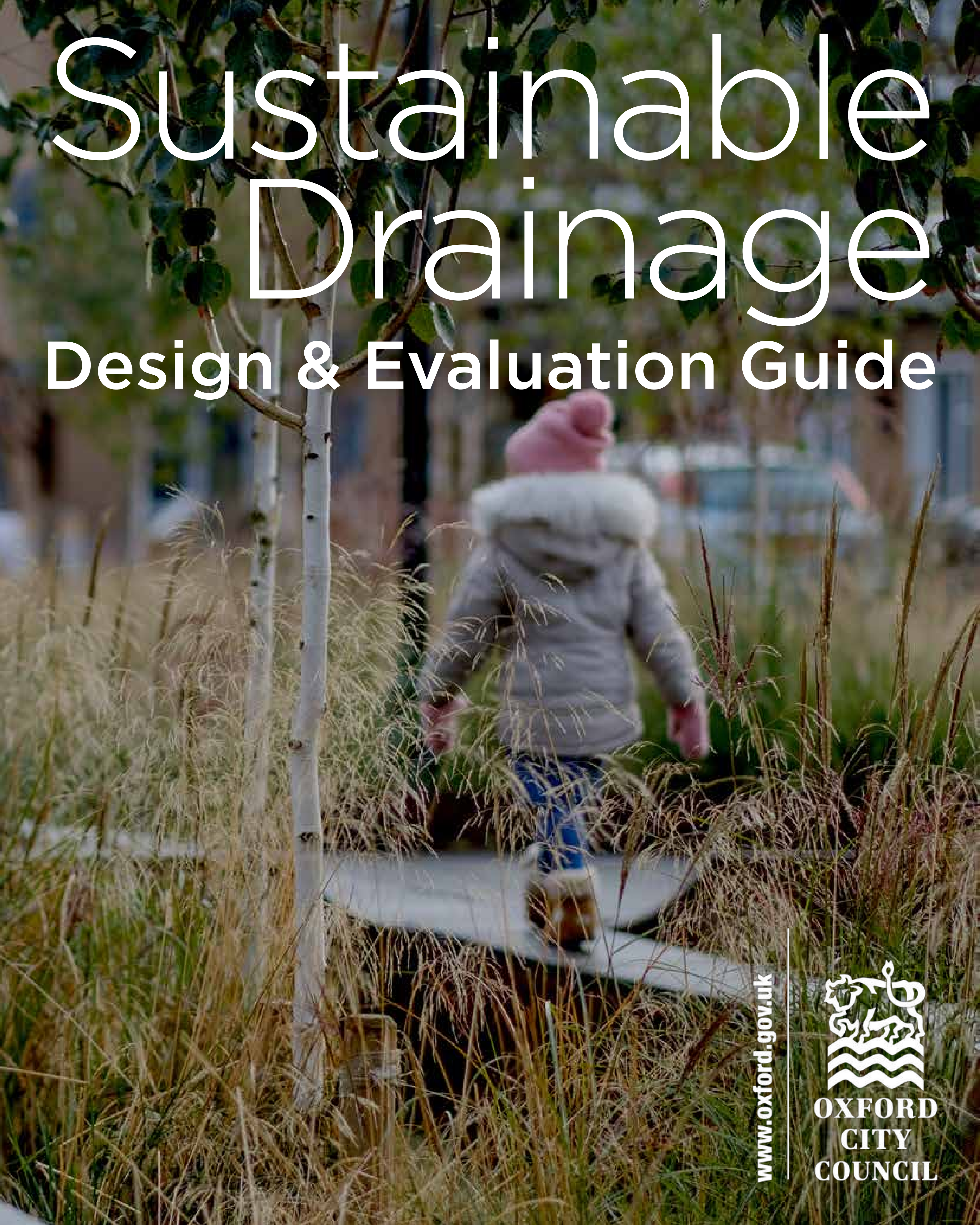
Sustainable Drainage

Design & Evaluation Guide



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Preface

Why this guide is needed

Our understanding of the negative impacts of conventional drainage are now well understood.

Pipe drainage collects and conveys water away from where it rains, as quickly as possible, contributing to increased risk of flooding, likelihood of contaminated water and the loss of our relationship with water and the benefits it can bring to us all.

Sustainable Drainage, or SuDS, is a way of managing rainfall that mimics the drainage processes found in nature and addresses the issues with conventional drainage.

Who this guide is intended for

In 2010 the Flood and Water Management Act proposed that SuDS should be used on most development and this was confirmed in a ministerial statement on 23 March 2015 introducing the 'non statutory technical standards' for SuDS.

The responsibility for ensuring that SuDS are designed and implemented to a satisfactory standard lies with the Local Planning Authority (LPA).

SuDS Designers will need to meet these required standards when submitting proposals to the LPA.

What the guide provides

This guide links the design of SuDS with the evaluation requirements of planning in a sequence that mirrors the SuDS design process.

This guide promotes the idea of integrating SuDS into the fabric of development using the available landscape spaces as well as the construction profile of buildings. This approach provides more interesting surroundings, cost benefits, and simplified future maintenance.

This guide begins by giving a background context for SuDS design. Next, the three accepted design stages are described: Concept Design, Outline Design and Detail Design. Subsequent chapters offer supporting information.

It is intended that this guide will facilitate consultation, in order to achieve the best possible SuDS designs.

Contents

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Anthony McCloy is a Chartered Engineer working exclusively in the water sector since 1998. Since 2003 he has focused on SuDS design, hydraulic modelling for SuDS and flood risk. He has co-authored SuDS Guidance documents for Planning Authorities and is a key tutor for the (CIRIA) National SuDS training workshops since 2006.

Bob Bray *Director Robert Bray Associates*

Robert Bray has been a pioneer of UK SuDS since 1996. He has been at the forefront of demonstrating how SuDS can be fully integrated with the surrounding landscape. Bob has been a key tutor for the (CIRIA) National SuDS training workshops since 2003.

Kevin Barton *Director Robert Bray Associates*

Kevin Barton has been working as a Landscape Architect for over 20 years and designing SuDS landscapes exclusively since 2011. In addition to project work, Kevin has also contributed to SuDS Guidance documents for Planning Authorities and presented on SuDS topics at Conferences, CIRIA 'Susdrain' events and to Planning Authorities.

Acknowledgements

Kevin Tidy - LLFA (retired)

Ruth Newton - Planner

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Project Partners

- Lewisham Council
- Lincolnshire County Council
- London Borough of Bexley
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- London Borough of Hackney
- London Borough of Hammersmith and Fulham
- London Borough of Haringey
- London Borough of Hillingdon
- London Borough of Merton
- Luton Borough Council
- Oxford City Council
- Oxfordshire County Council
- Peterborough City Council
- Royal Borough of Kensington and Chelsea
- Worcestershire County Council
- North Worcestershire Water Management Districts:
  - Wyre Forest District Council
  - Bromsgrove District Council
  - Redditch Borough Council

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1.0 Introduction

Since 2000 there have been an increasing number of publications that identify the problems with traditional drainage and describe a different approach to managing rainfall called Sustainable Drainage Systems or SuDS.

