Comhairle Contae Chill Dara
Kildare County Council

Sustainable Drainage Systems

Guidance Document

Preface

Why this guide is needed

The 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, reduced biodiversity, increased likelihood of contaminated runoff polluting our watercourses and the loss of our relationship with water and the benefits it can bring to us all.

Kildare County is under significant pressure with an ageing drainage system that is at capacity. As the pressures of climate change continue, we need to build resilience into our drainage systems to deal with both current and future pressures.

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.

It is intended that this guide will facilitate the best possible SuDS designs.

Who this guide is intended for

This Guide is primarily intended for those designing SuDS for new developments within the Kildare County Council (KCC) region. The Guide will support the planning process, where SuDS schemes which form part of planning applications are assessed by KCC against the Policies and Objectives set out in the Kildare County Development Plan along with requirements outlined by the KCC Strategic Flood Risk Assessment and the Greater Dublin Strategic Drainage Study.

What the guide provides

This guide promotes the idea of integrating SuDS into the built environment 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.

The three accepted design stages are described: Concept Design, Outline Design and Detail Design outlining the level of detail that should be considered at each stage of the design process. This guide provides guidance on both major and minor development. A SuDS approach can be applied regardless of development size.

This guide draws upon the author's 25 years of practical experience in the application of SuDS.

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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.

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Kevin Barton has been working as a Landscape Architect for over 25 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 water companies; presented on SuDS topics at domestic and international conferences; provided expert SuDS training through CIRIA and directly to local authorities.

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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.

Acknowledgements

We would like to thank the members of the Kildare County Council (KCC) SuDS Project Client Team:

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Building and Development Control
Development Management
Environment
Forward Planning
Housing
Municipal Offices
Parks and Recreation
Roads Projects
Strategic Projects and Public Realm
Sustainable Transport
Water Services

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Introduction

SECTION 1.0

Overview

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 in Ireland

During the late 1990s an awareness of better ways to manage rainfall runoff began to influence thinking in Ireland. Ideas of better ways to manage rainfall from the US and Sweden were initially introduced into the City West Business Park Scheme in Dublin. The Greater Dublin Strategic Drainage Study (GDSDS) was published in 2005 and included a statement that mandated SuDS on new developments.

1.2 What are SuDS

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):

'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'

Image below: ***City West Business Park, Dublin***
Courtesy of Davy Hickey

1.3 Why SuDS are required in Kildare

Kildare County Council (KCC) has identified SuDS through the County Development Plan as the preferred way of managing rainfall from new developments of any type or scale of development from single houses to multi-phase mixed use developments.

'Development Plan Objective IN O22: Require the implementation of Sustainable Urban Drainage Systems (SuDS) and other nature-based surface water drainage as an integral part of all new development proposals'

SuDS if well designed, will make a valuable contribution to Kildare's urbanised areas, making them a more pleasant and healthy environment in which to live, work and play.

Our drainage systems have been subject to increasing pressure over recent years both through climate change and additional hard landscape being connected to the sewer.

The county population is projected to increase by 31,500 persons to 2026 with an additional 12,500 to the year 2031 . The resulting additional development will further increase the pressures on existing drainage networks . This means that the way that we deal with surface runoff will have to evolve and adapt as existing drainage networks have a finite capacity, whilst also tackling the effects of climate change and improving water quality in our network of rivers.

The likely impacts of climate change in Kildare County include increased risk and severity of flooding, deteriorating air and water quality within the river networks and biodiversity loss. Introduction of SuDS will assist in addressing these risks. The Kildare Climate Change Adaptation Strategy promotes the use of Sustainable Drainage.

1.4 Background to this document

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 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 supports the delivery of the Kildare County Development Plan (2023-2029), the Kildare Strategic Flood Risk Assessment (2023) and is complementary to the CIRIA 2015 SuDS Manual (C753) and 'Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas Water Sensitive Urban Design Best Practice Interim Guidance Document (2023).

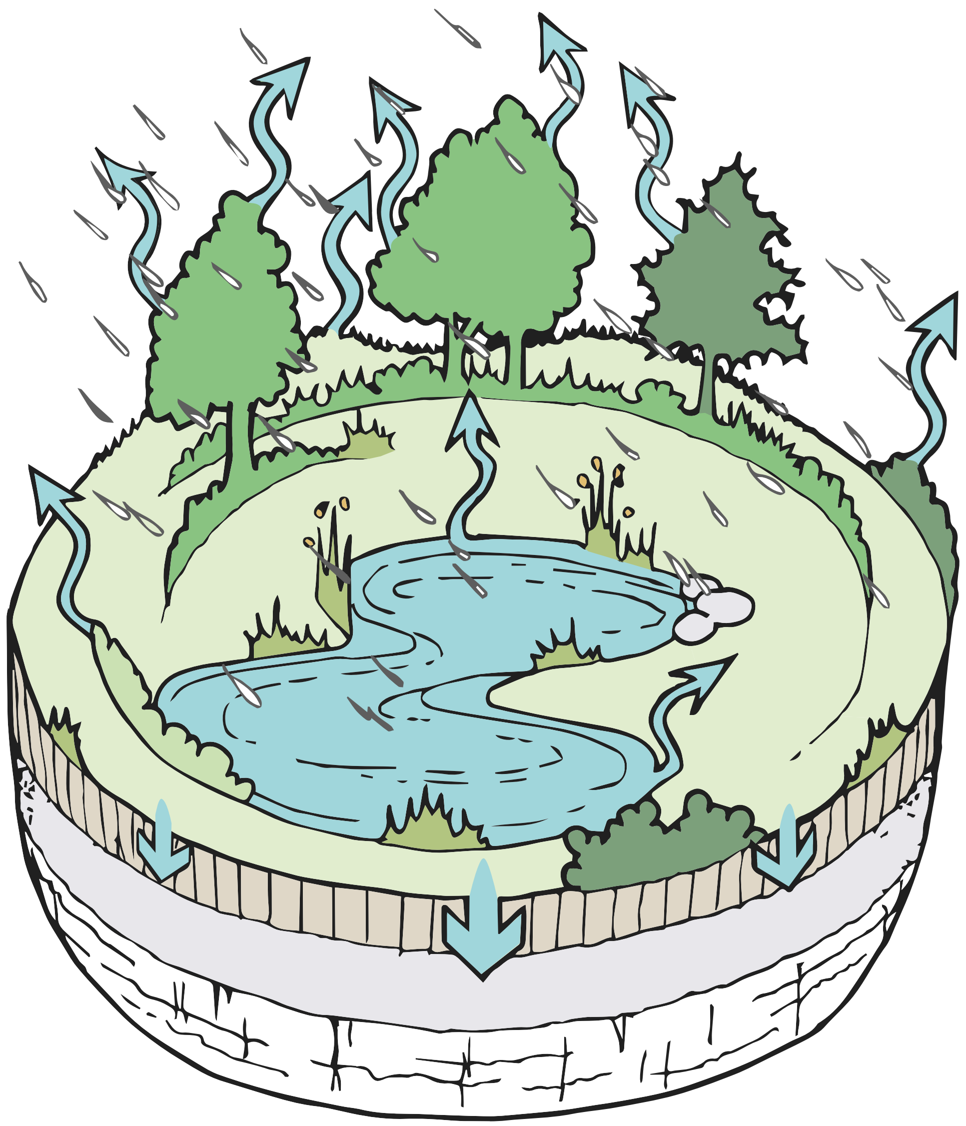
Understanding Rainfall

SECTION
2.0

Overview

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.

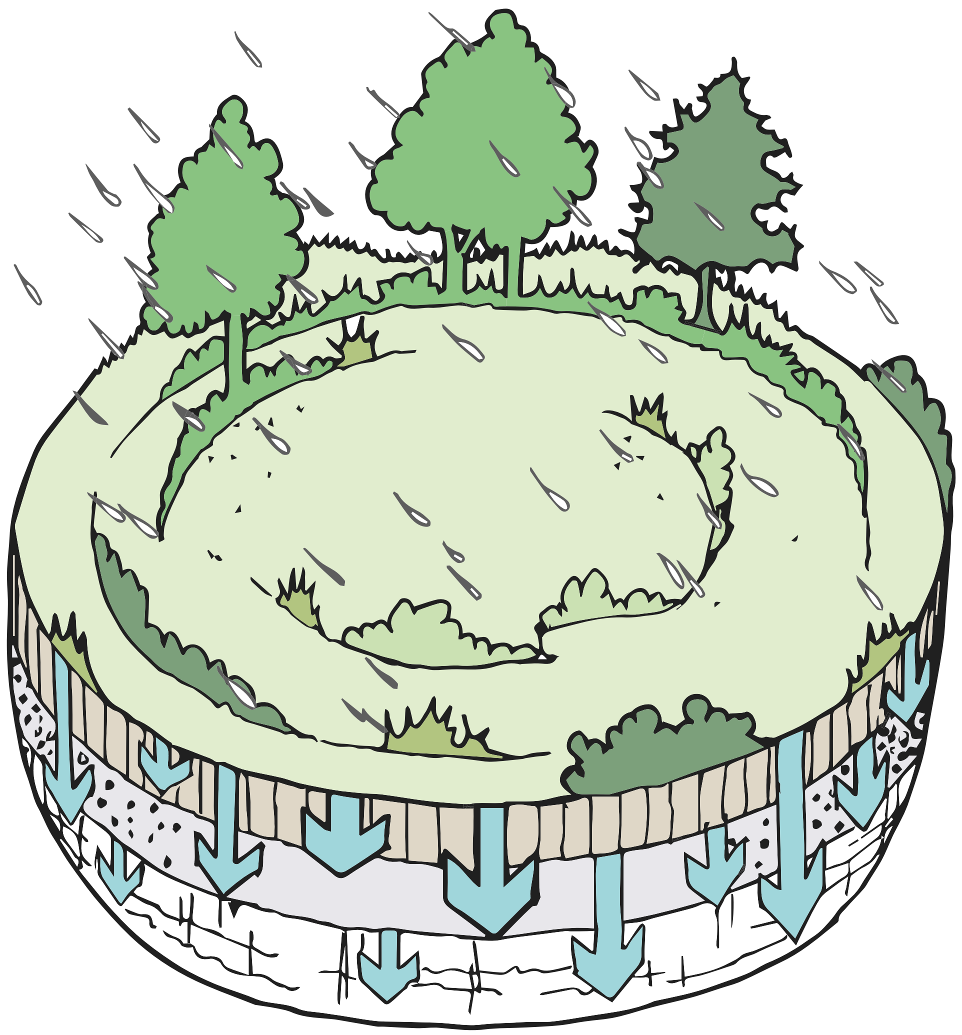
Image below: ***Interception losses in the natural landscape***



2.1 It begins to rain

In forests, meadows, 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.

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



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.

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**.

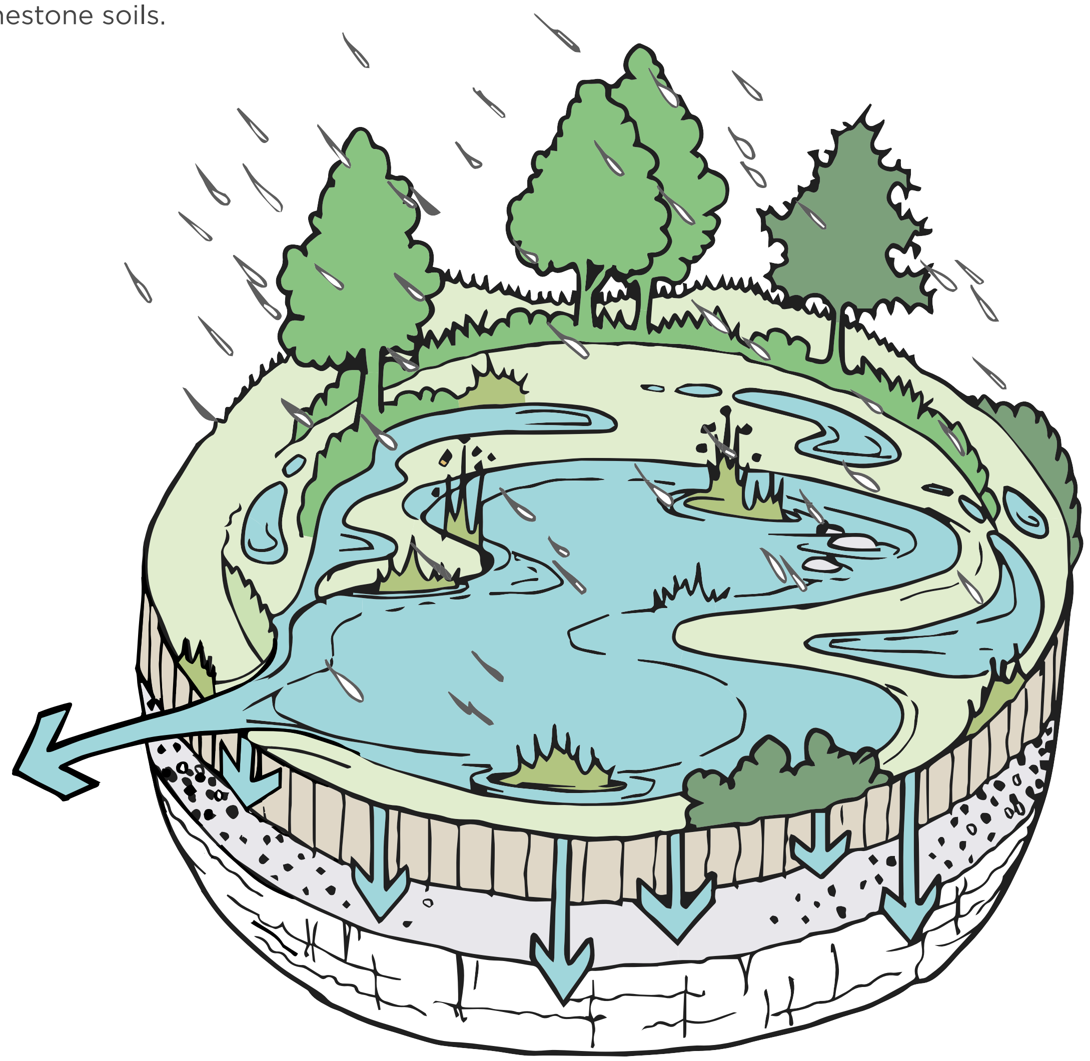


Image above: ***Surface flow rates are small at first, but increase with higher intensity rainfall events. The volume of runoff will generally be greater with increased rainfall intensity and duration.***

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.

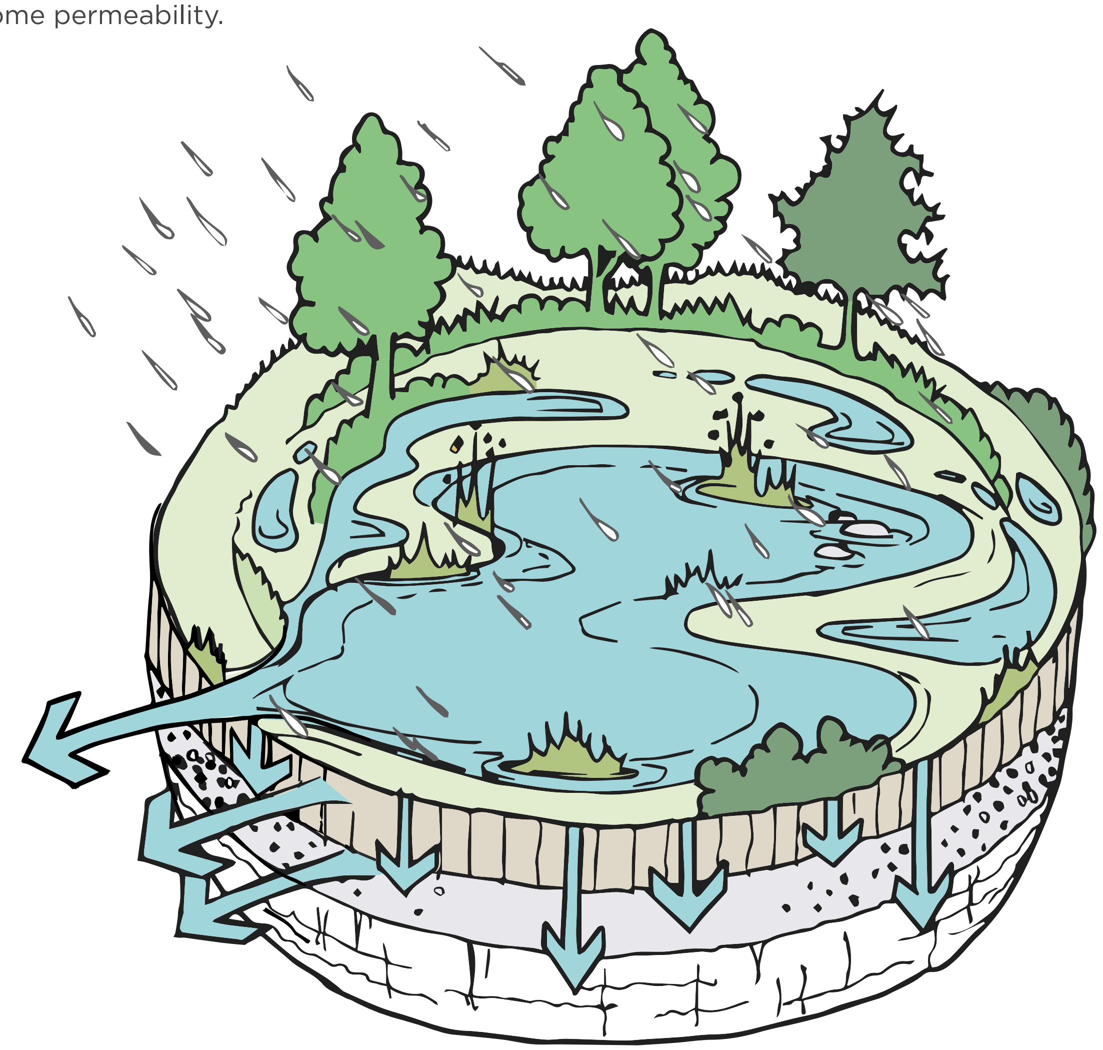


Image above: ***This dynamic process varies in accordance with permeability, the preceding weather conditions and extent of ground compaction.***

KCC SuDS Design Guide © 2024 Robert Bray Associates and McCloy Consulting

The Impact of Development

Overview

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 to both the people of Kildare County and the remaining natural environments, rivers and coastal waters.

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 continued urbanisation of Ireland 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**. The older parts of many areas in Kildare such as Kildare Town, Athy, Naas and The Curragh are served by combined sewers.

Kildare County has a strong network of towns, villages and smaller settlements, as well as minor development and single house developments in rural areas. These combine to make a measurable contribution to flooding and pollution.

Unfortunately, in newer separate sewer networks, 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 rainfall runoff at or near the surface.

Image below: ***The combined sewer.***

Image below: ***Separate pipes for foul sewage and surface water were introduced in the mid-twentieth century***

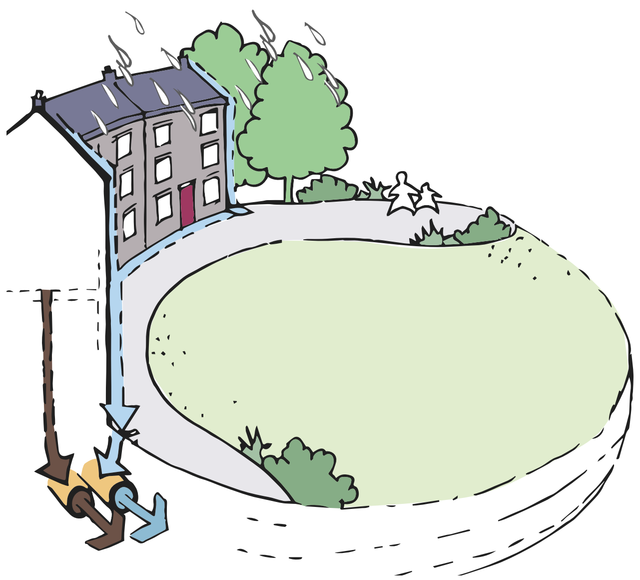
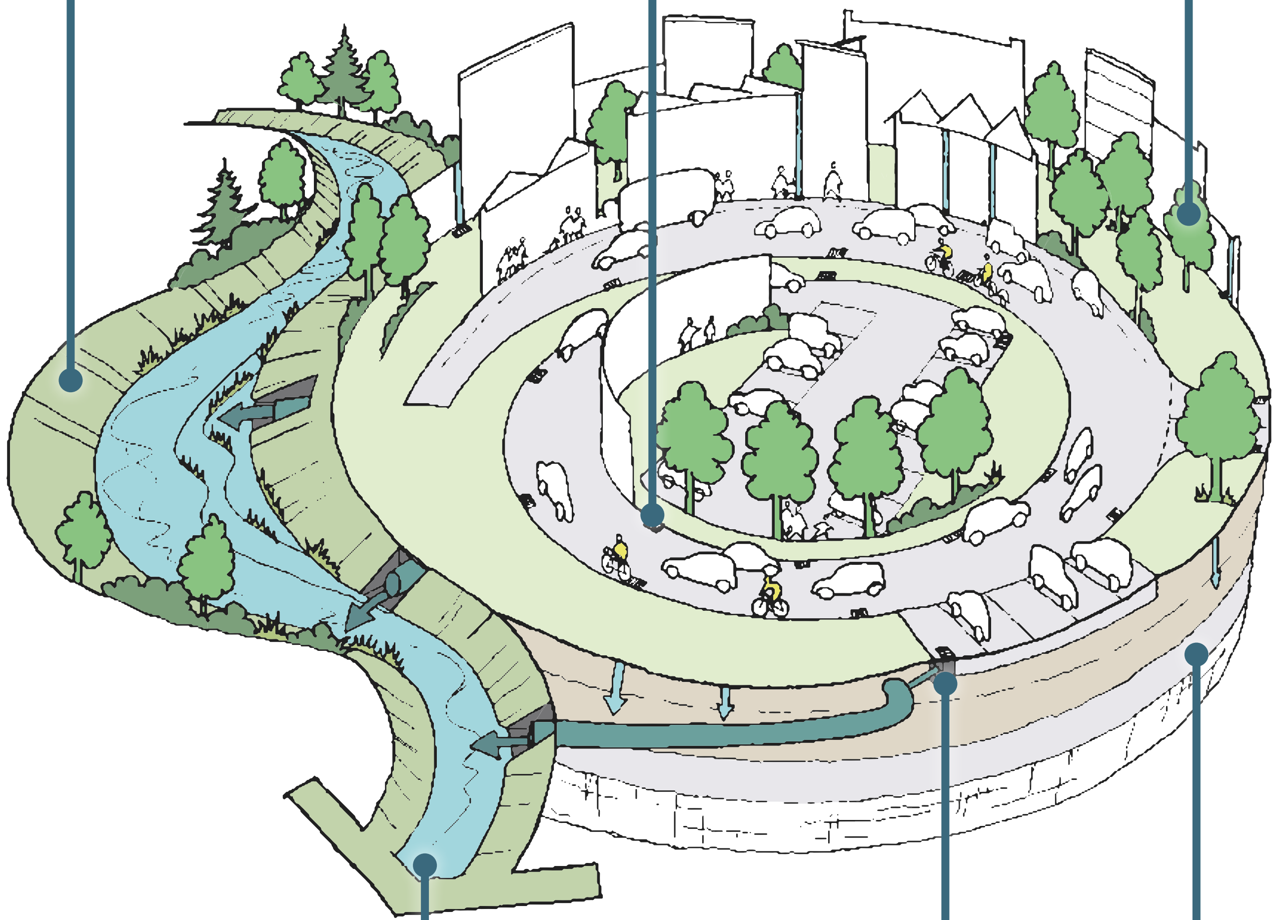


Image below: ***Conventionally drained landscape***



3.2 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 adversely affecting wildlife.**
- **Pollution from 'combined' sewers where too much rainfall causes an overflow of rainwater and sewage from the pipe to a watercourse.**
- **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.**

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

Image right: ***Example of bioretention raingarden***

The Role of SuDS in County Kildare

SECTION **4.0**

Overview

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 rainfall runoff contaminated by pollutants polluted flowing from development.

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

Many 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 habitat resulting from development can be mitigated when using a SuDS approach. It allows fauna and flora to flourish, and to connect with existing habitats.

