Overcoming common SuDS challenges – Busting some design myths

Background

We know that the best SuDS schemes are normally delivered following early engagement between the local authority, client and designer. This is the best way to overcome most challenges.

With effective engagement of the right design team at the right time SuDS can be delivered on any site in a cost effective way. This fact sheet presents some common challenges to implementing SuDS and the good practice to help overcome them. The type of myths this fact sheet deals with includes:

We can't use SuDS because of:

- the risk of flooding and difficulties in managing runoff
- interactions with groundwater impacts on water quality and water table
- challenging topography with sites, being either too flat or steep
- poor ground conditions, with low permeability, and/or contamination
- developer challenges relating to land-take, existing infrastructure, health and safety and costs of maintenance

More information and guidance on dealing with specific site conditions can be found in the SuDS Manual (CIRIA C753).

Areas susceptible to flooding

SuDS in a floodplain

Floodplains are historically used to manage various types of flooding and may be the only public space on a site. During storms and heavy rainfall these areas will naturally flood, making them ineffective for storing surface water runoff and are potentially vulnerable to erosion.

Overcoming the challenge: A floodplain should not stop a site from including SuDS as they could still be effective in managing everyday rainfall as well as providing some water quality treatment.

SuDS should be selected and designed taking into consideration the likely high groundwater table and susceptibility to erosion during periods of high flows/water levels. Design should limit grading and the creation of surface features (such as berms and non-reinforced channels) that could limit capacity or be washed out in a flood.

Surface discharges from SuDS should be dispersed (allowed to shed off as sheet flow), and point discharges minimised or eliminated. The SuDS shown in figure 1 are in Stamford which is located in the floodplain (see susdrain case study).

Figure 1 Use of SuDS in Stamford in a floodplain and area of contamination (EPG Ltd)

Attenuation periods for SuDS should be designed so that SuDS empty within 48 hours of any rainfall.

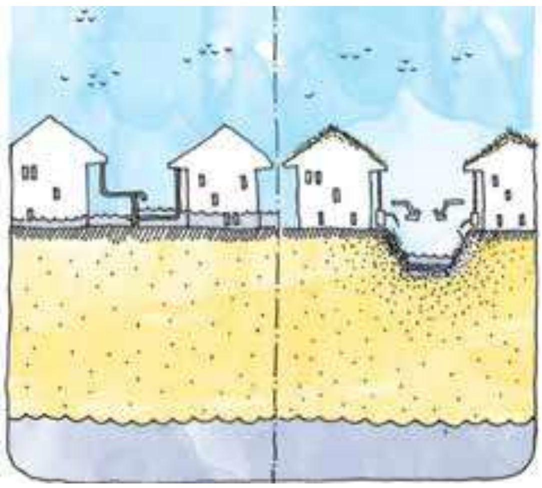
For more information read Chapter 8 of the SuDS Manual (CIRIA C753).

Managing runoff

Managing runoff from neighbouring sites that can increase flood risk
Some sites will lie downstream of surface water flows and as such can be at risk of flooding.

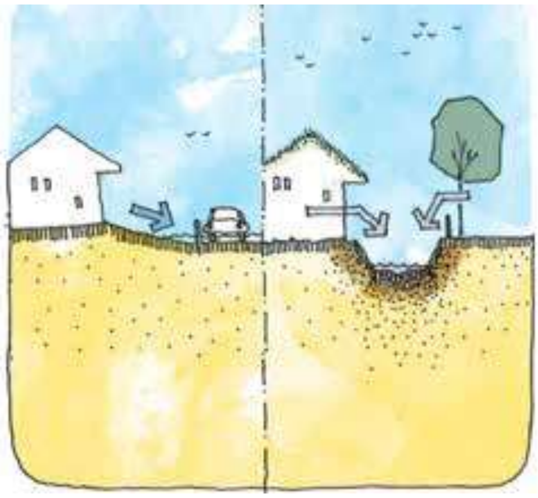
Overcoming the challenge: Runoff from adjacent sites should be managed at a sub-catchment , or catchment scale. SuDS such as swales could be used along the boundary to intercept and divert flows. The diversion does not have to provide storage for the offsite flows, just prevent them from affecting the development.

