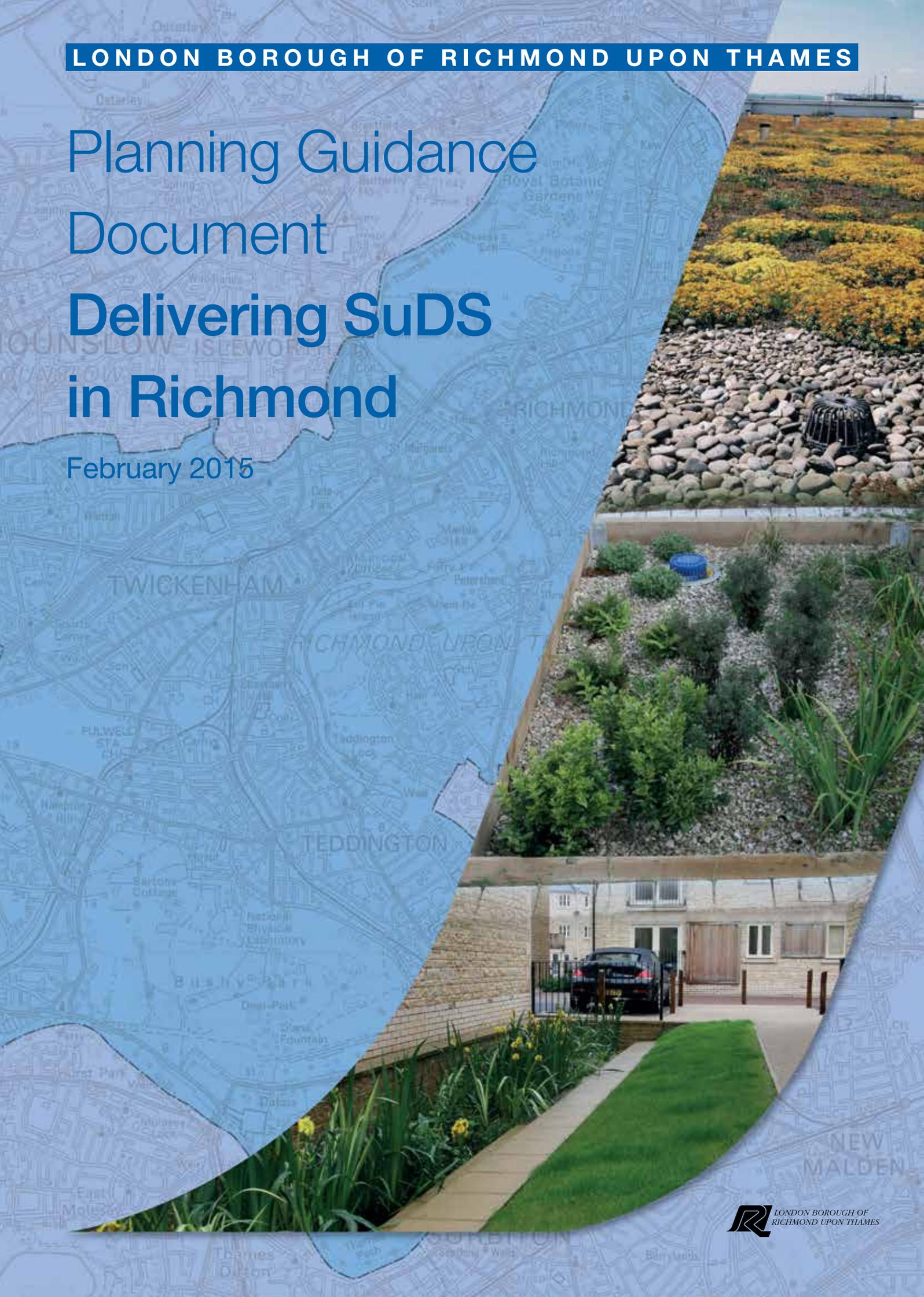


Planning Guidance Document Delivering SuDS in Richmond

February 2015



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I. CONTEXT (FEBRUARY 2015)

Schedule 3 of the Flood and Water Management Act was intended to make the provision of SuDS within new or refurbished developments a statutory requirement. It also sets out requirements for local authorities to set up SuDS Approval Bodies (SABs) to approve designs and adopt systems. More recently the Department for Environment, Food and Rural Affairs (Defra) and the Department for Communities and Local Government (DCLG) have issued consultation documents that suggest uptake of SuDS may be achieved more effectively by using the existing planning regime rather than SABs.

In response to the consultation on Delivering Sustainable Drainage Systems, DCLG and Defra announced late in 2014 that SuDS should be provided in new developments wherever appropriate. Local planning policies and decisions on planning applications relating to major developments (10 dwellings or more, or the equivalent) should ensure that SuDS for the management of runoff are put in place, unless demonstrated to be inappropriate. In addition, it is proposed that Local Planning Authorities should consult with Lead Local Flood Authorities to satisfy themselves that schemes are robust and will be appropriately maintained. It also says that SuDS should be designed to ensure the maintenance and operation requirements are economically proportionate. A further government consultation on changes to statutory consultee arrangements for planning applications, proposing that the Lead Local Flood Authority may become a statutory consultee on development that has surface water drainage implications, was carried out earlier this year.

Despite the current lack of legislation, this guidance document provides advice on how to incorporate SuDS in a range of developments, from single dwellings to larger scale developments. It supports applicants and developers in implementing the requirements of the adopted Development Management Plan (2011) Policy DM SD 7 Sustainable Drainage.

As at present the exact mechanism that will be used to approve SuDS in new developments is not clear, this document will be reviewed and updated regularly as arrangements for implementing SuDS become formalised.

2 WHAT ARE SuDS?

SuDS is an abbreviation for the term Sustainable Drainage Systems. These are surface water (i.e. rainfall) drainage systems for areas such as roofs, car parks and roads as well as green areas. Up until now surface water has been seen as a problem that has been dealt with by removing it from a site as quickly as possible using pipes buried in the ground. As towns and cities have expanded and as climate changes over time, it has been realised that this causes problems in rivers, streams and even sewers that the water is fed into. The problems include both flooding and environmental issues caused by polluted runoff or from sewage being washed into rivers and streams.

By using SuDS we can see rainwater as a resource rather than a problem and use it to enhance our surroundings and make more pleasant places to live. SuDS is a broad term that describes an approach to surface water management that means managing rainwater (including snow and other precipitation) with the aim of:

- (a) reducing damage from flooding,
- (b) improving water quality,
- (c) protecting and improving the environment,
- (d) protecting health and safety, and
- (e) ensuring the stability and durability of drainage systems.

The SuDS approach can include a variety of different methods used to reduce the amount of rainwater that is discharged from a site and also slows down the water that is discharged. Integral to the delivery of a SuDS scheme is the removal of diffuse pollution contained within runoff. They also tend to be more resilient in terms of dealing with more severe rainfall events; a well designed SuDS scheme could protect your new development from flash flooding better than piped drainage. Finally, most developers will find that using appropriate, well designed SuDS will save them money on construction costs.

3 WHICH TYPES OF SuDS TECHNIQUES SHOULD I USE?

There are many different SuDS techniques which would be used as part of a SuDS scheme. Each site may have different constraints and may require a different combination of methods. The following components have been widely used in the UK and around the world and can be used in combination or on their own (where less treatment is required).

3.1 GREEN ROOFS

Green roofs are a very effective SuDS method where the roof structure is suitable. They are very good at preventing runoff for small frequent rainfall events. Green roofs can be provided with flow controls to manage more extreme rainfall events (e.g. 1 in 100 year).



3.2 PODIUM DECK STORAGE (BLUE ROOFS)

Podium deck storage (blue roofs) is provided on decks where there is sufficient structural capacity. Flow controls are required in the structure to restrict runoff from the storage layer on the roof. They can be covered by pervious surfaces, green roofs, gardens or other public spaces.



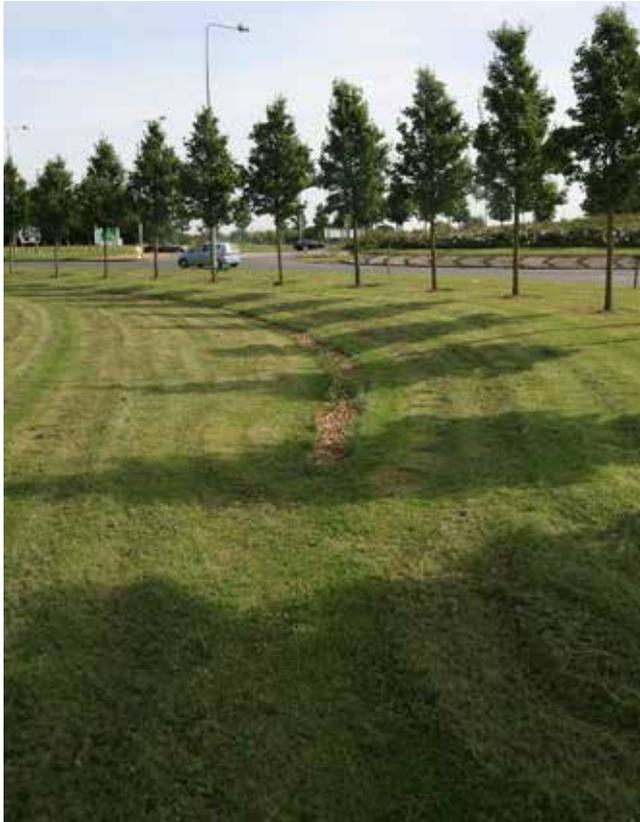
3.3 PERVIOUS PAVEMENTS

This can comprise a range of surfacing materials including concrete block permeable paving, porous asphalt, porous concrete, resin bound gravel, reinforced grass and gravel. The base, sub-base and capping layers (as required) will all be permeable to water and are used to provide storage. The permeable sub-base can be used below impermeable surfaces when the system is referred to as a reservoir pavement or macro pervious pavement. They provide treatment, interception and storage as well as conveyance.