1.1 The origins of SuDS

The industrialisation of the UK and the extensive use of pipes to collect and convey runoff to streams and rivers has created a legacy of flooding and pollution.

Pipe systems are at capacity, or surcharge in heavy rain, washing everyday contamination from hard surfaces directly into our watercourses.

During the 1990s an awareness of better ways to manage rainfall began to influence thinking in Britain.

Ideas from the US and Sweden were initially introduced in Scotland, to deal with runoff from a large new development in Dunfermline. Most of the concepts and terms commonly used in Sustainable Drainage Systems (SuDS) were introduced to Britain at this time.

Examples from the USA such as the Oregon Water Science Centre inspired the uptake of SuDS within the UK.

1.2 SuDS today

There have been a number of definitions of Sustainable Drainage over the years, but the following is based on the SuDS Manual 2015, which was published by the Construction Industry Research and Information Association (CIRIA):

SuDS became a statutory requirement on all major developments in 2015. This means that SuDS proposals are now required as part of the planning process.

Planning authorities can also ask for SuDS on other types of development, including smaller developments and regeneration projects.

'Sustainable Drainage or SuDS is a way of managing rainfall that minimises the negative impacts on the quantity and quality of runoff whilst maximising the benefits of amenity and biodiversity for people and the environment'.

One of the earliest examples of SuDS in the UK can be found at Dunfermline, Scotland.

1.3 Background to this document

A number of SuDS guides have been produced in the UK since 2000, many of which outline the benefits of SuDS, but fail to provide sufficient insight into how design should be approached with SuDS in mind, and with little guidance on the evaluation process for developments. This guide considers design and evaluation of SuDS as complementary. It explains both, from the earliest iteration of Concept Design through to the Detailing stage, in order to successfully integrate SuDS into development.

The main objectives of this Design and Evaluation guide are:

- To create a shared vision around SuDS for all involved in design and evaluation.
- To enable the design and evaluation of SuDS to meet agreed standards.
- To ensure SuDS are maintainable now and in the future.

This guide is complementary to:

- The National Planning Policy Framework (NPPF)
- Relevant Local Planning Policy
- Construction Industry Research and Information Association (CIRIA) 2015 SuDS Manual (C753)
- SuDS Non-Statutory Technical Standards (NSTS)
- Local Authority SuDS Officer Organisation (LASOO) NSTS Practice Guidance

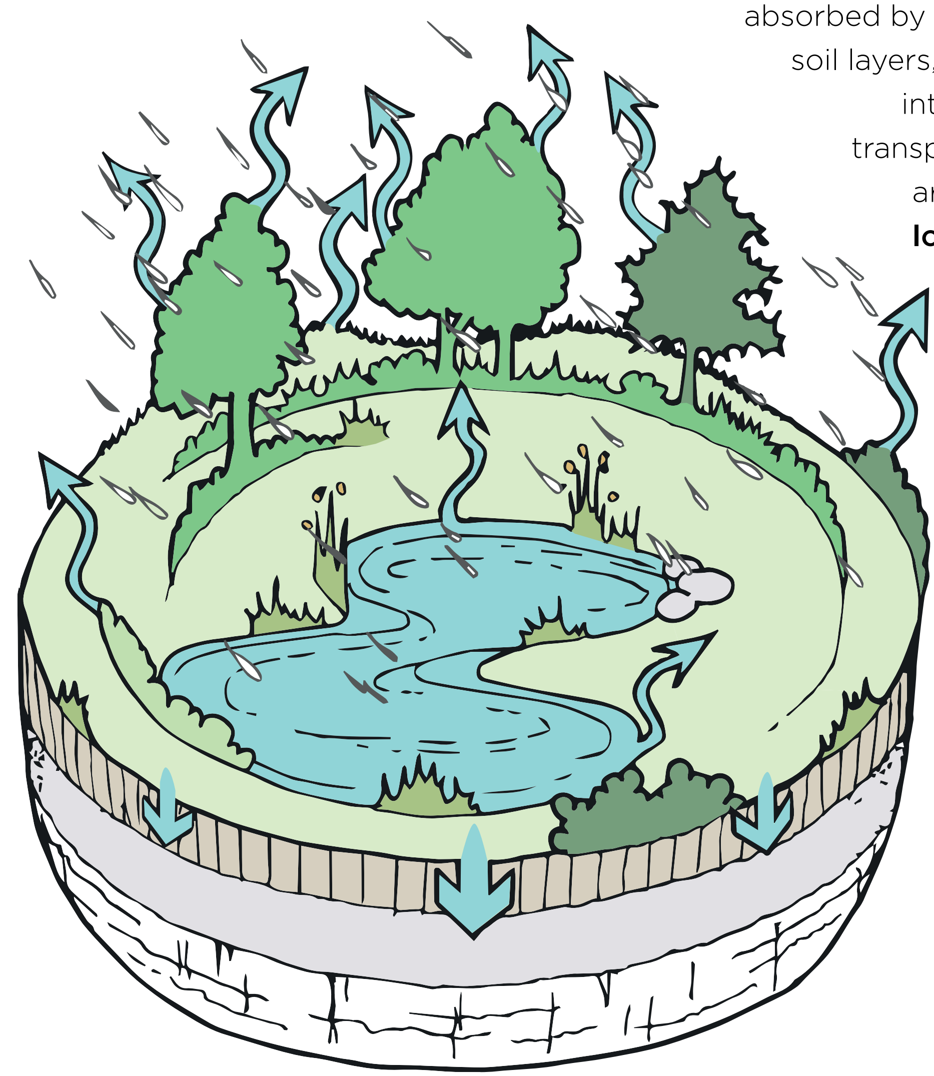
This guide draws upon the experience of the authoring team, which has been gained over 20 years of practical SuDS application.

2.0 Understanding Rainfall

It is important that everyone involved in the design and evaluation of SuDS has an understanding of the natural processes that occur in response to rain, so that proposed schemes can mimic these.

2.1 It begins to rain

In forests, glades, and wetlands, when it rains, water can be lost in a number of ways. The rain is held on the foliage of trees and plants and evaporates into the air, falls to the ground to be absorbed by leaf litter and surface soil layers, or is 'breathed' back into the air by plants as transpiration. These losses are called **interception losses** and are the first part of the natural losses that occur during rainfall.



Interception losses in the natural landscape.