An understanding of flows from elsewhere will help locate buildings outside existing surface water conveyance routes. Furthermore, the Local Planning Authority (LPA) should be open to collaboration from all stakeholders to help manage the risks.



Managing runoff to and from adopted highway
Large areas of impermeable surfaces, like highways can generate significant amounts of runoff. As such, development sites cannot usually discharge to highway drainage and conversely, there may be instances where some sites will be expected manage runoff from neighbouring highways.

Overcoming the challenge: The local Highways Authority should be engaged early in the development process, as there may be potential for an efficient solution which benefits the developer and the Highways Authority.
Adoption of SuDS in the roadway should also be discussed at this point.



Interactions with groundwater

Protecting the quality of a receiving body of water
As runoff flows over the surface it can pick up pollutants that will reduce the quality of the receiving body of water, damaging the ecological systems. This can be particularly acute for runoff from industrial sites. Conversely it is likely to be minimal from small areas of car park or domestic roofs. Any runoff at high risk of contamination from chemicals or other serious waterborne pollution should be contained and treated as industrial waste.

Runoff being discharged into a water body should be treated to remove nutrients and sediments and appropriate treatment is likely to be required when the risk of pollution or quality of the receiving body is high.

Overcoming the challenge: Particularly hazardous sites should be divided into sub-catchments that isolate areas where there is an identified risk so that they can drain into separate systems whilst less risky areas such as roof and car parking spaces can still be managed by SuDS. There are, however, a range of SuDS components that can provide useful treatment for less hazardous pollution. As different SuDS components provide different levels of treatment. Design should follow the guidance provided in chapters 4, 26 and 7 of

The SuDS Manual (CIRIA C753). This suggests using appropriate SuDS components to deal with different levels of pollution risk.

Infiltration SuDS such as soakaways, unsealed permeable pavement systems or infiltration basins can only be used where it can be demonstrated via risk assessment that they will not pose a risk to controlled waters (ie groundwater, inland freshwaters, coastal waters and relevant territorial waters).

Sites with a high groundwater level
Sites with a high water table are susceptible to flooding and may also damage deep SuDS components. If the surface of an infiltration system is too close to the water table (ie normally less than 1m), a rise in water levels during particularly wet periods could cause groundwater to enter the infiltration system, reducing the amount of storage available, it could also cause floating of storage tanks. Groundwater must also be protected from contamination and pollutants.

Overcoming the challenge: If a high groundwater table has been determined then SuDS selection will focus on surface and shallow features that avoid infiltration. Some SuDS components (eg permeable pavement, swales etc) that usually allow infiltration may possibly still be suitable if used in conjunction with an impermeable liner (such as a waterproof membrane or compacted native clay) to prevent infiltration. The minimum clearance between the base of infiltration SuDS and peak seasonal groundwater may be reduced if a risk assessment shows it is acceptable to do so.

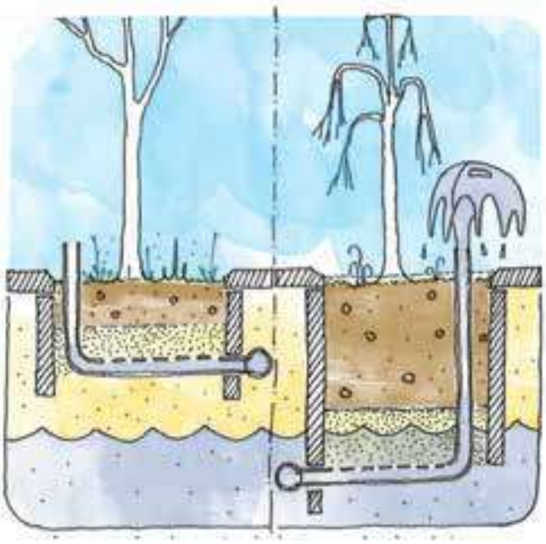
The Henry Box site in Witney, Oxfordshire (figure 2) overcame the challenge of high water levels by using shallow source control approaches that included swales and kerb drains.

Figure 2 Shallow swale on a site with shallow groundwater (EPG Ltd)

For more information read chapter 8 of The SuDS Manual (CIRIA C753).

Ground Water Protection Zones
Some areas are designated as a groundwater protection zone to protect the drinking water supply and as such are sensitive to contamination. In these areas there might be additional restrictions, particularly on infiltration.

