Guide to Sustainable Drainage Products and Services
Introduction

1. This Guide has been prepared by the British Water Sustainable Water Management (SuWM) Focus Group, whose participants are drawn from the designers, manufacturers, practitioners and regulators of contemporary drainage solutions; the logos of the organisations represented on the Focus Group are shown on the last page of this Guide.

Purpose

2. This publication complements the CIRIA SuDS Manual (C753) which can be downloaded on CIRIA’s website; its purpose is to assist users in selecting appropriate proprietary systems to be incorporated into a particular drainage solution. It does so by providing direct links to the suppliers of relevant products and services.

Disclaimer

3. Users of this Guide should note that the provision of these links does not constitute an endorsement or recommendation, either by British Water, or any of the organisations associated with its publication.

4. Guide users are therefore to note the disclaimer provided at Annex-E applies to all aspects of this publication.

Scope

5. This guidance document briefly reviews the context in which consideration needs to be given to sustainable drainage and outlines the principal issues which impact on surface water drainage.

6. It then identifies the various tools and techniques that are used in SuDS systems and links users to suppliers of relevant proprietary products and services.

Context


8. Outlined below are aspects of the context within which SuDS need to be considered.

SuDS Systems

9. The widespread implementation of sustainable drainage systems (also known as “SuDS”) best management practices (BMPs) should be integral to any development’s surface water management strategy. This will provide the platform to replicate the response of the existing catchment and its surfaces, ideally with some betterment, negating any increased on or off-site flood risk.

10. A contemporary sustainable drainage methodology for managing surface water runoff should use the techniques to focus on three key areas, each where applicable; including controlling surface water quantity (reducing off-site flow rates), improving surface water quality and providing added development amenity value, although not always in equal measures.

11. Contemporary sustainable drainage should be a design and implementation combination of natural and proprietary techniques, complemented by traditional drainage techniques where required.

12. SuDS can also play its part in addressing the following water industry challenges:

12.1 Flood Risk Management:

12.1.1 Artificial drainage systems designed to manage surface water runoff can pose a flood risk if the system is overwhelmed.

12.1.2 Current planning policy guidance considers surface water management a key flood risk issue and sustainable drainage techniques should be employed to manage residual flood risk wherever feasible.

12.2 Climate-change Impacts:

12.2.1 Increasing global temperatures and changing weather patterns confirm that climate change is a reality. Therefore, allowances for the impact of climate change are a critical part of any assessment of flood risk and should be included in the design and implementation of sustainable drainage. This would typically be an increase in peak rainfall intensity, but consideration should also be given to security of water supplies.
12.3 The Water Framework Directive:

12.3.1 The EU Water Framework Directive (WFD) is a major opportunity to improve the entire water environment and promote the sustainable management of water for the benefit of people and wildlife alike. The WFD aims to deliver long-term protection of the water environment and improve the quality of all waters bodies to “good status.”

12.3.2 Many of the issues associated with implementation of the WFD are fundamental to contemporary sustainable drainage and proprietary techniques will have a very important role to play. This is particularly significant for many emerging advanced technologies for sustainable drainage, which are aimed at managing, controlling and improving surface water quality.

12.4 Whole-life Issues:

12.4.1 Experience has underscored the importance of fully considering the planning, design and construction phases of sustainable drainage schemes and, when using proprietary products, to ensure that optimum whole life performance is achieved through appropriate material choice, system design and effective maintenance, thus delivering authentic sustainable drainage implementation and longevity.

12.5 Designing for Exceedance:

12.5.1 As a result of extreme rainfall and/or inflows above the design levels, it is inevitable that any drainage system or component will have either its inlet or outlet capacity exceeded at certain times. This is known as an exceedance event and the resultant flood volume will likely begin to move across the ground as overland flow. Consideration should be given to temporary storage on the surface and further analysis should be undertaken to ensure that any exceedance flows can be managed in a sustainable way and not pose a residual flood risk, either on-site or further downstream. Sewers for Adoption and the National Planning Policy technical guidance identify that overland flood pathways should be considered. Further guidance can be found in CIRIA C635 Designing for exceedance and CIRIA C738 Managing urban flooding from heavy rainfall.