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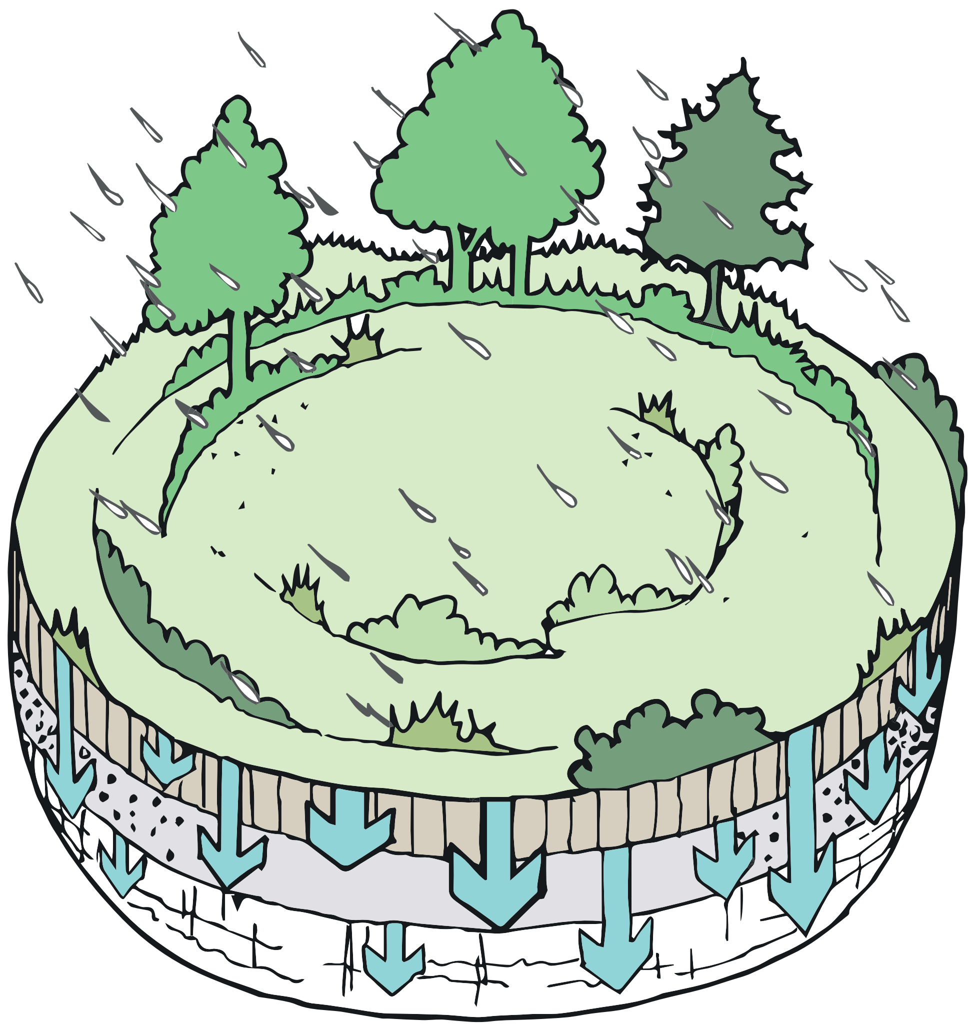
2.2 The ground becomes saturated

After a while the surface of the landscape can absorb no more water.

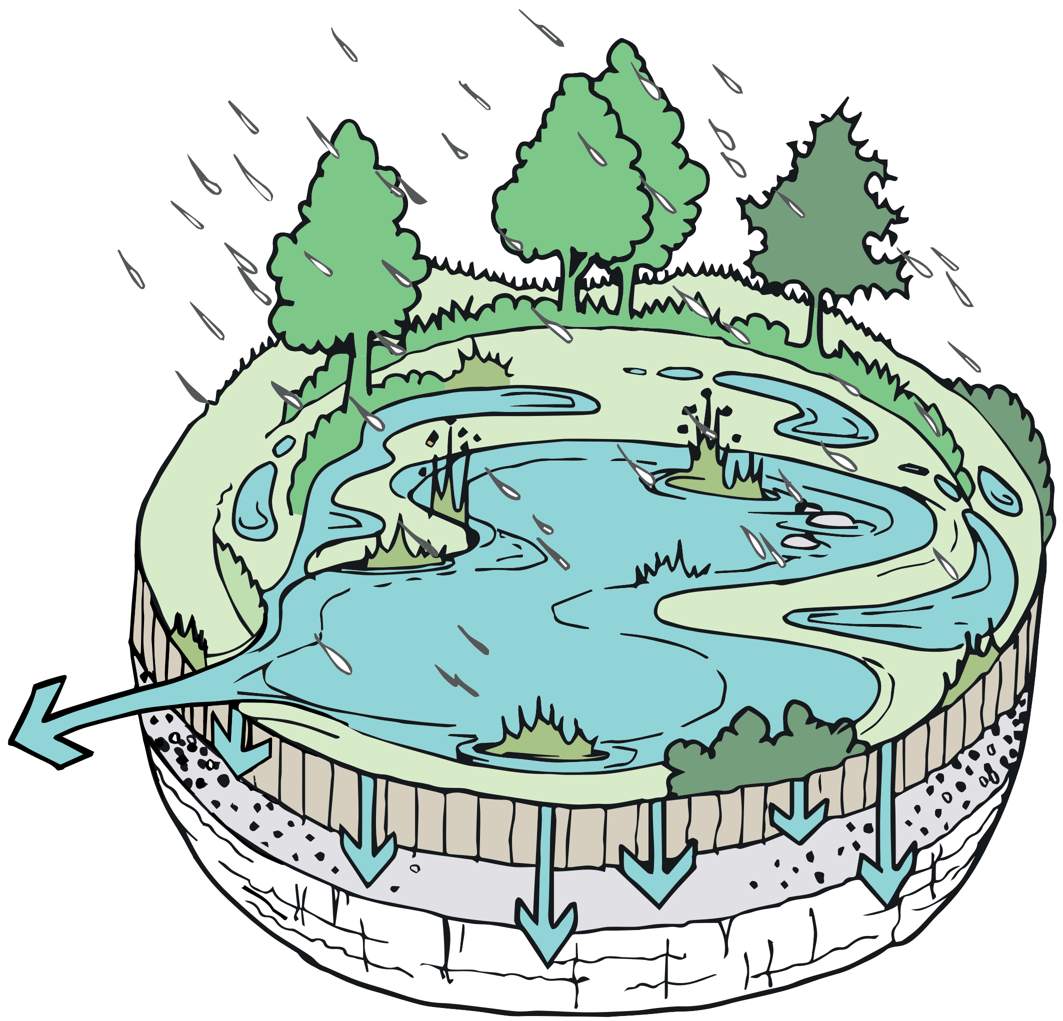
Where the ground is **permeable**, water begins to soak into lower soil profiles and then the underlying geology. This is called **infiltration** and is common on sandy, gravelly and limestone soils.