Overcoming the challenge: Some SuDS, such as permeable paving and some raingardens can provide treatment of surface water before infiltration and potentially avoiding contamination. However, it is important that the proposed drainage strategy is discussed with the environmental regulator and if infiltration is not permitted then SuDS can be lined as discussed above. A groundwater risk assessment may be required to show the risk from infiltration is acceptable.



Topography

Incorporating SuDS on a flat site
Conveying water using gravity ideally requires a gradient. Flat sites can, therefore, be a challenge. If a piped system is being used to convey surface water on a flat site, downstream SuDS can become deep, expensive, unsafe and unattractive due to the drop required for pipe cover and gradient.

Overcoming the challenge: Manage surface water runoff at the surface and as close to its source as possible (eg swales, pervious pavements). Good SuDS design should manage the site into small sub-catchments and provide source control. If conveyance is required, surface approaches could include roadside kerbs with shallow rills and swales. Pumping should only be used as a last resort and where maintenance can be ensured.

Incorporating SuDS on a steep site
Steep slopes increase the velocity of surface water, which can in turn increase erosion and potential scour. They can also affect the amount of storage capacity that can be provided within SuDS components.

Overcoming the challenge: Runoff can be controlled by conveying it on platforms in a similar manner to switchback roads that go across contours, or using bioretention and wetland features staggered in a terraced arrangement. Sub-catchments are again useful for managing the runoff in smaller manageable areas, providing local opportunities for conveyance and storage. Infiltration is not recommended near steep slopes as it can cause instability.

A co-housing site in Stroud, see figure 3 delivers SuDS on a steep slope by providing terracing for parking areas that uses pervious pavements to store water. Basins are provided on terraces as well and there is some use of geocellular storage tanks (see susdrain case study).

Figure 3 SuDS on a steep slope in Stroud (Robert Bray Associates)

For more information read chapter 8 of The SuDS Manual (CIRIA C753).

Check dams and staged storage can be used to slow runoff as it travels down steeper slopes. These can also be combined with pedestrian crossings.

Figure 4 Use of check dams in a swale in the Grey to Green project in Sheffield

Ground conditions

Poor permeability

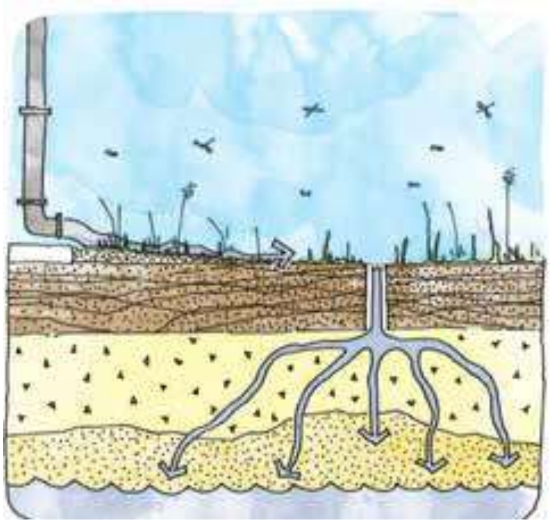
Impermeable soils restrict infiltration and can lead to surface water flooding.

Overcoming the challenge: Where infiltration is not possible the required treatment and attenuation will need to be delivered as close to the surface as possible. As areas with poor permeability are likely to have naturally high greenfield runoff rates, these requirements should be relatively manageable.

Rainwater harvesting, green roofs, permeable surfaces, swales, ponds and wetlands can all operate without infiltration. Permeable surfaces, used for car parks and drives are very effective, even where infiltration is not possible.

It might be that a more permeable layer occurs beneath shallow layers of impermeable geology. As such, it is worth understanding the vertical geology to see if infiltration could occur at a greater depth. It's also likely that not all the site will have no permeability, so it may be possible to work around some of these constraints.

It should be noted that deep bore and other deep soakaway systems are not appropriate in areas where groundwater constitutes a significant resource. The requirements for deep bore soakaways should be discussed with the environmental regulator.



Contaminated land

Some sites may have contaminated soils. This restricts infiltration as concentrated ground flow could lead to water-borne contaminants being transferred to deeper soils or sensitive aquifers.

Existing contamination may have an adverse impact on materials used in the SuDS construction. In addition, inappropriate SuDS design could compromise the contaminated land remediation system.