3.4 FILTER DRAINS

Filter drains are gravel filled trenches or trenches with geocellular boxes wrapped in oil retaining geotextiles that collect and treat runoff from an area. Water should flow onto the surface of the filter drain from the edge of the surface being drained.



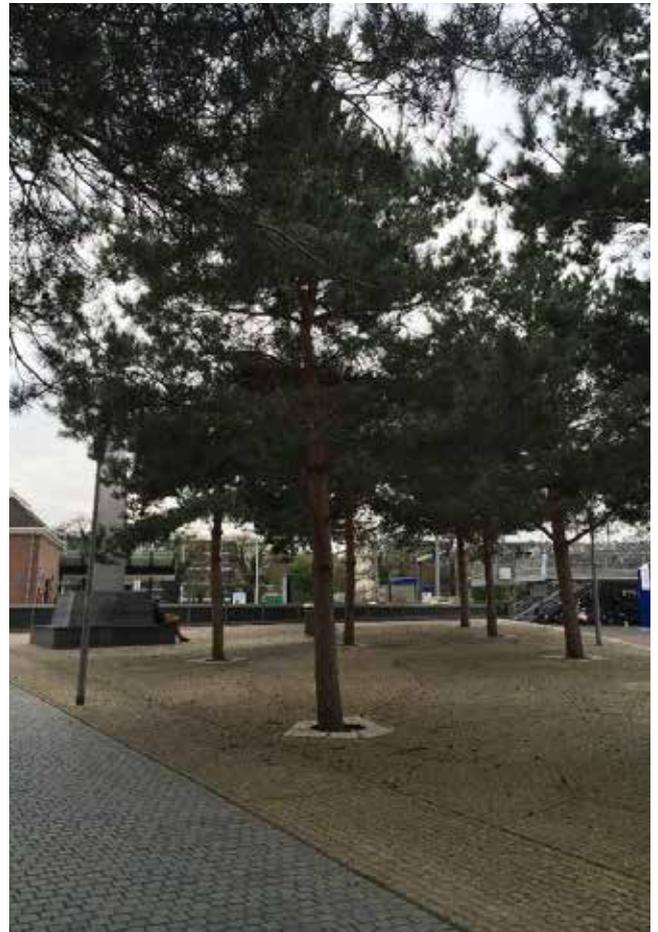
3.5 RAIN GARDENS AND BIORETENTION SYSTEMS

Rain gardens and bioretention systems are shallow planted basins with either an engineered soil in the base or a filter media with under drainage. They provide interception, some storage and treatment.



3.6 TREES

Trees can be used in pits and planters that collect surface water and incorporate storage layers below the tree roots. Using trees as part of SuDS is an effective way of providing amenity and biodiversity in dense urban areas.



3.7 SWALES

Swales are flat bottomed shallow channels that clean and filter water. They convey water across a site but also provide treatment, interception and storage. In urban areas swales can have hard edges (e.g. using kerbs or steps) if appropriate so that they fit into urban spaces.



3.8 PROPRIETARY TREATMENT SYSTEMS

Proprietary treatment systems are often useful in developments with limited green space to provide treatment. They can also be used to improve water quality before discharge to open water features such as ponds. They usually comprise filters or vortex devices to separate out silt and/or remove hydrocarbons. Treatment channel systems are a proprietary source control method using specially adapted channel drains.

The photo shows a filter media contained in a steel basket that has been removed for cleaning. These types of systems require regular cleaning to maintain their performance and manufacturers can provide recommended cleaning intervals.



3.9 BASINS

Basins are open planted areas that are used to occasionally temporarily store water. They are normally dry and would be used for other purposes most of the time (e.g. a picnic area). Basins can allow water to soak into the ground (infiltration basin) or can have a piped or other outfall (detention basin).



3.10 ENGINEERED STORAGE TANKS/ PIPES

Engineered storage tanks/pipes can form part of a SuDS scheme. They should be designed to be as shallow as possible and should not be used below the groundwater table. Tanks and pipes can be made from plastic, concrete or steel. If plastic geocellular tanks are used for attenuation the structural design of the tank and the specification and installation of a robust membrane is vital. Storage tanks do not provide any treatment of runoff and should be combined with appropriate treatment techniques if treatment is required. They will require at a minimum effective silt traps upstream. Further information on the structural design of geocellular tanks is provided on the Susdrain website:

http://www.susdrain.org/files/resources/SuDS_manual_output/paper_rp992_27_geocellular_design_checklist.pdf



3.11 PONDS/WETLANDS

Ponds/wetlands are open water bodies that are used to treat and attenuate surface water. In urban areas they tend to be smaller and decorative to fit in the landscape. Urban parks and open spaces may provide space for ponds and wetlands.



The most appropriate solution will depend on the particular constraints and design parameters of a site. For example on very high density sites, hard landscaping elements will be more suitable when compared with the use of grassed swales and ponds. Usually several different methods are used together to provide an overall scheme within a site. These can be open surface features where the site layout allows or they can be underground engineered or proprietary systems. Often the features can be connected on the surface by open channels, canals or rills, even in urban areas. Equally they will often have to be connected by pipes because of other constraints (e.g. because of pedestrian movements in an area or to take the flow from basins etc. below roads). However the starting point on any site is to consider the use of open surface or near surface features that provide source control.

The reasons for this are:

1. Open surface features are usually cheaper to construct;
2. Well designed methods such as permeable paving, swales and bioretention are normally more tolerant of not being maintained than buried systems, although they do require regular maintenance to ensure they continue to look acceptable; and
3. Well designed and maintained surface and landscape features or tree pits provide additional benefits over and above drainage such as visual improvements to the public realm, cooling and biodiversity.

On the other hand there are many examples where successful SuDS use normal piped drainage leading to larger ponds and wetlands around the edge of the site. Providing that the open water features are designed with a forebay to trap pollution at the entry point (prior to water entering the pond), to be visually pleasing, integrated into the landscape and safe, then there is no reason to discount this approach to SuDS. It can however lead to increased maintenance requirements at the forebay to the ponds and wetlands as more silt is likely to reach them. This should be taken account of in the design of inlets. The cost of construction is also likely to be greater as the size of pipes required will be larger than if source control is used and local attenuation provided.

Further detailed information on each of the methods is provided in the 'SuDS Manual' - <http://www.susdrain.org/resources/ciria-guidance.html>

4 MAKING SPACE FOR SuDS?

Developments should be laid out so that there is space to provide SuDS. Most developments will have some provision for landscaping and public open space and these areas can also be used to locate some parts of the SuDS, for example basins. In sites with little space, methods such as pervious surfaces, trees and green roofs can form part of the SuDS approach without additional land take requirements.

Developing the layout should start with a consideration of natural water flow paths across a site and the ground conditions. The layout should try as far as possible (taking account of other constraints and development

requirements) to provide flow paths on the surface to manage surface water.

Water should be allowed to soak into the ground wherever possible if the ground conditions and situation are suitable. The table below shows the most suitable components for use in different parts of various types of development.

An example development layout is shown in Figure 1 and this shows where there are potential opportunities for locating the SuDS system.

Further information is provided in 'Planning for SuDS' - <http://www.susdrain.org/resources/ciria-guidance.html>

		DEVELOPMENT SETTINGS		
		High density	Medium density	Low density
MOST SUITABLE SuDS COMPONENTS	Integrated Buildings	Green/blue roofs Rainwater harvesting	Green roofs Rainwater harvesting	Green roofs Rainwater harvesting
	Streetscape	Pervious surfaces Bioretention Trees	Pervious surfaces Bioretention Trees Swales	Pervious surfaces Bioretention Trees Swales Filter strips
	Public realm and open space	Pervious surfaces Underground storage Rills and channels Hardscape pools Micro-wetlands Bioretention	Ponds and wetlands Basins Bioretention Underground storage	Ponds and wetlands Swales