Image above: ***Permeable Paving, Kildare Village***

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:

Signpost: Kildare County Council development plan (2023-2029), Kildare SFRA (2023)

- **Amenity: enhancing people's quality of life through an integrated design that provides useful and attractive multi-functional spaces.**
- **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.**
- **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.**

Image below: ***SuDS Design Objectives***

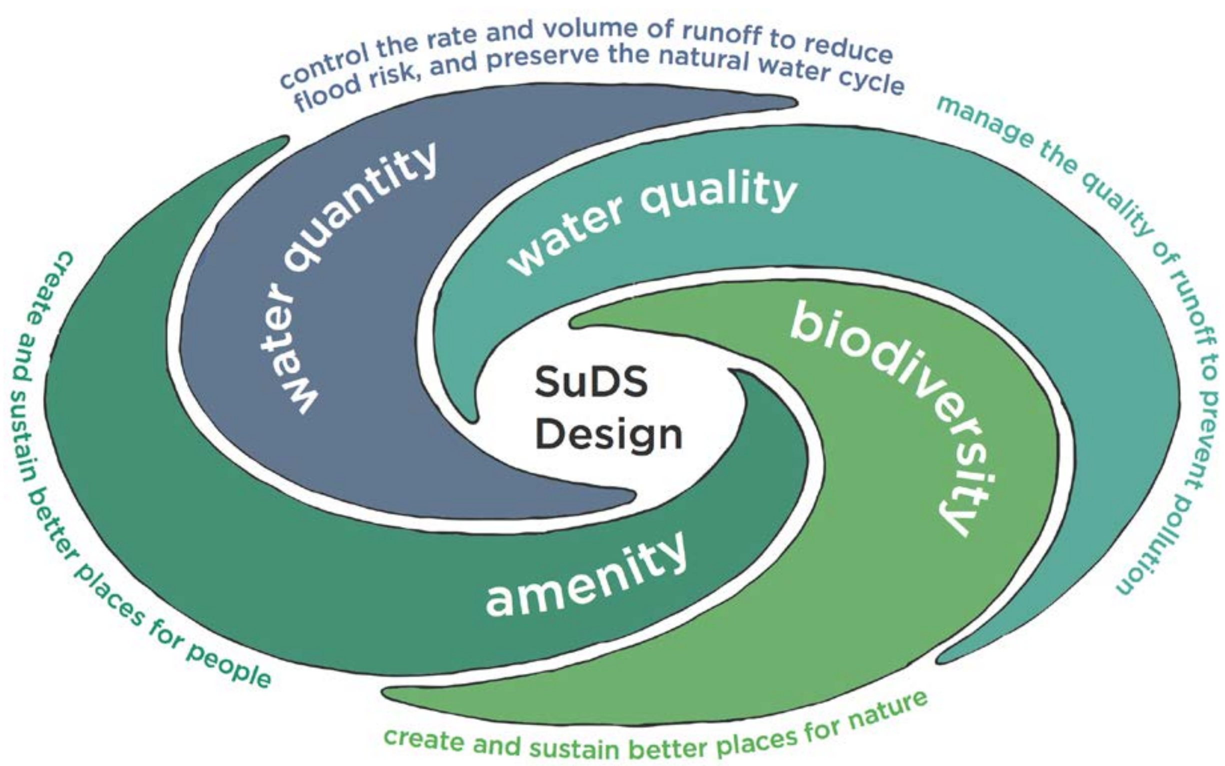
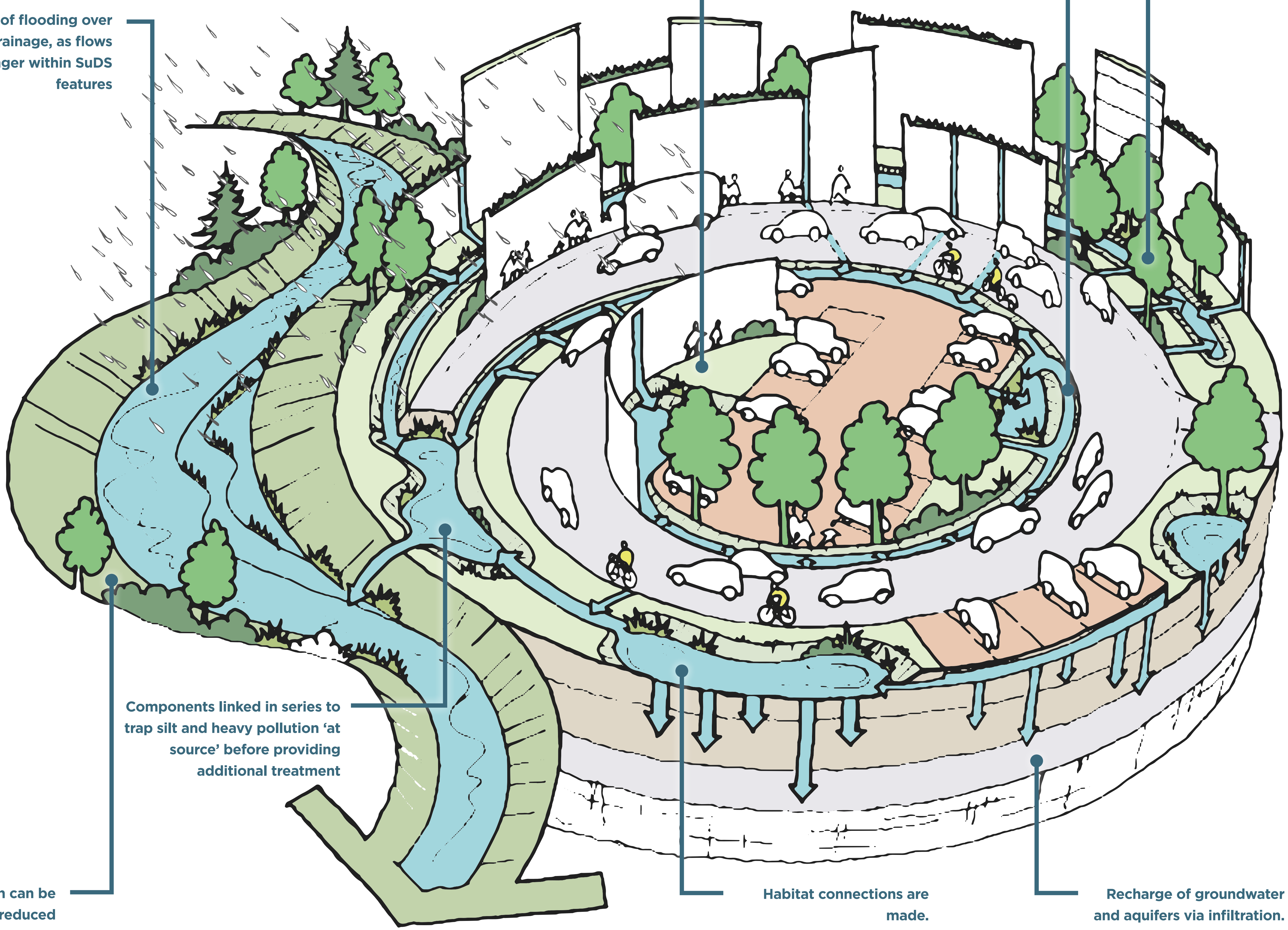


Image below:
Benefits of SuDS landscape



SuDS Design Requirements

SECTION
5.0

Overview

The following section sets out the SuDS design requirements which underpin delivery of the respective Development Plan policies and objectives.

5.1 SuDS and the County Kildare Development Plan 2023-2029

The County Kildare Development Plan 2023-2029 (Development Plan) requires SuDS to be incorporated into new development. KCC considers that SuDS is appropriate and reasonably practicable in all types of development.

It is a policy of the Council to:

IN P4
Ensure adequate surface water drainage systems are in place which meet the requirements of the EU Water Framework Directive and the River Basin Management Plan in order to promote the use of Sustainable Drainage Systems

Meeting the associated objectives will assist in delivery against policy. Failure to demonstrate how objectives are fully and robustly considered within proposed scheme designs may impact upon planning application determinations.

IN O22
Require the implementation of Sustainable Urban Drainage Systems (SuDS) and other nature-based surface water drainage as an integral part of all new development proposals.

IN O24
Only consider underground retention solutions when all other options have been exhausted. Underground tanks and storage systems will not be accepted under public open space, as part of a SuDS solution.

IN O26
Ensure as far as practical that the design of SuDS enhances the quality of open spaces. SuDS do not form part of the public open space provision, except where it contributes in a significant and positive way to the design and quality of open space.

In instances where the Council determines that SuDS make a significant and positive contribution to open space, a maximum of 10% of open space provision shall be taken up by SuDS. The Council will consider the provision of SuDS on existing open space, where appropriate. The 'Sustainable Urban Drainage Systems Guidance Document' prepared as an action of this plan shall supersede this standard.

This guide will explain the design approaches to achieving integrated design may facilitate achieving a greater percentage of open space to deliver SuDS functionality.

5.2 Designing SuDS to support delivery of the County Development Plan

A cohesive and integrated design should consider how SuDS can support the delivery of the Development Plan policies and objectives, and maximise the multifunctionality of the scheme.

Design note: Delivering high quality SuDS which are nature based and integrated with the development will support the delivery of wide range of the Development Plan policies and objectives contained in the following Development Plan chapters

- **Chapter 3. Housing**
- **Chapter 5. Sustainable Mobility and Transport**
- **Chapter 6. Infrastructure and Environmental Services**
- **Chapter 12 - Biodiversity and Green Infrastructure**
- **Chapter 15. Development Management Standards**

5.3 Hydraulic requirements

Hydraulic requirements are as set out in the GDSDS and Regional Drainage Code of Practice.

IN 023
Require new developments to reduce the generation of storm water runoff and ensure all storm water generated is disposed of on-site OR attenuated and treated prior to discharge to an approved water system, with consideration for the following:

- ***The infiltration into the ground through the provision of porous pavement such as permeable paving, swales, and detention basins.***
- ***The holding of water in storage areas through the construction of green roofs, rainwater harvesting, detention basins, ponds, and wetlands.***
- ***The slow-down in the movement of water.***

IN 027
Ensure that all development, including rural one-off residential developments will maintain existing surface water drainage systems, particularly at access points to the development

Criterion	Sub-criterion	Return Period (years)	Design Objective
Criterion 1 River water quality protection	1.1	<1	Interception storage of at least 5mm, and preferably 10mm, of rainfall where runoff to the receiving water can be prevented.
Criterion 2 River regime protection	2.1	1	Discharge rate equal to 1-year greenfield site peak runoff rate or 2l/s/ha, whichever is the greater. Site critical duration storm to be used to assess attenuation storage volume.
	2.2	100	Discharge rate equal to 1 in 100 year greenfield site peak runoff rate. Site critical duration storm to be used to assess attenuation storage volume.
Criterion 3 Level of service (flooding) for the site.	3.1	30	No flooding on site except where specifically planned flooding is approved. Summer design storm of 15 or 30 minutes are normally critical.
	3.2	100	No internal property flooding. Planned flood routing and temporary flood storage accommodated on site for short high intensity storms. Site critical duration events.
	3.3	100	No internal property flooding. Floor levels at least 500mm above maximum river level and adjacent on-site storage retention.
	3.4	100	No flooding of adjacent urban areas. Overland flooding managed within the development.
Criterion 4 River flood protection (Criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.

5.4 Water Quality

KCC policies and objectives applicable to water quality requirements are;

IN P2
Ensure the protection and enhancement of water quality throughout Kildare in accordance with the EU WFD and facilitate the implementation of the associated programme of measures in the River Basin Management Plan 2018-2021 (and subsequent updates).

IN 05
Manage, protect, and enhance surface water and groundwater quality to meet the requirements of the EU Water Framework Directive

KCC will require demonstration that the SuDS design provides sufficient treatment to cater for the anticipated pollution risk to protect to protect the receiving watercourse, groundwater and SuDS features intended to provide amenity or biodiversity value. KCC will consider the number of SuDS techniques in series (SuDS management train) along with their design to enable the robust removal of pollutants.'

5.5 Amenity & Biodiversity

KCC policies and objectives applicable to amenity and biodiversity SuDS requirements are;

Policy B1 P15
Promote and support the development of Sustainable Urban Drainage Systems (SuDS) to ensure surface water is drained in an environmentally friendly way by replicating natural systems.

Objective IN O26
Ensure as far as practical that the design of SuDS enhances the quality of open spaces. SuDS do not form part of the public open space provision, except where it contributes in a significant and positive way to the design and quality of open space.

In instances where the Council determines that SuDS make a significant and positive contribution to open space, a maximum of 10% of open space provision shall be taken up by SuDS. The Council will consider the provision of SuDS on existing open space, where appropriate. The 'Sustainable Urban Drainage Systems Guidance Document' prepared as an action of this plan shall supersede this standard.

SuDS where well designed and incorporated into open space at the start of the design process, have the potential to make a significant provision for biodiversity and opportunities for high quality amenity value, including private shared spaces and commercial spaces open to the public.

The SuDS Strategy should complement the Open Spaces Strategy and form part of balanced open space provision providing opportunities for both active and passive recreation. KCC will consider the following in determining the areal extent of SuDS features which contribute to POS.

- **contribute in a significant and positive way to the design and quality of open space,**
- **enhance biodiversity and amenity value, and link with the existing Green Infrastructure network in the settlement.**
- **provide an open space benefit even when holding surface water (for example ponds and wetlands),**
- **be readily available for use in most weather conditions,**
- **be accessible and usable**
- **be designed by a multi-disciplinary team to include a drainage engineer, ecologist, arborist, landscape architect etc. as part of the overall project.**

SuDS which form part of public open space provision will be assessed on a case-by-case basis by the planning authority, having regard to site specific conditions and the quality of design.

5.6 Single dwelling developments

KCC expect SuDS to be applied in single dwelling developments. It is anticipated that a simplified approach can be taken to the delivery of SUDS for these sites.

Flood risk

In lieu of detailed hydraulic calculations for storage KCC will accept demonstration of provision of temporary storage of rainfall runoff in accordance with the following

- **•For single house developments where attenuated surface water run off discharges to a surface water pipe or watercourse, attenuation storage requirements are estimated to be 80 litres for every square metre of impermeable development (roof, driveway and paved area) surface being drained.**
- **•Where rainfall is discharged via infiltration, an infiltration rate should be established along with determining the development area being drained to allowing sizing of the SuDS feature.**

Water quality

KCC will expect any runoff from areas regularly trafficked by vehicles to pass through a minimum of one SuDS component.

Amenity and Biodiversity

There are no County Development Plan amenity and biodiversity requirements for single dwelling developments. Homeowners are encouraged to maximise benefits for amenity and biodiversity through integration of SuDS which are nature based and provide benefits to the home and wider area.

IN 028
Ensure development proposals in rural areas demonstrate compliance with the following:

• The ability of a site in an un-serviced area to accommodate an appropriate on-site surface water management system in accordance with the policies of the Greater Dublin Strategic Drainage Study (2005), in particular those of Sustainable Urban Drainage Systems (SuDS).

• The need to comply with the requirements of the Planning Systems and Flood Risk Management Guidelines for Planning Authorities, published by the Minister for the Environment, Heritage, and Local Government (2009)

Image above: ***Ballymore Development, Riverwalk Ballymore Eustace***

5.7 SuDS taking in charge

Where KCC it agree in principle that SuDS features will be taken in charge, it must be demonstrated that SuDS features;

› **are within lands vested to KCC**

› **are accessible for maintenance**

› **have suitable and appropriate operation and maintenance requirements**

› **adhere to KCC taking in charge requirements.**

SuDS features proposed by developers to be taken in charge by KCC should demonstrate how they comply with KCC taking in charge specifications.

SuDS features within the curtilage of a private property shall remain the responsibility of the property owner.

Signpost: Refer to KCC for taking in charge requirements

Permeable pavement can be used to temporarily store rainfall runoff, either for slow release to a watercourse or drain or for infiltration to the underlying soils.

5.8 Other requirements

SuDS may be within curtilage of the property, within public open space or within the road corridor. Depending upon the site layout and context, other requirements that SuDS will have to meet as part of the multifunctional landscape design are contained within the following;

› **Greater Dublin Regional Code of Practice for Drainage Works**

› **Building Regulations Technical Guidance - Document H**

› **CIRIA SuDS Manual 2015 (and subsequent revisions)**

› **Design Manual for Urban Roads and Streets - Advice Note 5: Urban Drainage**

Additional guidance is provided by 'Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas - Water Sensitive Urban Design Best Practice Interim Guidance' document.

Communication between the design team and KCC during the design process will aide designers and developers to deliver successful and cost-effective SuDS projects.

Design Note: SuDS retrofit schemes may also require planning including those undertaken by KCC directly (Part 8 of the Planning and Development Regulations 2001).

Design Note: Industry guidance is a useful for informing design. Designers should self-validate that any guidance or specification being used is 'fit for the purpose intended'. This Guide will not be consistent with other guidance or specifications in all instances.

Image below: ***Bridget Joyce Square, London - multifunctional SuDS design, creating & safe playful landscape in front of a School***

SuDS & The Design Process

SECTION 6.0

6.1 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.

To achieve integration of SuDS into the site layout, the design should reflect the topography, geology and drainage characteristics of the site together with the character of the landscape and have due consideration of any impact on heritage assets.

To maximise the opportunities that SuDS can contribute to the development a multi-disciplinary design team should be in place from the start of the project.

SuDS Concept Design ensures that SuDS can be properly considered as part of the layout of the development.

6.2 Design and evaluation

This guide follows the process of design from the earliest consideration of potential development through to detailed design. Development of the SuDS design in parallel with the overall scheme design will minimise the risk of missed opportunities for integration of SuDS as part of the fabric of the development.

KCC will facilitate discussion of SUDS as part of the pre-application consultation process as appropriate. To inform discussions a concept plan should be presented by the design team, illustrating proposed SuDS source controls, methods of conveyance and site storage , integrated as part of the site layout.

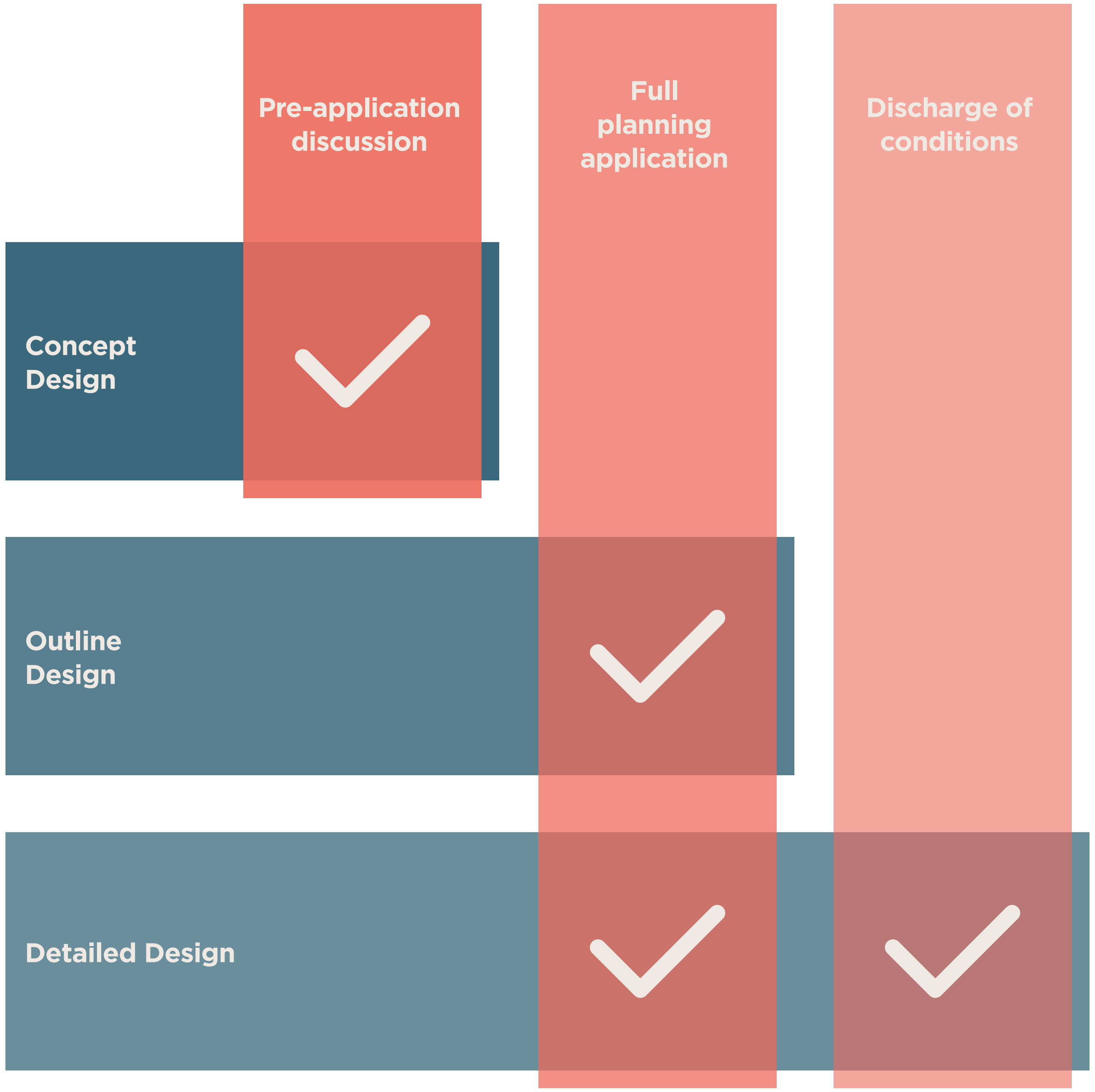
6.3 The objectives of evaluation

Throughout the various design stages the emerging designs should be evaluated by the designer 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 requirements for water quantity and quality, amenity and biodiversity**
- **integrate into the development's layout and design**
- **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.**
- **maximise opportunities for multi-functionality and amenity use**
- **enhance biodiversity throughout the development**
- **take opportunities to conserve and enhance built and natural heritage assets**
- **are appropriate, cost-effective and robust**
- **are practical to maintain in the long term**
- **considered Health and safety must at each design stage, with confirmation that this has been achieved through the 'safety by design' principle (see section 8.5).**
- **meet the requirements of Greater Dublin Regional Code of Practice for Drainage Works, and Design Manual for Urban Roads and Streets (Advice Note 5 - Urban Drainage) and follow KCC taking in charge standards and specifications where SuDS are proposed to be taken in charge.**

The checklists contained within this Guide act primarily as a self-checking aide for the designer, to ensure that critical aspects of the design have been considered. Additional checks can be carried out by the designer, dependent on the complexity and sensitivity of the scheme.



Stage 1 Concept Design

SECTION 7.0

Overview

SuDS Concept Design is used to express initial ideas for the management of rainfall within a development. It is also applied through masterplanning of major development sites and the preparation of local area planning, to ensure that sufficient consideration Is made for the conveyance and storage of rainfall runoff.

7.1 Objectives of SuDS Concept Design

Development of a SuDS Concept Design will ensure that SuDS opportunities are properly explored from the initial design stage.

The Concept Design Plan and Preliminary Design Statement are necessary where discussions with KCC are proposed at pre-application stage.

The development of surface water management strategies for Local Area Plans and masterplans will follow the SuDS concept design process.

7.2 Presentation of the Concept Design

The Concept Design information will usually be presented in two parts:

- **a plan with all aspects of the design that can be shown graphically, and**
- **a short SuDS design statement including information such as hydraulic data providing an initial idea of storage volumes required and how these will be accommodated by the scheme layout.**

The Concept Design will reflect the criteria and performance parameters set out in the Site Specific Flood Risk Assessment for the development (where present) along with the relevant policies within the Development Plan (or Local Area Plan).