In landscapes with infiltrating soils, after interception losses have taken place, most rainwater is lost by soaking into the ground.



Where the ground is **impermeable,** water begins to trickle and flow across the surface, collects in natural depressions, and is stored in wetlands. These natural features attenuate the rate and volume of flow of rainwater running off the landscape. These flows are called **natural** or **greenfield runoff**.

Surface flow rates are small at first, but increase with higher **intensity** *rainfall events. The* **volume** *of runoff will generally be greater with increased rainfall intensity and duration.*



2.3 Natural losses continue during heavy rain

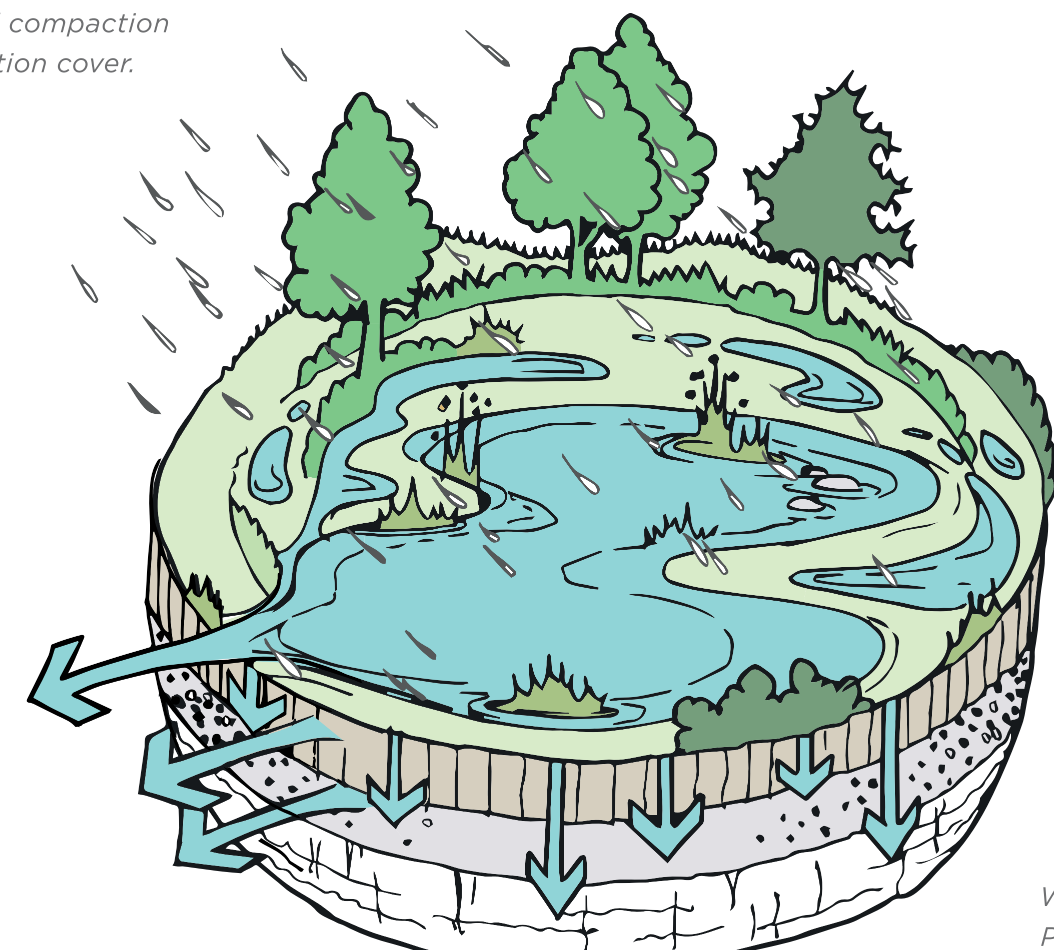
In many soils, both a degree of infiltration and surface runoff can occur simultaneously.

Once the ground is saturated there are ongoing natural losses that occur during rainfall, particularly where the ground has some permeability.

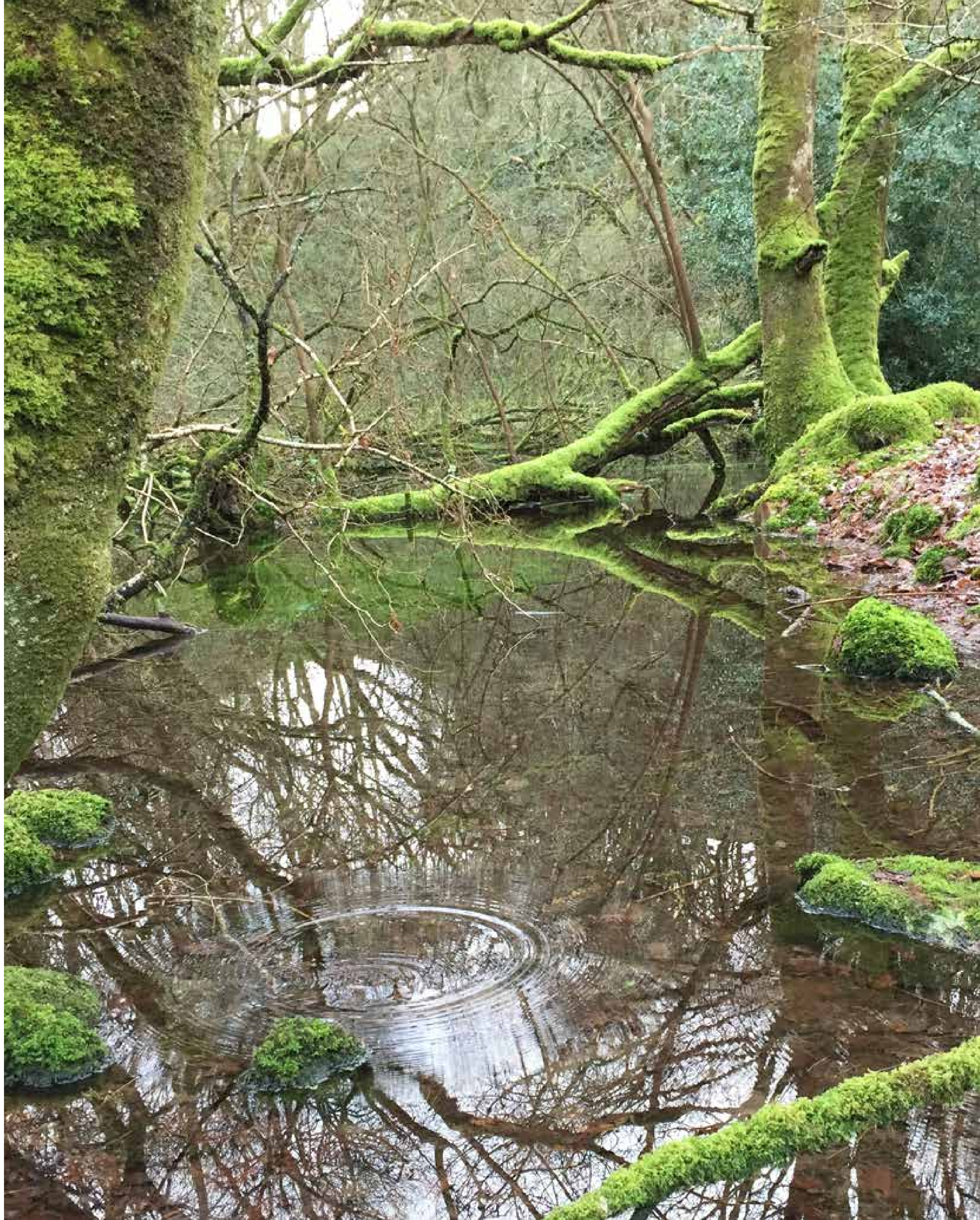
During warmer weather when the ground is relatively dry, interception and ongoing natural losses will occur during most rainfall events.