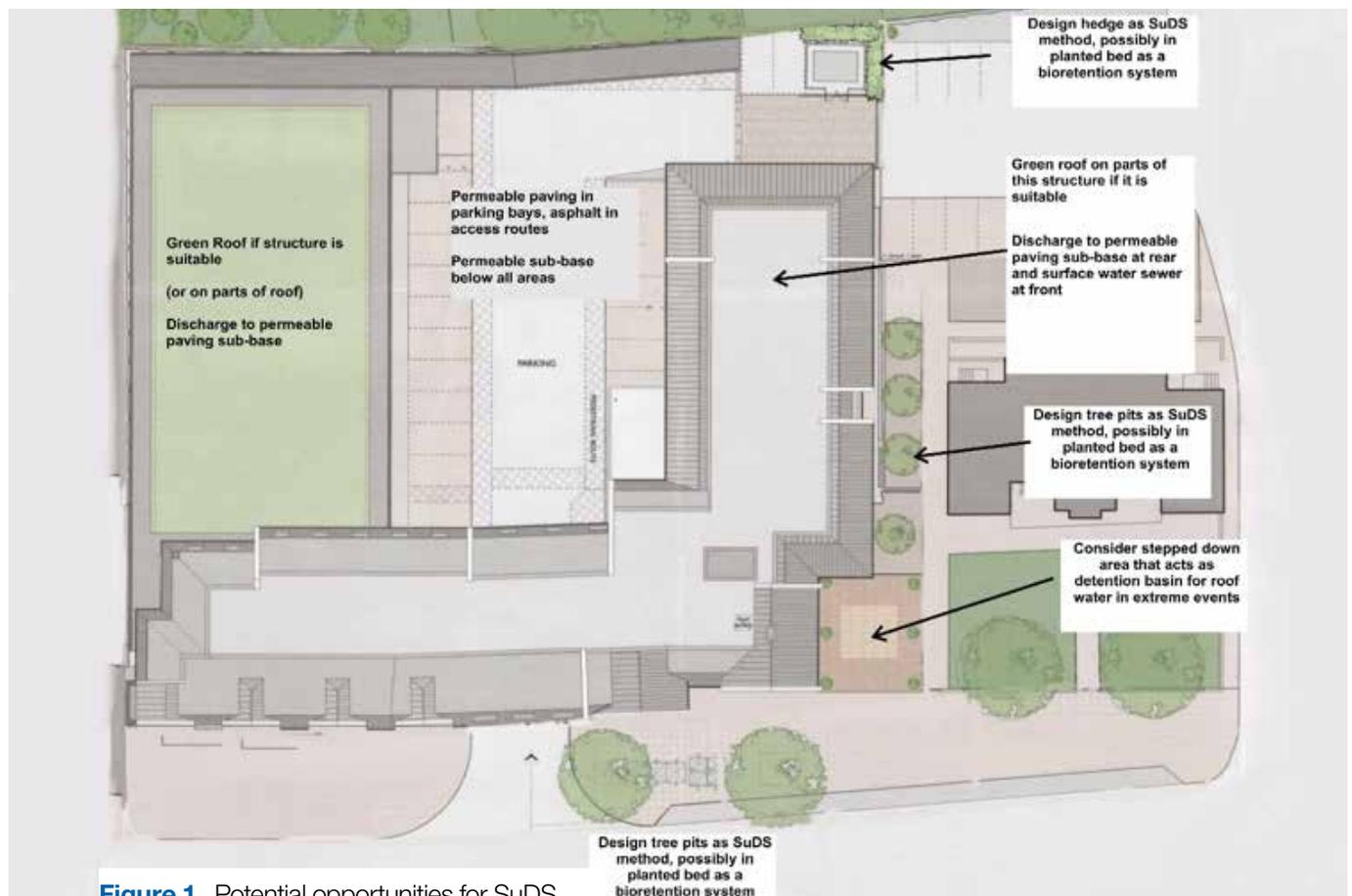


Figure 1. Potential opportunities for SuDS

5 WHY AM I BEING ASKED TO INCLUDE SuDS IN MY PROPOSALS?

The London Borough of Richmond upon Thames has a policy requiring the incorporation of SuDS into development proposals; see policy DM SD 7 - Sustainable Drainage of the adopted Development Management Plan (2011): http://richmond.gov.uk/development_management_plan

POLICY DM SD 7 Sustainable Drainage

All development proposals are required to follow the drainage hierarchy (see below) when disposing of surface water and must utilise Sustainable Drainage Systems (SuDS) wherever practical. Any discharge should be reduced to greenfield run-off rates wherever feasible.

When discharging surface water to a public sewer, developers will be required to provide evidence that capacity exists in the public sewerage network to serve their development.

There are also requirements for SuDS specified in the London Plan. The Flood and Water Management Act 2010 will also make SuDS compulsory for most developments if and when the provisions come into force. However at present Government is reconsidering the provisions of the Flood and Water Management Act; and there is a likelihood that the planning system will be the main means to drive the requirement for SuDS in the future.

Recent flooding events in the borough, particularly the event in the summer of 2007, have shown that the area is very susceptible to surface water flooding. The wider use of SuDS will lead to a steady reduction in the overall amount of rainfall being discharged to the drainage system and reduce

the borough's susceptibility to surface water flooding. It may also minimise the risk of flooding from surface water sewers within new developments.

The Council's Strategic Flood Risk Assessment http://www.richmond.gov.uk/flood_risk_assessment has identified that reducing the rate of discharge from development sites to greenfield runoff rates is one of the most effective ways of reducing and managing flood risk within the borough. This will be part of the SuDS design, along with a number of other considerations such as preventing any discharge of surface water from a site for the majority of rainfall events up to 5mm depth and treating pollution in runoff.

6 WHAT DO I NEED TO DO?

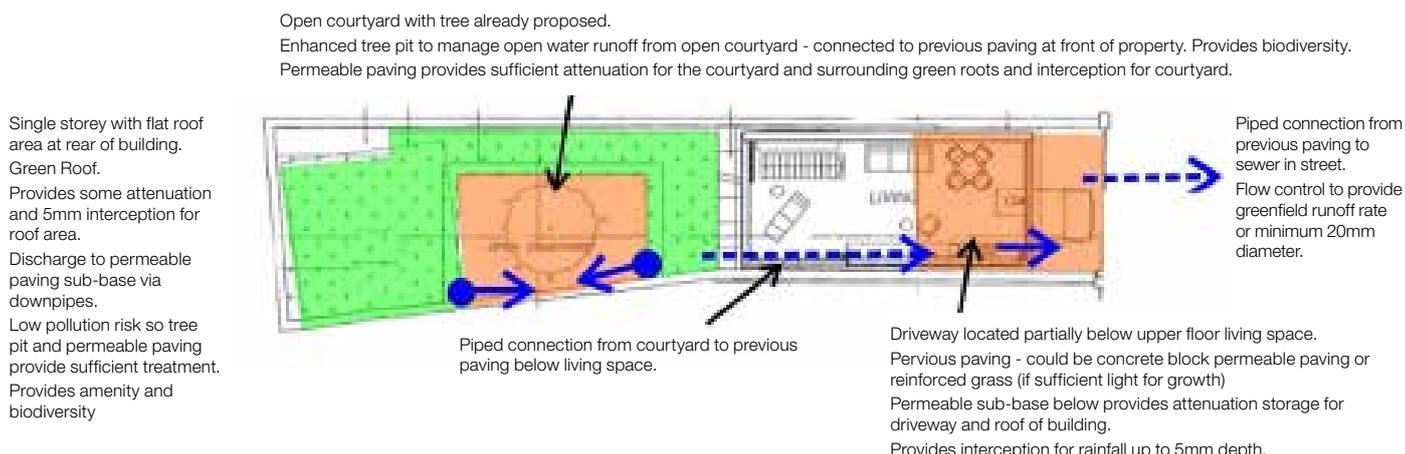
6.1 PRE-APPLICATION DISCUSSIONS

To get the best SuDS for your site and avoid wasted time it is best to have pre-application discussions with the Planning Officers at LBRuT. To get the most from the pre-application discussions, a conceptual design should be submitted to the Council prior to the meeting. Once the conceptual design is agreed with LBRuT, then further work can be undertaken to develop it into an outline design for the planning application.

An example of a conceptual design is shown below in Figure 2. This may need the help of an engineer, landscape architect or planner to help plan the layout of the development to accommodate SuDS but for most small developments it should not take a lot of time to prepare. If space for SuDS is planned in early on it is easy to fit a suitable and cost effective scheme into all developments. The later that SuDS design starts, the harder it is to fit in SuDS and the costs will increase.

See the following pages for details of the information required for pre-application discussions.

Figure 2. Example of a conceptual design diagram for a small development



Note: In general terms the infilled, worked and made Ground may not be suitable for infiltration drainage. A thorough site investigation and geotechnical assessment would be required to determine if these areas are suitable or not. The Gravel formations and Members will often be suitable for infiltration. The Alluvium, Head, Langley Silt Member, Claygate Member and London Clay Formation are unlikely to be suitable for infiltration drainage due to the clay content of the soils.

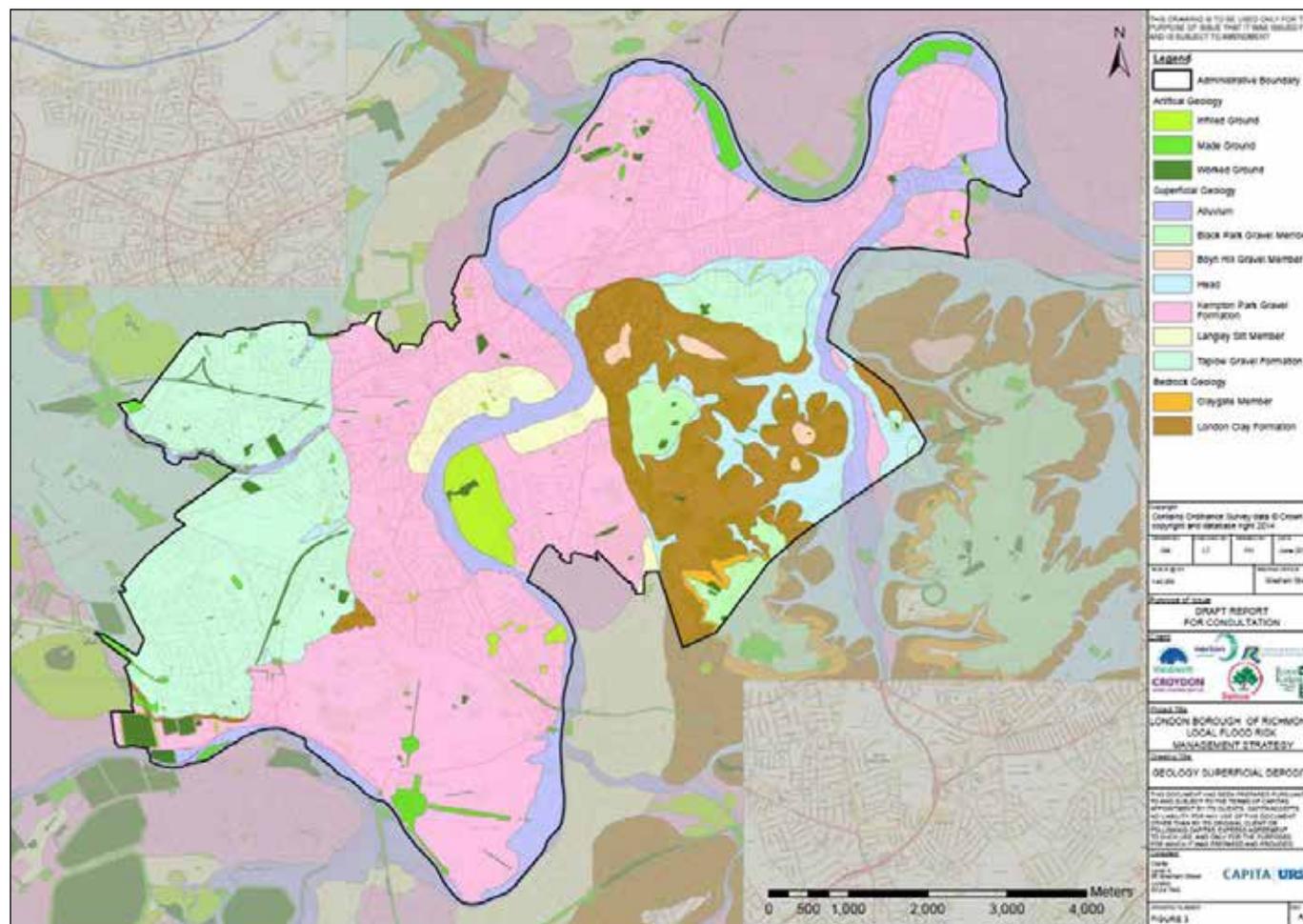


Figure 3 Geology of the London Borough of Richmond

The following information should be submitted for the pre-application discussion:

1. A site layout with SuDS conceptual design showing the individual components and how they are likely to be connected together. This should be in the form of a diagram rather than an engineering or landscape drawing. An example is shown in Figure 2;
2. Description of likely geology below the site. This can be obtained from a geological map, which can be viewed freely online at the British Geological Survey website www.bgs.ac.uk. A preliminary indication of the geology is also provided on the map in Figure 3. There is no need at this stage for a site investigation, although if you have one this will be extremely useful to assess if infiltration will be suitable (often a site investigation will be required anyway to check for contamination or for foundation design);
3. Description of existing topography of the site and natural or existing surface water drainage flows;
4. The proposed destination for the surface water. The draft National SuDS Standards, London Plan, Building Regulations and the SuDS Manual all specify the following drainage hierarchy should be followed:
 - store rainwater for later use;
 - use infiltration techniques in suitable areas;
 - provide attenuation with discharge to a watercourse;
 - provide attenuation with discharge to a surface water sewer (drain);
 - provide attenuation with discharge to the combined sewer (drain).

Note: If discharging surface water to a public sewer, developers will be required to provide evidence with the application that capacity exists in the public sewerage network to serve their development in the form of written confirmation. The formal confirmation is not required at pre-application stage, but it is worth considering at this point whether capacity issues may be a problem. See policy DM SD 10 of the LBRuT Development Management Plan: http://richmond.gov.uk/development_management_plan

5. An explanation of how the proposed SuDS will provide:

- Interception (no runoff from site for majority of rainfall events up to 5mm);
- Attenuation to greenfield runoff rates;
- Long term storage;
- Treatment;
- Amenity and Biodiversity - On some sites the constraints may mean that there is little potential to provide large open surface water features or basins. In these cases consider using tree pits and rain gardens to provide amenity and biodiversity.

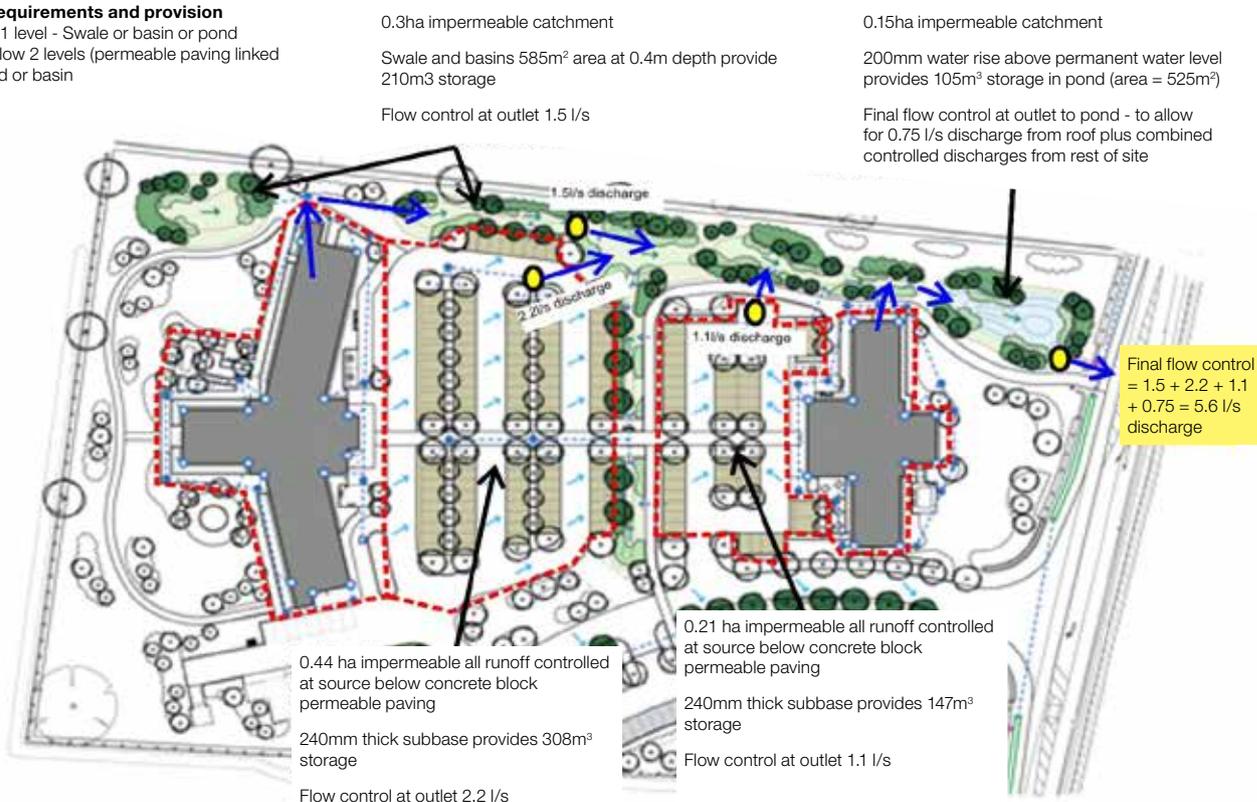
Figure 4 – storage in sub-catchments (SuDS Outline by Illman Young)

Hydraulic requirements

Estimated storage required = 0.07m³/m² for 1 in 100 year event + climate change
 Estimated discharge allowed - 5 l/s/ha = 5 x 10⁻⁴ l/m²

Treatment requirements and provision

Roofs - allow 1 level - Swale or basin or pond
 Car parks - allow 2 levels (permeable paving linked to swale, pond or basin)



Note: For small sites the explanation can be included in the SuDS diagram.

The satisfactory performance of SuDS depends not only on good design but also adequate maintenance, and provision for adoption and maintenance should be considered at the conceptual design stage. The developer and the Council will agree who will adopt the SuDS scheme and be responsible for the on-going maintenance.

6.2 PLANNING APPLICATION

For a planning application the following information should be submitted along with a completed application checklist (See Appendix 1):

1. A diagram of the proposed scheme showing the outline design of SuDS for the site. This should show where areas drain to, the flow routes for water through the system, where water will be stored and the volume of storage provided for the design rainfall event, the location, capacity and details of flow controls and the discharge point. Exceedance routes should also be indicated or explained. An example is provided in Figure 4.

Note: The flow controls in the diagram are sized to deal only with the impermeable areas. Where larger areas of landscaping are draining into the system the outflow allowance at the flow controls and the size of the any conveyance features should be increased to allow for runoff from these areas in larger rainfall events.

2. Description of likely geology below the site as described below;
3. Description of existing topography of the site and natural or existing surface water drainage flows and how these have been allowed for in the design;
4. The proposed destination for the surface water as below;
5. If discharging surface water to a public sewer, developers will be required to provide evidence with the application that capacity exists in the public sewerage network to serve their development in the form of written confirmation. If discharging to infiltration then the developer will need to provide evidence that the site is suitable. This will require a site investigation including infiltration tests (see the 'SuDS Manual');
6. Landscaping plans for any open surface features showing how they are integrated into the overall landscape design for the development;
7. Health and safety checklist for the scheme (see Susdrain website);
8. Demonstrate how interception losses are provided through the provision of SuDS techniques, which absorb water or allow small volumes to soak into

the ground. This means that there should be no runoff for the majority of rainfall events up to 5mm depth (i.e. around 50% of all rainfall events). This is achieved by using systems that allow water to soak into the ground, soil or stone layers and allowing for evapotranspiration. Interception losses occur in the top parts of the system or only require low infiltration rates in the soil below, and therefore can be provided even if the ground is not suitable for full infiltration. This is only a small volume of water so is achievable on most if not all sites in Richmond.

9. Supporting calculations to demonstrate the system has sufficient capacity. The calculations should be accompanied by a summary as shown in the table below. This can be included on the diagram of the scheme;
10. Supporting justification for the treatment provision within the system (see the 'SuDS Manual');
11. Explanation of the amenity and biodiversity provision within the system and the basis for the design of these aspects. Whilst these are one of the benefits of SuDS, they may not be provided on all smaller developments (especially single houses). However, providing these aspects can create much more pleasant places to live as shown in the example in Figure 4;

Discharge rate for the site	l/s/ha drained area (note drained area may include landscaped areas if they are likely to contribute significant flows during larger rainfall events).
Storage required for the site	m ³ /m ² of drained area and the return period this relates to. Normally flows should remain in the drainage system up to the 1 in 30 year event and should be held on site for the 1 in 100 year event plus an allowance for climate change.
Sub-catchment	Provide cross reference to diagram of outline design
Drained area (m²)	Surface area
Sub-catchment Use	Land use of area being drained (e.g. car park for residential area)
Treatment required	What are the pollution hazard indices for the sub-catchment
Treatment provided	Demonstrate that the proposed system mitigation indices exceed the required pollution hazard indices in accordance with the SuDS Manual– cross reference to sketch diagram.
Storage required	Volume of storage required in the sub-catchment
Storage provided	Volume of storage provided for the sub-catchment and location
Flow control and discharge rate	Type of flow control and design discharge rate
Interception provision	How has interception been provided and for what rainfall depth?