13. Control of Water Volume at Source

13.1 Rainwater Harvesting:

13.1.1 Rainwater harvesting is the process of collecting rainwater close to where it falls rather than allowing it to drain away. It includes water that is collected within the boundaries of a property, from roofs and surrounding surfaces. Rainwater recovery may also reduce the demand for treated mains water by re-using the harvested water for activities such as garden watering, toilet flushing and laundry.

13.1.2 The systems comprises a tank (or battery of tanks) which stores the collected rainwater from roof areas ready for use in non-potable applications so reducing the volume of surface water run-off from new developments on both green and brownfield sites.

13.1.3 The design and type of solution required will need to be calculated. The calculations will be based on the surface area for water collection and the project application, i.e. industrial, retail or residential. If for residential use the size of the rainwater harvesting tank or tanks will depend on the number of people per dwelling or building.

13.2 Green and Brown Roof Technology:

13.2.1 Green roofs, also known as living roofs are constructed ecosystems located on top of buildings or structures, contributing to local biodiversity. The growing medium provides limited attenuation for surface water runoff, but the vegetated surface facilities both evapotranspiration and bioremediation.

13.2.2 Brown roofs, also known as biodiversity roofs, are similar to green roofs in benefits and construction methods. However, the overriding aim is to encourage biodiversity, including maximising the number of species (biodiversity) living on the rooftop and/or providing a habitat for a specific species.

14. Infiltration

14.1 Perforated & Porous Pipes:

14.1.1 Where the ground is suitable, porous pipes are installed in the same tried and tested way as conventional gravity drainage and sewer pipe systems and must be suitable for installation under the specified loading conditions. The pipes receive the rainwater collected from roofs, roads, car parks or other drainage surfaces and the water slowly disperses into the surrounding ground.

14.1.2 Under some soil conditions a permeable geotextile wrapped around the pipe may be advisable to prevent silt migration.

14.2 Soakaway Chambers: A subsurface chamber typically of concrete construction, but which, due to the provision of holes or voids in the construction or manufacture, permits surface water to flow from the chamber into the surrounding ground by infiltration.

14.3 Geocellular Systems:

14.3.1 Underground structure comprising a number of geocellular storage units (plastic box-like structures; modular cells) containing voids for the storage of surface water in which each of the geocellular storage units contributes to the load-bearing capacity of the structure. Large volumes of water from roofs, gutters or surface drains can be retained. The modular cells are lightweight, easy to handle and fit together to create a modular underground water tank of any shape and size.

14.3.2 With the use of a silt trap, sediments can be removed before entering the tanks. Some systems provide access for maintenance/cleaning as necessary or are designed to facilitate silt removal.

14.3.3 The modular structure can be wrapped in a permeable membrane allowing the slow release of the water back into the surrounding soil.

14.4 Pre-formed Detention Tanks:

14.4.1 A subsurface construction of various shapes, manufactured from a high-strength material, for the provision of attenuating and storing surface water runoff.

14.4.2 When constructed with a permeable invert, these systems will provide infiltration flows to the below ground.

SuDS Tools & Techniques

Further guidance can be found in CIRIA C635 Designing for exceedance and CIRIA C738 Managing urban flooding from heavy rainfall.

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14.5 Box Culvert Detention Tanks:

14.5.1 A monolithic subsurface reinforced concrete box construction, oversized in terms of dimensions and sometimes length, for the provision of attenuating and storing surface water runoff.
14.5.2 When constructed with a permeable invert, these systems will provide infiltration flows to the below ground.

Find a supplier

15. Proprietary Treatment

15.1 Proprietary treatment systems are manufactured products or systems that remove pollutants from surface water runoff. They are particularly useful where there are site constraints of space, infiltration capacity or specified discharge levels of pollutants. They can also be used to reduce the maintenance requirements of downstream SuDS elements.