Key data and information will include:

- **data to inform the design where relevant e.g. maps of site context, outline river, and surface water flood risk, and ground water source protection zones**
- **a drawing to identify existing landscape and habitat features that may influence SuDS proposals**
- **information on utility services, as these may fundamentally affect the SuDS design, particularly on previously developed land or SuDS retrofit schemes**
- **a contour plan using the best source of topographical information available.**
- **Any available geology information**

Sign post: Geology information

7.3 What Concept Design demonstrates

The SuDS Concept Design will enable the Designer along with the Evaluator/Planning Authority to understand how proposed development will impact on:

- **the site and its natural hydrology**
- **historical drainage elements where these are present**
- **the ecology of the site and its surroundings**
- **the landscape character of the locality**
- **natural flow routes.**

Evaluation will begin with:

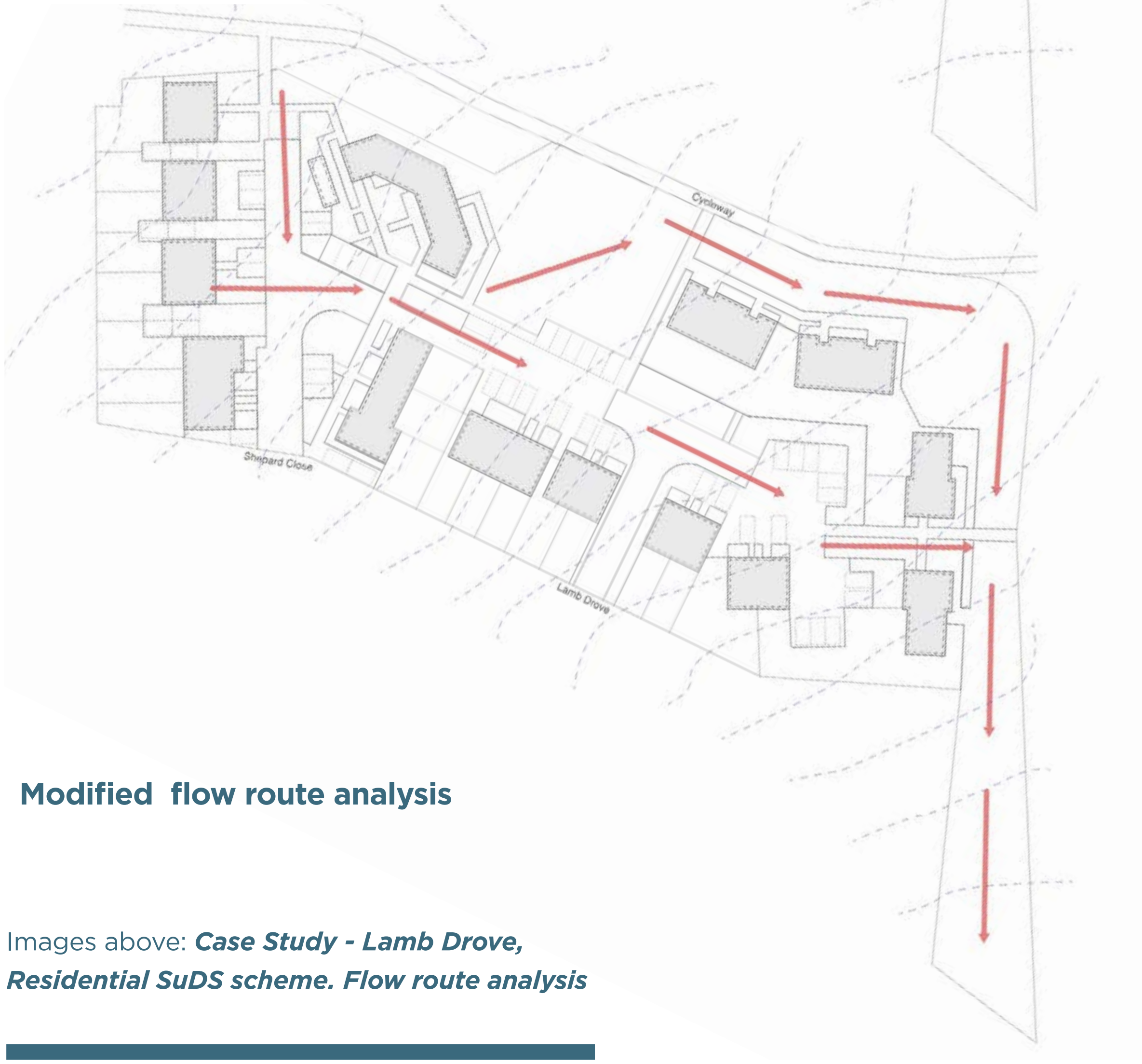
- **existing flow route analysis for the existing site**
- **a modified flow route analysis for the proposed development.**

Preliminary design will include:

- **Runoff collection – how rainfall is collected and conveyed to source control features.**
- **Source control – runoff managed as close as possible to where rain falls.**
- **The management train – SuDS components and storage features linked in series, which convey flows along modified flow routes through the development.**
- **Sub-catchments – small discrete areas that manage their own runoff.**
- **Maintenance – effective performance and reasonable care costs.**

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.

Existing flow route analysis



Modified flow route analysis

Images above: ***Case Study - Lamb Drove, Residential SuDS scheme. Flow route analysis***

7.4 Concept Design process

7.4.1 Flow route analysis

The natural hydrology, and the way that a development affects how rainfall behaves on a site, are assessed initially by flow route analysis.

The first step in flow route analysis is to consider how a site behaves naturally before development. This analysis can be applied to re-development and retrofit sites and is informed largely by topography and geology. There may be a number of other factors influencing the analysis, including:

- **historical drainage e.g. pipe network or land drains**
- **discharge locations**
- **contamination issues**
- **existing landscape features**
- **habitat considerations.**

A topographical survey provides the basic template for determining existing and future flows. Geology indicates whether rainfall will flow from the site as runoff and / or infiltrate into the ground.

Designers should be mindful that a site that infiltrates naturally may not continue to infiltrate once it has been developed.

Kildare County has a varied urban typology, ranging from large urbanised towns where a building can take up the footprint of the site to peri-urban development and rural single dwelling developments. Flow routes are an important consideration for any type of development.

Consideration as part of the modified flow route analysis should be given to how flows can be managed at or above ground level.

Images below: ***Case Study - Lamb Drove, Residential SuDS scheme***

Top: ***Swale & Basin features***

Bottom: ***Signage demonstrating the SuDS management train***

Image above: ***Case Study - Lamb Drove, Residential SuDS scheme. SuDS Management train***

Legend - SuDS features

- Rainwater butt
- Underground rainwater pipe
- Swales
- Basins
- Permeable pavement
- Flow controls
- Flow route
- Exceedance route

7.4.2 Building the management train

A management train begins with source control, and uses surface conveyance, wherever possible, to link subsequent SuDS components in series. Integration of the management train should be considered from the Concept Design stage and throughout the design process.

The management train provides potential for 'interception losses' along its whole length, as well as through soakage into the ground, evaporation, and transpiration through the leaves of vegetation. It also reduces the rate at which runoff flows through the site and provides treatment of runoff as it passes through each SuDS component.

Selecting SuDS components within the management train:

› **Source Controls: green and blue roofs, permeable surfaces, filter strips, protected filter drains, together with swales and basins, provide the first stage of treatment, intercepting primary pollution and reducing runoff flow rates. Permeable surfaces can be used at source and will often store the whole attenuation volume for the site particularly on small sites negating the need for further storage.**

› **Site Controls: these features will normally be preceded by source controls and meet remaining storage requirements. Where there is insufficient storage at source, additional open conveyance and storage structures, such as basins and wetlands or ponds, will manage remaining runoff volumes on most sites.**

7.4.3 Collection of runoff from hard surfaces

The way that runoff is collected from roofs, roads, car parks and other hard surfaces is a critical consideration in any SuDS design.

Conventional drainage techniques such as gully pots and pipes, take flows underground, so that management of runoff at or near the surface is more difficult to achieve.

Surface collection in channels, gutters and permeable pavements, or as sheet flow onto grass surfaces, keeps runoff at or near the surface, enabling cost-effective construction and maximising the opportunities for **nature based** SuDS.

Collection of **runoff** at or near the surface also reduces maintenance costs, and allows for simple removal of blockages.

Image above: ***Collection of rainfall runoff through openings in kerb into a linear rain garden. Residential development, Leixlip***

Image above: ***Strategic Housing Development Harpur Lane, Leixlip, Co.Kildare - Permeable pavement managing runoff at source.***

7.4.4 Building the management train

Source Control features include pervious surfaces, filter strips, green / blue roofs, SuDS treepits, basins and swales. Source control features slow the flow of runoff and remove pollution at the beginning of the management train. Trapping pollution in nature based SuDS components, or stone based SuDS components, allows organic pollution such as hydrocarbons to biodegrade naturally over time.

Source control features protect the remaining parts of the management train, enhancing amenity and biodiversity within the development.

Providing Source control SuDS structures also ensures that SuDS components are less susceptible to erosion further down the management train, as runoff is not conveyed at peak flow rates along the system.

Design note: Source Control features, such as pervious pavements and blue-green roofs, can be designed to attenuate the 1 in 100 + CCA storage, with the introduction of a simple flow control device.

7.4.5 Conveyance of runoff between SuDS components

Runoff should be conveyed along the management train at or near the surface wherever possible. The features commonly used for this purpose are swales or other vegetated channels and hard-surfaced channels such as rills, gutters or dished channels in a more urban context. Conveyance is also possible through permeable pavement sub-base as well as filter drains and under-drained swales.

Surface conveyance can provide the following benefits:

- **a reduction in infrastructure costs**
- **increased interception losses**
- **treatment of pollution**
- **ease of maintenance**
- **easily understood SuDS operation – 'legibility'**
- **connectivity for wildlife**
- **attractive landscape features.**

Where runoff is conveyed below ground through a pipe, for example connecting one SuDS component to the next to facilitate crossing under a road or pathway, the invert level of the pipe should be kept as shallow as possible to re-connect flow into surface SuDS features downstream without adversely affecting their depth. Pipes should ideally only be used as short connectors, without inspection chambers or bends, to reduce the risk of blockage and allow simple rodding or jetting when necessary.

Signpost: Where shallow cover to pipework is proposed, this should be discussed with KCC Roads Department to ensure that the proposed design will be structurally adequate.

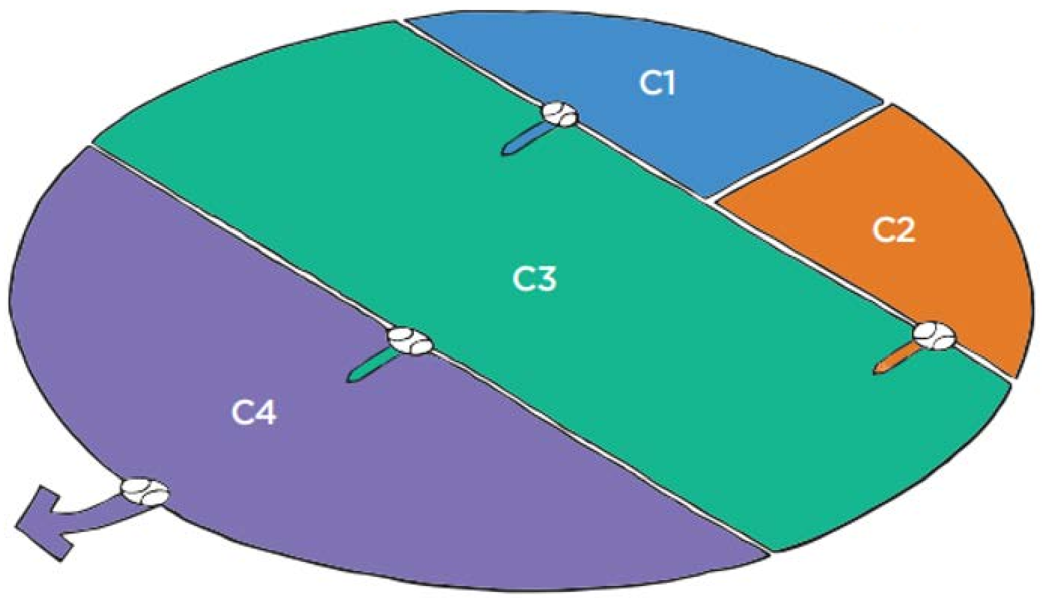
Image above: ***Shows shallow short piped connection under a driveway allowing the swale to remain shallow downslope.***

The CIRIA SuDS manual (Page 876) notes that:

"SuDS design usually avoids use of below-ground structures such as gully pots, oil interceptors, and other sumps which are a wildlife hazard, often ineffective and expensive to maintain."

Identification of surface or shallow sub-surface conveyance at the Concept Design stage is important to ensure that these pathways are retained through the remaining design process.'

Image below: ***Example sub-catchment areas & flow controls diagram***



Key

Flow control with controlled discharge from one catchment to the next

Sub-catchments are generally defined by flow controls. Flows are conveyed from one sub-catchment to the next.

7.4.6 Introducing sub-catchments

Many drainage designs adopt an approach where all flows are taken to the lowest point of the site and attenuated in a single location, often referred to as a '**pipe-to-pond**' or 'pipe to box' approach.

The 'pipe to pond' approach can result in unsightly, polluted and sometimes hazardous pond or basin features that offer little amenity or wildlife benefit. The 'pipe to box' approach results in below-ground structures that provide no amenity or wildlife benefit at all. All end of pipe solution may fill with silt and generate management problems.

When integrating SuDS into a development, the site should be divided into sub-catchments to maximise treatment and storage capacity.

The sub-catchment boundary is usually defined as the surface area which drains to a particular flow control and can be considered as a mini-watershed.

Flows are conveyed from one sub-catchment to the next along one or more management trains, following the modified flow routes determined early in the design process.

Each sub-catchment contributes flows to the following sub-catchment or to an outfall.

A flow control generally defines the downstream end of a sub-catchment, with the flow control situated at the lowest topographical point within the sub-catchment in locations that are accessible for inspection and maintenance.

Concept Design drawings should identify sub-catchment boundaries with associated storage and flow control locations throughout the development.

Design note: Integrating storage within sub-catchments, as part of site layout, greatly reduces the land take requirement for attenuation, by exploiting the inherent storage capacity of individual SuDS features.

7.4.7 Managing pollution

The treatment required to mitigate pollution depends upon the level of pollution hazard. An adequate number (and type) of SuDS components is required in order to intercept or break down pollutants.

Source control components are introduced at the beginning of any management train to protect the development and meet amenity and biodiversity criteria within the site.

The following table is based on the requirements for discharge to surface waters set out in the SuDS Manual, Chapter 26, Water quality management: design methods, (CIRIA, 2015).

Discharge to surface water (usually on impermeable soils)

Contributing Surface Type	Pollution Hazard Level	SuDS Components
Residential roofs	Very low	Discharge to any SuDS components
Normal commercial roofs	Low	Discharge to any SuDS components
Leachable metal roofs	Low but polluting	Bioretention or source control with one or two further SuDS components. Refer to Detail Design Section
Driveways, residential, car parks, low traffic roads, low use car parks (schools and offices)	Low	Permeable pavement or source control with one SuDS component
Commercial yards, delivery areas, busy car parks, other low traffic roads (except trunk roads and motorways)	Medium	Permeable pavement or source control with one or two further SuDS components. Refer to Detail Design Section
Haulage yard, lorry parks, waste sites, sites handling chemicals and fuels, industrial sites	High	Carry out detailed risk assessment and consult with the EPA.

Additional levels of treatment may be required where surface water discharges to protected waters or areas of environment sensitivity.

The National Planning Strategy RPO 7.15 states "Local authorities shall take opportunities to enhance biodiversity and amenities and to ensure the protection of environmentally sensitive sites and habitats, including where flood risk management measures are planned".

Image above: ***Shows the effects of 'day to day' pollution.***

Objectives set out in the KCC CDP states;

BI O1 Require, as part of the Development Management Process, the preparation of Ecological Impact Assessments that adequately assess the biodiversity resource within proposed development sites, to avoid habitat loss and fragmentation and to integrate this biodiversity resource into the design and layout of new development and to increase biodiversity within the proposed development. Such assessments shall be carried out in line with the CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine

The Ecological Impact Assessment will inform SuDS design and how nature based SuDS should be integrated with the layout.

BI O75 Require multifunctional open space provision within all new developments; this includes provision for ecology and sustainable water management.

Delivery of this objective should be a key consideration when designing open spaces. Designs should look to integrate ecological corridors, which can manage day to day rainfall runoff as well as providing exceedance flow paths.

Signpost: Regional Spatial & Economic Strategy

Where potential for infiltration exists, as is the case across significant parts of Kildare County, care should be taken not to put the ground water resource at undue risk of pollution (**Policy objective IN O5**).

- **For Low pollution hazard level developments (residential and roofed areas of other types of development) the Simple index approach can be applied – Table 26.2, 26.3 and 26.4 of the SuDS Manual.**
- **For Medium and High pollution hazard level developments (trafficked areas with exception of residential carparks and low traffic roads with less than 300 traffic movements per day) a risk screening can be undertaken to determine whether it is appropriate to infiltrate. Refer to table 26.5 and 26.6 of the SuDS Manual**

Signpost: Source protection zones can be sourced at EPA Maps

7.4.8 Method of discharge – how rainfall leaves the site

SuDS Designs should explore opportunities for; sustainable reuse of rainfall, recharge of aquifers and direct discharge to open watercourses; thus reducing the pressure on existing pipe networks. The way that rainfall leaves a development should follow the preferred hierarchy.

1. **Use surface water runoff as a resource (IN 03)**
2. **Use nature based SuDS features that deliver interception losses**
3. **Where appropriate, infiltrate runoff into the ground (IN 023)**
4. **Discharge to an open surface water drainage system**
5. **Discharge to a piped surface water drainage system**

Discharging runoff from a site may utilise one or more means of discharge. Full advantage should be taken with each method of discharge on the list in turn, prior to considering the next sequential option.

The older parts of towns in Kildare County such as Kildare town, Athy, Naas and The Curragh are served by combined sewer systems. In cases where all means of discharge have been fully explored and there are no other available means of discharging runoff other than to the combined sewer, the developer must obtain written agreement from Uisce Éireann to discharge.

Design note: Rainfall must never discharge into the foul sewer.

Depending on the site characteristics, drainage from different parts of the site can have different means of discharging.

	m3 (for the entire site)	m3/ of runoff stored / m2 of development	mm depth of runoff stored /m2 of development
Site Storage	800	0.08	80

Example above: ***Where a 10000m2 development area requires 800m3 of storage this could be expressed in the following ways.***

7.4.9 Preliminary flow and volume calculations

It is convenient to consider flow and volume requirements at this stage in the design process to ensure that natural losses are replicated, and sufficient volumes of runoff can be temporarily accommodated to allow for discharge from site via a flow control and/or infiltration. A modified flow route analysis will be required to show that runoff can be effectively conveyed to a discharge location.

Storage volumes are usually presented as a single volume for the entire site. This form of expression encourages the 'pipe to pond' practice and prevents simple comparison of storage values between similar sites.

Expressing storage as 'volume per m2' allows the designer to allocate storage throughout a site in discrete sub-catchments and provides a straightforward way for KCC to check that calculated storage volumes are as anticipated.

Ideally each sub-catchment will manage its own runoff up to the 1 in 100 year return period rainfall event. Where this is not viable, part of the storage volume will be provided depending upon the opportunities for storage within the subcatchment, with all residual flows cascaded into an adjacent sub-catchment or 'site control'.

This approach maximises the opportunity for storage throughout the development.

Design note: Where development is speculative, it may be necessary for the Concept Stage to estimate extent of impermeable areas likely to be anticipated based on proposed land use to inform the initial flow and volume calculations.

7.4.10 Infiltration

After any allowances have been made for the potential to harvest runoff, the next consideration in managing flows and volumes is to assess the ability of a site to infiltrate rainfall completely, partially, or discharge largely as runoff.

The ability of a site to infiltrate water should be evaluated considering:

- **the nature of the soil geology and capacity to infiltrate**
- **the risk to stability of the ground where infiltration is proposed**
- **the risk of pollution to groundwater**
- **the depth of seasonal groundwater**
- **the risk of unpredictable pathways being taken by infiltrating water.**
- **Potential ingress to combined or foul sewers**
- **damage to structures, buildings and roads, etc. by infiltrated water ingress**

County Kildare has significant potential for infiltration, particularly across the southern part of the county. The following figure identifies infiltration potential.

Building Regulations Part H indicates that Soakaways should not be constructed within 5m of a building or road or in areas of unstable land.

This is usually applied as a general rule where infiltration within the 5m offset from the foundation or structure is not permitted. The 5m guidance was originally intended for point infiltration 'soakaways' in susceptible soils and in close proximity to structures. SuDS design encourages 'blanket infiltration' features that are less likely to affect soil conditions, as they mimic grass surfaces around buildings. For blanket infiltration the geotechnical risk is greatly reduced and the distance offset for infiltration from adjacent buildings or structures will be at the professional judgment of a suitably qualified engineer.

Design Note: Significant areas of Kildare are currently used for infiltration and the geology across large parts of the county is suitable for infiltration. Passing flow through a SuDS component prior to infiltration will remove silt and reduce maintenance / increase the life of the infiltration feature.

Additional site investigations may be necessary to assess risks associated with infiltration, and design / assessment should follow guidance in the CIRIA SuDS Manual 2015, Chapter 25 p543.

Signpost: Risks Associated with Infiltration: CIRIA SuDS Manual 2015, Chapter 25

Signpost: Using SuDS Close to Buildings

Signpost: BRE Digest 365 - Soakaway design

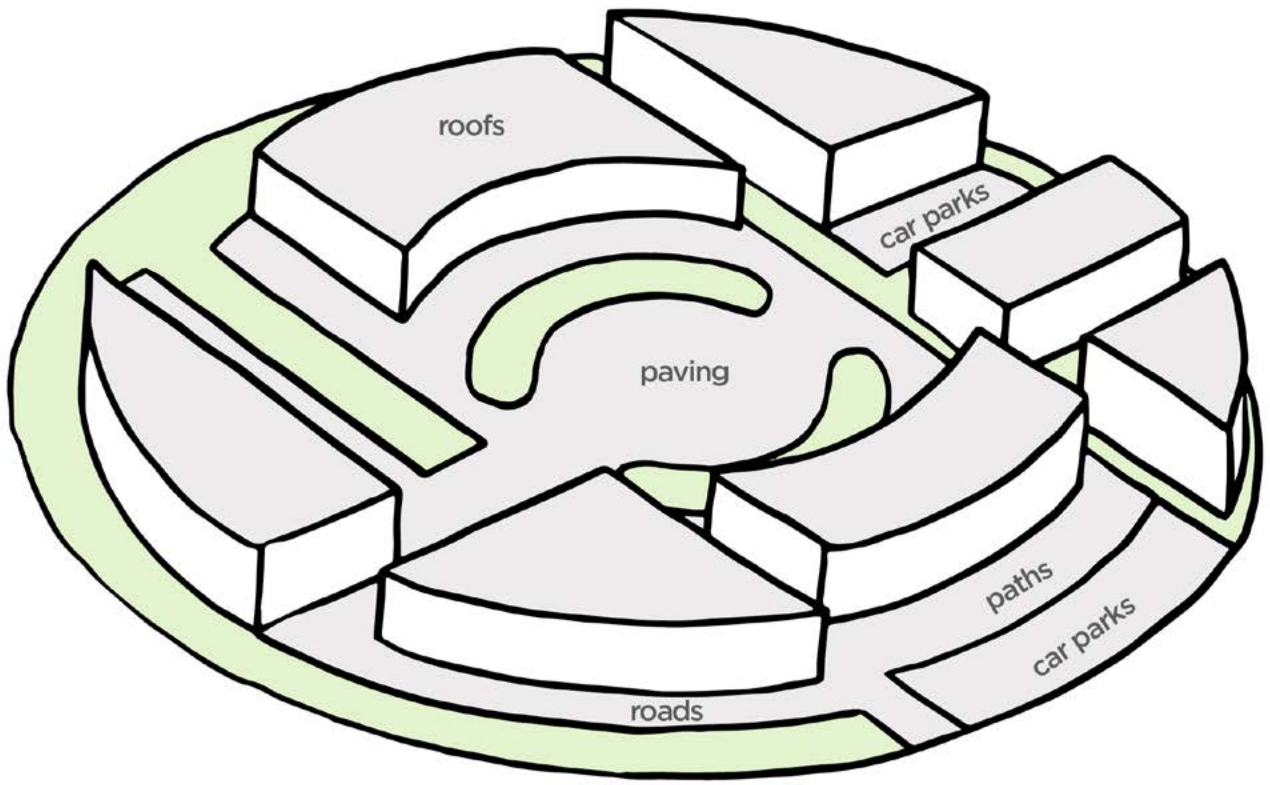


Image above: ***Example highlighting possible runoff areas of a site***

7.4.11 Managing runoff from site

If the site does not infiltrate effectively over all return periods, then rainfall will leave the site as outflow to a watercourse, or sewer.

New hard surfaces that are introduced through development increase both the rate and volume of runoff. This is because runoff flows more quickly from the site, and natural losses do not happen as they did before development. **Attenuation storage** is required when the rate of runoff being generated by a rainfall running off a developed surface (**inflow**) is greater than the flow control rate (**outflow**).

Design note: The website www.uksuds.com provides estimation tools for the calculation of 'greenfield runoff rates', 'attenuation' volumes and 'long-term storage' volume losses.

7.4.12 Defining areas of runoff

The inflow to the drainage system is calculated by multiplying the design rainfall by the developed area.

The area of development may change during the design process, but it is important to have an initial estimate of the amount of storage, to inform the layout of the SuDS design.

The area generating increased runoff is the developed area of the site, and **comprises roofs and hard surfaces (roads, car parks, paving, footpaths etc.) proposed for the site. Permeable surfaces should also be accounted for within calculations where they connect to the drainage system.**

7.4.13 Defining flow control rates

The maximum outflow from the site will be controlled to **greenfield runoff** rates where discharge is to the surface water sewer / watercourse. **Qbar** and **Qmed** are terms used to describe the average Greenfield runoff rate from the catchment that a site is situated.

Rainfall runoff is required to be managed (attenuated and contained on site) up to the 1 in 100 year rainfall event with allowance for climate change and urban creep. The term '1 in 100-year rainfall event' is used to define rainfall (intensity and duration) that statistically has a 1% chance of occurring in any given year. This can also be expressed as a 1 in 100 year event or 1% Annual Event Probability (AEP).

Discharge from the SuDS feature is restricted by a '**flow control**' which allows the stored water to drain down slowly.

7.4.14 Initial storage calculations

The approach to managing flows and volumes from developments – set out previously in the GDSDS seeks to minimise the impact of the additional volume and rate of rainfall runoff generated by development to pre-development patterns.