Overcoming the challenge: As with areas that are impermeable, water will need to be treated and attenuated as close to the surface as possible in shallow components. This should reduce the excavation and disposal of potentially contaminated soils and the potential risk of creating pathways for vapour and gas migration. SuDS that are shallow and on the surface, will also usually reduce health and safety impacts.

Like any other construction on contaminated land, SuDS would only be acceptable if a phased site investigation showed the presence of no significant contamination risks.

For more information read chapter 8 of The SuDS Manual (CIRIA C753).

Development challenges

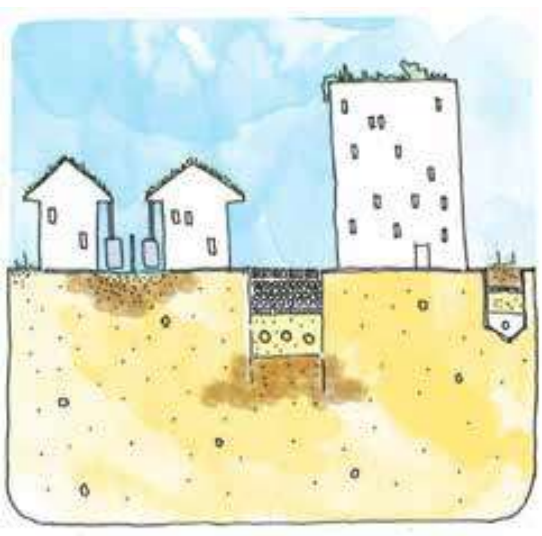
Limited space

SuDS are often associated with large open areas, with land take and space constraints often cited as a reason for not incorporating them into drainage strategies. However, this doesn't always need to be the case.

Overcoming the challenge: Considering SuDS early in the masterplanning and/or design process is key to ensuring that spatial requirements of SuDS components are planned appropriately.

Integrating multi-functional SuDS as part of the landscape and parking provision can help reduce land-take and deliver multiple benefits. This integration and benefits should also improve the desirability of developments and make them more attractive places to live and work.

There are also a range of SuDS components which can be easily designed into tight urban settings. Space efficient SuDS include green roofs, bioretention systems, permeable paving, rills, rainwater harvesting, hardscape storage, micro-wetlands, and tree pits.



Compatibility with existing infrastructure

Previously developed sites can include all manner of services and become constrained with existing infrastructure.

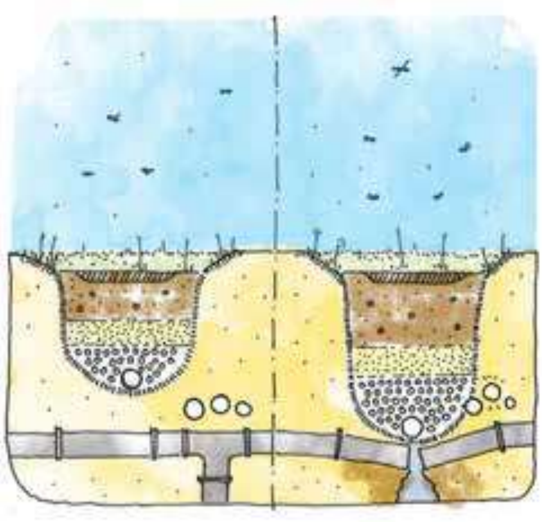
Buried infrastructure, such as utilities, will need to be located and considered in SuDS design and construction. Access to these utilities is likely to restrict SuDS selection and require design workarounds.

Overcoming the challenge: Using SuDS such as permeable paving and bioretention systems should be avoided in major service strips where the main shallow services are present, as access will require disturbance and rebuilding of the SuDS, but compatibility can be achieved by constructing dedicated and well-marked service strips that are designed with access in mind. Surface water and foul sewers are acceptable below permeable pavements.

Existing drainage infrastructure could be usefully reused as part of a cost-effective drainage strategy. As such it will be important to understand the location and capacity of existing drainage to determine it is potential.

When retrofitting SuDS into existing developments and public realm it is essential that existing buried services are located on the site. It may also be necessary to physically locate and mark the services when construction begins.