15.2 Treatment Channels: These are channels that are designed to treat surface water as well as conveying it to other SuDS elements. They may contain proprietary filter media to remove pollutants and include design features to trap oil and floatables.

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15.3 Solids/Liquid Separators: Devices such as a hydrodynamic separator or vortex separator are specifically designed to remove and collect sediments and other debris by passing the surface water in a centrifugal manner between inlet and outlet, thus facilitating the sediment removal process within a small space. Some pollutants, such as metals, may be bound to the sediment and also removed.

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15.4 Filter Systems:

15.4.1 Systems specifically designed to remove particulates and/or soluble pollutants from surface water run-off and which are capable of cleaning surface water run-off from roofs, car parks, and the most polluted roads, even in heavily trafficked areas.
15.4.2 The systems usually hold filter media in cartridges and a wide array of filtration or absorbing media are available delivered in prefabricated, standard units or custom made systems.
15.4.3 These systems can be designed to remove heavy particles, silt and nutrients and dissolved heavy metals, such as copper, zinc and cadmium, from the surface water to provide an environmentally sound solution which benefits the natural watercourse and increases biodiversity.

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15.5 Hydrocarbon Separators:

15.5.1 Devices installed on surface water drainage systems to protect receiving waters from pollution by oil and petrol, which may be present due to minor leaks from vehicles and plant, or from accidental spillage.
15.5.2 Two types are generally available - 'Full Retention' for high risk areas (risk of regular contamination of surface water run off with oil and/or risk of larger spills e.g. vehicle maintenance area, Goods Vehicle parking or vehicle manoeuvring) and 'By-Pass' for larger, low risk areas such as car parks.
15.5.3 A particular version of Full Retention separator with larger hydrocarbon storage is required for petrol station forecourts.

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15.6 Advanced Material Technologies (ATM): Specialist filter media or material can be used in a variety of filter devices and are designed to capture and retain specific pollutants such as hydrocarbons.

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15.7 Packaged Treatment Train (PTT): Devices specifically designed to remove particulates and/or soluble pollutants from surface water run-off by a series of treatment techniques such as settlement screening and filtration. These may be contained within a single chamber or in multiple chambers linked in series.

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16. Bioretention

16.1 Packaged Reed Beds: Devices designed to treat runoff to remove bacteria, heavy metals, nutrients, petroleum hydrocarbons, and suspended solids. Contained within a single modular tank or a series of several chambers through which the effluent flows and is treated by various methods.

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16.2 Packaged Bioretention: A packaged system can include indigenous vegetation with engineered soils or filter media for high levels of surface water treatment. Systems can typically be designed as conveyance devices, attenuation systems or source control/infiltration systems. Their relatively small footprint makes them ideal for both new developments and retrofit applications particularly in the urban environment.

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17. Pervious / Porous Pavements

17.1 Pervious pavements allow rainwater to pass through the surface and into the underlying structural layer(s) where it is either infiltrated into the surrounding soil or stored for controlled discharge downstream.

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17.2 Porous pavements infiltrate water across their entire surface and may be constructed of reinforced grass or gravel surfaces, resin bound gravel, porous concrete or asphalt.

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17.3 Permeable pavements have a surface material that is usually impermeable to the passage of water but, due to specific changes in manufacture or construction, permits surface water to flow through to the ground below.

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18. **Attenuation**

18.1 The purpose of attenuation storage is to prevent surface water entering the drainage infrastructure during peak weather events, for later release at a time and rate the downstream infrastructure can cope with without giving rise to flood risks.

18.2 **Geocellular Systems:**

18.2.1 Underground structure comprising a number of geocellular storage units (plastic box-like structures; modular cells) containing voids for the storage of surface water in which each of the geocellular storage units contributes to the load-bearing capacity of the structure. Large volumes of water from roofs, gutters or surface drains can be retained. The modular cells are lightweight, easy to handle and fit together to create a modular underground water tank of any shape and size.

18.2.2 With the use of a silt trap, sediments can be removed before entering the tanks. Some systems provide access for maintenance/cleaning as necessary or are designed to facilitate silt removal.