Interception and **ongoing losses** are the two elements of **total natural losses**.

This dynamic process varies in accordance with permeability, the preceding weather conditions and extent of ground compaction or vegetation cover.



Facing Page: Wet Woodland, Pembrokeshire.



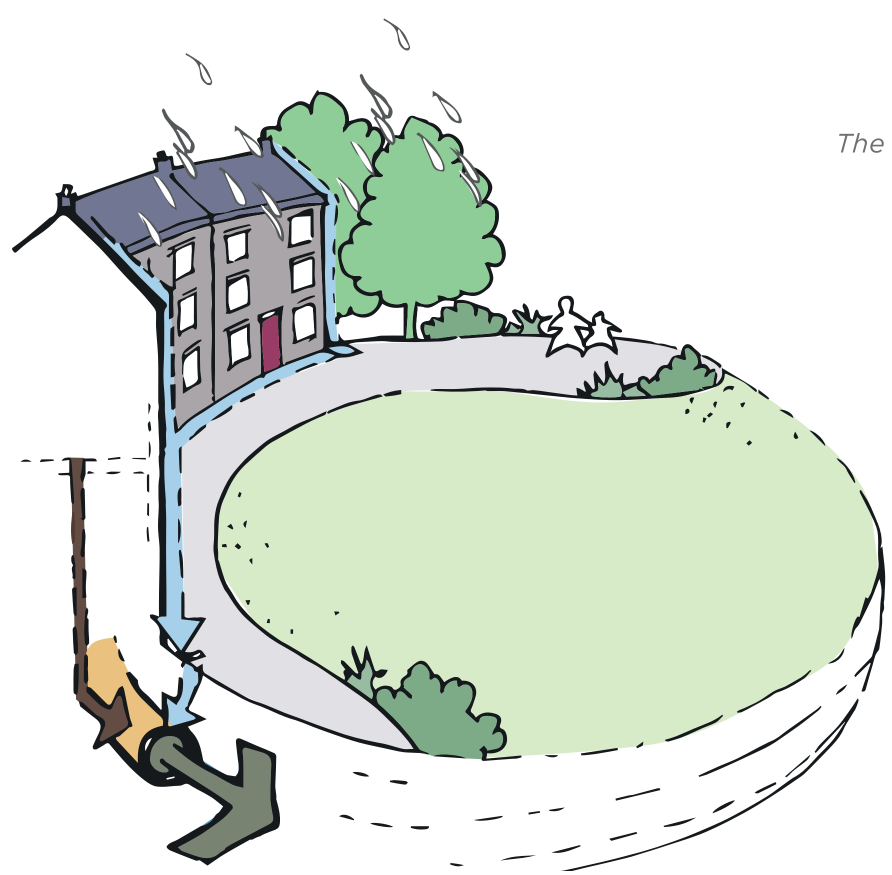
3.0 The Impact of Development

For millennia, people have been making changes to our landscapes which affect the fate of the rain that falls on the land. In recent history, the scale of urbanisation and our attitudes toward rainwater have caused serious problems both for ourselves and for the natural environment.

3.1 A rural landscape becomes urban

Before the universal use of piped drainage it was common to collect and convey runoff across the land surface directly into ditches, streams and local rivers.

With the growth of Victorian cities and the development of piped drainage, human and industrial waste, together with rainwater runoff from buildings and streets, was directed into a single underground pipe called the **combined sewer.** In periods of heavy rainfall, **combined sewer overflows** act as a relief valve when flows exceed sewer capacity, discharging untreated foul sewage into local watercourses. Many British cities and towns of Victorian age are served by combined sewers.

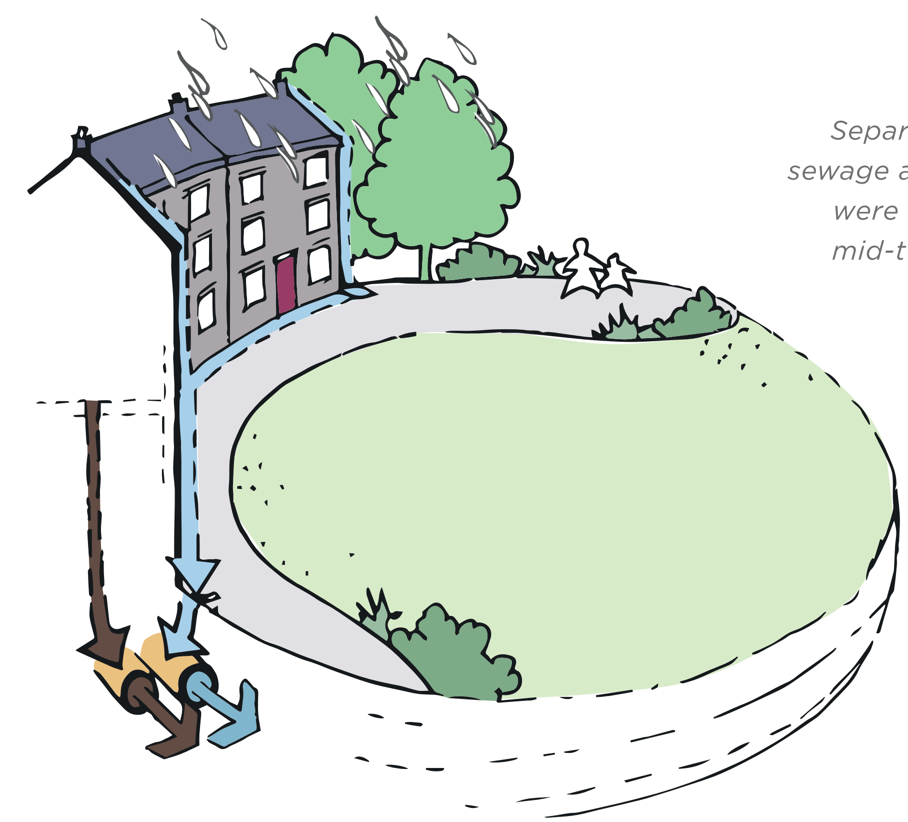


The Combined Sewer.