12. Explanation of the maintenance requirements for the system (what to do and the frequency) along with an indication of how lack of maintenance affects the performance of the system (hydraulic and water quality). Indication of the likely annual cost of maintenance.
13. The checklist in Appendix 1 should be completed to accompany the application.

The information listed above sets out the drainage strategy for a site and demonstrates how the SuDS will help mitigate the impact of a development on certain types of flood risk within the site and elsewhere. Flood Risk Assessments cover a wider range of issues including flooding from rivers into a site, groundwater flooding etc. but also include consideration of the impact of a development on flood risk elsewhere. The information listed can be provided as part of the drainage impact assessment within an overall Flood Risk Assessment.

There is also a policy requirement for a flood risk / surface water assessment in Flood Zone 1 (i.e. low risk of river flooding – see the Council’s SFRA), where there has been evidence of a risk from flooding from local sources such as smaller streams or sewers. In some instances it may be acceptable for such a development to propose SuDS to mitigate the potential impacts of flooding if this is feasible.

Note: If the provision of the Flood and Water Management Act 2010 comes into force, it is likely that it will be a statutory requirement to submit a full detailed surface water design. This may require additional information to that required for current planning applications.

The submission will be assessed against the attached checklist.

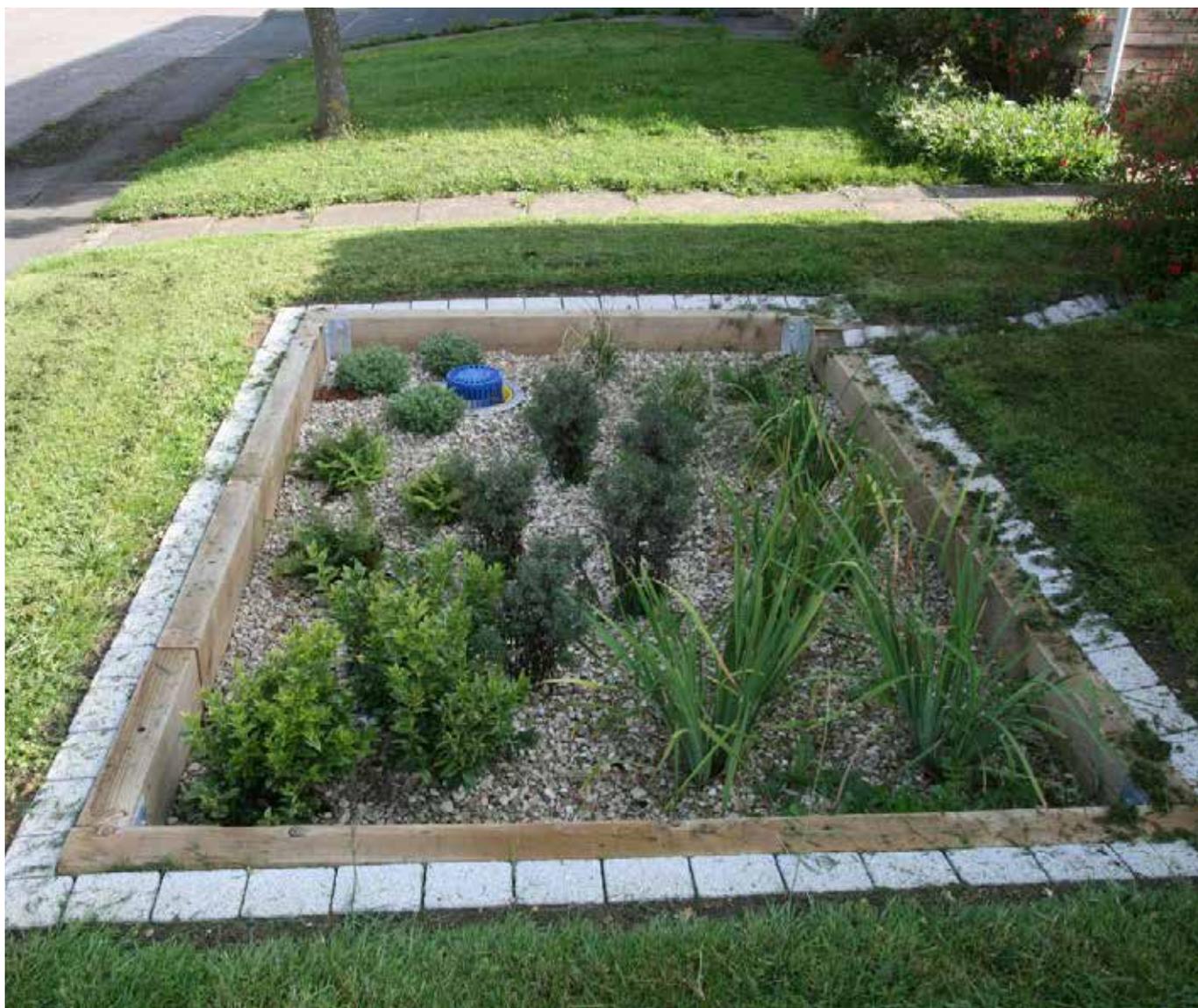


Figure 5 Amenity provision using a rain garden to a single property

6.3 HOW DO I DESIGN SuDS FOR MY SITE?

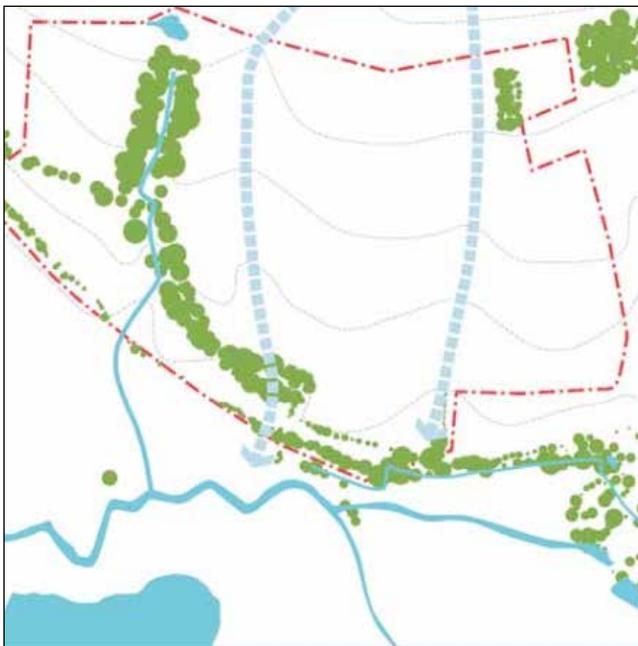
All site requirements should be considered at concept stage including requirements for drainage. The site arrangement should consider flows paths. Properly designed SuDS should not require additional space, as any green spaces should be located such that they can provide a dual drainage / attenuation function. Where all parts of the site are impermeable the implementation of green roofs, pervious pavements or proprietary systems (with additional underground storage where required) will not require additional green space requirements.

Sustainable drainage is integral to a development scheme and not an 'add-on'. Because of this the SuDS design team for larger sites should include engineers working

with master planners. Smaller sites may be designed by an engineer working with the landscape architect or architect.

There are numerous different ways that SuDS can be incorporated into a development. The appropriate application of a SuDS scheme to a specific development is heavily dependent upon the layout, topography and geology of the site and its surroundings. The developer should use and follow the guidance provided by CIRIA for design criteria, technical feasibility and to ensure the future sustainability of the drainage system. The Environment Agency may also be able to provide advice for larger development sites.

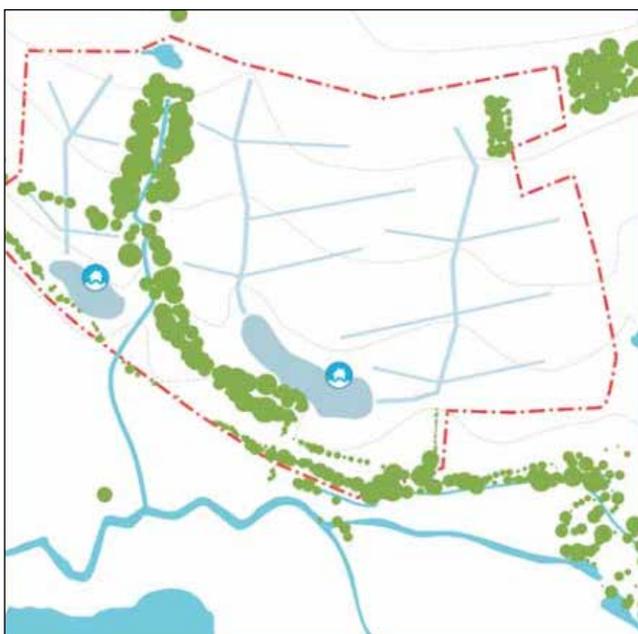
The following process is taken from 'Planning for SuDS' by CIRIA and is a useful process even on small sites, although some aspects such as clustering land uses will not be relevant to small sites.