Estimating the volume of runoff to be stored on site at concept stage will ensure that this aspect can be considered in the development of site layout and locating of SuDS storage.

A useful online tool for estimating Greenfield runoff rates for concept design stage can be found at **www.uksuds.com**. The uksuds.com calculator is based on regional geological mapping which can be unrepresentative of actual site conditions. Inputs to the Greenfield runoff calculation should rely upon **actual soil types for the site** rather than regional geological maps.

Calculations will need to be re-assessed in latter design stages as the scheme design develops.

In SuDS design it is useful to use a range of return periods to identify everyday rainfall (e.g. 1 in 1 or 1 in 2 year events), occasional rainfall (e.g. 1 in 10 year events) and exceptional rainfall (e.g. 1 in 30 or 1 in 100 year events). This enables the allocation of different volumes in different places and encourages the use of sub-catchment design.

Design note: Storage volumes derived at Concept Design stage will be approximate and should demonstrate that the scheme is sensibly proportioned. The Designer should identify how attenuation storage will be distributed across the site at concept design stage.

For single house developments attenuation storage requirements are estimated to be 80 litres for every square metre of impermeable development (roof, driveway and paved area) surface being drained. Where this volume is demonstrated as being available within SuDS structures provided at the property, no further attenuation storage calculations will be required to be presented to KCC.

Detail on SuDS features which are applicable to single house developments are contained in Sections 10.1 - 10.11 (identified by S symbol).

7.5 Integrating SuDS as part of the development

Designers should consider opportunities within the fabric of the building, within public open space and as part of the streetscape to provide collection, treatment and storage of surface runoff prior to controlled release.

7.5.1 Integrating SuDS into the fabric of the development

On very high density, particularly where the building takes up the full footprint of the site, opportunities for storage of rainfall runoff as part of the building will need to be utilised.

The primary opportunities for storage of rainfall runoff will be part of green blue roofs (on both roofs and podium decks), within permeable surfaces, and storage within raised rain planters and SuDS tree pits. These features can be integrated into amenity design so that the space becomes multi-functional. Rainwater butts are now available which self empty (leaky and smart water butts).

Where a green roof is installed with a flow control to attenuate rainfall on the roof, this is referred to as a 'blue roof'.

Image left: ***Permeable pavement courtyard constructed over a podium deck.***

Image below: ***Residential development proposal***

7.5.2 SuDS as part of streetscape

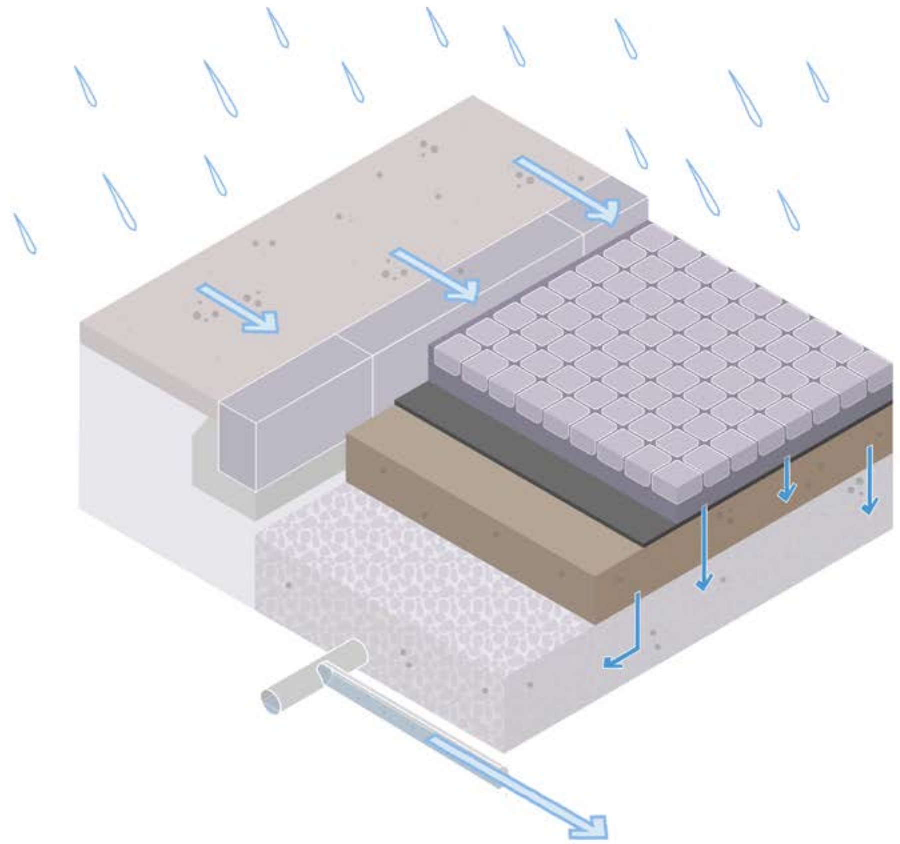
The methods that are used to collect and treat runoff such as permeable pavement, SuDS treepits and bioretention should also be considered for potential attenuation storage.

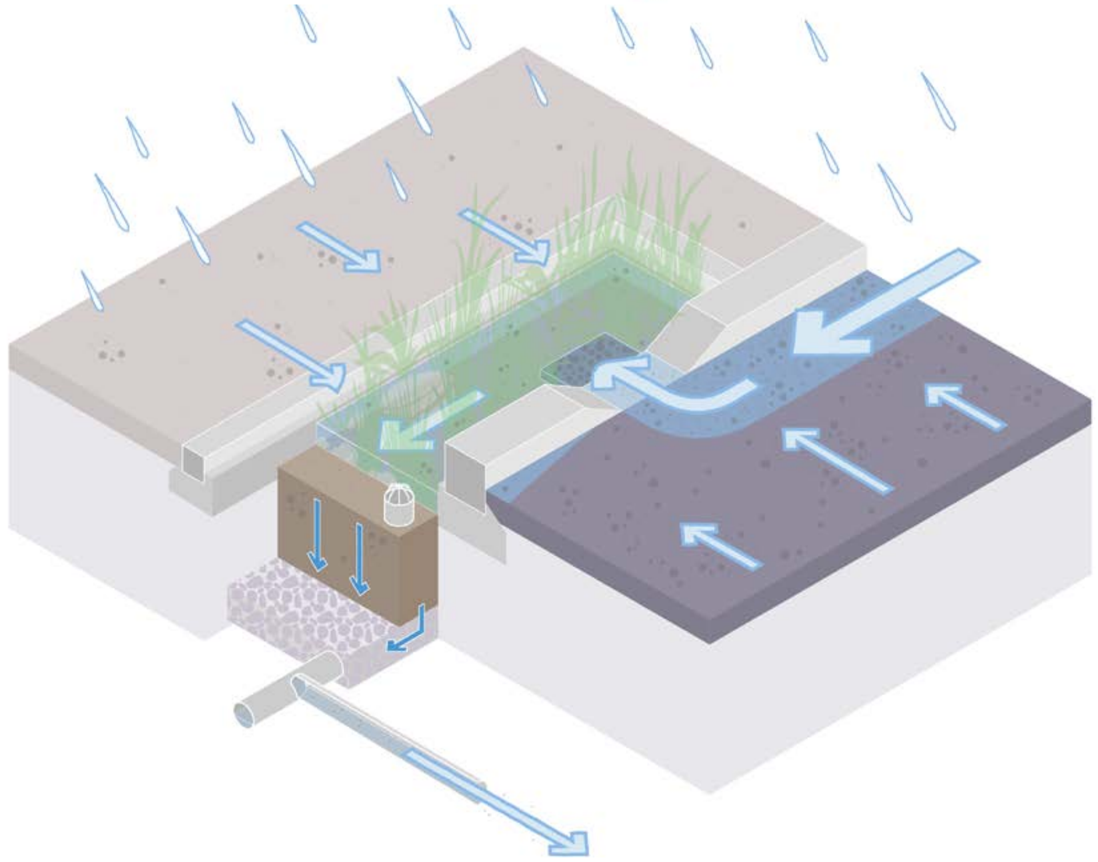
Simple flow controls such as orifice plates can be placed on the outlets from these systems, as the filtering runoff through the soil layers ensures that the outlet is protected from blockage.

Image below: ***Typical SuDs treepit diagram***

Image top right: ***Typical permeable pavement diagram***

Image bottom right: ***Typical bioretention raingarden diagram***





7.5.3 SuDS as part of public open space

Where rainfall runoff is managed in POS key design aspects for early consideration are;

- **How flow is collected. Flow should be collected at or close to the surface, using source control SuDS features prior to flow being conveyed to the public open space**
- **Landscaping of SuDS basins within public open space to provide variability of topography and avoid the entire base of the basin becoming waterlogged after each rainfall event.**
- **Provision of nature based play or other design aspects to integrate with SuDS**
- **Ensure that SuDS are designed to taking in charge standards for both new development and retrofitting existing developments.**

Images above & left: ***Examples of SuDS basins used for informal play by children. Features include a low flow channels and remain dry vast majority of the time.***

Signpost: See Section 8.7.6 SuDS in public open space

7.6 Local Area Plans & Masterplanning

The development of surface water management strategies for Local Area Plans (LAPs) and Masterplans will follow the SuDS concept design process.

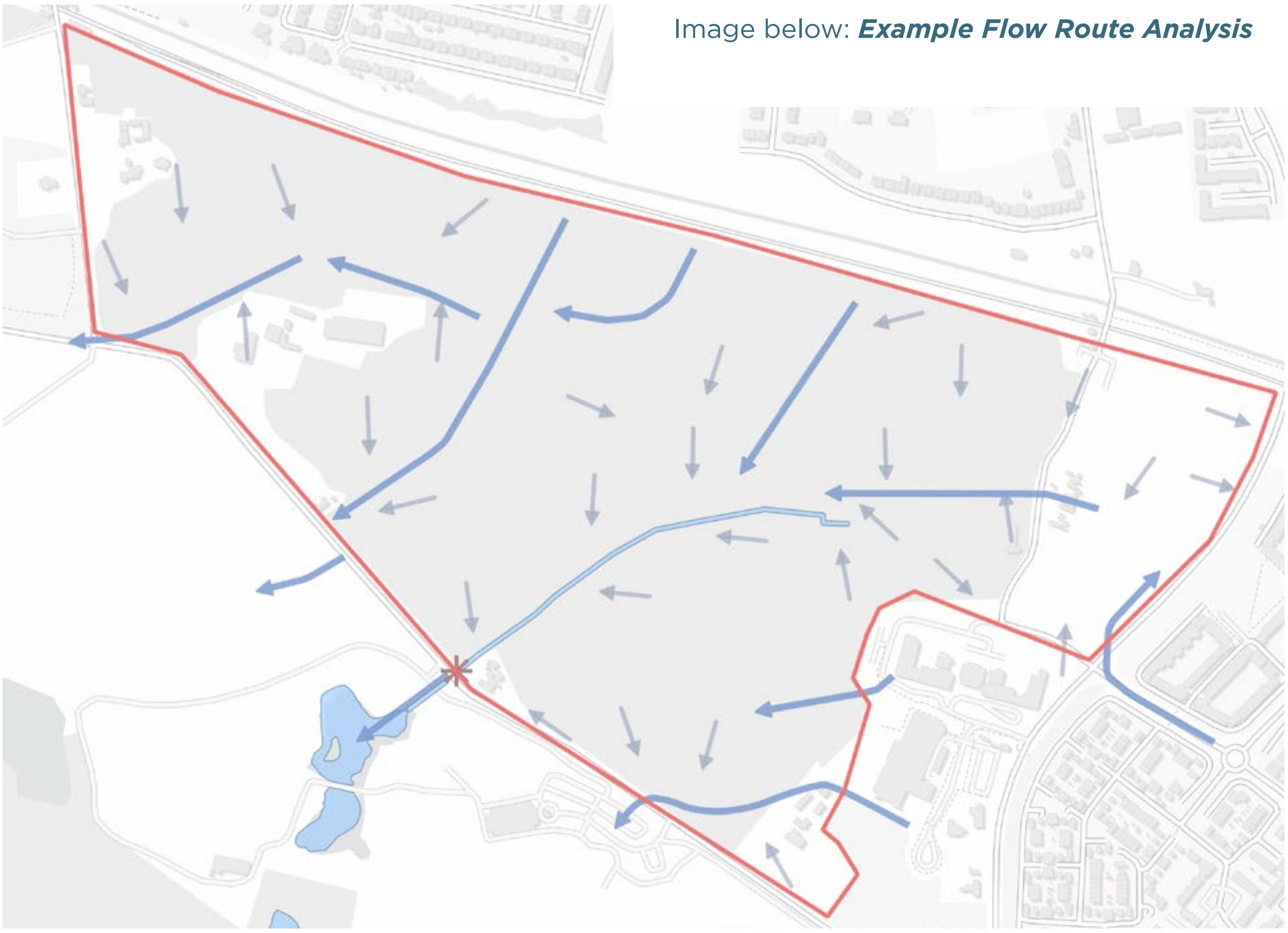
The natural hydrology and existing site characteristics should be assessed through flow route analysis to determine how the Plan Area behaves naturally before development. The SuDS design will have to consider how flows along these flow paths will be managed.

The modified flow route analysis is the basis for low flow conveyance, overflow arrangements and exceedance routes when design criteria are exceeded. The modified flow routes have been assessed in conjunction with the preliminary Plan Area layout and inform the concept SuDS design by suggesting a preferential flow path through the Plan Area.

Amenity and biodiversity site specific considerations should be identified which may further influence the modified flow routes.

Runoff from the Plan Area should be managed within subcatchments using natural overland conveyance. Flows will be conveyed from one subcatchment to the next along one or more management trains, following the modified flow routes. A comprehensive review of potential SuDS components relative to Plan Area characteristics should be undertaken to identify appropriate SuDS techniques at an early stage to be taken through the design process.

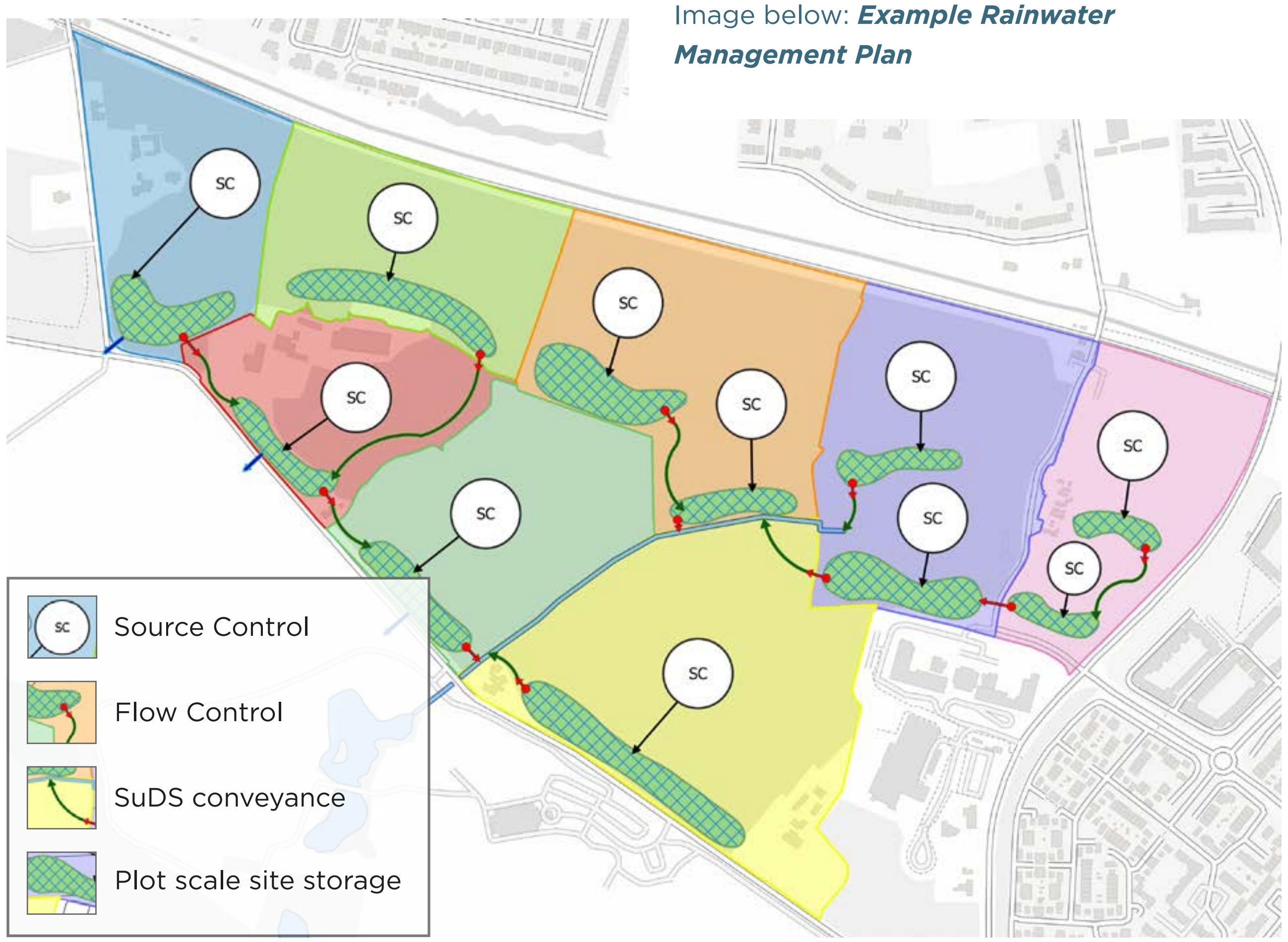
Image below: ***Example Flow Route Analysis***



The Rainwater Management Plan (RMP) for the Plan Area should identify any specific requirements pertinent to the future development. Considerations should cover;

- **Criteria or standards that the SuDS design should comply with**
- **Provisions for ownership and maintenance of the SuDS features**
- **Identification of any protected areas**
- **Identification of any site specific constraints (floodplains or presence of utilities etc.) known at this stage.**

Image below: ***Example Rainwater Management Plan***



7.7 Evaluating SuDS concept design

The information that the designer will collate at Concept Design stage will depend on the type and scope of the proposed development. The designer should check that all opportunities for SuDS have been explored and that the design will satisfy KCC Development Plan policy requirements prior to developing to outline / detailed design status.

Having a multi-disciplinary design team be in place from the start of the project will ensure that all key aspects have been considered at concept design stage.

Image below: ***The Curragh Racecourse, The Curragh, County Kildare - Image shows permeable pavement with potential for storing rainfall runoff***

7.7.1 Preliminary water quantity considerations

At the Concept Design stage, it is necessary to show how rainfall runoff is collected and how it is stored within the development:

- **The designer will confirm how volumes of rainfall runoff are being temporarily stored to allow discharge to ground or water course / drain or sewer. .**
- **Approximate storage volumes should be provided for each location where flows are attenuated.**
- **Storage will be demonstrated within sub-catchments and along the management train, with the location of flow controls confirmed.**

Design note: There are numerous ways to store rainfall runoff at or close to surface, either within shallow landscape features or within permeable surfaces.

Infiltration test results, where possible, should be included at concept stage to support concept designs. Where this is not possible, they should be submitted as soon as possible/practicable. Acceptance of SuDS designs based on infiltration will not be accepted at further planning stages without supporting infiltration tests.

7.7.2 Preliminary water quality considerations

At Concept Design stage it is necessary to show how water quality is managed:

- **A simple assessment of risk using the 'treatment stage' approach is acceptable on low and medium risk development. If the risk screening (SuDS Manual p571) demonstrates that the 'simple index approach' is appropriate, then the 'treatment stage' is acceptable.**
- **All sites should demonstrate source control to remove silt, heavy metals, hydrocarbon pollution and microplastics (tyre waste etc) at the beginning of the management train.**
- **Unless permeable pavement is used to collect runoff, where the pavement provides high water quality treatment, there will usually be a second feature to manage additional volumes and provide additional treatment.**

The design will also consider:

- **Sensitivity of the receiving watercourse or groundwater.**
- **Environmental and technical constraints such as contamination, protected landscapes, SSSI, SAC, nature reserves and existing biodiversity features.**
- **KCC will not accept the gully pot as a method of treatment. Table 26.15 of the CIRIA SuDS Manual denotes that conventional gully and pipe drainage provide zero treatment.**

Signpost: Mapping resources to identify potential site constraints EPA Maps

7.7.3 Preliminary amenity considerations

Amenity relates both to the usefulness and the appearance of SuDS features. Ideally, SuDS features should be integrated into the landscape, to minimise SuDS dedicated land take and management obligations.

The visual character of SuDS features needs to be carefully considered and should be reflective of the host landscape and intended functionality. Landscape design using topographical diversity can maximise biodiversity benefits and create a natural appearance. Equally, SuDS can be designed for formal settings.

Key amenity elements to consider when designing SuDS features include:

- **Legibility** – can the design be understood by users and managers? Information signs can be used to further enhance understanding, particularly where there is a lack of understanding of SuDS.
- **Accessibility** – can all parts of the SuDS scheme be easily reached, both for recreation and maintenance? All parts of the scheme must be safe by design. It is not usually appropriate to fence SuDS features for safety reasons (except toddler fences where young children may not be fully supervised).
- **Multi-functionality** – all parts of the SuDS landscape should be available for use by people when not performing a SuDS function.
- **Visual character** – all elements of the SuDS design must be attractive (or at least visually neutral, e.g. inlets, outlets and control structures) and safe.

7.7.4 Preliminary biodiversity considerations

There are key biodiversity requirements that should be demonstrated at the Concept Design stage:

- **Clean water – 'a controlled flow of clean water' is provided by the use of source control at the beginning of the management train. Subsequent surface conveyance and open SuDS features will ensure connectivity and habitat opportunities.**
- **Connectivity - habitat connections outside and within the development ensure that plants and animals can travel between habitat areas.**
- **Topographical diversity – variation in vertical and horizontal structure allows for complex habitat development. This is implicit in SuDS design, e.g. swales, basins, ponds and wetlands.**
- **Ecological design - the creation of habitats within the development.**
- **Sympathetic management – through considered management, a mosaic of habitat types can be created, ensuring maximum ecological value. Prohibit the use of herbicides to eliminate risk of entering river or stream networks.**

Image above: ***Highlighting potential planting typology for SuDS raingarden***

7.7.5 Management and maintenance

It is important to consider a realistic and appropriate level of ongoing maintenance at the Concept Design stage.

SuDS features that require specialist maintenance, hazardous waste removal or replacement of component parts should be avoided.

Most landscape-based SuDS treat organic pollutants passively through natural processes. This approach encourages the continual breakdown of organic pollutants throughout the design life of the SuDS.

Source control is critical to passive maintenance as silt, heavy metals and heavy oils are trapped at the beginning of the management train where they can easily be removed and will not contaminate SuDS features further down the train. This can enhance amenity and biodiversity potential.

Landscape-based SuDS techniques and surface conveyance ensures that ongoing care can be provided as part of everyday site maintenance by landscape contractors, grounds or park maintenance crews, caretakers or by residents (single house development).

7.8 Pre-application discussion

KCC will facilitate discussion of SUDS as part of the pre-application consultation process as appropriate, which will involve the appropriate departments for the site specific proposals.

The pre-application discussions may include 'Waster Services' and 'Parks and Open Spaces' Departments from KCC along with other departments as appropriate.

Discussions will be more productive where the multidisciplinary design team can provide a Concept Design for a pre-application meeting.

Pre-application meetings provide an opportunity for the designer to confirm the preliminary requirements for the SuDS design, and for KCC to understand the objectives and character of the SuDS proposed for the development.

Constructive discussion between KCC and the SuDS designer will save the developer time and the cost of potential re-design, providing planners with reassurance that the project that is delivered will meet local planning expectations.

Designers checklist for Concept Design Stage

The following list (**see next page**) serves as a useful guide to designers to ensure that the concept design has been properly developed to meet requirements of KCC Development Plan prior to advancing to outline design stage.

Checklist for Concept Design Stage

1. Data gathering	
Information to understand site constraints including geology, topography, flood risk, utilities, landscape context, community and wildlife	To understand site constraints and conditions that inform Concept Design
Planning requirements that influence SuDS design	To be aware of planning constraints that impact SuDS design
2. Flow route analysis	
Existing flow routes	To understand site hydrology
Modified flow routes	To understand the impact of development
3. General SuDS design elements	
Collection of runoff	Runoff retained at or near the surface
Source control	Primary treatment stage to protect the development
Conveyance	At or near the surface
Management train	SuDS components in series to manage quantity and quality
Sub-catchments	Dividing development into discreet SuDS entities
Storage	Indicate extent and location where runoff is stored
Flow control	Location to demonstrate storage location
Outfall	Locations and method of discharge
4. Quantity	
Confirm interception losses will occur	Demonstrate the use of SuDS components that provide interception losses
Confirm how rate of flow from development will be reduced to greenfield runoff rates	Demonstrate flow rates are achievable. Increase in allowable discharge rates from Greenfield
Confirm how runoff will be managed to greenfield runoff volumes	Demonstrate that scale of SuDS will be sufficient to deal with volumes generated
Confirm climate change allowance and whether urban creep is applied	Demonstrate how attenuation volumes are to be managed
Confirm 'long term storage'	Demonstrate no increase in runoff from pre-development status; or, demonstrate that runoff will be restricted to QBar rate or 2l/s/ha as appropriate.