18.2.3 The modular structure must be wrapped in a water tight membrane.

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18.3 **Oversized Pipes:** A subsurface pipe construction (typically reinforced concrete or plastic), oversized in terms of diameter and sometimes length, for the provision of attenuating and storing surface water runoff.

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18.4 **Concrete Box Culvert/Tank:** A monolithic subsurface reinforced concrete box construction, oversized in terms of dimensions and sometimes length, for the provision of attenuating and storing surface water runoff.

Find a supplier

18.5 **Pre-formed Tanks:** A subsurface construction of various shapes, manufactured from a high-strength material, for the provision of attenuating and storing surface water runoff.

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19. **Inlets, Outlets and Flow Controls**

19.1 **Swale Inlets & Outlets:** Swales are shallow, flat bottomed, vegetated open channels designed to convey surface water runoff and treat it through sedimentation, infiltration and evapotranspiration. For point inflows, flow spreaders are required to reduce the risk of erosion (‘scour’) around the inlet. These can be constructed on site using various materials but preformed swale inlets offer quick installation and construction convenience.

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19.2 **Vortex Flow Controls:**

19.2.1 A self-activating device that provides improved hydraulic performance over conventional flow controls such as orifice plates and throttle pipes and reduced maintenance requirements.

19.2.2 It consists of an intake, a volute and an outlet. Flow is directed tangentially into the volute to form a vortex. High peripheral velocities induce an air-filled core with resulting back pressure that reduces the rate of discharge of the flow.

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19.3 **Orifice Plates:** An orifice is a circular or rectangular opening of a prescribed shape and size. The outlet flow rate depends on the height of the water above the opening (hydraulic head) and the size and edge treatment of the orifice.

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19.4 **Penstocks:** Penstocks or sluice gates are plates that can be moved up and down to allow the area of flow to be adjusted. They can be moved manually or mechanically. They have an advantage over fixed orifices as they can be adjusted to suit flow conditions. This could be as part of a real time control system.

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19.5 **Throttle Pipes:** A small diameter pipe from a tank or pond may provide flow control - this could be in the form of a short pipe where the inlet behaves like an orifice. A longer pipe may provide control by means of friction along its length.

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19.6 **Weirs:**

19.6.1 Weirs and notches discharge proportionately more water than orifices or pipes, with an equivalent increase in head. An advantage of weirs is that floating debris will pass downstream and they are not vulnerable to blockage.

19.6.2 Weirs can be “sharp-crested”, “broad-crested”, triangular or of various intermediate cross sections, each of which has slightly different head-discharge characteristics. Weirs can be used as level and/or flow control structures and/or emergency spillway devices.

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19.7 **Float Operated Controls:** Controls are sometimes required to ensure discharge only occurs under desired conditions, a range of different control methods are available. Float controls can be used to control discharge based on level.

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20. **Control Systems**

20.1 **Pumps:** The requirement for pumping storm water should be avoided where possible. Pumping may be required in special circumstances where a discharge would not be possible, for example due to high river levels during extreme events.

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20.2 **Real Time Controls:**

20.2.1 In some circumstances it is necessary to have controls that are reactive to the conditions on site or the receiving watercourse or sewer. Penstocks for example may be required to close due to increasing levels in the receiving sewer, potentially by a mechanical / electrical input.

20.2.2 Real time controls are likely to incorporate some form of sensing or measurement of conditions. They require careful design and regular maintenance.

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Annex-A

Glossary of Terms

SuDS Sustainable drainage systems or sustainable (urban) drainage systems. A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques; They are design philosophies rather than defined process solutions.

Attenuation. Reduction of peak flow and increased duration of a flow event.

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

Bioremediation. The treatment and breakdown of pollutants or waste by the use of microorganisms.

Brown Roof. Roof with a diverse range plants growing on its surface to improve biodiversity and provide specific habitat.

Catchment. The area contributing surface water flow to a point on a drainage or river system.

Combined sewer. Sewer system designed to carry both waste/foul water and storm water.