KEY			
	Site boundary		Local flood risk management
	Contours		Multifunctional benefit
	Natural Flow path		Biodiversity & habitat benefit
	SuDS network		SuDS treatment feature
	Attenuation feature (soft landscape)		Residential/mixed uses
	Attenuation feature (hard landscape)		Industrial uses
	Public green space		Streets

Examine site topography and geology

Aim to mimic the natural drainage systems and processes as far as possible. Identify key natural flow paths, existing water bodies and potential infiltration areas to understand opportunities



Create a spatial framework for SuDS

Minimise runoff by rationalising large paved areas and maximising permeable surfaces. Consider likely space needs for site control SuDS based on character of development and the proposed degree of source control. Use flow paths and possible infiltration or storage areas to inform development layout.



KEY			
	Site boundary		Local flood risk management
	Contours		Multifunctional benefit
	Natural Flow path		Biodiversity & habitat benefit
	SuDS network		SuDS treatment feature
	Attenuation feature (soft landscape)		Residential/mixed uses
	Attenuation feature (hard landscape)		Industrial uses
	Public green space		Streets

Look for multifunctional spaces

Consider how SuDS features could be co-located with open space and public realm areas to create multifunctional spaces. SuDS can be designed to be valuable amenity and ecological features.



Integrate the street network with SuDS

Structure the street network to complement and manage flow pathways. Integrate SuDS features into street cross-sections, ensuring street widths are adequate. SuDS should be used to improve the streetscape providing amenity and multifunctionality by integrating with other street features including tree planting, traffic calming, parking bays, verges and central reservations.



Cluster land uses to manage pollution

The number, size and type of SuDS will be affected by land uses and the corresponding pollution risk. Potential polluters, eg industrial developments, should have their own isolated SuDS network. Integrate a series of SuDS features that will provide water treatment throughout the networks, responding to the level of pollution risk. Clustering should be considered alongside other mixed use ambitions.

Some important considerations for design are provided hereafter.

7 IMPORTANT CONSIDERATIONS FOR DESIGN

Surface SuDS features such as bioretention, basins etc. should be designed so that they are attractive, unobtrusive and safe as well as functioning correctly. Therefore, be sure the design team includes both a landscape architect and an engineer who work together. The engineering aspect is particularly important and the engineering aspects of the overall design should be approved by a suitably qualified and experienced engineer (e.g. pavement design, infiltration design, materials specification etc.). Similarly the planting and landscape design should be approved by an appropriately qualified and experienced landscape architect.

Landscaped areas and public open space can be multifunctional and can include a drainage function as well as being used for play, recreation or visual pleasure. An example of an open space that is also a detention basin is shown below in Figure 6. The basin is normally dry and only occasionally fills with water during extremely wet weather. It empties in a relatively short time afterwards so it can be used as an open space again.

Basins, ponds and wetlands that are directly accessible within a housing development should have shallow water depths. Deeper lakes may be suitable in larger open space around the edges of a development that are not directly accessible from houses (for example in a park

area). All water features should be designed with health and safety in mind. Health and safety advice is provided at http://www.susdrain.org/files/resources/SuDS_manual_output/paper_rp992_17_health_and_safety_principles.pdf including a checklist to help assess the health and safety of a design. The key considerations are that water features have shallow slopes and should be integrated into the landscape design with attractiveness in mind.

7.1 GEOLOGY

The geology in Richmond is shown in Figure 3. Much of the borough is underlain by the terrace gravels of the River Thames and will be suitable for infiltration. In the areas where clay soils are predominant close to the surface infiltration is not likely to be suitable and an outfall to a surface water feature or sewer will be required. Infiltration requires careful assessment on brownfield sites to make sure it does not mobilise contaminants that may be present. It also needs careful consideration on steeply sloping sites (e.g. Richmond Hill).

7.2 CONTROLLING FLOWS AND VOLUMES

Greenfield run-off is the surface water drainage regime from a site prior to development. To maintain the natural equilibrium of a site, the surface water discharge from a developed site should not exceed the natural greenfield run-off rate. Advice on allowable discharge rates to watercourses for sites or on the design criteria, technical feasibility and future sustainability of the drainage system can be found on the Susdrain website (www.susdrain.org).



Figure 6 Multi functional landscape space – attenuation basin



Figure 7 Example protected orifice flow controls with removable screen box (for cleaning) and with removable weir plate and perforated debris guard (for cleaning)

The rate of water flowing out of the drainage systems is restricted using a flow control. The most effective type of flow control for most sites is an orifice plate (a small circular hole in a plate or other structure over the end of the pipe). Orifice plates replicate more closely the flow from a greenfield site over a range of water depths and are therefore more suitable than other types of flow control. They are also significantly cheaper. Small sites and sub-catchments will require quite small diameters and so the flow control should be designed to prevent blockage by using a protected orifice. Typical examples are provided in Figure 7.

Typical greenfield runoff rates for Richmond will be between about 1.5l/s/ha and 5l/s/ha for a 1 in 1 year event and 5l/s/ha and 16l/s/ha for a 1 in 100 year event. The lower values are for areas underlain by gravel deposits and the higher ones in areas with clay. For smaller sites these rates may not be achievable because the minimum acceptable orifice size is 20mm (if protected from blockage) which means that at 16l/s/ha the minimum area to be drained via a single flow control will be 350m².

Typical storage volumes required in Richmond for SuDS discharging to surface waters are as provided in the table.

Return period	Greenfield runoff rate	Storage volume required
Clay site		
1 year	5 l/s/ha	0.012 m ³ /m ² of impermeable catchment
30 year	12 l/s/ha	0.027 m ³ /m ² of impermeable catchment
100 year + climate change allowance (CCA for storage only)	16 l/s/ha	0.05 m ³ /m ² of impermeable catchment
Sandy site	Note infiltration is preferred on sandy soils if site is suitable. If site is not suitable for infiltration then it might be possible to consider an attenuation design based on a higher greenfield runoff rate. This would be justified on a site by site basis	
1 year	1 l/s/ha	0.023 m ³ /m ² of impermeable catchment (note half emptying times may be more than 24 hours and the storage may need to be increased to compensate)
30 year	4 l/s/ha	0.039 m ³ /m ² of impermeable catchment
100 year+ climate change allowance (CCA for storage only)	5 l/s/ha	0.07 m ³ /m ² of impermeable catchment

Note:

1. The greenfield runoff rates assume that flow controls and attention volumes will be designed to provide long term storage will be provided – see the 'SuDS Manual' for details.
2. Greenfield runoff rate from landscaped and impermeable areas should be taken into account in sizing flow controls if the landscaped areas are likely to contribute significant flows to the drainage system during more extreme events.

The values provided in the table are for preliminary design. The designer of the SuDS should ensure that they are applicable to their site and the services of a Civil Engineer will be required to confirm the hydraulic capacity of the system.

7.3 TREATMENT OF DIFFUSE POLLUTION USING SUDS

Source control is an important part of SuDS and helps provide more effective treatment and performance than systems without it. It also helps provide interception, which is a real benefit in reducing overloading of existing sewers. Designs using source control tend to be more cost effective as shown by a DEFRA report on the costs of SuDS, which can be downloaded on the Susdrain website: <http://www.susdrain.org/resources/evidence.html>

SuDS should provide an adequate level of treatment of pollution. Design to provide sufficient treatment should follow the guidance in the 'SuDS Manual'. Normally for most small residential sites of one or two houses the use of permeable paving, tree pits or bioretention systems will provide sufficient treatment. On larger sites a management train will be necessary, which comprises 2 or 3 different components that lead from one to the other. Runoff from roofs does not require any treatment apart from a trap to remove litter and large solids.

7.4 AMENITY AND BIODIVERSITY

Amenity and biodiversity should inform a SuDS design where appropriate. This can be achieved on many schemes with a little thought and helps provide more pleasant places to live. The simplest way of achieving this in urban settings is to provide trees that are part of the SuDS. It can also increase the value of a development if designed and maintained in an appropriate manner. An example of attractive water features integrated into a design for purely decorative purposes is shown in Figure 8.

7.5 FLOODPLAINS

On some sites, the floodplain might be the only available public open space. Attenuation of runoff in these cases should be integral to the scheme and provided outside the floodplain where possible. During extreme rainfall these flood plain areas will naturally flood, making them ineffective for use in storing surface water runoff at that time. The presence of a floodplain, however, should not stop the site from including SuDS, as they could still be effective in managing day to day rainfall and runoff may need to be discharged safely across the floodplain.



Figure 8 SuDS in an urban site

8 BASEMENTS

Developments may have basements or sub-basements (e.g. for habitable purposes or car parks etc.) and buildings may cover the whole footprint of the site. SuDS storage and treatment (if required) can be provided by using green roofs, pervious surfaces or other treatment systems along with a storage layer on the podium deck (known as blue roofs).

Basement extensions are also common in residential properties. Providing they are designed with consideration of the site conditions, basement extensions should not have any significant impact on local flood risk. Basement extensions below gardens should be provided with 1 metre of soil over them, along with either vegetation or pervious surface construction, which will prevent any runoff for most frequent rainfall events. This is one of the fundamental requirements of a sustainable drainage system in accordance with the SuDS Manual (known as interception). It is easy to provide the roof with an effective sustainable drainage system that can manage more extreme events in accordance with the SuDS Manual and the current draft of the National Standards for Sustainable Drainage Systems.

An example of how SuDS might be provided is shown in Figure 10.

Provision of a pumped outfall from the basement will provide adequate mitigation against flooding from sewers into basements. The design of basements should take account of other forms of flooding such as from over topping of river walls. This can be achieved for example by maintaining threshold levels at a level that minimizes the risk of flood water entry.

9 FURTHER INFORMATION

Further information on SuDS design including links to many of the documents referred to in this guide can be obtained from www.susdrain.org. This site also provides up-to-date news relating to SuDS and case studies showing various examples of sites where SuDS have been used successfully.