3.2 Separating rainwater from foul sewage

In the mid-twentieth century it was realised that foul sewage and storm water should be separated. A separate sewer arrangement was introduced with the **foul sewer** for human waste and the **surface water sewer** for rainfall. However, in many urban areas these connections are still unclear and are complicated by highway drainage and other ad hoc arrangements.

Unfortunately, rainwater still gets into the foul sewer and misconnections contaminate surface water sewers and receiving watercourses. The SuDS approach to managing rainfall can minimise these misconnections by keeping runoff at or near the surface.



Separate pipes for foul sewage and surface water were introduced in the mid-twentieth century.

3.3 Consequences of piped drainage

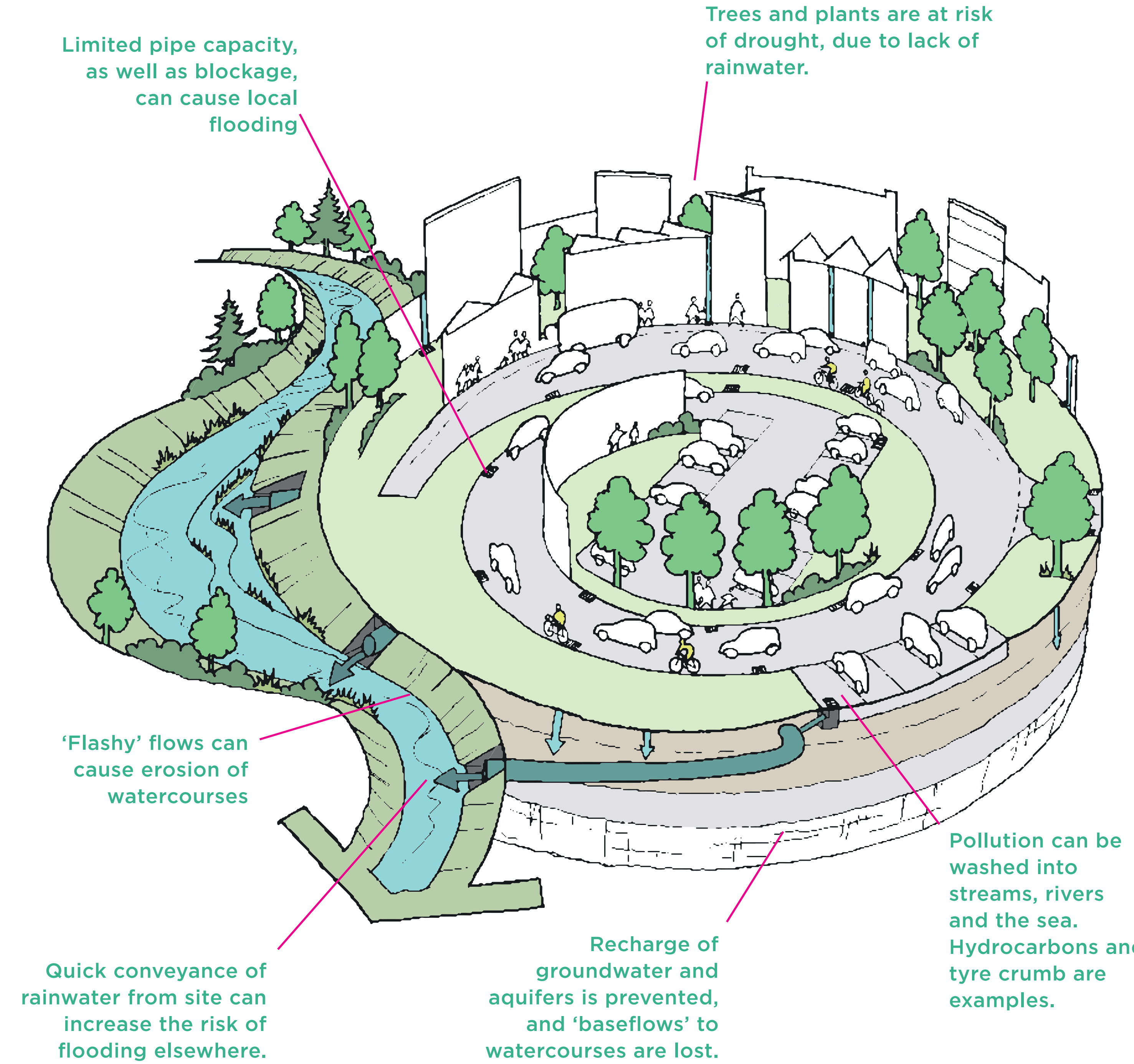
Piped drainage is designed to convey water away from developments as quickly as possible, and has become the default way to manage rainfall across the developed world. However, this is at a cost to the environment and developments themselves.

The disadvantages of traditional piped drainage are now becoming clear:

- Quickly carrying rainwater away from where it falls can increase the risk of flooding elsewhere.
- Limited pipe and network capacity, as well as blockage, can cause local flooding as water cannot get into the system.
- Pollution from roofs, roads and car parks is washed into the sewer when it rains, contaminating streams, rivers and the sea and killing wildlife.
- Recharge of groundwater and aquifers is prevented, and the natural 'baseflow' of water through the ground to watercourses is lost.
- 'Flashy' flows from urban areas can cause erosion of watercourses.
- Trees and plants in urban areas are at greater risk from drought stress, due to lack of access to rainwater.
- Wildlife is often trapped and killed by conventional drainage structures.

Foul water misconnections to surface water pipes result in polluted waterways at Glenbrook, Enfield where sewage fungus is evident.

Pollution from roads and car parks is often visible - fuels, oil, heavy metals, tyre dust and silt all get washed into drainage systems.



Conventional drainage results in high rates and increased amounts of runoff reaching streams and rivers. Pollution from urban surfaces is also washed into watercourses.

4.0 The Role of SuDS

Sustainable Drainage is a way of managing rainfall that mimics natural drainage processes and reduces the impact of development on communities and the environment.