5. Quality	
Confirm 'treatment stage' requirements	Demonstrate SuDS components used in series to mitigate 'pollution hazard level'
Confirm source control is present	Demonstrate protection of development to enable amenity and biodiversity benefits
Confirm interception losses	Demonstrate everyday pollution retained on site
6. Amenity	
Legibility	An understanding of how the SuDS function by people using or managing the site
Accessibility	All parts of the SuDS easily reached and safe for recreation and maintenance. Safety by design.
Multi-functionality	All parts of the SuDS landscape usable wherever possible
Visual character	All elements of the SuDS design attractive (or at least visually neutral, e.g. inlets, outlets, and control structures) and safe
7. Biodiversity	
Clean water	A controlled flow of clean water' within and outside the site using 'source control' and the 'management train'
Connectivity	Links to outside and within development to ensure plants and animals can travel between habitat areas
Topographical diversity	Variable vertical and horizontal structures for complex habitat development
Habitat creation	Exploit opportunities through ecological design
Sympathetic management	Create a mosaic of habitat types through maintenance

Stage 2 Outline Design

SECTION 8.0

Overview

Outline Design bridges the gap between Concept Design and Detailed Design and may require additional information from that considered at concept stage, to ensure that all aspects of the design are fully considered.

Outline design is the minimum level of detail required to assess drainage aspects within planning applications.

8.1 Objectives of SuDS Outline Design

SuDS Outline Design builds on the ideas introduced in Concept Design considering responses from stakeholders. Outline design provides sufficient detail to demonstrate that the scheme can be successfully delivered.

Outline SuDS Design should clearly demonstrate how the SuDS design adheres with KCC Development Plan policies. The SuDS design should outline how requirements for quantity, quality, amenity, and biodiversity have been met and how the SuDS scheme is integrated into the wider development.

Designers note; Outline design is the minimum level of detail which would be expected to support a planning submission and will be requested as further information where it is not presented with the original application.

8.2 What Outline Design should demonstrate

Outline Design will confirm how the SuDS will function, the scale, depth, relative levels, appearance and character of the SuDS as well as the practicality of the design by demonstrating the following:

- **appropriate response to site conditions, constraints and opportunities relating to SuDS**
- **the layout reflects the Modified Flow Route analysis**
- **the design will show the appearance of the site and how the site will function**
- **how runoff is collected, the use of source control and the integration of management train into site layout**
- **demonstrate how SuDS design complies with GDSDS hydraulic criterion (see Sections 5.3 & 5.6)**
- **the design will be developed to a stage that confirms it can be constructed practically and can be managed and maintained at reasonable cost.**
- **demonstrate SuDS components are designed to KCC Adopted Taking in Charge Policy and Specifications where SuDS are proposed in areas to be taken in charge**

The level of detail provided as part of the planning application will be representative of the scale of development being proposed.

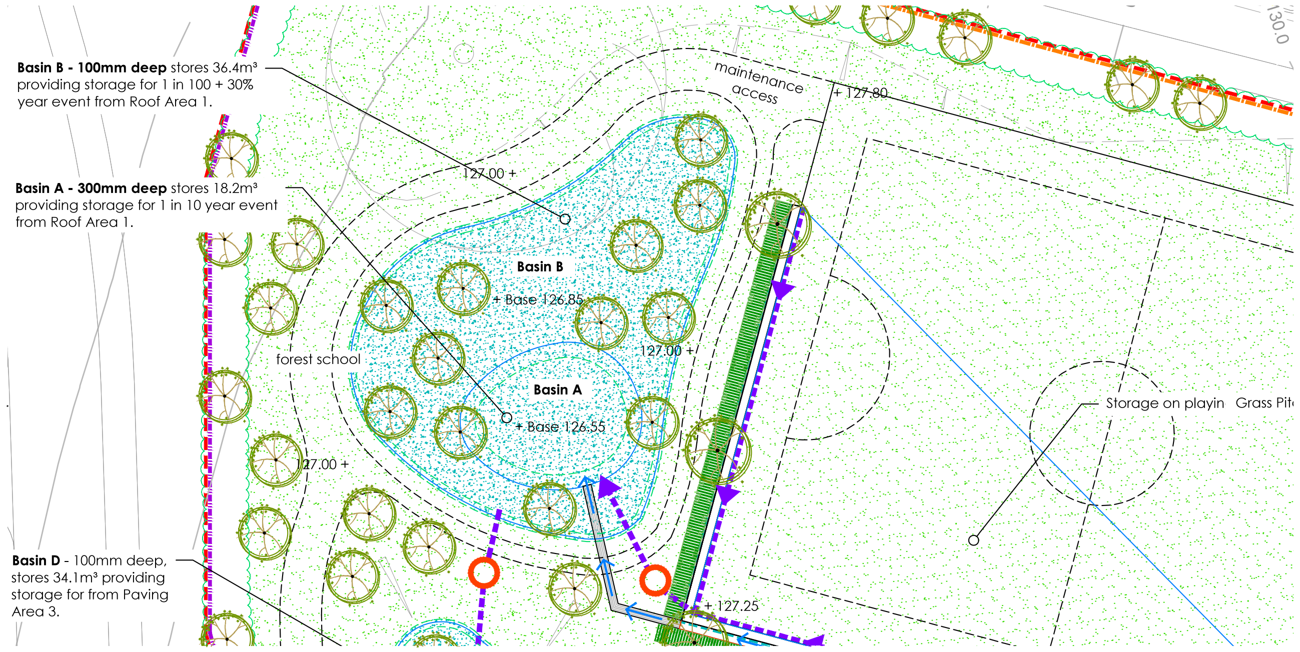


Image above: ***Example of Outline SuDS Masterplan***

8.2.1 Developing an Outline Design

Limited information may be available at Concept Design Stage and must be augmented to provide a full understanding of the site at Outline Design. The additional information required at Outline Design stage will depend on whether a Concept Design has been undertaken and the level of information already collated. **Where concept design has not been completed then designers should refer to the Concept Design section** of this Guide to ensure that the SuDS design is approached correctly.

The following information should be collated to evaluate site constraints and inform SuDS design:

- **Existing services, including location and depth. These can influence layout, depth and placement of SuDS features.**
- **Planning policy, for example SuDS in designated Architectural Conservation Area (ACA), which may influence choice of SuDS components and the use of materials. Adopted ACA boundaries are defined in the County Development Plan and Local Area Plans.**
- **Ownership and future management of SuDS will influence component selection, typically where the structure is taken in charge by KCC.**
- **Consents affecting off-site and on-site elements of the SuDS (proposed way-leaves and land transfers).**
- **Confirmation of the method of discharge: infiltration or runoff to a watercourse or sewer and impact of runoff volumes on the site. Infiltration test results are required to demonstrate potential for infiltration where this is proposed. Any discharge should be agreed in principle with the relevant authority.**

Confirmation of ownership and maintenance arrangements would be subject to a planning condition.

8.3 Design criteria

Quantity

The designer should **confirm:**

› Existing drainage patterns, natural and modified flow routes

› an appropriate means of discharge(s) following the discharge hierarchy as set out in section 7.4.8.

› how flow rates and volumes will be managed

› contributing area of impermeable hard surface

› sub-catchment extents

› flow control locations

› storage locations and volumes to appropriate flow rates and rainfall return periods

› overflow arrangements from each storage location

› exceedance routing when design volumes are exceeded, or flows are generated from outside the site

› allowances for climate change and urban creep.

Quality

The designer should **demonstrate:**

› there are sufficient SuDS surfaces to meet interception losses requirements (no runoff from site for rainfall depths up to 5mm for the majority of rainfall events)

› sufficient treatment is available to manage pollution risk along the management train

› how spillage could be managed

› how runoff could be managed during construction.

Amenity

The designer should **demonstrate:**

› the SuDS is understandable to people using the site and maintenance personnel – legibility

› the site is generally accessible to people, safe by design and adopts the 'general principles of prevention'

› the visual character of the SuDS will enhance the development

› spaces and connecting routes are multi-functional and can be used for passive and active recreation purposes when not providing a SuDS function for rainfall management.

Biodiversity

The designer should **demonstrate:**

› confirm that water is clean as soon as possible along the management train using the principle of source control

› demonstrate water is kept at or near the surface as it flows from the beginning to the end of the SuDS management train and then onwards to the wider landscape, to ensure habitat connectivity

› demonstrate ecological design and maximising the creation of varying habitats within the SuDS corridor

› confirm 'management practices' to enhance habitat development during maintenance.

8.4 Designing for hydraulic requirements

Development causes an increase in runoff which increases the risk of flooding on site and elsewhere. Where runoff is temporarily stored it allows for a controlled release either into the ground or into a watercourse or sewer.

The storage volume required can be estimated using information such as the local rainfall characteristics and the rate at which flow is controlled to leaving the site. Expressing calculation outputs in an understandable format allows for easy application within the design process as well as transparency for evaluation.

8.4.1 Objectives of hydraulic calculations

Hydraulic calculations can:

› **inform and validate the SuDS design**

› **provide confidence that there is sufficient capacity to cater for the additional runoff generated by the development to desired design standards**

› **make allowance for unknown factors such as runoff from off-site**

› **provide confidence that SuDS will function hydraulically and will not be prone to erosion.**

8.4.2 What calculations should demonstrate

Designers should demonstrate through the calculation process:

› **how the rates and volumes of runoff generated from development will not pose a flood risk within site boundary or elsewhere**

› **that future impacts to runoff such as climate change and urban creep are accounted for**

› **that the correct calculation inputs and methods have been used**

› **where exceptional flows are experienced, such as; design exceedance, instances of blockage, or flows from offsite, they can be managed without causing unreasonable risk to humans or development.**

8.4.3 Calculation processes

Calculations outputs should always be viewed as an estimate of what is experienced in reality. Outputs will vary depending upon how inputs are selected and the calculation process used.

The calculations for SuDS design are used to assess:

- **appropriate discharge rates via infiltration or controlled discharge rates to a watercourse or sewer**
- **the volume of runoff that requires storage to allow infiltration or attenuation to controlled discharge rates (see 9.6)**
- **the long-term storage volume that needs to be managed (see 8.4.7)**
- **flow velocities.**

Calculation process	Purpose of calculation	Main calculation inputs
Greenfield runoff rate - sites estimate	Used to define flow control rate	Local rainfall data; site area; soil characteristics.
Attenuation storage or infiltration storage estimate.	The runoff generated by the site is balanced against the controlled rate of outflow	Local rainfall data; site area; proposed site impermeable area; climate and creep allowances; infiltration rates; soil characteristics; discharge rate(s).
Flow velocity check	Flow velocity calculated to ensure: Conveyance along vegetated channels do not cause erosion during peak rainfall events; Peak flows should not exceed 1-2m/sec. Low flow velocities (less than 3m/sec) for 1 in 1 year 30 minute rainfall to allow settlement of silt within swales.	Component sectional geometry; component gradient; component surface type (roughness); estimated flow rates.

Design note : Velocity criteria will be dependant upon SUDS feature. SuDS manual advises on velocity criteria for individual SuDS techniques.

8.4.4 Calculating storage requirements

The additional rainfall runoff generated by development be managed by either infiltration back to ground or controlled flow discharge to a watercourse or sewer.

Unlined storage will enable full infiltration in areas of free draining soils, which are prevalent across the south of the county. In areas of lower infiltration potential, unlined SuDS features may deliver partial infiltration which contribute to long term losses.

Both infiltration and attenuation require storage within the development to hold water long enough to be discharged either into the ground or through flow-controlled discharge to a watercourse or sewer.

The storage required will be determined by calculation. Calculation outputs are influenced by a number of factors such as defining area drained, runoff coefficients, flow control method, climate change allowance and urban creep. These factors must be carefully considered as part of the calculation process.

Sections 6.4.3.1 and 6.4.3.5 cover the basics of infiltration and attenuation storage calculation and should be referred to prior to progressing with this section where calculation inputs are considered in more detail.

8.4.5 Long term storage

SuDS design seeks to mimic the natural losses that occur across natural catchments. The volume of post development runoff should match that of the natural catchment.

Some of the volume losses can be mimicked by using SuDS components to demonstrate interception losses and ongoing losses, which represents Long Term Storage. Other methods such as rainwater harvesting will further reduce the additional volume of rainfall runoff generated by the development.

Design note: Long term storage can be factored into attenuation storage calculations.

Signpost: See Section 8.4.6.1 & 8.5.2.

8.4.5.1 Defining runoff coefficients (Cv)

In extreme rainfall conditions the losses anticipated from hard development surfaces such as roofs or paved areas are anticipated to be minimal.

The designer must consider the runoff coefficient (Cv) for the types of surfaces contributing runoff to the storage location. Runoff coefficients of 0.95 for roofs and 0.9 for paved areas would be considered acceptable by KCC where no more detailed assessment is undertaken.

Where there is permeable surface contribution to SuDS storage, then this should be considered within calculations. The 'UKSuDS' website allows input for permeable surface runoff contribution within attenuation calculations. A similar approach can be applied within hand calculations or through software. A Cv of 0.10 - 0.15 (free draining – clay soils) is suggested for permeable runoff areas that drain to SuDS storage features.

Design note: Designer should explain how rainfall will be lost where CVs are used which are lower than those suggested by this Guide.

8.4.5.2 Demonstrating interception losses

The design should identify SuDS features which can generate interception losses.

Criterion 1 (Section 16.3 of the Greater Dublin Regional Code of Practice for Drainage Works) requires demonstration of no runoff from site for rainfall depths up to 5mm for the majority of rainfall events.

As a rule of thumb, where the total wetted area of SuDS equates to at least 25% of the buildings and hard surfaces draining to SuDS then it is acceptable to make an allowance for interception losses.

For more detailed analysis methods which consider individual SuDS components interception losses - see SuDS Manual Section 24.8

8.4.6 Infiltration

A large extent of Kildare County is considered to be potentially suitable for infiltration. It is therefore vital that infiltration techniques be given full consideration throughout the design process.

The WRAP classification provides a regional context and should not be relied upon for determining suitability for infiltration at site level.

Sign post: SuDS Manual C753 Chapter 25 Infiltration

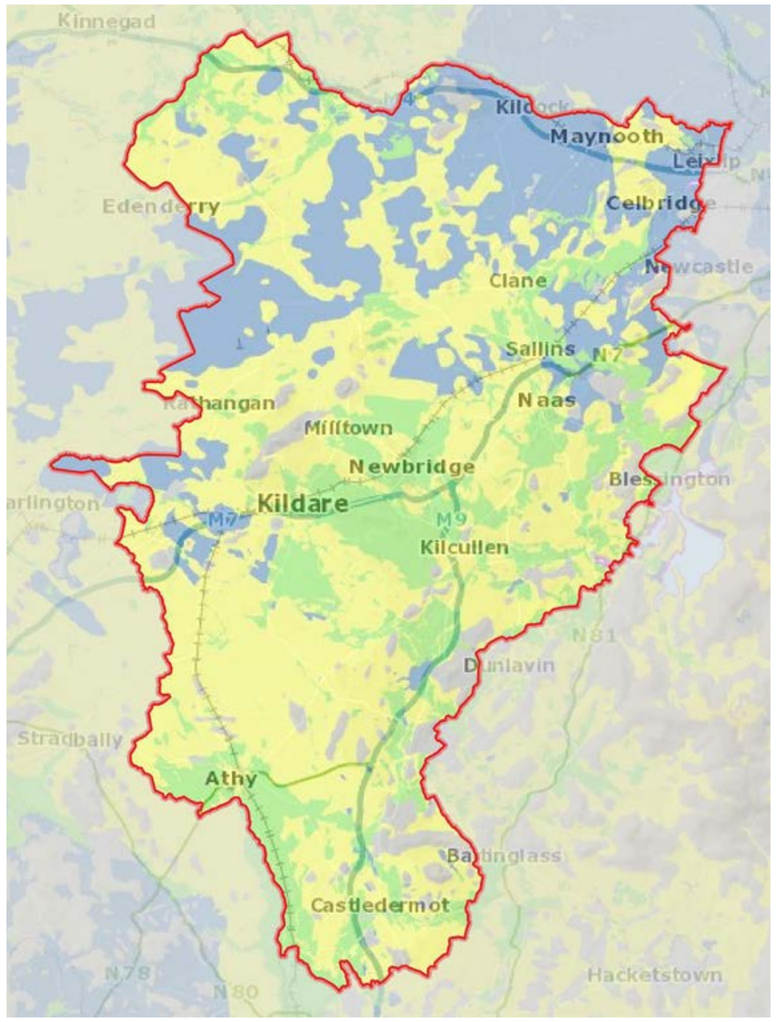


Image above: ***Subsoil permeability map***

Map legend - IE GSI Subsoil Permeability 40k Ireland (ROI) ITM

- High
- Moderate
- Low
- Not mapped

When specifying an infiltration test it is important that the test conditions are representative of the proposed design. The depth of water and invert of test trench relative to proposed ground levels should seek to replicate the design configuration of the proposed infiltration system (stored water depth, invert level, location etc.).

For example, tests should not be undertaken 1.5m below ground level when shallow infiltration is proposed from permeable pavement, rain gardens or basins which will be located close to ground surface.

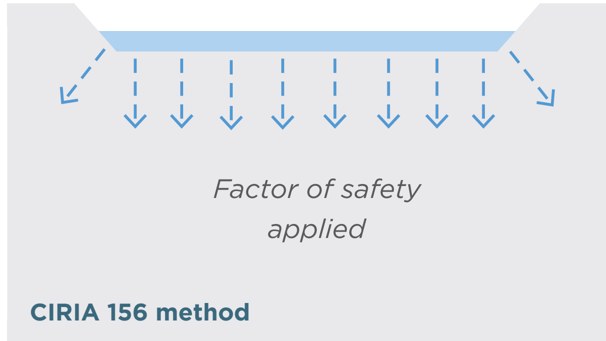
Design note: Any designs which rely upon infiltration which is not surface based, using infiltration trenches for example, should demonstrate how silt is intercepted using source control SuDS features, prior to infiltration.

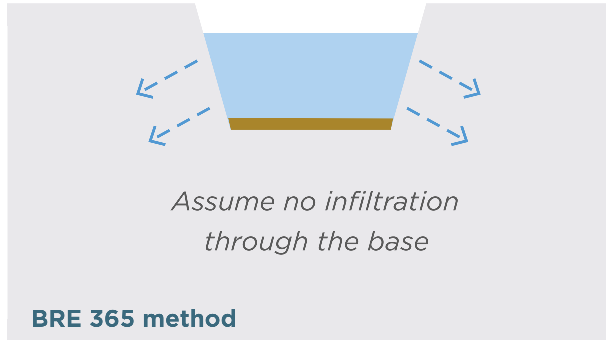
There are two methods for calculating temporary storage for infiltration.

The CIRIA 156 method assumes that there will be infiltration through the base and sides of the structure on an ongoing basis. Factors of safety ranging between 1.5 and 10 depending on the consequence of failure, and the area draining to the infiltration structure (see C753 Table 25.2), are allocated to account for potentially reduced infiltration over time.

The BRE 365 method assumes that the base of the system, such as traditional soakaway, will silt up and therefore infiltration is only calculated through the vertical sides. The assumption of no infiltration through the base is the equivalent of the factor of safety.

Various SuDS structures such as permeable pavement are resilient to ingress of silt.





Design note: Infiltration schemes are not straight-forward and sites which are free draining can quickly become compacted during the construction phase. Protecting infiltration zones during construction should be considered as part of a construction plan.

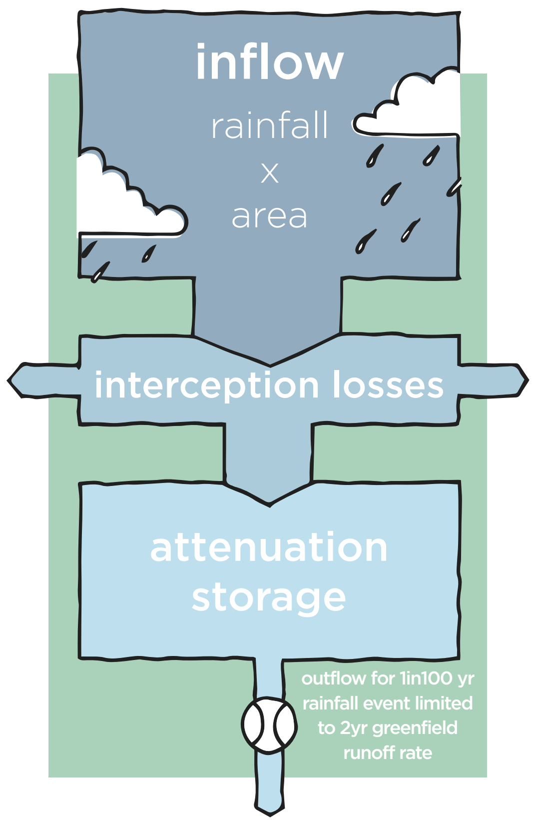
Design note: KCC will require monitoring of groundwater levels for a minimum period of 6 months (including a winter season) to determine highest seasonal ground water table level. A 1m unsaturated zone is required to be demonstrated below the invert of the infiltrating SuDS features. KCC WSP recommend that a geotechnical and hydrogeological report completed by a competent profession on the feasibility of infiltration be submitted with outline design.

8.4.6.1 Calculating flow control rates and attenuation storage

KCC requires that SuDS attenuate runoff from all sites to equivalent greenfield runoff rates. The rate that the flow control is sized to will depend upon where the site is discharging to and whether the overall volume of runoff is controlled.

> **Design note: Where discharge from the site contributes to a combined sewer network**
>
> **Discharge will be subject to consent from Uisce Éireann. If discharge is permitted, allowable discharge rates may be lower than rate identified by GSDSD depending on available sewer capacity.**

Image below: ***GDSDS Criterion Approach 1***



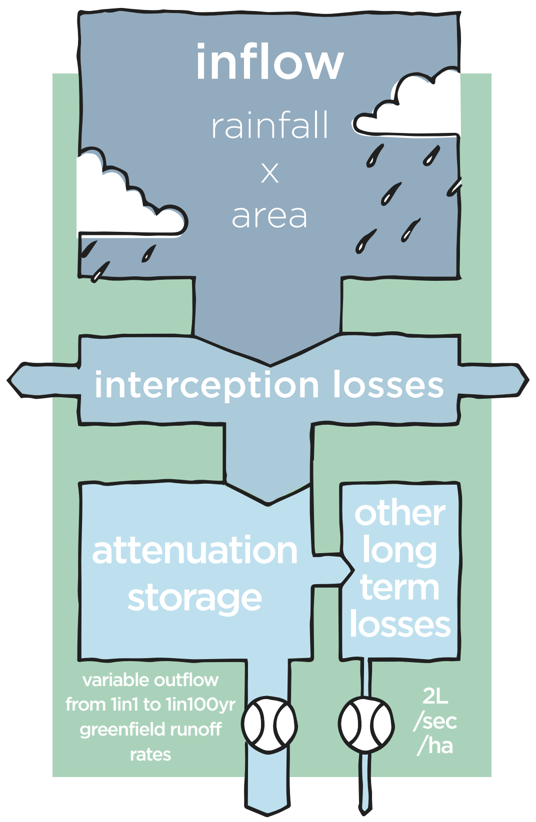
Where discharge is to a surface water sewer or open watercourse channel

As per the criterion previously set out in GDSDS and Section 16.3 of the Greater Dublin Regional Code of Practice for Drainage Works, there are two approaches for determining flow control rates (and resulting storage volumes).

GDSDS Criterion 4.3 (Approach 1)

Where the volume of development runoff is not controlled to greenfield volumes of runoff, the rate of outflow for all rainfall events up to the 1 in 100 year (with CCA and urban creep where appropriate) is controlled to the equivalent GF Qbar rate.

Image below: ***GDSDS Criterion Approach 2***



The GF rate will be a function of the SAAR value which can vary significantly across the county and soil type with Soil types2, 3 and 4 common across the Kildare region.

The following Qbar rates can be used as a benchmark and are based upon a Standard Average Annual Rainfall (SAAR) of 750mm (as per page 71 of GDSDS Vol 3).

	SOIL type 2	SOIL type 3	SOIL type 4
QBAR/ha (l/s/ha	2.0	3.1	5.2

GDSDS Criterion 2.1, 2.2, 4.1, 4.2 (Approach 2)

Where the volume of runoff is controlled to greenfield volumes, the rate of outflow can be controlled to the 1 in 1 year and 1 in 100 year greenfield runoff rate for the respective rainfall return period. The Qbar flow rate can be factored to the relevant rainfall return period rate using the following factors.