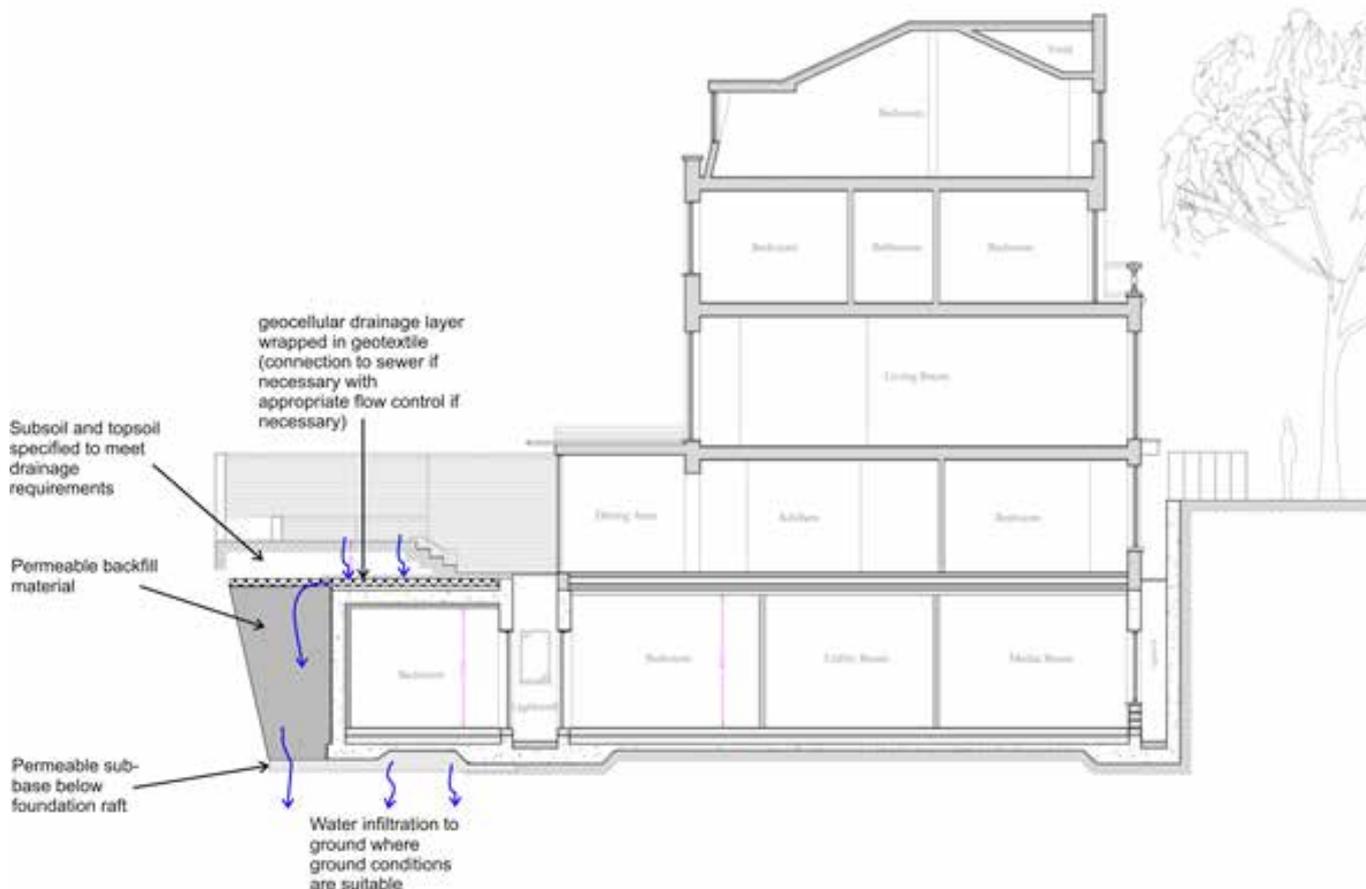


Figure 10 Example layout of an infiltration blanket for basement roof runoff

IO GLOSSARY

Amenity – The quality of being pleasant or attractive; agreeableness. A feature that increases attractiveness or value, especially of a piece of real estate or a geographic location

Attenuation storage – Volume used to store runoff during extreme rainfall events. Comes into use once the inflow is greater than the controlled outflow.

Biodiversity – The diversity of plant and animal life in a particular habitat

Brownfield site – A site that has been previously developed.

Catchment – The area contributing surface water flow to a point on a drainage or river system. Can be divided into sub-catchments.

Combined sewer – A sewer designed to carry foul sewage and surface runoff in the same pipe.

Control structure – Structure to control the volume or rate of flow of water through or over it.

Conventional drainage – The traditional method of draining surface water using subsurface pipes and storage tanks.

Conveyance – Movement of water from one location to another.

Diffuse pollution – Pollution arising from land-use activities (urban and rural) that are dispersed across a catchment, or sub-catchment, and do not arise as a process effluent, municipal sewage effluent, or an effluent discharge from farm buildings.

Environment – Both the natural environment (air, land, water resources, plant, and animal life) and the habitats in which they live.

Evapotranspiration – The process by which the Earth's surface or soil loses moisture by evaporation of water and by uptake and then transpiration from plants.

Filtration – The act of removing sediment or other particles from a fluid by passing it through a filter.

Flood plain – Land adjacent to a watercourse that would be subject to repeated flooding under natural conditions. (see Environment Agency's Policy and practice for the protection of flood plains for a fuller definition).

Flow control – A device used for the control of surface water from an attenuation facility, e.g. a weir.

Forebay – A small basin or pond upstream of the main drainage component with the function of trapping sediment.

Foul drainage – The infrastructure that drains the water and sewage that is discharged from within houses.

Geotextile – A plastic fabric that is permeable.

Greenfield runoff – The surface water runoff regime from a site before development, or the existing site conditions for brownfield redevelopment sites.

Groundwater – Water that is below the surface of ground in the saturation zone.

Impermeable – Will not allow water to pass through it.

Impermeable surface – An artificial non-porous surface that generates a surface water runoff after rainfall.

Infiltration (to the ground) – The passage of surface water into the ground.

Interception – The capture and infiltration or evaporation of a depth of rainfall (typically 5mm). This is required for the majority, and not all, rainfall events.

Joint probability – The probability that two or more specific outcomes will occur in an event

Long term storage – Provided to allow volumetric runoff control during an event by discharging water very slowly during and after the storm event.

Management train – The management of runoff in stages as it drains from a site.

Orifice plate – Structure with a fixed aperture to control the flow of water.

Pavement – The road or car park surface and underlying structure, usually asphalt, concrete, or blockpaving. Note: the path next to the road for pedestrians (the UK colloquial term of pavement) is the footway.

Pervious surface – A surface that allows inflow of rainwater into the underlying construction or soil.

Piped system – Conduits generally located below ground to conduct water to a suitable location for treatment and/or disposal.

Pollution – A change in the physical, chemical, radiological, or biological quality of a resource (air, water or land) caused by man or man's activities that is injurious to existing, intended, or potential uses of the resource.

Public sewer – A sewer that is vested and maintained by the sewerage undertaker.

Rainfall event – A single occurrence of rainfall before and after which there is a dry period that is sufficient to allow its effect on the drainage system to be defined.

Rainwater butt – Small scale garden water storage device which collects rainwater from the roof via the drainpipe.

Return period – Refers to how often an event occurs.

A 100-year storm refers to the storm that occurs on average once every hundred years. In other words, its annual probability of exceedance is 1 per cent (1/100). A 500-year storm is the storm expected to occur once every 500 years, or has an annual probability of exceedance equal to 0.2 per cent (1/500).

Risk – The chance of an adverse event. The impact of a risk is the combination of the probability of that potential hazard being realised, the severity of the outcome if it is, and the numbers of people exposed to the hazard.

Risk assessment – "A carefully considered judgement" requiring an evaluation of the consequences that may arise from the hazards identified, combining the various factors contributing to the risk and then evaluating their significance.

Runoff – Water flow over the ground surface to the drainage system. This occurs if the ground is impermeable, is saturated or rainfall is particularly intense.

Source control – The control of runoff at or near its source.

Sub-catchment – A division of a catchment, to allow runoff to be managed as near to the source as is reasonable.

Treatment – Improving the quality of water by physical, chemical and/or biological means.

Watercourse – A term including all rivers, streams, ditches, drains, cuts, culverts, dykes, sluices, and passages through which water flows.

Water table (or groundwater table) – The point where the surface of groundwater can be detected. The water table may change with the seasons and the annual rainfall.

APPENDIX I:

DESIGN ASSESSMENT CHECKLIST: SCHEME

Table 1: Scheme Design Assessment Checklist

Requirements			
Site ID			
Site Location and co-ordinates			
Site description		Drawing Reference(s)	
Date of assessment		Specification Reference	
Type of development		Site Area	

	SuDS Manual Page Ref*	Y	N	Summary of details	Comments / Remedial actions
PRINCIPLES					
Is the runoff managed at or close to its source, wherever possible? If not, give reasons.					
Is the runoff managed at or close to the surface, wherever possible? If not, give reasons e.g. infiltration systems are being used to manage the runoff.					
Where the drainage system serves more than one property, is public space used and integrated with the drainage system in an appropriate and beneficial way? If not, give reasons.					
Have the opportunities afforded by the drainage system in terms of green infrastructure, biodiversity, urban design, climate adaptation and amenity provision been maximised?					
Has an appropriate SuDS Management train been provided?					
Are the operating and maintenance requirements of the drainage system adequately defined?					
Is operation and maintenance achievable at an acceptable cost?					
POINT OF DISCHARGE					
Does the design meet the following discharge hierarchy 1. Infiltration is preferred where it is safe and acceptable to do so; 2. If infiltration is not possible discharge to water course; 3. Discharge to sewer as last resort.					
If infiltration is used: Confirm that an acceptable infiltration assessment has been undertaken and submitted?					