Disconnection. Removing surface water discharges into sewers by use of appropriate SUDs structures such as soakaways. This has a positive impact by recharging aquifers and reducing flood risk.

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

Evapotranspiration. The process by which the Earth’s surface (water and soil) loses moisture by evaporation of water and by uptake and then transpiration (water loss) from plants.

Exceedance. An exceedance event occurs when the rate of surface water runoff exceeds the inlet or outlet capacity of the drainage system.

Filter drain (infiltration trench). Linear drain consisting of a trench filled with a permeable material, often with a perforated pipe in the base to assist drainage, to store and convey water, and may also permit infiltration.

Flow control device. Device to control the rate of surface water flow at a location within a drainage network.

Foul water. Water contaminated by soil, waste (or trade effluent) which should only be discharged to a foul sewer or a combined sewer (see misconnections).

Geocellular system. Modular structure which provides for underground water storage or infiltration with variable complexity of internal structure, including load bearing supports.

Geotextile. Strong synthetic fabric used in civil engineering.

Green roof. Roof with specific plants growing on its surface providing a degree of retention, attenuation and treatment of rainwater, it also promotes evapotranspiration.

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

Infiltration device. Device designed to aid infiltration of surface water into the ground.

Living roof. Alternative name for green or brown roof.

Misconnections. Foul water discharged to surface water sewers causing pollution. Foul water must be discharged to foul sewers, septic tanks or cesspools as appropriate.

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

Permeable/pervious surfaces. A surface that allows surface water into the underlying construction or soil.

Rainwater. Water that has fallen as rain and contains little dissolved mineral matter.

Rainwater harvesting. Process to collect and store rainwater for reuse, rather than allowing it to drain away.

Reed bed. System using reeds to reduce pollutants in surface water.

Soakaway. Subsurface structure into which surface water flows to allow infiltration into the ground.

Source control. Control of runoff at or near its source, e.g. rainfall on a car park.

Surface water. (in drainage) Water, principally rainwater that is on, or collected from, roofs and other areas within a drainage area and is not contaminated by soil or waste.

Surface water sewer. Sewer system that carries uncontaminated rainwater directly to a local river, stream or soakaway.

Suspended solids (SS). Undissolved particles in a liquid.

Throttle pipe. Generally smaller diameter than the upstream pipe, used to control the pass forward flow by limiting the carrying capacity of the network.

Weir. Flow control structure with a number of shapes/geometries that only permits flow to pass forward when a predetermined water depth is achieved.

Vortex flow control. Process which induces spiral water flow in a device to control flow rates.
Summary of Regulations

1. The primary water legislation from the different UK legislatures contains general requirements for the management and discharge of surface and drainage waters.

2. In England and Wales the Flood and Water Management Act 2010 (FWMA) was introduced to address the concerns and recommendations made following a review of the lessons learned during the 2007 floods (the Pitt Review). The Act requires better management of flood risk.

3. Note: Schedule 3 of the FWMA was specifically concerned with the implementation of SuDS in any development and would have led to the establishment of SuDS Approval Bodies (who would approve surface water management schemes at the time of planning application and adopt such schemes after construction) and national standards covering discharge volume, flow rate and water quality. Schedule 3 was not implemented and, effective April 2015, the responsibility for approval of SuDS schemes was placed with the local planning system (with Lead Local Flood Authorities as statutory consultees).

4. In Scotland the Flood Risk Management (Scotland) Act 2009 applies. Other guidance can be found in Sewers for Scotland 3rd Edition.


6. There is a general expectation that a drainage system should be adequate. This applies particularly to drains created by developments subject to Building Regulations. Overland flow paths as a result of an excess of surface water, above the design limit, or due to a blockage in foul sewerage must be considered.