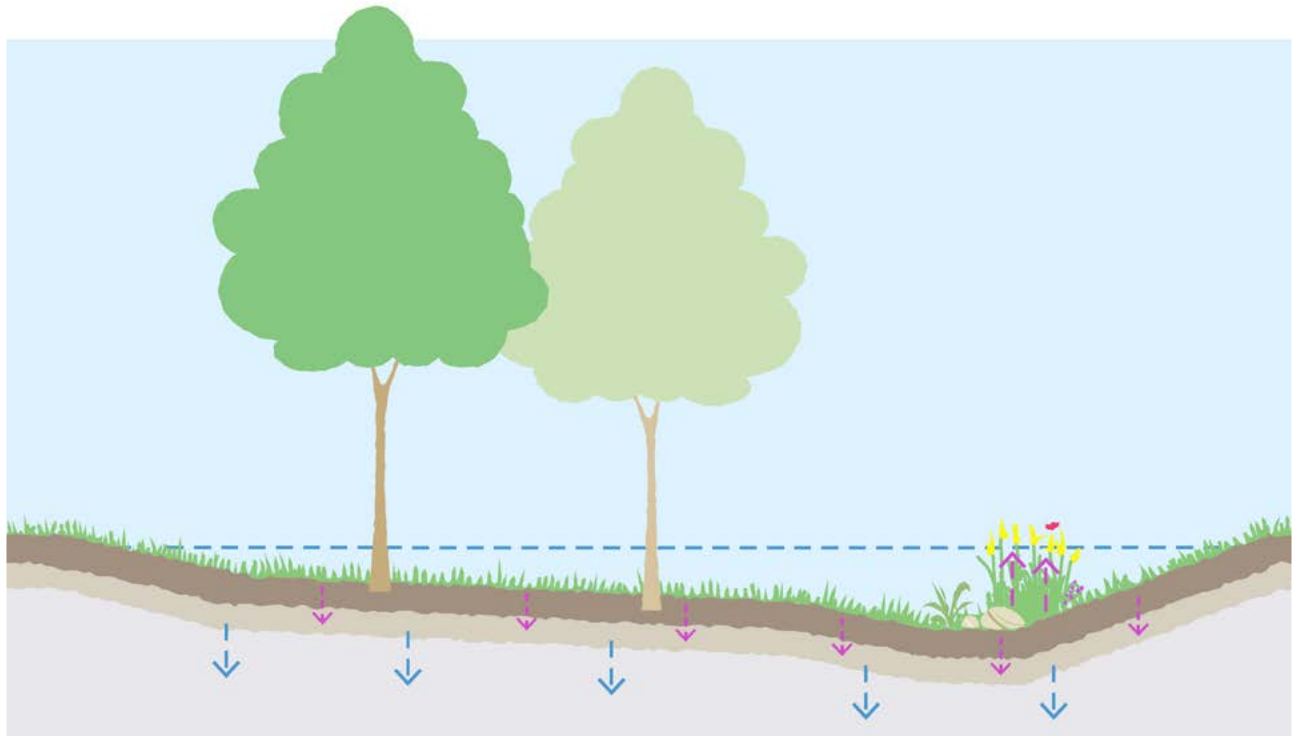
Return period (years)	Growth curve factor
1	0.85
QBAR	1.0
10	1.7
30	2.1
100	2.6
200	2.9

Supporting calculations should be provided where values proposed are greater than those identified above.

In calculating and designing the storage volumes some runoff must be retained on site for a longer period after attenuation storage has emptied to mitigate for the increased runoff volume generated by the development.

There are a number of ways to reduce and manage the volume of runoff generated by development leaving the site:

- **Rain harvesting -** Where it can be demonstrated that the harvesting system will be in use for the majority of time and demand exceeds supply, 50% of the rain harvesting volume can be offset against the long-term storage volume requirements. (BS 8515:2009)
- **Natural Losses –** For SuDS components which provide natural losses (interception) a 5mm reduction can be applied to rainfall depths to account for interception losses where the design demonstrates a ratio of 'SuDS space' to 'developed area' of 1:4.
- **Infiltration -** Where SuDS components are unlined, infiltration may occur even if rates are low. These additional losses can be offset against the long-term storage volume requirements. Infiltration rates should be demonstrated from infiltration tests (with suitable factor of safety applied to infiltration rate).
- **Separate area of storage -** A separate area of storage can be provided. It is prudent for areas which serve other purposes such as carparks or playing fields not to be inundated on a regular basis. The 1 in 30 year event is suggested as the point at which these areas would be first utilised for long term storage. Outflow from Long Term storage areas should be via infiltration or a controlled discharge rate of 2 l/s/ha.



Key

- - - 1:100 year attenuation storage level

Initial interception losses occur which reduces the over all volume of runoff leaving the site

As water resides in SuDS features a further volume of runoff will be lost to underlying soils. Even medium to heavy clays have potential for low to moderate filtration (2-10mm/hr). Infiltration rates would have to be proven via testing

Image above: ***Long term storage example***

This example shows a basin with a low flow channel and a sloped base. As rainfall runoff fills the basin, **interception losses** will occur. When runoff is held in an **unlined** basin over a period of time further **infiltration losses** will occur (even on many clay soils). These losses contribute to **long term storage**.

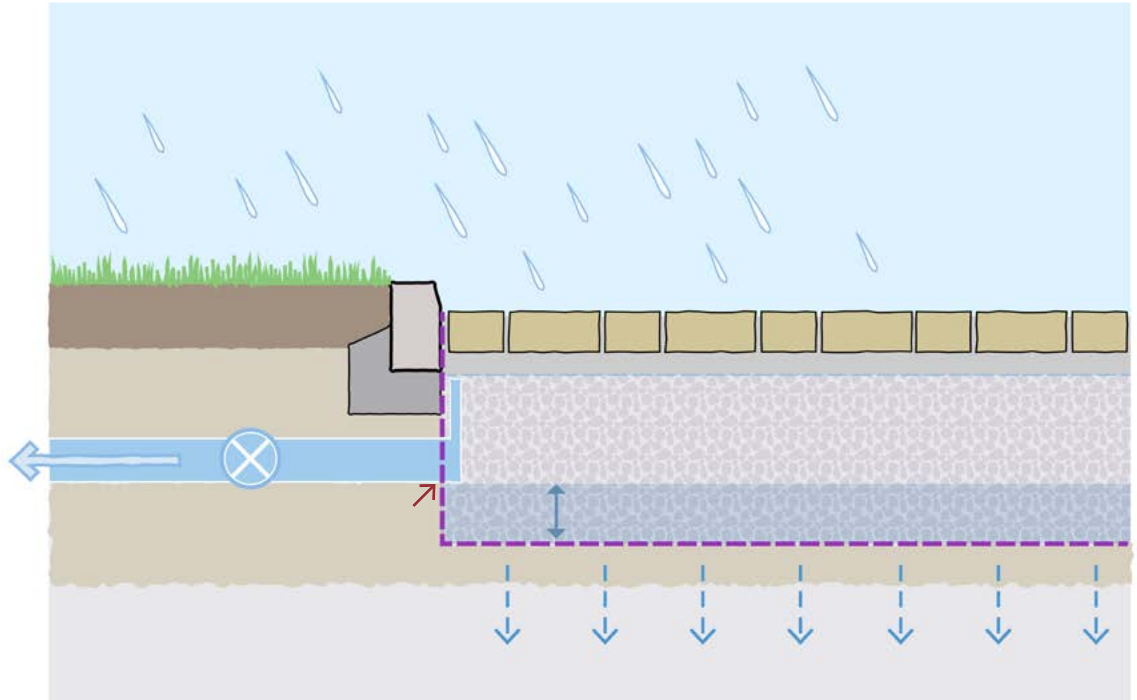


Image above: ***Raised outlet example***

This example shows a reservoir area within the permeable pavement subbase below the flow control level. There must be sufficient infiltration rate to permit the permeable pavement to empty (a minimum infiltration rate of 5mm per hour is suggested). Using hydraulic modelling software the volume infiltrated can be determined. As this volume of runoff is infiltrated it can be treated as '**long term losses**'.

Design note: Infiltration tests where low rates of infiltration are anticipated may have to be specified over a period greater than 24 hours. Where rates of infiltration are low there should always be gravity discharge (via flow control).

Key

Raised outlet

Stored water allowed to infiltrate after every rainfall event

Outlet from permeable pavement is raised to allow storage of additional volume of surface runoff to be slowly infiltrated

Flow Control Discharge Limits

	1 in 1 year rainfall (maximum outflow rate)	1 in 100 year rainfall (maximum outflow rate)	Long term storage- volume control
Discharge to a combined sewer	Confirm with Uisce Eireann	Confirm with Uisce Eireann	Confirm with Uisce Eireann
Discharge to a surface water sewer or watercourse Criterion 4.3 (Approach 1)	Qbar/ Qmed	Qbar/ Qmed	No
Discharge to a surface water sewer or watercourse Criterion 2.1, 2.2, 4.1, 4.2 (Approach 2)	1 in 1 year greenfield rate	1 in 100 year greenfield rate	Yes

8.4.6.2 Accounting for Climate Change

Future predictions suggest that more extreme rainfall events will occur with greater regularity.

To make allowance for this within SuDS calculations the current industry approach is to increase rainfall intensities by 30% for **Climate Change Allowance** (CCA). This figure may be updated in line with national guidance.

Design Note: Climate Change should be considered for both attenuation storage and conveyance calculations.

Sign post: KCC Climate Action Plan

8.4.7 Accounting for Urban Creep

Urban Creep considers the potential impact on the drainage system from '**exempted development**' such as small extensions to houses and paving over front gardens to create driveways. Exempted development rights generally applies to residential development but can also apply to commercial development and schools.

The following table is taken previously completed research and defines the anticipated percentage increase to impermeable area:

Image above: ***Example of urban creep - paving over front gardens***

	Residential development density (dwellings per hectare)					
	<25	30	35	45	>50	flats & apartments
Percentage area increase applied as percentage of proposed impermeable area within curtilage of private lands.	10%	8%	6%	4%	2%	0%

For housing developments, designers should determine the number of properties per hectare and apply the percentage increase to impermeable areas which are not taken in charge, for example roofs, pathways and driveways (but may exclude road areas which are taken in charge).

Urban creep allowance for commercial developments and schools should be agreed with the KCC.

8.4.8 Drain down times

Storage volumes should ensure that 50% of the total attenuation volume is available within 24 hours of a 1 in 30 year critical duration rainfall event occurring.

8.4.9 Critical duration

A range of storm durations (15 minutes – 48 hours) should be assessed to determine maximum storage required.

8.4.10 Flow velocities

Peak flows should be retained to less than 1m/s velocity to avoid risk of erosion of vegetated surfaces such as swale channels.

Where velocities are less than 0.3m/s this will encourage silts to drop out of flow along the Management Train.

The Manning's Equation (SuDS Manual EQ.24.12) is used to estimate open channel flow velocities. The depth of flow will affect how much 'roughness' is applied by the channel. The SuDS Manual Figure 17.7 details the manning's roughness values which should be adopted for SuDS calculations.

Image above: ***Example, use of source control***

Image below: ***Demonstrates impact of erosion***

8.4.11 Design flexibility

Where a single storage volume is presented, it is the intuitive response of most designers to try and accommodate all flow at a single storage location. However, the opportunities for storage across the site are diverse and flexible.

Appearance, functionality and character of a space can be influenced by how flows are stored and controlled within each SuDS component.

A framework of four approaches are explored by this guide. These approaches are intended to inspire the designer to think about the possibilities that exist for integrating storage as part of the development rather than defaulting to an underground storage structure prior to discharge from the site. Distributed storage components

Image above: ***Example exploiting parcels of usable space for storage***

8.4.11.1 Distributed storage components

Distributed storage volumes into discreet storage components such as raingardens, swales, basins and permeable pavement with the potential for different rainfall depths being stored at each location.

This approach is useful for exploiting small parcels of available space within the development and results in features, such as rain gardens and small basins which can be located close to buildings. These small features are usually sized for between the 1 in 1 year and 1 in 10 year rainfall, with excess rainfall volumes conveyed along the management train to site control.

This approach keeps subsequent storage components from regular wetting as around 95% of rainfall events would be managed by the first component.

This can protect the functionality of downstream components as amenity spaces. The flow control opening for each component can be easily calculated and outflows from one storage component will passively move through subsequent storage components without the requirement for further storage.

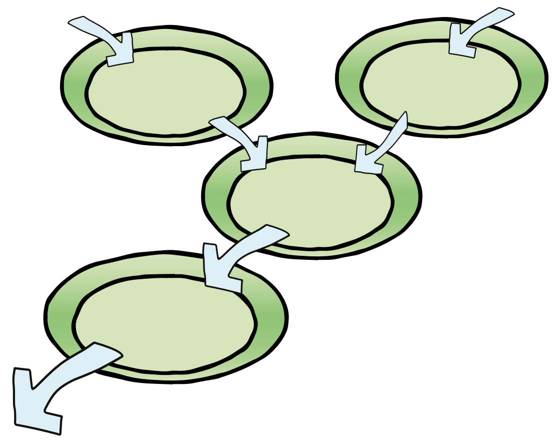


Image above: ***Diagram showing distribution of storage volumes***

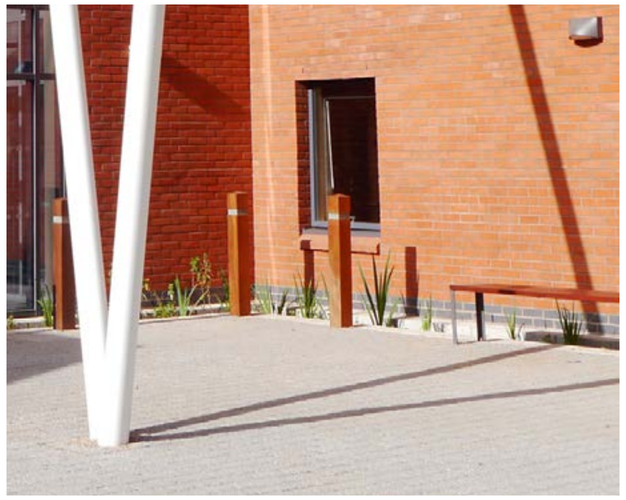


Image above: ***Example use of permeable pavement storage at a school***

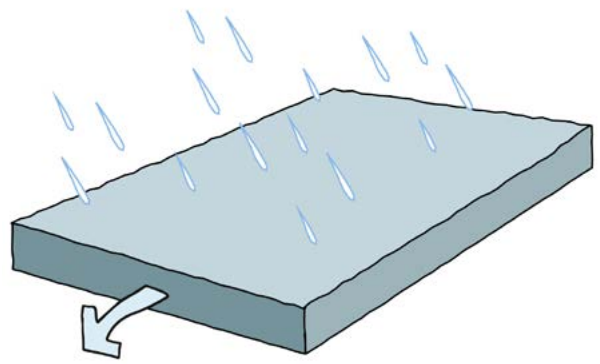


Image above: ***Diagram single, uniform storage component***

8.4.12 Single, uniform storage components

Permeable pavements and blue-green roofs which have relatively flat formations can store all rainfall events up to the 1 in 100 year within their footprint. In this scenario the flow control would be designed to ensure that the depth of stored flow discharged at the respective 1 in 1 and 1 in 100 year greenfield runoff rates.

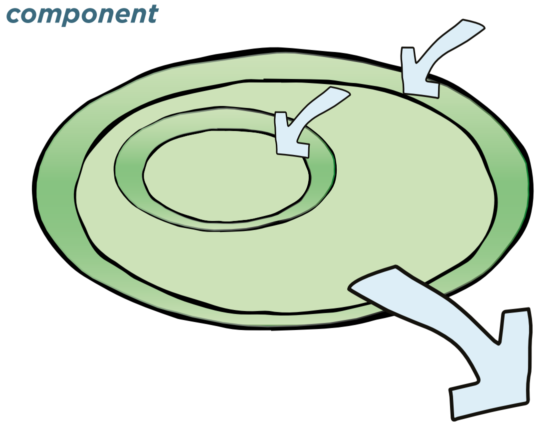
8.4.13 Single, tiered storage components

Store up to the 1 in 100 year rainfall in a single, tiered storage component, such as a smaller basin used on a regular basis within a more extensive basin for more extreme rainfall events and openings sized to achieve the variable outflow rates.

Source control should be in place where flows are taken to an amenity play basin. In this scenario, a tiered approach to storage is useful in order to maximize the usability of features for general amenity, play or sports. Biodiversity can be introduced in the smaller basin by creating wetland or any other desired habitat.

More frequent rainfall events which produced less runoff such as the 1 in 1 event, are prevented from covering the whole storage component by accommodating them in a smaller basin located within a more expansive basin which can accommodate further volumes of runoff up to the 1 in 100 event. As with other approaches the flow control can be designed to manage the desired variable outflows at various depths of storage.

Image below: ***Diagram tiered storage component***



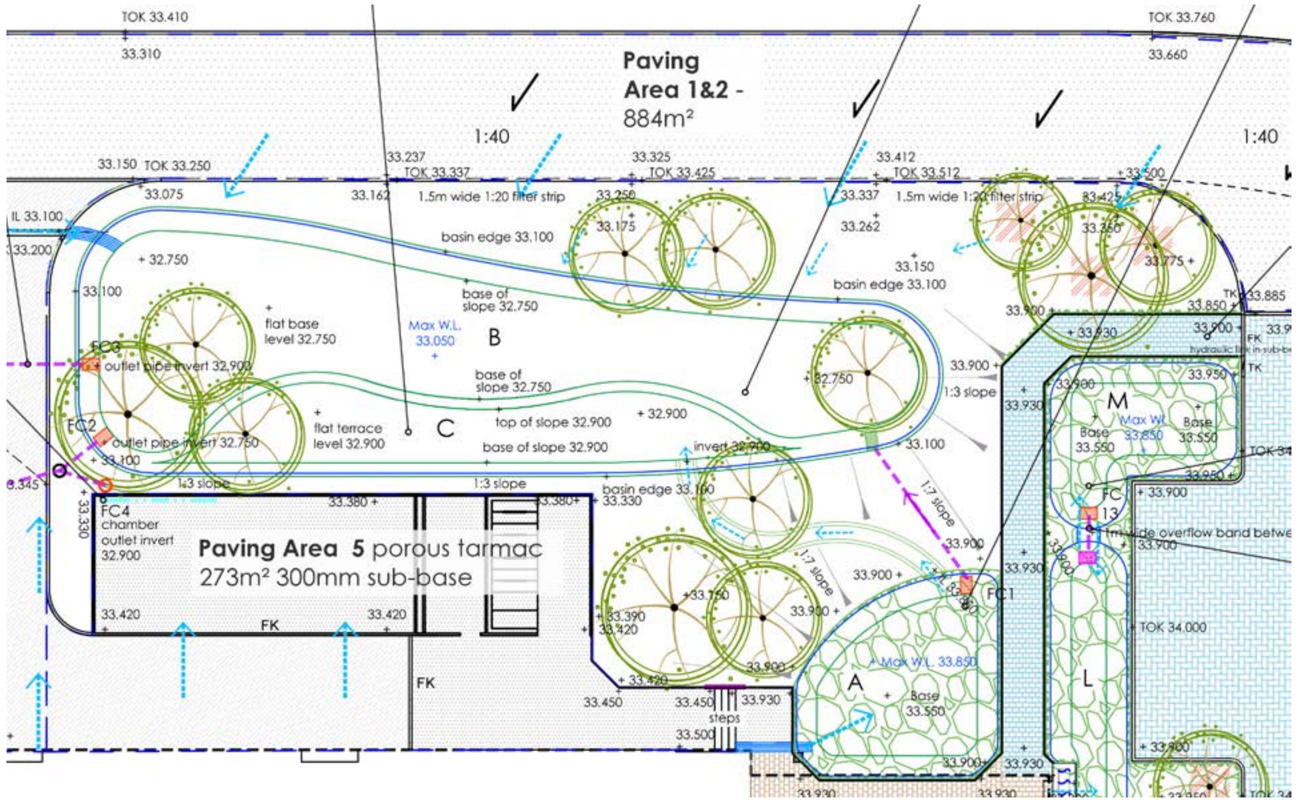
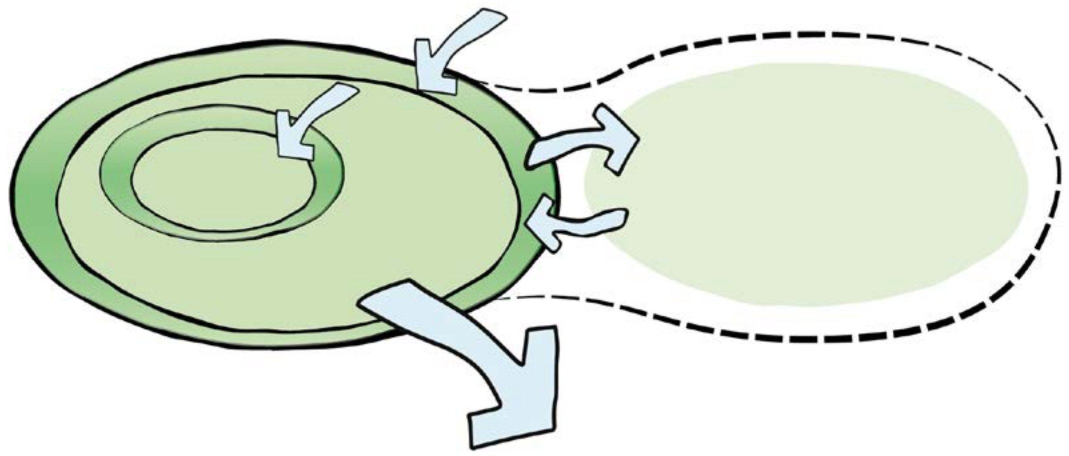


Image above: ***Detailed SuDs plan utilising combination of storage components***

Image below: ***Example of tiered storage component***



8.4.13.1 Site containment storage

On some sites, rainfall runoff from extreme rainfall could be stored in parts of the site such as overspill carparks or public open space, where the overall functioning of the site is not affected during these weather conditions. Storing water outside of the defined SuDS structures is referred to as **site containment.**

These areas should drain down within a short timeframe and should not come into operation until rainfall events above the 1 in 30 year rainfall. Depth of flowing within areas of site containment should be shallow (no greater than 150mm) and flow velocities should be less than 1m/s.

Design note: design detail for any proposed 'site containment' within public open space shall be agreed with Park Department as part of planning approval and discharge of condition process.

Image above: ***Diagram designing for exceedance***

8.4.14 Designing for exceedance

The designer must demonstrate that extreme flows, beyond design parameters, can be managed in a safe and predictable manner. Site levels should be designed to allow exceedance flows to flow from one storage location to the next along a defined management train/conveyance route.

The designer should evaluate likely flood volumes, depths and velocities to ensure there is no significant risk to development or people. Generally, depths less than 0.25m will not present a risk, but steep parts of sites may generate high velocities which may be unsuitable.

8.4.15 Managing off-site flows

Many sites are at risk of significant surface runoff from offsite with indicative flow routes identified by Surface Water flood maps.

SuDS design should demonstrate how offsite flows are intercepted and managed through the site without causing flood risk to the site or increasing flood risk elsewhere. Unless specifically required by KCC, developers are not required to attenuate surface water flows which are generated from off site. This advice may be revised in exceptional circumstances which will be determined on a case-by-case basis.

Image above: ***Example designing for exceedance***

Sign post: https: Flood info

Sign post: Kildare SFRA (2023)

8.5 Flow controls

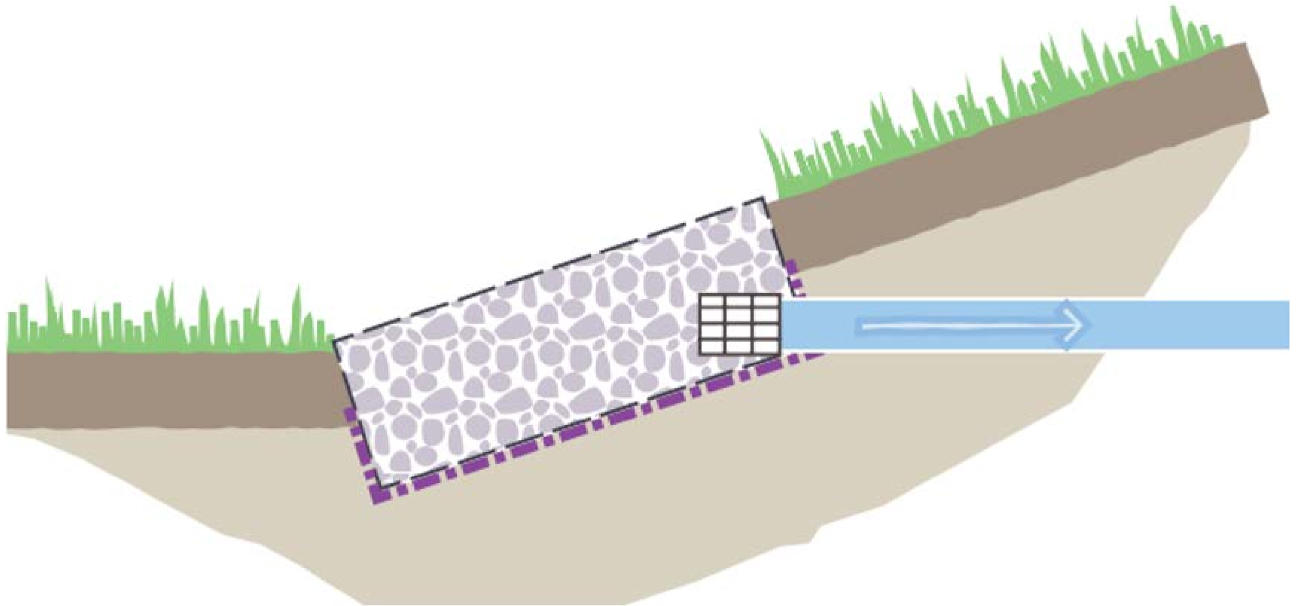
Attenuation storage within sub-catchments and along the management train can require several flow controls. Flow controls come in many forms including orifice plates, slot or V-notch weirs and vortex controls. Any type of flow controls can be prone to blockage unless the opening is protected.