	SuDS Manual Page Ref*	Y	N	Summary of details	Comments / Remedial actions
If discharge is to sewer, rather than a surface water body, provide justification.					
If discharge to a sewerage asset is proposed, has evidence been provided that the design criteria have been agreed with the sewerage undertaker and that an appropriate connection detail has been agreed?					
Have adequate and appropriate exceedance routes been provided and are they protected from future development?					
INTERCEPTION					
Does the scheme design demonstrate on-site retention of approximately the first 5mm of runoff from impermeable surfaces for most events? How is Interception to be delivered (e.g. infiltration, green roofs, permeable pavements, vegetated surfaces, bespoke design - provide details)?					
PEAK FLOW RATE CONTROL					
Does the design demonstrate control of the 1 year, critical duration site event to the equivalent 1 year greenfield peak flow rate or below?					
Does the design demonstrate control of the 100 year, critical duration site event to the equivalent 100 year greenfield peak flow rate or below?					
Do the design calculations take account of future development (urban creep) and climate change?					
VOLUMETRIC CONTROL (FOR THE 100 YEAR, 6 HOUR EVENT)					
Does the design demonstrate that, for the 100 year 6 hour event: <i>Either:</i> The discharged site runoff volume is not greater than the equivalent greenfield runoff volume? <i>Or:</i> The discharged site runoff volume over and above the equivalent greenfield runoff volume (i.e. the Long Term Storage Volume) is discharged at a rate < 2 l/s/ha (or another rate that is considered acceptable in not negatively impacting flood risk of the receiving water body) <i>Or:</i> Peak flow rates from the site are restricted to 2 l/s/ha or Qbar, whichever is the greater ha (or another rate that is considered acceptable in not negatively impacting flood risk of the receiving water body).					
WATER QUALITY TREATMENT					
Is the receiving water body (surface or groundwater) environmentally sensitive (E.g. Groundwater Source Protection Zone? What is its designation? Are any implications for drainage design clearly defined?					

	SuDS Manual Page Ref*	Y	N	Summary of details	Comments / Remedial actions
<p>Does the design include an appropriate treatment strategy that ensures:</p> <p>1. Sediment is trapped and retained on site in accessible and maintainable areas?</p> <p>2. Has a sufficient number of drainage components been provided in series prior to discharge?</p> <p>3. Suitable pollution removal capability e.g. % TSS removal (where this is a requirement of the SAB)</p>					
FUNCTIONALITY					
Are the design features sufficiently durable to ensure structural integrity over the system design life (residential 100 years and commercial 60 years), with reasonable maintenance requirements?					
Are all parts of the SuDS system outside any areas of flood risk? If not, provide justification and evidence that performance will not be adversely affected.					
Is pumping a requirement for operation of the system? If yes, provide justification and set out operation and maintenance/adoption arrangements.					
Has runoff and flooding from all sources (both on and off site) been considered and taken into account in the design?					
Are 1 in 30 year flows fully conveyed within the SuD system ?					
Are 1 in 100 year flows contained or stored on-site within safe exceedance storage areas and flow paths? Note some approving authorities may require greater return periods.					
CONSTRUCTABILITY					
Has an acceptable construction method statement been submitted and approved?					
MAINTAINABILITY					
Has an acceptable Maintenance Plan been submitted and approved?					
INFORMATION PROVISION					
Do the design proposals include sufficient provision for community engagement and awareness raising?					

(*) to be added on completion of SuDS Manual update

SYSTEM DESIGN ACCEPTABILITY	Summary details including any changes required	Acceptable (Y/N)	Date changes made
Acceptable: Minor changes required: Major changes required / re-design:			

APPENDIX 2:

SUDS RISK ASSESSMENT CHECKLIST

SITE/SYSTEM OVERVIEW	
Site ID	
Asset ID	
Location	
SuDS Component	
Assessment Date	
Date of next assessment	
1. ESTABLISH CONTEXT	
General description of component and its operation	
2. IDENTIFY POTENTIAL HAZARDS	Are hazards present? (Y/N)
Drowning/Falling through ice in winter	If YES complete Section 3
Slips, trips and falls	If YES complete Section 4
Entry into pipes/confined spaces (note this is for inadvertent public access. Follow relevant legislation and guidance for worker access)	If YES complete Section 5
Water quality – health risk	If YES complete Section 6

3. DROWNING OR FALLING THROUGH ICE IN WINTER		
Consider factors that might affect: (a) the likelihood of people entering the water/accessing the ice (b) the potential consequence of entering the water/accessing the ice	Summary of influence of factor on likelihood of entry/access, including justification (Consider for children < 5 years, children > 5 years, adults)	Summary of influence of factor on consequence of entry/access, including justification (Consider for children < 5 years, children > 5 years, adults)
ENVIRONMENTAL FACTORS		
1. Proximity to populated areas: schools, inns, retail/tourism, picnic areas, play areas, car park, roads, especially attractive features likely to be visited		
2. Features allowing/encouraging access (e.g. paths)		
3. Physical accessibility of proposed drainage feature: consider intended use and inadvertent access (including of small children)		
4. Visibility and natural surveillance of proposed drainage features		
BEHAVIOURAL FACTORS		
1. Category and volume of expected users: swimmers; anglers; walkers; drivers; specialist water users; general public; dog walkers, teenagers; accompanied/unaccompanied children		
2. Nature of Development (housing, commercial, industrial, etc.)		
3. Any known existing risks (e.g. records of accidents) posed by water/drainage features at or close to the site?		
DESIGN FACTORS – WATER'S EDGE		
1. Type and nature of water-edge planting		
2. Definition of water edge and nature of ground (e.g. soft/hard)		
3. Natural obstacles, barriers/fencing		
4. Height of edge above water		
5. Gradient and extent of slopes above, at and below water level		

DESIGN FACTORS – WATERBODY		
1. Water depth profile		
2. Water surface area		
3. Clarity		
4. Underwater obstacles or traps		
5. Potential currents, velocities		
6. Potential increase in depth of water and rate of rise		
7. Potential for ice formation and significant depth of water below in winter		
PUBLIC EDUCATION		
1. Signage		
2. Community engagement strategies		
3. Local education strategies (e.g. schools)		
OVERALL ASSESSMENT OF LIKELIHOOD OF ENTRY/ACCESS AND CONSEQUENCES	Likelihood	Consequences
Children <5 years Children >5 years Adults		

SUMMARY OF SECTION 3 RISK ASSESSMENT FOR DROWNING OR FALLING THROUGH ICE						
Group	Likelihood of entry to water	Likely consequence of entry to water	Overall level of risk posed by the design	Additional mitigation measures required	Action Date	Final level of risk
Children <5 years Children >5 years Adults						

4. SLIPS/TRIPS/FALLS		
Factors that might affect likelihood of people slipping/tripping/falling	Summary of influence of factor on likelihood of slip/trip/fall, including justification (Consider for children < 5 years, children > 5 years, adults)	Summary of influence of factor on consequence of slip/trip/fall, including justification (Consider for children < 5 years, children > 5 years, adults)
DESIGN FACTORS - INLETS AND OUTLETS OR CHANNELS		
1. Headwall or channel location		
2. Headwall height or channel depth and width		
3. Slope of headwall or channel profile		
4. Channels – profile and risk of freezing water		
DESIGN FACTORS - SURFACES		
1. Level changes		
2. Surfacing materials		

SUMMARY OF SECTION 4 RISK ASSESSMENT FOR SLIPS/TRIPS/FALLS						
Group	Likelihood of slips/trips/falls/ other injury	Likely consequence of slips/trips/falls/ other injury	Overall level of risk posed by the design	Additional mitigation measures required	Action Date	Final level of risk
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

5. ENTRY INTO PIPES/CONFINED SPACES (Note: This risk assessment covers inadvertent access by the public. Where specific access is required by workers the requirements of relevant health and safety legislation and guidance should be followed.)		
Factors that might affect likelihood of people entering pipes or confined spaces	Summary of influence of factor on likelihood of entry into pipes or confined spaces, including justification (Consider for children < 5 years, children > 5 years, adults)	Summary of influence of factor on consequence of entering pipe or confined space, including justification (Consider for children < 5 years, children > 5 years, adults)
DESIGN FACTORS- INLETS AND OUTLETS		
1. Pipe diameter		
2. Are grilles provided?		
DESIGN FACTORS - CHAMBERS		
1. Depth of chamber		
2. Is access possible?		

SUMMARY OF SECTION 5 RISK ASSESSMENT FOR ENTRY INTO PIPES/CONFINED SPACES						
Group	Likelihood of entry into pipes/ confined spaces	Likely consequence of entry into pipes/ confined spaces	Overall level of risk posed by the design	Additional mitigation measures required	Action Date	Final level of risk
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

6. HEALTH ISSUES		
Factors that might affect likelihood of people suffering from ill health as a result of SuDS water quality	Summary of influence of factor on likelihood of poor health, including justification (Consider for children < 5 years, children > 5 years, adults)	Summary of influence of factor on consequence of resulting ill health, including justification (Consider for children < 5 years, children > 5 years, adults)
POLLUTION TREATMENT STRATEGY		
1. Level of contamination of publically accessible water		
2. Likely contamination from rat urine		
3. Likely contamination from dog/bird fouling		
4. Likelihood of toxic algal blooms		
5. Likelihood of vectors (organism which carries disease-causing microorganisms from one host to another)		
6. Public accessibility to any sediment accumulation zones		
PUBLIC EDUCATION/RISK MANAGEMENT		
1. Signs		
2. Community engagement strategies		
3. Local education strategies (e.g. schools)		
4. Litter management/control		
5. Dog fouling management/control		

SUMMARY OF SECTION 6 RISK ASSESSMENT FOR Health Issues						
Group	Likelihood of entry into pipes/ confined spaces	Likely consequence of entry into pipes/ confined spaces	Overall level of risk posed by the design	Additional mitigation measures required	Action Date	Final level of risk
Children <5 years Children >5 years Adults						

For definition of Levels, see Risk Matrix, Table 2

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