Figure 5 Impact of underground services (Arup)

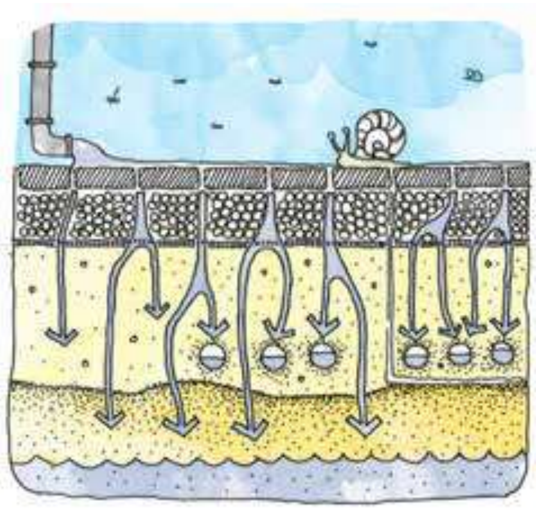


Incorporating SuDS on a site that is mainly paved

Hard surfacing, such as paved areas, prevents infiltration and increases runoff.

Overcoming the challenge: Permeable paving can be used for part of the paved area to drain a larger area. The areas of permeable paving should be selected to be the least trafficked (eg parking and footpaths) and outside of service strips where possible. Hardscape depressions and rills can be used to provide surface storage and double as an attractive water feature in courtyard and paved public realm areas. It may also be possible to shed runoff from impermeable paved areas into other SuDS components.

Underground storage is also an option, but one which will not deliver multiple benefits.



Health and safety concerns

The presence of open water in some surface SuDS components like ponds, wetlands etc are sometimes a barrier to their use on the grounds of health and safety for the public.

Overcoming the challenge: There are many ways to reduce the chances of accidents in and around SuDS. With an appropriate risk assessment and design these risks can be minimised particularly if components are visible and successfully integrated into spaces.

Options include the design of banks for ponds and swales with a maximum of a 1 in 3 slope and the depths of ponds and wetlands should be kept to a minimum, with the maximum depth of water being located away from the edges.

Barriers other than fences can be integrated into the landscape around SuDS components. If after consideration and as part of a risk assessment fences are provided they should be attractive and be appropriate to the landscape.

Figure 6 Use of an appropriate fence (EPG Ltd)

Figure 6 demonstrates how a combination of low fencing and planting forms an effective barrier. Reliance on signs is not an effective health and safety strategy.

For more information read chapter 36 of The SuDS Manual (CIRIA C753). This was developed with input from the Royal Society for the Protection of Accidents (RoSPA).

Addressing cost and time needed for maintenance

There is a common perception that SuDS are expensive and time consuming to construct and manage.

Overcoming the challenge: It is a common misconception that the construction and maintenance of SuDS is more expensive and time consuming and less effective than conventional drainage methods.

However, overwhelming evidence suggests that if there is effective engagement and a good design process that sustainable drainage systems are generally cheaper to construct

Several developers now see SuDS as a way to reduce costs of development. However, this does rely on engagement with local authorities or other adopting bodies charging reasonable amounts for maintenance and commuted sums for allowing SuDS to be part of formal Public Open Space (POS) provision. Unrealistic commuted sums (eg permeable paving maintenance) or requiring additional space for SuDS over and above POS provision will make them too expensive.

The annualised cost of maintaining SuDS is about 0.5% of capital costs (WSP, 2013). Removing silt is one major cost as well as the cost of maintaining vegetated SuDS to keep them looking good.

The size of the site, type of SuDS used and the design approach can have a significant impact on maintenance costs. The cost to an organisation also depends on whether it is responsible for the landscape maintenance of an area. If SuDS are incorporated into a maintained landscape then the extra cost for the SuDS is reduced.

It is important to design SuDS for ease of construction and maintenance from the outset. It is also useful to consider what benefits can offset potential costs by delivering multi-functionality and the associated financial benefits.

Further reading

For general information on SuDS evidence and costs and benefits visit susdrain.org here

Specific resources:

- Woods Ballard, B., Wilson, S., et al (2015). The SuDS Manual. CIRIA, C753 (click here)
- Central Bedfordshire/Aecom. (2014). Sustainable drainage guidance (click here)
- WSP. (2013). Final Surface Water Drainage Report. Defra WT1505 (click here)