4.1 SuDS addresses community and environmental problems

Conventional drainage seeks to remove runoff from development as quickly as possible. In contrast, SuDS slow the flow and store water in both hard and soft landscape areas, thereby reducing the impact of large volumes of polluted water flowing from development.

SuDS uses components linked in series to trap silt and heavy pollution 'at source'.

Contaminants are broken down naturally as runoff passes from one SuDS component to the next.

Multi-functional SuDS components that manage water at or near the surface, can bring significant community benefits, adapting their function to the weather.

The loss of aquatic habitat is reversed when using the SuDS approach. It allows fauna and flora to flourish, and to connect with existing habitats.

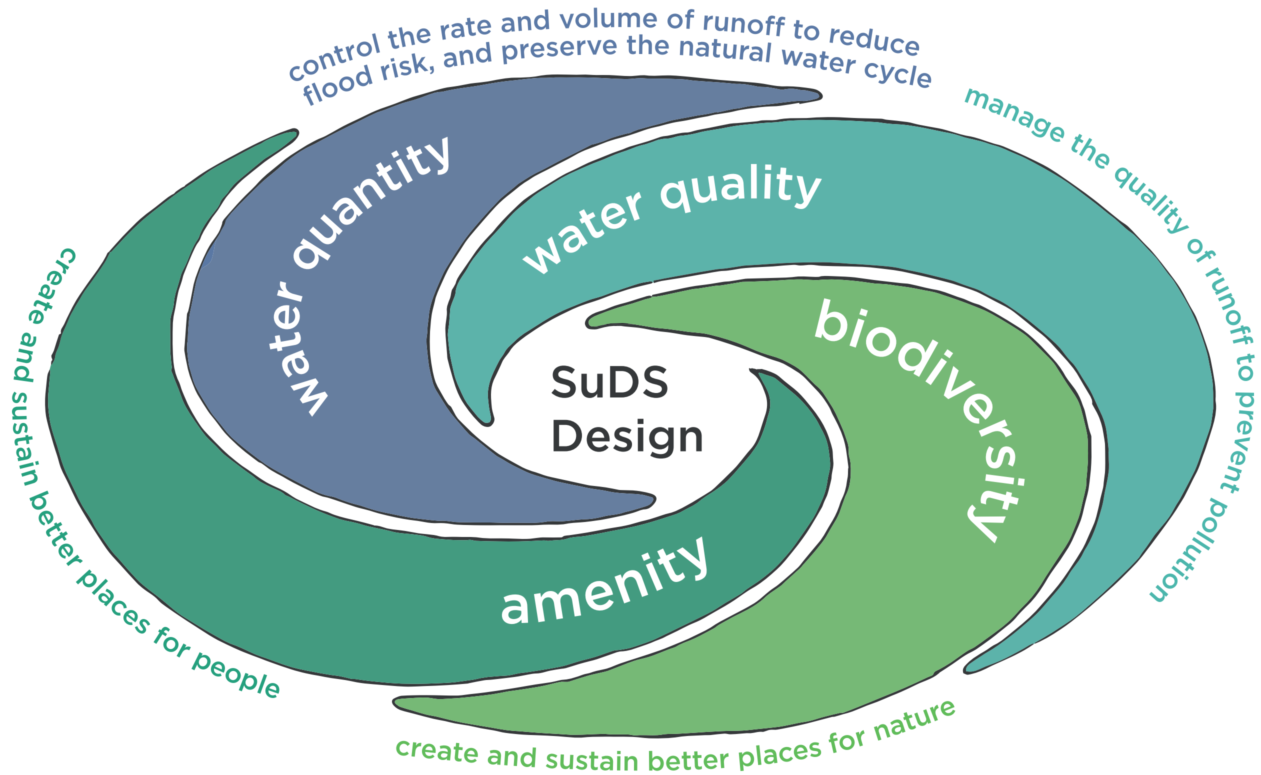
A wildlife area at Robinswood Primary School, Gloucestershire, manages rainfall as well as providing amenity and biodiversity benefits to the school.

4.2 SuDS objectives

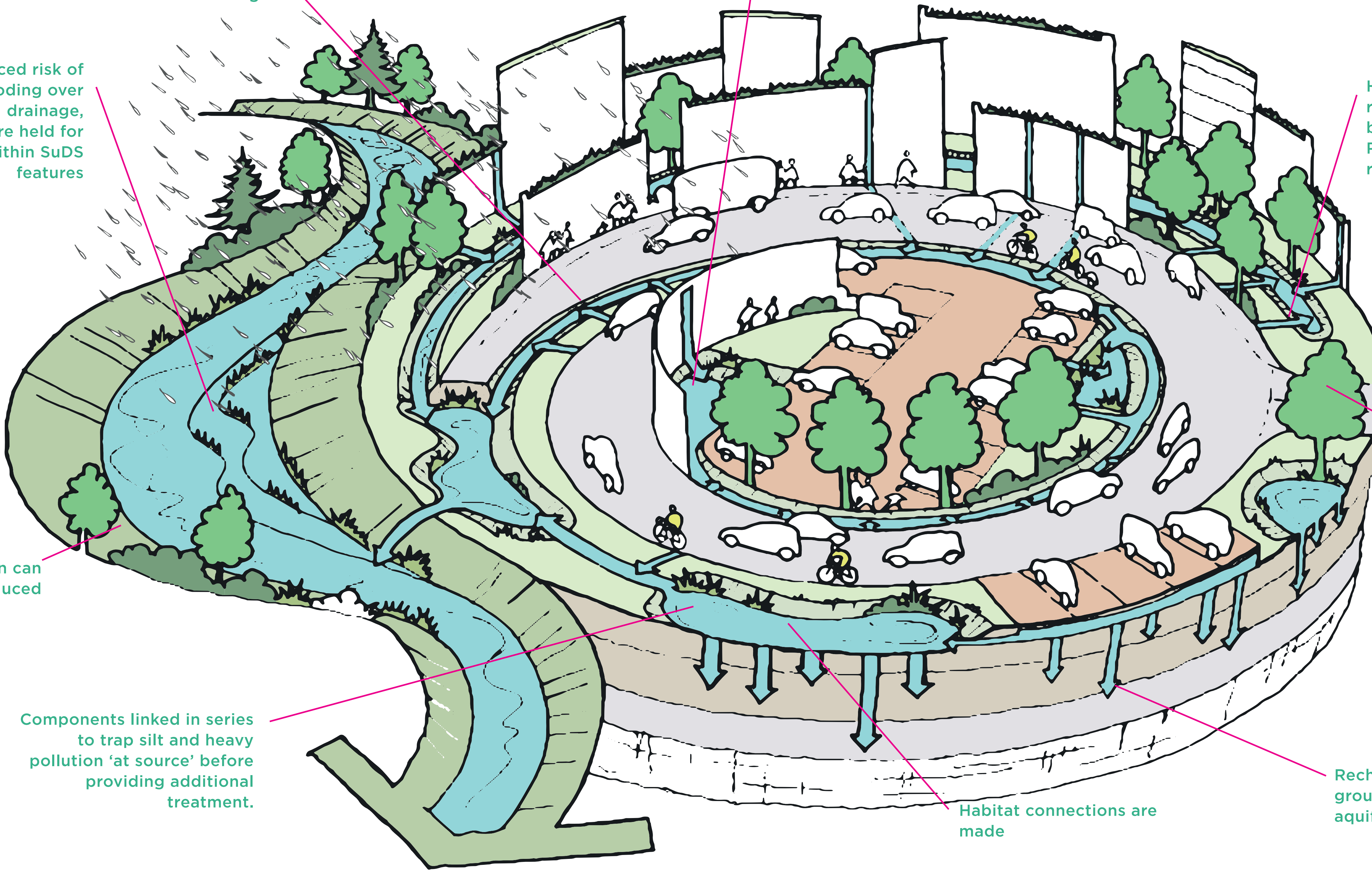
Where SuDS are designed as an integral part of the urban fabric they will help mitigate the contribution to flooding and the impact that development has on the natural landscape. They are also able to rehabilitate the hydrology of the urban environment through sustainable re-development and SuDS retrofit.