The rate of flow of water through SuDS components is slow as it is restricted to 'greenfield rates' of runoff through each flow control. There should always be an overflow arrangement to deal with blockage or exceedance of the design storm.

Silt is trapped at source in SuDS components and settles out along the management train. Where slow movement of flow is maintained throughout, floating debris that easily blocks outlets is not driven against openings; as is the case with conventional drainage. Simple design features such as sloping headwalls can direct floating debris past the outlet as the storage structure fills.

Images above: ***Example flow control features***

Image right: ***In profile - a stainless steel mesh basket filled with 80-150mm aggregate forms an effective protection for pipe openings. Note the pipe opening has a mesh guard to stop stone migrating through the pipe***



8.5.1 The importance of protected openings

There are no minimum thresholds for attenuated flow rates in SuDS design. Previously the drainage industry has applied a minimum flow rate of 5 l/s but this does not take into account the need in SuDS for low flow rate controls and the design of **protected openings**.

Small sites and sub-catchments of larger sites may need to meet minimal outflow flow rates. Flows can be controlled down to 0.5 – 2 l/s using small openings (15-20mm diameter) with shallow depth of storage.

SuDS components such as permeable pavements, bioretention or filter drains are pre-filtered, and assuming collection through perforated pipes or similar, the flow control opening requires little additional protection.

Open SuDS components such as swales, ponds and basins, require additional protection. One way to provide this protection is to use a stainless steel basket filled with 80-150mm stone with the connecting pipe opening set within the stone to prevent floating debris reaching the flow control.

Key points to be considered when designing protected openings:

› **Protection to the opening should be of a reasonable surface area to allow for accumulation of litter and vegetation across the surface of the protection.**

› **Outlets in open structures should be located on a slope to encourage debris to pass over the outlet as water rises in the SuDS component.**

› **Openings in the protective screen should be smaller than the orifice opening size, thus any residual silt passing through protective screen will pass through the orifice opening.**

8.5.2 Sizing flow control openings

The following methodologies for sizing flow controls are intended for use by those with knowledge of hydraulic calculations. Careful consideration should always be given to the selection of equations and coefficients. Section 6.4.3.6 outlines two approaches for the control of flow, summarised as follows:

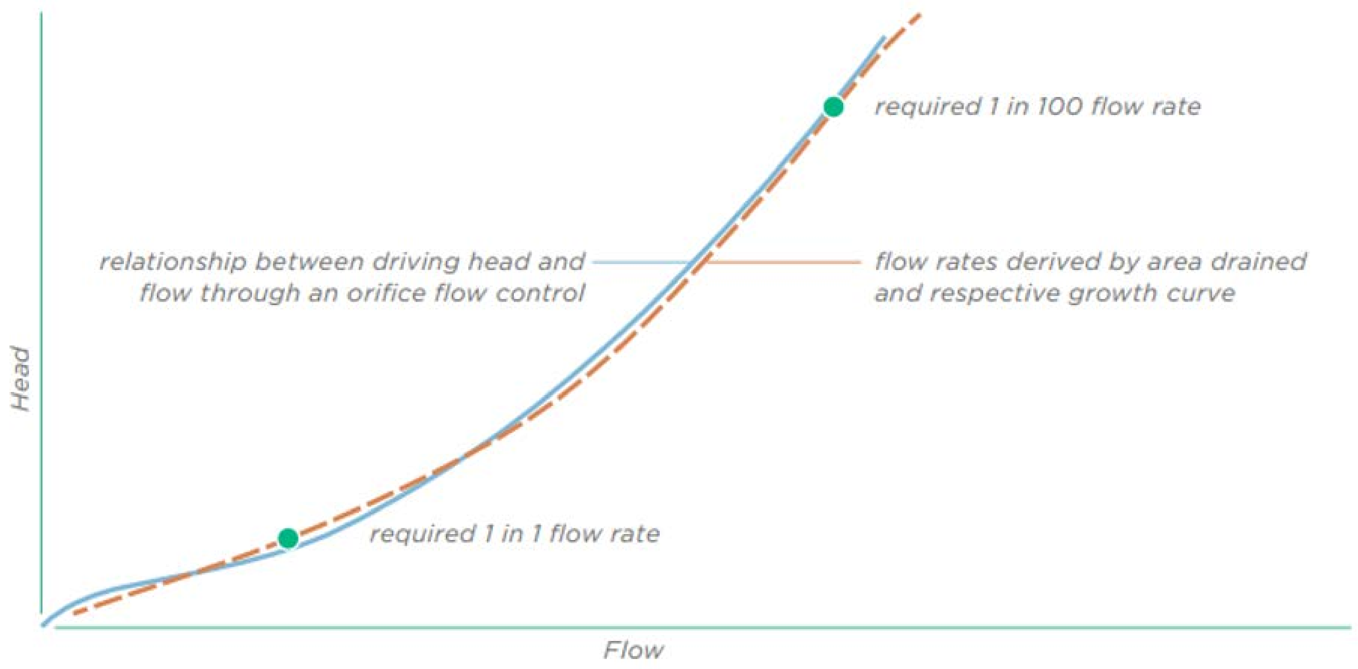
Approach 1 - Qbar method or maximum outflow of 2l/s/ha

Where the design requirements for volume control cannot be achieved then all runoff from the site for the 1 in 100 year event including CCA should be discharged at a maximum Qbar rate (or equivalent) for the development. A lower threshold of 2 l/sec/ha is acceptable to enable reasonable drain down times whilst not adversely impacting on flood risk within receiving watercourses.

It is noted that for gravity controlled systems the maximum permitted outflow Qbar rate (or 2l/s/ha) is only reached when the SuDS component is full, and the design head reached.

Approach 2 – Variable control

This approach allows for varying the outflow rate for the 1 in 1 year and 1 in 100 year greenfield runoff rates for the respective rainfall events.



8.5.2.1 Approach 2 methodology

An orifice opening will deliver variable outflow rates as the severity of rainfall increases, producing and storing more runoff. As the depth of stored water increases the gravitational pressure forces more flow through the opening - sometimes referred to as the 'driving head' of water stored.

The following steps outline the process of calculating the opening size of an orifice flow control to meet the requirements of GDSDS Criterion 4:

Establish the controlled outflow (or Greenfield runoff) rates for the 1 in 1 year and 1 in 100 year rainfall event.

Define the first, lower orifice invert. A reasonable starting point is to set the invert at the base (or slightly below the base) of storage.

Calculate the maximum storage depth for your SuDS component, based on its catchment, for the 1 in 100 year event and the 1 in 100 flow rate - for example this may be 350mm for a permeable pavement or up to 600mm for basins.

Make a note of the calculated opening size to achieve the 1 in 100 flow rate at this storage depth.

Based on the same storage component design and flow control opening, calculate how a 1 in 1 year rainfall event will behave – make a note of the maximum storage depth and maximum flow rate. Note that the volume and therefore driving head will be significantly smaller for the 1 in 1 year rainfall event and therefore the flow rate through the orifice will be significantly lower.

If the calculated maximum flow is less that the 1 in 1 year control rate then the opening does not need changing.

If the calculated maximum flow for the 1 in 1 event is larger than the 1 in 1 year control rate then reduce the opening size and recalculate based on the 1 in 1 event being mindful that the 1 in 100 year scenario will have to be reconsidered. Amend the opening size until the 1 in 1 year event is attenuated to the 1 in 1 discharge rate and make a note of the resulting maximum storage depth.

Re-run the calculations for the 1 in 100 year event based on the changed opening. The maximum flow rate will now be below the allowable discharge rate resulting in more storage than is necessary. To overcome this, a second opening may be placed above the 1 in 1 storage depth noted in step 7. Add a second opening so that it's lower most point (invert) is at or above the 1 in 1 storage depth and recalculate the storage behaviour in a 1 in 100 event. Adjust the opening size and height above the 1 in 100 storage depth until the 1 in 100 flow rate is achieved at the maximum storage depth for the 1 in 100 event.

Design Notes: Both the 1 in 1 and 1 in 100 discharge rates can be achieved by combination of the following:

Adjusting the depth of each defined storage tier by adjusting the area and therefore volume of each tier

Incorporating one or more additional openings

Other options can be explored where there is difficulty in matching outflow rates for both the 1 in 1 year and 1 in 100 year flows:

Try different types of openings such as rectangular and v-notch weirs.

Store for a different return period – it is not necessary to store for the 1 in 100 year return period in every sub-catchment. The final discharge from the site must meet requirements of GDSDS Criterion 4.

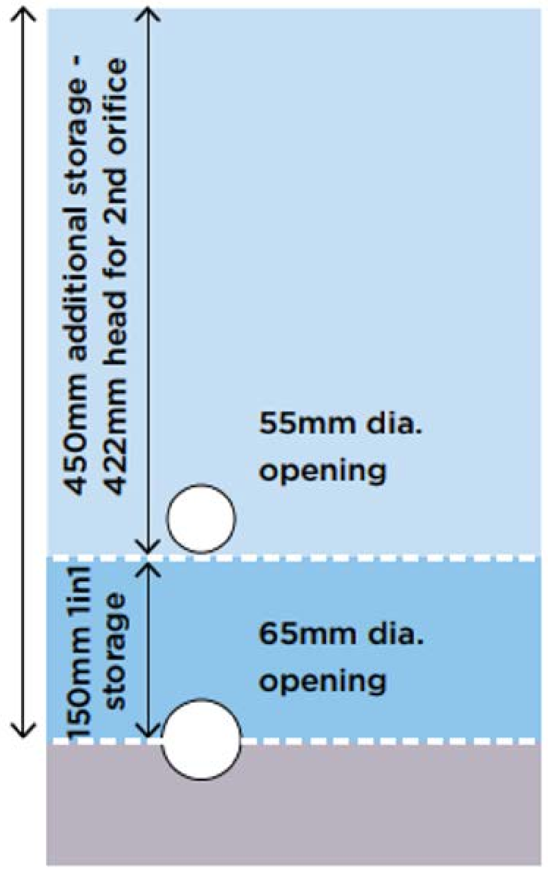


Image above: ***Sizing flow control - 600mm total depth of storage, 1 in 100 year rainfall + CCA***

Approach 2 - worked example

For the purpose of the example the following rates are assumed:

- 1 in 1 year 3.5 l/s
- 1 in 100 year 11.1 l/s

Depths of storage are assumed as 150mm and 600mm for 1 in 1 year and 1 in 100 year return periods respectively.

1 in 1 year

65mm opening with 150mm depth of storage for 1 in 1 year, which provides 3.5 l/s outflow .

1 in 100 year

65mm opening for 600mm depth of storage provides outflow rate of 6.9 l/s. Allowable discharge is 11.1l/s.

Therefore 11.1 – 6.9 = 4.2 l/s. The additional flow will be provided by an additional opening which will only operate once the 1 in 1 year storage is utilised.

Using an additional 55mm opening with invert 150mm above base invert of storage provides 4.2 l/s outflow

8.5.3 SuDS Calculation checklist

Key calculation inputs and outputs should be presented in the SuDS design statement. The following checklist identifies calculation considerations:

Parameter	Guidance on design/ calculation input	Information for assessment
✓ **Rainfall data.**	A range of rainfall durations must be considered when calculating attenuation storage.	Designer to demonstrate that sufficient rainfall durations have been considered to achieve maximum storage requirement
✓ **Areas generating runoff**	All area of contributing runoff should be represented within the storage calculation. Coefficients of runoff to be appropriately allocated	Provide a drawing clearly identifying the areas of surface runoff contribution within each subcatchment. Designer to state Cv's used and justify use of Cv less than 0.9.
✓ **Hierarchy of discharge**	Discharge of rainfall runoff to the sewer network should be minimised.	Designer to demonstrate that they have considered discharge methods in the following order – rainwater reuse; infiltration; watercourse; surface water sewer.
✓ **Maximum flow control rate**	As per GDSDS. KCC or Uisce Éireann may place further restrictions on the outfall flow rates based on the available capacity of receiving infrastructure.	The flow control rate should be identified along with the approach used to calculate this rate.
✓ **Climate change allowance**	CCA has been applied within calculations.	Designer to justify selection of CCA.
✓ **Urban creep**	Urban creep allowance applied to impermeable areas on developments where permitted development is likely to occur (extensions, driveways etc).	Designer to justify selection of Urban Creep percentage

Parameter	Guidance on design/ calculation input	Information for assessment
Initial interception losses	As a rule of thumb, where the area of development is no greater than 4 times the SuDS wetted area, a 5mm allowance may be made for interception losses for each m2 of development.	Designer to confirm whether 5mm interception losses have been applied in calculation.
Outfall design	Outfalls into receiving sewers or watercourses can be at risk of surcharge and lack of free discharge due to elevated water levels. This can result in additional storage being required. Free discharge should not be assumed. The risk of surcharge should be assessed and accounted for within calculations as appropriate.	Designer is to indicate whether SuDS storage calculation is likely to be influenced by high water levels at the point of discharge.
Hydraulic Modelling of SuDS	Layout drawings should be clearly labelled with the numbering convention used by hydraulic model. It is not anticipated that SuDS design will require extensive piped networks where subcatchments. In instances where the scheme is not hydraulically complex standard calculations may be accepted in lieu of a hydraulic model. It is noted that hand calculations can be prone to error and therefore outputs from spreadsheets should be checked by benchmarking (against outputs from UKSuDS.com for example)	Summary details of model parameters and simulation results. The designer is to justify where no hydraulic modelling is undertaken and demonstrate that outputs are within expected ranges.
Long section	Long sections will allow consideration of levels across the site.	Long section showing peak water levels.

Parameter	Guidance on design/ calculation input	Information for assessment
Erosion check	Flows along swales (or other vegetated surfaces) are at risk from erosion. Peak flow velocities should be less than 1 - 2 l/s. Concentrated inlet points are also prone to erosion.	Designer to demonstrate that they have considered risk of erosion and taken measures to safeguard scheme. Peak flow velocity calculations to be provided as appropriate.
Designing for exceedance	The design should incorporate overflows at each SuDS component. Hydraulic calculations should demonstrate that overflows have sufficient capacity to deal with anticipated flow rates. SuDS layout drawing should identify the anticipated flow route for exceedance events.	Locations of overflows should be identified on the layout drawing along with proposed exceedance flow route.
Managing flows from off site	The SSFRA should identify the potential for flows from offsite. These flows can be unpredictable and difficult to quantify. Management of flows through the site should not increase flood risk elsewhere. Detailed modelling to establish the rates of flow anticipated would not be considered compulsory (but may be required on a case by case basis).	The designer should demonstrate how anticipated flows from off site will be managed through the site using the layout drawing and design statement.
Consistency of calculations and design.	Detailed design of SuDS components should reflect hydraulic calculations / hydraulic models, taking into account slopes and low lying levels. KCC will consider design drawings to ensure that flow control sizing and storage provision is as per calculations.	Drawings should clearly identify site levels, storage locations and flow controls with cross sections and long sections. The design statement should confirm that drawings deliver calculated volumes.

8.6 Water quality

Rainfall picks up pollution from development surfaces. As runoff moves slowly through SuDS components the majority of pollution is removed through sedimentation, filtration and bioremediation. Naturally occurring processes in many SuDS components break down organic pollution, meaning that there is no build up or need for removal of this pollution over time.

Using source control and the management train, SuDS provides a controlled flow of cleaned water through the development.

Open water features should not receive flows directly from development without sufficient treatment.

› **Hydrocarbons remain in pond sediments for extended periods.**

› **Silts which carry heavy metals impact on the aquatic environment and add to maintenance problems due to the build-up of toxic sediments.**

The amenity and biodiversity value of ponds and wetlands should be protected with pollutants removed at source and along the management train.

8.6.1 The objectives of designing for water quality

› **Treat runoff to prevent negative impacts to the development's landscape and biodiversity as well as receiving watercourses and water bodies within the wider landscape.**

› **Treat runoff to prevent negative impacts on the receiving water quality. This may include onsite SuDS components which have amenity and biodiversity potential.**

› **Manage surface water runoff at or close to source and at or near the surface where possible to begin treatment quickly and maximise treatment through the system.**

Designer note: Where water quantity design adopts a SuDS management train approach, most designs will meet water quality requirements by default, due to the number of components already used in series.

8.6.2 Hazard and mitigation risk assessment

The 2015 CIRIA SuDS Manual adopts a '**Source-Pathway-Receptor**' approach, with

the extent of analysis required associated with the level of risk.

› **On low to medium risk sites where discharge is to surface water – apply 'Hazard and Mitigation' Simple Indices Approach (SIA) to confirm that the proposed SuDS components required (CIRIA SuDS Manual Section 26.7.1).**

› **For medium risk sites where discharge is via infiltration, undertake risk screening to establish whether infiltration would have an undue risk to groundwater and apply the indicies approach to identify the number of SuDS components required prior to infiltration. (CIRIA SuDS Manual Section 26.7.2)**

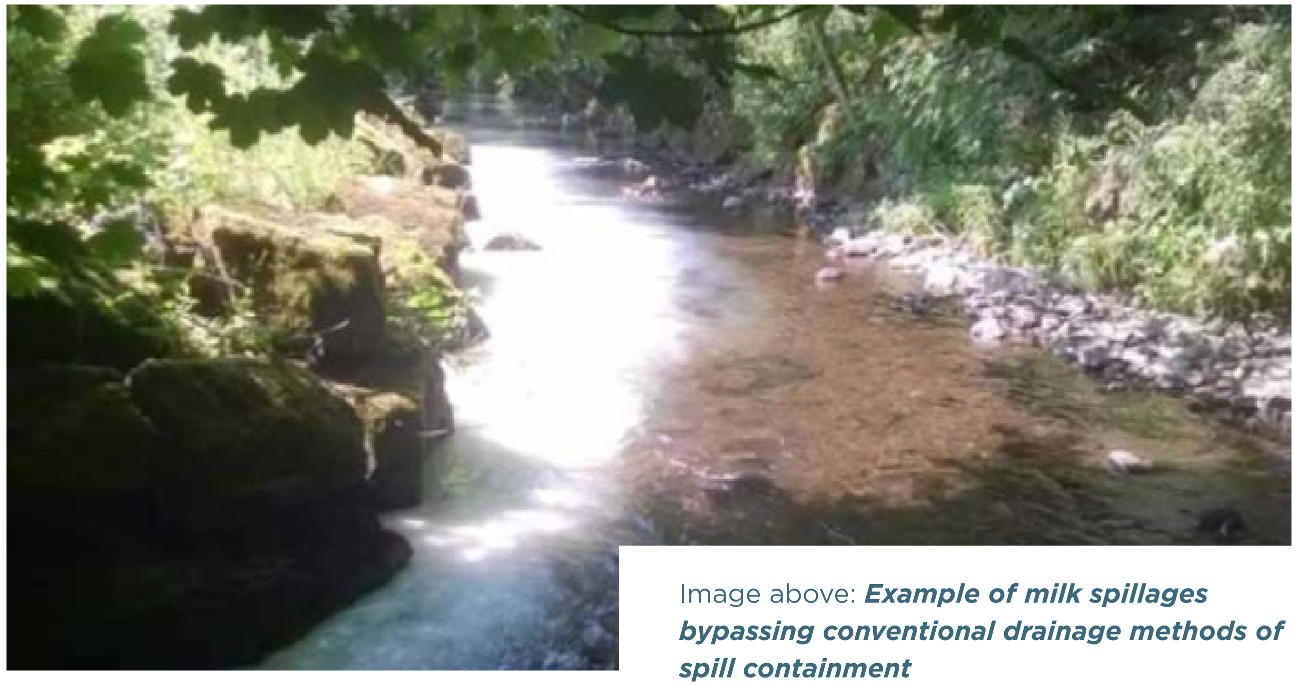


Image above: ***Example of milk spillages bypassing conventional drainage methods of spill containment***

› **For High Risk sites, there will generally be a requirement for a discharge licence. this should be discussed with the EPA.**

DESIGN NOTE; Table 26.15 of the 2015 SuDS Manual notes that conventional gully and pipe drainage provide zero treatment

A level of understanding of the site's soil and underlying geology is required to undertake the infiltration risk screening assessment. The screening assessment will determine whether it will be permissible to infiltrate and the indices approach is applied to define the level of treatment required prior to the point of infiltration

Signpost: Table 26.2, 26.3 and 26.4 of the 2015 SuDS Manual identify the hazard indices and the treatment efficiency indices for a range of SuDS attenuation and infiltration features.

8.6.3 Dealing with spillage

SuDS components are very effective at dealing with 'day to day' pollution. When a spillage occurs this can overload the treatment processes which occur within SuDS components. Where the spillage is an organic based pollutant a spill kit is used to take up the excess and the residual pollutants left in situ to breakdown naturally

Designing SuDS to cater for spillage should demonstrate:

› **spillage is retained at or near the surface so that it is visible and accessible.**

› **slow travel time along the management allows time for reaction and initial cleanup to take place.**

› **mechanical mechanisms such as shut off values should be avoided. An awareness of outlet locations which can be easily sealed off can provide simple and robust containment.**

8.6.4 Water quality design checklist

Item	What's being checked	Information presented for assessment
✓ Method of discharge	Sensitivity of receptor and level of treatment required	Design statement to specify method of discharge and sensitivity of receptor
✓ Treatment	Sufficient treatment in place protecting site biodiversity and amenity assets and the wider environment. Evidence of source control, subcatchments and management train	Layout drawing clearly indicating SuDS components and management train. Details of Indices approach and infiltration screening assessment (as appropriate).
✓ Spill management	Contingency measures in the event of a minor / major spillage	Indicate on layout drawing potential for containment and where spill kits might be positioned
✓ Infiltration	Presence of contaminated land, depth to seasonal high groundwater table	Coordinated constraints plan.
✓ Construction phase	Demonstration of how site runoff could be managed during construction to minimise the risk of pollution to the wider environment due to silty construction runoff	Section of the drainage design statement outlining a potential approach for construction runoff management. Contractors will be responsible for developing and carrying out mitigation measures.
✓ Operation and maintenance plan	Operation and maintenance should be simple to understand and easy to implement. Where available, SuDS design should deploy natural treatment process to breakdown organic pollutants passively. Contingency measures in the event of a minor / major spillage	Concise operation and maintenance plan. Description of tasks and detailing of where personnel are required to visit site to remove hydrocarbon based pollutants (i.e. organic pollutants have not been fully broken down passively as part of SuDS treatment process). Plan indicating potential for containment and positioning of spill kits (as appropriate)

Image left: ***Example of informal play through integrated design***

8.7 Amenity

Confirming integrated SuDS design

Amenity is one of the four pillars of SuDS design and perhaps open to the most interpretation and judgement.

Amenity focuses on the usefulness and aesthetic elements of SuDS design associated with features 'at or near the surface', and considers both multifunctionality and visual quality.

The amenity value of SuDS will have been considered at both Concept and Outline design stages but some finer aspects of value will be enhanced by detail design at stage.

An evaluation of the successful integration of amenity uses the design criteria set out in Concept Design.

8.7.1 Legibility

Understanding how the SuDS design functions is important both to everyday users of the SuDS environment and those who look after it.

An exercise in following each management train from source to outfall and imagining how the scheme presents itself to the visitor should highlight any problems with legibility.

Considerations will include:

- **How is rainfall collected?**
- **What 'source control' techniques have been used and how they can be accessed and maintained?**
- **How does runoff travel from where it has been collected onwards through 'source control' components to each part of the site. This is conveyance?**
- **Where is runoff stored and cleaned along the management train in 'site controls' recognising that these functions may occur within permeable construction?**
- **Where are flow controls are located?**
- **Are overflow and exceedance routes clear and understandable?**
- **Is the outfall obvious, accessible and understandable?**

8.7.2 Accessibility

All parts of the SuDS landscape should be accessible to both everyday users and site managers.