7. Adequate performance will usually be achieved if the drainage system:
   a. conveys the flow via a suitable network or treatment system to a suitable outfall (a soakaway, a watercourse, a surface water or combined sewer)
   b. minimises the risk of blockage or leakage and with good access for clearing blockages and any necessary maintenance
   c. has a sufficient capacity to carry or retain the expected flow at any point in the system and so does not increase the vulnerability of the development to flooding.
   d. provides drainage from roofs or paved areas to an adequately and suitably designed drainage system
   e. where necessary is adequately ventilated such that foul air does not enter any buildings

8. It should be noted that:
   a. the hierarchy for discharge of rainwater is firstly to an adequate soakaway or infiltration system, if that is not reasonably practicable then to a surface water body, the last option is to a sewer.
   b. discharges into the ground (where permitted) should be distributed sufficiently so that foundations of buildings or structures are not damaged.

9. It should also be remembered that runoff from impermeable surfaces can contain pollutants that cannot be discharged into groundwater or surface water. The relevant legislation differs depending which country you are in, but if you are developing a drainage scheme for a high risk site (such as a trunk road or industrial estate) you should speak to the local environmental regulator for advice. Enhanced treatment may be required to meet the regulatory requirements. Infiltration systems may not be allowable if they will create a risk of pollution to groundwater.
Annex-C

Documents which give further information and guidance on SuDS:

Source control using constructed pervious surfaces; hydraulic, structural and water quality performance issues: CIRIA C582, 2002
Sustainable drainage systems; hydraulic, structural and water quality advice: CIRIA C609, 2004 [download]
Model agreements for sustainable water management systems. Model agreements for SUDS: CIRIA C625, 2004 [download]
Model agreements for sustainable water management systems. Model agreements for rainwater and grey water use systems: C626, 2004 [download]
Designing for Exceedance: CIRIA C635, 2006 [download]
Planning for SUDS: CIRIA C687, 2010 [download]
Site handbook for the construction of SUDS; CIRIA C698, 2007 [download]
Retrofitting to manage surface water: CIRIA C713, 2012 [download]
The SUDS Manual: CIRIA C753, 2015 [more information]
Structural and geotechnical design of modular geocellular drainage systems: C737, 2016 [download]
Soakaway design: Building Research Establishment (BRE) Digest 365, 2016 [download]
Groundwater Protection: Principles and Practice (GP3): Environment Agency (EA), 2013 [more information]

Other Information and regulations

Flood and Water Management Act 2010 [download]
Flood Risk Management (Scotland) Act 2009 [download]
National Planning Policy Framework, 2012 [download]
Scottish Planning Policy, 2014 [download]
Planning Policy Wales, 2016 [download]
The Planning (Amendment) (Northern Ireland) Order 2003 [download]
Planning Policy Statement 15 (PPS 15) Planning and Flood Risk (Northern Ireland) [download]
Building Regulations, Approved Document H, Drainage and waste disposal, 2015 [download]
Technical Standards For compliance with the Building Standards (Scotland) Regulations 1990, and amendments, Part M, 1999 [download]
Sewers for Adoption, 2013 [download]
Sewers for Scotland: 3rd Edition: Scottish Water 2016 [download]
Use and design of oil separators in surface water drainage systems: PPG 3 [download] Note: PPG3 was withdrawn by the Environment Agency in December 2015 but is still retained by SEPA.
Useful Web Addresses

Regional regulatory and guidance information can be accessed at the following websites:

Building Research Establishment (BRE)  http://www.bre.co.uk
Construction Industry Research and Information Association (CIRIA)  http://www.ciria.org/suds
Department for Environment Food and Rural Affairs (Defra)  http://www.defra.gov.uk
Department of the Environment Northern Ireland  http://www.nics.gov.uk
Environment Agency (EA)  http://www.environment-agency.gov.uk
Environment and Heritage Service Northern Ireland (EHSNI)  http://www.ehsni.gov.uk
Highways England  http://www.highways.gov.uk
Livingroofs.org for information on green roofs  http://www.livingroofs.co.uk
Office of the Deputy Prime Minister (ODPM)  http://www.odpm.gov.uk
Scottish Environmental Protection Agency (SEPA)  http://www.sepa.org.uk
The Scottish Executive  http://www.scotland.gov.uk
UK Rainwater Management Association  http://www.ukrma.org

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