF

HARDSCAPE STORAGE

POND

Designing SuDS to deliver benefits

Well-designed SuDS rarely function with only a single purpose (e.g. water attenuation). By using SuDS as part of an urban design toolkit and keeping water management above ground where possible, SuDS can be used to enhance their surrounding environment and provide a host of additional benefits. The following paragraphs outline a range of typical benefits that SuDS can be designed to provide.

Attenuation

Storing and slowly releasing runoff is one of the primary benefits SuDS offer. Rather than spilling off quickly into sewers or watercourses, increasing the risk of flooding and erosion, SuDS act as a sponge, soaking up excess water, storing it in plants, soils and constructed voids, before slowly releasing back into the surrounding environment through infiltration, plant up-take or controlled discharge. Areas with less permeable soils can incorporate SuDS features that are designed to hold and manage water on or near the surface for controlled discharge or re-use.

Water treatment

Pollution typically found in runoff including sediment, oils, metals, fertilizer, pesticides, and rubbish can be harmful to watercourses and coastal waters. The soils, gravels and vegetation present in many forms of SuDS act as filters, removing many pollutants before returning cleansed water to the natural environment.

Infiltration

SuDS can be used to first cleanse rainwater runoff then to promote infiltration into the ground to replenish groundwater, thereby letting water infiltrate which would have been prevented from soaking into the ground by impermeable development areas. This also helps to prevent soils from drying out.

Water reuse

South East England is a water stressed region. Many SuDS features can be used locally to capture, treat and manage water for re-supply of cleansed water to buildings or landscapes. Rainwater harvesting can be installed at a range of scales, from individual property scale to site-wide scale, by storing treated runoff at the end of a SuDS treatment train. Re-using rainwater for non-potable purposes such as irrigation and toilet flushing will help reduce potable water demand and deliver Code for Sustainable Homes, BREEAM and other sustainability targets.

Biodiversity and Habitat

SuDS can be designed to include a range of natural processes for managing and filtering surface water runoff. The inclusion of plants, trees, and other vegetation is often advantageous to slow and store water while providing filtration. These can be designed to support local biodiversity aims. SuDS treatment trains can be used to develop ecological corridors at the same time. They can also incorporate a range of vegetation species, ranging from wetland plantings to more common garden varieties. SuDS should be designed to complement and improve the ecology of the area, however consideration should be given to the effects of both species selection and maintenance requirements on the ability of existing habitats to continue functioning effectively.

Amenity

SuDS that integrate greenery or water features can improve the visual character of a development, and in doing so they can also increase property values. Access to green space, views of high quality public realm and street trees have all been shown to increase the resale value of properties. This is particularly the case in urban areas where these elements are not as common. Views of green space and water have been shown to increase commercial rents between 15 and 35%, while a view of a natural environment or high quality public realm can increase residential property values by as much as 15%[1].

Education

SuDS present an opportunity to educate and engage communities about water management and to grow a greater appreciation and respect for urban water. If schools incorporate SuDS on their premises, they can be viewed as a valuable learning and play opportunity for students and children.

Open space

Designing green space and public realm with SuDS that work well when both wet and dry can provide valuable community recreational space as well as important environmental infrastructure. Sports pitches, squares, courtyards, playgrounds, landscapes around buildings, urban parks, green corridors and woodlands are all popular types of open space which can be integrated with SuDS. SuDS can also contribute to development targets for open space where they are designed to be multi-functional.

Character

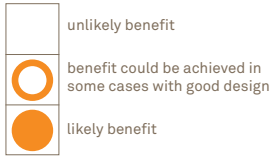
SuDS can be used to enhance and influence the character of development and its surroundings. As with all good design, SuDS design should respond to context, complementing the approach taken to landscape character and urban design. More rural areas often call for SuDS with a more natural feel and soft edges. Similarly, SuDS with hard edges and straight lines can be more appropriate in built up areas.

Microclimate

The inclusion of water and/or vegetation in the urban environment can help to regulate local temperatures and to mitigate the urban heat island effect. SuDS can be used to naturally irrigate trees and green areas, which help to provide shade, regulate heat and filter air.

1. Whitehead, Tim, Simmonds, David and Preston, John (2006) The effect of urban quality improvements on economic activity. Journal of Environmental Management, 80, (1), 1-12.

SUDS SELECTION MATRIX FOR BENEFITS



	Green Roof	Rainwater Harvesting	Soakaway	Permeable Paving	Filter Strip	Bioretention area	Swale	Hardscape/ Modular Storage	Pond	Wetland	Underground Storage
Attenuation	○	○	●	●	○	●	●	●	●	●	●
Water Treatment	○	○	●	●	●	●	●		●	●	
Infiltration			●	○	●	○	○		○	○	○ Geocellular storage system
Water Reuse	○ Pre-storage treatment	●		○ Pre-storage treatment		○ Pre-storage treatment	○ Pre-storage treatment	○ Storage	○ Treatment and/or storage	○ Pre-storage treatment	○ Storage
Biodiversity and Habitat	●		○		○	●	●		●	●	
Education	●	○	○	○	○	●	●	○ If aboveground	●	●	
Amenity	●	○	○	○	○	●	●	○ If aboveground	○	●	
Open Space	○			○	○	○	○	○	○	○	
Character	○			○	○	○	○	○ If aboveground	○	○	
Microclimate	●			○		●	●	● If aboveground	●	●	