There are four critical objectives that SuDS seek to meet:

- **Quantity**: managing flows and volumes to match the rainfall characteristics before development, in order to prevent flooding from outside the development, within the site and downstream of the development.
- **Amenity**: enhancing people's quality of life through an integrated design that provides useful and attractive multi-functional spaces.
- **Quality**: preventing and treating pollution to ensure that clean water is available as soon as possible to provide amenity and biodiversity benefits within the development, as well as protecting watercourses, groundwater and the sea.
- **Biodiversity**: maximising the potential for wildlife through design and management of SuDS.



SuDS schemes offer diverse benefits over conventional drainage.



5.0 The SuDS Design & Evaluation Process

Integrating SuDS into development is a planning-led activity. Planning permission is required for all new development and re-development, and usually for SuDS retrofit.

5.1 The role of planning in SuDS

The Ministerial Statement of December 2014 gave responsibility for evaluating SuDS within planning applications to Local Planning Authorities (LPAs).

SuDS designs should conform to DEFRA's Non-Statutory Technical Standards (NSTS) for sustainable drainage systems and Local Authority requirements.

The LPA considers that SuDS is appropriate and reasonably practicable in most developments.

The evaluation process is led by the LPA. The LPA will consult with statutory consultees including the Lead Local Flood Authority (LLFA), and other professionals within disciplines complementary to SuDS design.

Consultation with the LPA evaluation team during the design process will help developers and SuDS designers deliver successful and cost-effective SuDS projects.

5.2 Design and evaluation in parallel

This guide considers the design and evaluation of SuDS as complementary. It follows the process of design from the earliest consideration of potential development through to Detail Design. It should involve both the developer and designer together with the planner, LLFA and all other parties with an interest in delivering integrated SuDS design.

The separate design stages and requirements for evaluation are set out in the guide for both small and large developments, with advice on how these design criteria can be met by SuDS designers, and checked by the evaluation team.

National Planning Policy Framework
www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

Non-statutory technical standards

www.gov.uk/search?q=sustainable+drainage+systems

The design stages and where they are appropriate within planning stages

	Pre-application discussion	Outline planning application	Reserved matters	Full planning application	Discharge of conditions
Concept Design	✓	✓			
Outline Design		✓		✓	
Detailed Design			✓	✓	✓

The extent of information required at each planning stage will be stipulated by the LPA. This may vary on a case by case basis dependant on the complexity and sensitivity of the scheme.

Where a developer would like to minimise the number of conditions for SuDS, to avoid time delays between planning approval and commencement, a detailed SuDS design should accompany the detailed planning application.

In all cases a concept design would be anticipated for pre-application discussion and detailed design will be required for discharge of conditions.

Refer to LASOO Practice Guidance for SuDS pg4 for an Illustrative Planning process
www.susdrain.org/files/resources/other-guidance/lasoo_non_statutory_suds_technical_standards_guidance_2016_.pdf

Design Note:

Ideally the developer and designer will liaise with the Planning Authority throughout the design process to ensure that the scheme is mutually acceptable. If design criteria are not met or are compromised during the design process this may result in significant redesign at a later stage to meet the design criteria set out in this guidance document.

5.3 The objectives of the evaluation process

Throughout the various design stages the emerging designs should be evaluated against core design criteria relating to the four main objectives of SuDS design: quantity, quality, amenity and biodiversity.

The objectives of the evaluation process are to ensure that SuDS:

- meet mandatory (NSTS) and LPA requirements for water quantity and quality, amenity and biodiversity
- maximise opportunities for multi-functionality and amenity uses
- enhance biodiversity throughout the development
- integrate into the development's layout and design
- are appropriate, cost-effective and robust
- are practical to maintain in the long term.

5.4 SuDS design is considered at the beginning

In the past, drainage was usually considered at the end of the design process, with a piped drainage solution superimposed onto a site layout. In many respects the pipe infrastructure was independent of the topography, geology and other hydraulic and environmental characteristics of the site.

Sustainable drainage, however, must be integrated into the site design. It should reflect the topography, geology and drainage characteristics of the site together with the character of the landscape.

SuDS Concept Design ensures that SuDS can influence the layout of the development and is a key part of pre-application discussions.

A wetland at Fort Royal Primary School, Worcestershire, enhances biodiversity within the school grounds.

5.5 SuDS design is evaluated at each subsequent design stage

All aspects of SuDS design should be evaluated at each design stage.

The management of flows and volumes and the location of attenuation storage should be indicated to an appropriate level at the Concept, Outline and final Detail Design stages.

Similarly, the design will demonstrate the use of appropriate source control measures, conveyance and other SuDS components and how these are arranged in a management train with discreet sub-catchments.

The basic requirements of amenity and biodiversity must be demonstrated at each design stage.

Health and safety must be considered at each design stage, with confirmation that this has been achieved through the 'safety by design' principle (see section 8.5).

In the same way, effective, safe and cost-effective maintenance of the SuDS scheme will be ensured through careful design at every stage.

Design Note:

As SuDS components don't manage water most of the time, avoid colouring them blue on plan. Blue is best used for denoting permanent water bodies, like ponds and wetlands.

The 'swale maze' at Redhill School is usable as a play and education space when it's not raining and even in small rainfall events.