Full accessibility requires safety by design for every element of design including:

- **open water**
- **changes of level**
- **design detailing eg. headwalls, inlets and outlets**
- **clear visibility of the system**
- **physical accessibility to all with an understanding of the limitations of level changes and open water**

Signpost: CIRIA C753 SuDS Manual (2015) Chapter 36 - Safety

Image above: ***Hopwood Park MSA M42. Wooden terrace and balustrade with wet bench and planted aquatic bench protection to open water***

8.7.3 Multi-functionality

Many parts of the SuDS landscape can be useful in ways not associated with managing rainfall.

Permeable pavement is an example of full multi-functionality in that the surface is always available for managing rainfall and also allows vehicle access, parking and pedestrian use.

Reasonably level green space can be used for sports and other social activity most of the time but not when inundated. Everyday rainfall (1-2 year return period events) can be designed to be managed elsewhere in the landscape.

Other functionality can include:

- **play opportunity throughout the SuDS landscape**
- **informal leisure like jogging, picnics, dog-walking etc.**
- **community activities such as gardening etc.**
- **wildlife habitat**
- **education.**

Usability of swales and basins can be enhanced by under-draining into filter trenches below the ground to keep grass surfaces dry most of the time. For instance, within housing where grass surfaces are valuable for play.

8.7.4 Visual quality

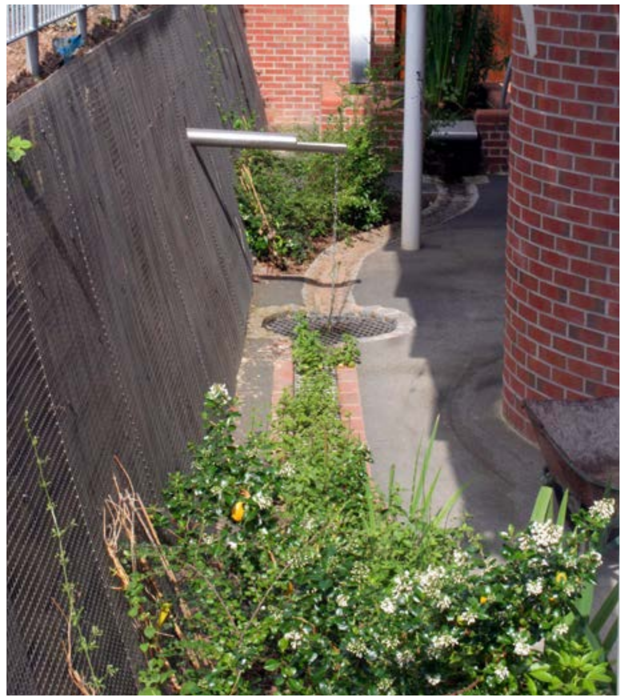
The overall character of the SuDS landscape and surrounding areas will have been considered during Concept and Outline Design stages.

Design detailing of SuDS components, particularly inlets, outlets, control structures, channels and basins with their edges and profiles remain to be confirmed during Detail Design Stage.

Firstly, the collection and conveyance of runoff can add visual interest to development, spouts, rills surface channels, for instance, should be considered as part of the landscape character of a development.

Secondly, it is important to clean runoff as soon as possible so that water that flows through development is as clean as possible for both Amenity and Biodiversity benefits. This requires 'source control' at the beginning of the SuDS to remove silt and gross pollution.

Source control components such as permeable surfaces, filter strips, green/blue roofs, bioretention and in some cases swales and basins can all provide early cleaning and flow reduction at the beginning of the management train.



Images above: ***Integration of SuDS with Amenity, Biodiversity and site layout***

Community use and wildlife interest are both compatible with SuDS design. SuDS should integrate with both designated public open space, where both everyday rainfall and occasional heavy storms can be managed, and public pedestrian routes where conveyance of water and biodiversity can be combined.

The integration of SuDS with Amenity, Biodiversity and site layout provides additional benefits including:

- **efficient use of space through multi-functionality**
- **usability through integrated use of landscape space**
- **visual and biodiversity interest as part of integrated site design.**

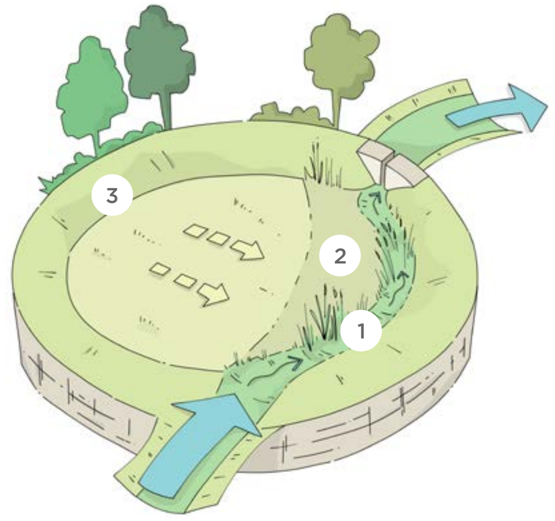


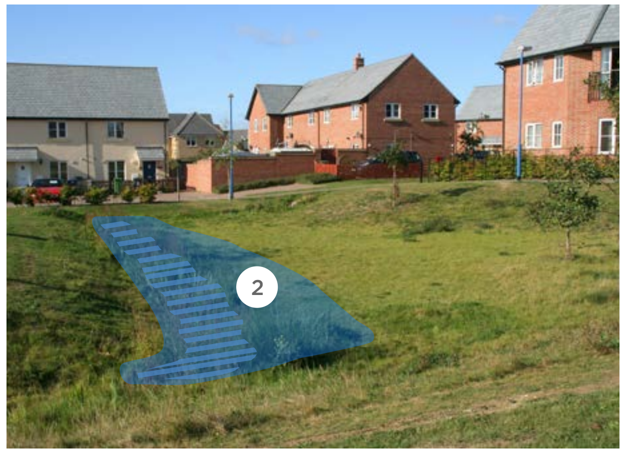
Image above: ***SuDS in public space - Strategy diagram***

1. Everyday rainfall: runoff travels along low flow route.

2. Design rainfall: as rain increases the basin will start to fill, what we typically design systems to achieve e.g. a 1:30 rainfall event.

3. Extreme rainfall: following extreme rainfall e.g. a 1:100 rainfall event, the whole basin can fill and will empty over a couple of days.

Note: careful landscaping of levels will mean that most of the basin area will be available for amenity use nearly all of the time



Images above & left: ***Example basin, refer to Case Study page 30-32 for further detail***

8.7.5 The integration of amenity and SuDS

Early SuDS design tended to create dedicated SuDS corridors with a series of basins, swales and wetlands which were in many cases fenced off, that were separate from the development they served. They were therefore thought to be land hungry, expensive and required additional site maintenance.

In order to maximize the value of SuDS it is important to understand the principle of integrated SuDS design. SuDS design should integrate the requirements of rainfall management with the use of development by people.

8.7.6 SuDS in public open space

The following graphic demonstrates how levels within a basin can be adapted to ensure that most of the basin is available for play during the majority of rainfall events. As further surface runoff is stored water will encroach gradually up the slope, until the full storage capacity of the basin is utilised.

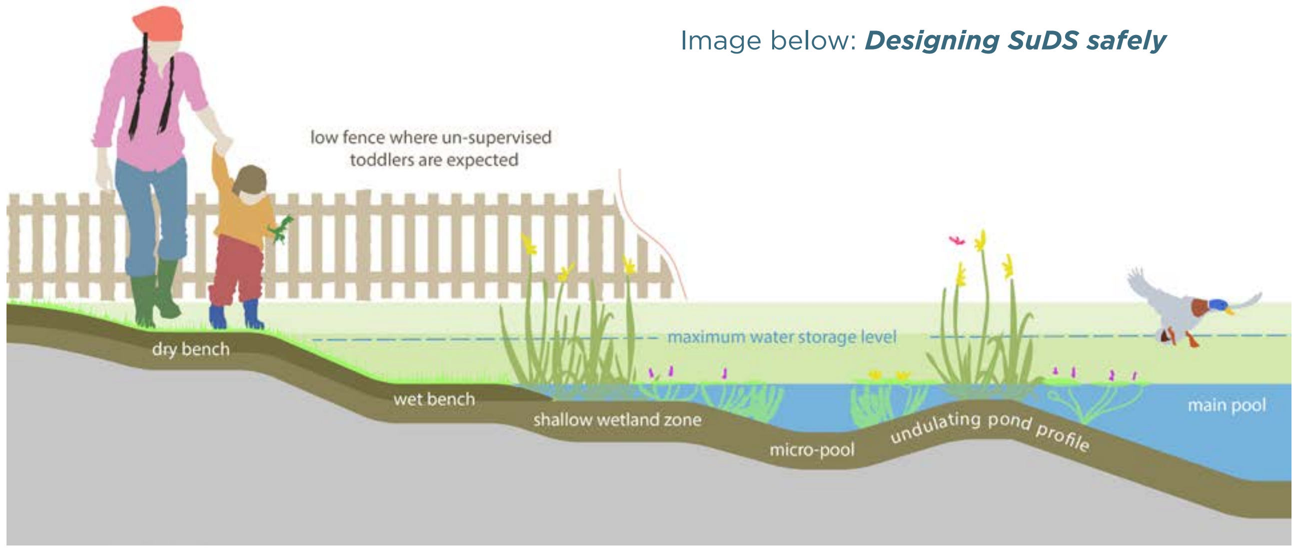
Where Sustainable Drainage Systems (SuDS) form part of the public open space provision they must be in adherence with the KCC CDP Open Spaces Strategy. The following points will be considered in determining the areal extent of SuDS which serve as multifunctional space and/ or contribute to the public open space allocation:

- **contribute in a significant and positive way to the design and quality of open space,**
- **enhance biodiversity and amenity value, and link with the existing Green Infrastructure network in the settlement.**
- **provide an open space benefit even when holding surface water (for example ponds and wetlands),**
- **be readily available for use in most weather conditions,**
- **be accessible and usable**
- **be designed by a multi-disciplinary team (to include a drainage engineer, ecologist, arborist, landscape architect etc.) as part of the overall project.**

The Designer should demonstrate how a range of rainfall events (i.e. 1 in 1, 5, 10, 30 and 100 rainfall return periods with CCA) will be managed and the extent of POS likely to be subject to ponding along with the duration of ponding for the respective rainfall events.

SuDS which form part of public open space provision will be assessed on a case-by-case basis by the planning authority, having regard to site specific conditions and the quality of design.

Image below: ***Designing SuDS safely***



8.8 Health and Safety by design

8.8.1 The place of water in the landscape

Although there are a number of risks associated with SuDS features, as there are with any landscape design, it is usually the presence of open water that is a concern.

It is important to consider the place water occupies in our everyday lives and its cultural importance. Water plays an integral part of the Kildare landscape with presence of the Naas Ponds along with the River Liffey, River Boyne and the River Barrow. Over 70 miles of canals extend across the countryside of Co Kildare. Water has increasingly become appreciated for its visual, recreational and wildlife value and most people like to see and experience water in the landscape. Canal tow paths and ponds in parks have proved to be popular gathering places.

The issue of Health and Safety is therefore not one of risk elimination but of developing a design approach that celebrates water whilst managing any real or perceived risk in a way that is acceptable to the community and maintenance team.

8.8.2 Aspects of Health and Safety in SuDS

A number of risks associated with SuDS can be identified:

1. **the risk of drowning**
2. **slip and trip hazard**
3. **risk of disease**
4. **risk of toxicity**
5. **infrastructure issues –highways, sewers, aircraft (bird strikes) etc.**

This issue is considered in greater detail in the Detail Design section but the general approach to 'Principles of Prevention' for SuDS is that all parts of a SuDS design should be fully accessible to people, with each element of the design considered from the health and safety perspective.

The design of the water edge to ponds, wetlands and basins is a good example of where the design allows a person to walk into and out of the feature safely in the design sequence;

A flat dry bench at the edge of the structure: a gentle slope, max 1:3 down to the water: a wet bench at permanent water level: another gentle slope into the water and another underwater level bench before deeper water.

Designer Note

The appointment of a PSDP is required when:

- **construction work is expected to take longer than 30 working days;**
- **if the work involves more than one contractor (or sub-contractor);**
- **if there is a particular risk present on the project;**
- **if work will exceed 500 person days.**

Sign post: PSDP

8.9 Affordability

The design of SuDS is influenced by the type of development and how important each component is to the appearance and functionality of the scheme.

An urban renewal project in highly urbanised areas of County Kildare towns will require a different approach to the visual quality than a simple SuDS design for a suburban layout.

SuDS components are cost effective when compared to conventional drainage but cost savings are only realised through good SuDS design.

Example:

Use of permeable pavement as a replacement for impermeable surfaces on new build sites. The cost of the profile construction is marginally more expensive but avoids extensive pipe work, gullies, manhole, dedicated SuDS storage and in some situations oil interceptors. The open graded sub-base provides 30% void storage which is utilised by a placement of flow control. Permeable pavement has been demonstrated to require a low level of maintenance into the future.

Completing a cost comparison for permeable pavement should fully consider drainage (pipes, gully pots, storage tanks, petrol interceptor, etc), surfacing and engineering profiles that have to be provided in traditional construction approaches.

Signpost: Evidence on performance of SuDS

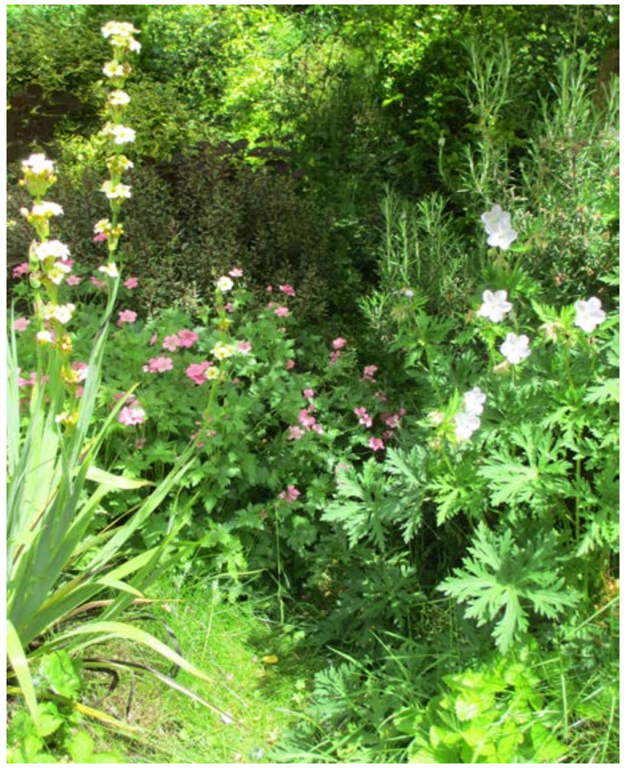


Image above: ***Designing for biodiversity***

8.10 Biodiversity

8.10.1 Principles of design for biodiversity

Geology and climate are fundamental influences on the natural character of the landscape and determine the basic habitat types likely to evolve over time.

Local topography, aspect, soils, landscape design and habitat management all affect biodiversity in a developed landscape and can be influenced by SuDS design.

Biodiversity must be considered at the larger catchment scale to create a sympathetic green / blue infrastructure and also at a local scale to provide habitat and connectivity linkages within and around development.

8.10.2 Biodiversity at development scale

There is usually a host landscape that provides an enclosing envelope to the SuDS 'management train'. This term describes the landscape not directly affected by SuDS features and the impact of rainfall management.

This surrounding 'host landscape' may include natural habitat or reflect more ornamental planting, particularly where it is close to buildings.

The wider host landscape should reflect the ecological character of surrounding natural habitat wherever this is possible but careful design can still enhance wildlife value in ornamental planting by following specific guidance.

Where SuDS installations are more isolated, for instance in urban retrofit and redevelopment, then SuDS spaces can act as biodiverse islands, sometimes likened to 'service stations', that act as staging posts and feeding sites for mobile species like birds, insects and other wildlife in an otherwise hostile environment.

Design note: Site specific planting designs should be completed in consultation with KCC Parks Department, Biodiversity Officer and developers Ecological Consultant (as appropriate) to ensure the continuation and enhancement of ecological corridors

8.10.3 Key design criteria for biodiversity in the developed landscape

8.10.3.1 Clean water

Clean water is critical as soon as possible for all open water features in the landscape. Clean water is delivered using initial pollution prevention measures to prevent contaminants reaching water, source control features and further site controls along the management train.

8.10.3.2 Structural diversity

Structural diversity both horizontally and vertically within water features, the landscape and in vegetation generally provides habitat variety for wildlife. Structural diversity is inherent in many SuDS features particularly swales, basins, wetlands and ponds that can easily be enhanced for habitat creation. Ornamental planting should mimic natural vegetation by developing a complex vertical structure of trees, shrubs and herbaceous cover.

8.10.3.3 Connectivity

Connectivity between wetland habitat areas both within and outside the site encourages colonisation into and throughout the development landscape. These connections are particularly important both for animals on the ground but animals like bats use individual trees and woodland edges to travel from one place to the next and use SuDS wetlands to feed.

Connectivity is inherent in the management train principle but must be considered carefully where one feature links to the next.

Surface conveyance and overflow routes, with a minimum use of pipework and inspection chambers, is helpful in retaining wildlife links.

There should be a direct connection between the SuDS landscape and the blue/green infrastructure that receives the 'controlled flow of clean water' from the development.

8.10.3.4 Prevent pollution to habitat

Permanent vegetation should cover all soil surfaces to prevent silt runoff and planting should be designed to avoid the use of fertilizer, pesticides and herbicides.

8.10.3.5 Maintenance for wildlife

Sympathetic maintenance enhances biodiversity but should be compatible with the aspirations of the local community to ensure acceptance of a more natural landscape character.

8.11 Management of SuDS features

The future maintenance of SuDS is influenced by design. Wherever the management of SuDS components will be integrated into 'everyday' site management, eg. grass cutting. Maintenance can therefore be allocated to site care (landscape management and cosmetic sweeping of hard surfaces) rather than dedicated SuDS management.

The dedicated SuDS maintenance obligation can sometimes be reduced to checking inlets, outlets and control structures. These structures must be easily accessible and able to be maintained by landscape care personnel.

Design note: Well designed SuDS are not 'land hungry' in that they can be integrated into both hard and soft landscape spaces which are available within development. Making SuDS cost effective reinforces the requirement to consider SuDS layout at Concept Design stage.

Where SuDS is not taken in charge the developer must confirm who will be responsible for this maintenance (along with specifying any legal agreements which confirm that the maintenance will be carried out).

Replacement

Where the design life of the SuDS component does not exceed the design life of the scheme, then engineering implications of replacement should be considered. This includes:

- **A methodology for how the item will be replaced whilst maintaining drainage functionality of the site.**
- **Identification of how replacement will be financed (where not taken in charge by KCC).**

It is noted that some SuDS components may need some degree of rehabilitation / dedicated SuDS maintenance, for example, re-gritting of the joints in a permeable pavement. This is not the same as replacement, which may be required for geocellular tanks for example or other items with a defined or finite design life.

8.12 Submitting SuDS design as part of a planning application

The design information should be provided in plan form, confirming site layout and SuDS infrastructure together with a SuDS Design Statement presenting all information that cannot be conveyed on plan.

8.12.1 SuDS design drawings

The SuDS drawings will normally include plans, typical sections and typical details. Sufficient information should be presented within the drawing package to confirm / identify the following;

- **type of runoff collection to ensure runoff is at or near the surface**
- **source control type(s) and location**
- **management train (SuDS components in series) – extent and expected critical levels**
- **sub-catchment boundaries with flow control locations**
- **storage locations, extent and critical levels**
- **conveyance – ideally at or near the surface**
- **landscape character – the nature of the development and how SuDS is integrated into site design**
- **biodiversity – opportunities for wildlife, clean water, connectivity and habitat design**

8.12.2 SuDS design statement

The SuDS Design Statement should cover SuDS provisions on quantity, quality, amenity and biodiversity and how opportunities provided by the site have been maximised along with addressing the following:

- **confirm drainage design criteria stated by policy / SuDS requirements or agreed with KCC. For example, rainfall return periods, discharge allowance, traffic loading requirements etc.. Outline how GDSDS Criterion 1-4 are delivered**
- **summarise the findings of the SSFRA and highlight any other significant site constraints**
- **outline how requirements of KCC Development Plan SuDS related policies and objectives, requirements for multi-functional use of SuDS space and local objectives for sustainability including climate resilience are dealt with**
- **explain how SuDS will function passively in terms of treatment and management.**
- **outline details of any offsite works required, together with any necessary consents**
- **Details of any proposed wayleaves or land transfers in relation to surface water drainage**
- **detail site specific landscape maintenance plan including frequency, elaborating on weed control measures ensuring no use of herbicides.**

8.12.3 SuDS design calculations

Calculations are required to demonstrate the hydraulic performance of the scheme.

Structural / geotechnical assessments are also required for SuDS structures where loading is exerted. As a minimum an assessment of the following will be required;

- **Strength of the soil supporting the SuDS structure**
- **Loading from vehicles (including construction vehicles), buildings and other structures**
- **Loading from**
- **Structural capacity of the SuDS structure**

8.12.4 Outline Design evaluation checklist

The following table provides a list of key considerations for design and evaluation.

The CIRIA SuDS Manual Table B.3 provides other aspects for checking which may be incorporated on a case by case basis.

Deliverable	Key design points	Key evaluation points
✓ Design standards	Designers should confirm how all policies and standards have been achieved for quantity, quality, amenity and biodiversity.	Confirm discharge rates. Confirm that sufficient treatment is in place. Confirm amenity and biodiversity requirements.
✓ Confirm method & locations of discharge	Where positive discharge is made to a watercourse / sewer, consider likelihood of surcharge on storage from the receiving sewer / watercourse. Infiltration – outline how ground will be protected from compaction during construction.	Review the level at which water is stored relative to receiving flood plain levels/sewer invert. Infiltration – review how groundwater table level has been confirmed and how ground will be protected from compaction during construction. Review risk of infiltrating close to buildings. Review how infiltration on brownfield sites has been assessed.
✓ Hydraulic calculations	Detailed checklist is contained Section 9.5.10. GDSDS Criterion 1-4	The level of analysis required should reflect the risk of failure, scale of development and complexity of drainage.
✓ Detailed consideration of site and drainage design levels	Levels are crucial – check that there are no locations where low points might compromise design. Designer to present drawing showing detailed levels across the site	Sensibility check to be performed for each subcatchment, comparing top level of storage, and lowest level of contributing areas.
✓ Drainage details	Minimise risk of blockage by designing protected outlets and flow controls	Review of inlets, outlets, flow controls, storage, edge details, connection details to receiving watercourse / sewers
✓ Hydraulic calculations & drawings match	Drawings should confirm volumes provided on design drawings and refer to hydraulic analysis requirements. Drawings references / annotations should clearly relate to calculations.	Sensibility check to be performed to ensure that sufficient storage is provided to meet hydraulic calculations.
✓ Designers hazard & risk assessment.	To consider construction, maintenance / operation by personnel and day to day site use by public.	Demonstrate safe design for users and operatives of the scheme.
✓ Long sections and cross sections	Cross sections should not use exaggerated vertical scales to allow proper understanding of how scheme will actually look	Review in general, side slopes and depths shown.
✓ Planting design & schedule	Outline any SuDS specific planting requirements.	Ensure plants from accredited source to minimise risk of invasive species.
✓ Landscape design drawings	Integrate SuDS within the wider landscape design	Check that the SuDS network is accessible, multifunctional and contributes to the overall landscape quality.
✓ Consents & permits	Vary and can include: discharge consents; offsite works & 3rd party access consent.	Check that relevant consents are in place or can be obtained in principle.
✓ Maintenance	Key plan (1 side of A4) detailing the maintenance regime and identifying key maintenance locations such as outlets and flow control locations.	Maintenance is appropriate & proportionate and features are easily accessible. Design achieves passive maintenance where possible.
✓ Taking in charge arrangements	Confirmation of commitment to take in charge aspects of the scheme agreed with KCC. Confirmation of ownership and maintenance responsibilities for all parts of the SuDS scheme which are not being taken in charge.	Review that sufficient safeguards are in place for the long term maintenance and operation of the drainage. Review that SuDS are designed to KCC taken in charge standards

Stage 3 Detailed Design

SECTION **9.0**

Overview

The development of the SuDS design to Detailed Design stage will ensure that delivery against SuDS requirements and related policies within the Development Plan are upheld post planning through to construction stage. A detailed design will enable a contractor to build the scheme to the correct specification and will confirm the specific detailing associated with the SuDS structures (where not confirmed at outline design stage).

Changes can arise during construction, which may affect the design such as the presence of unknown utilities or ground condition variations. Further detail may also be required by KCC where SuDS structures are proposed to be taken in charge from that presented during the planning approval phase.

9.1 Objectives of Detailed Design

Detailed Design should develop and refine the agreed SuDS strategy from the Outline design stages (agreed through the planning process). Outputs from the detailed design should:

- **Be based upon further detailed testing and site investigation results as may be appropriate to the scheme or arise as part of the construction phase.**
- **Provide sufficient information for full understanding of how the scheme will appear and operate.**
- **Provide sufficient materials and performance specification to allow a contractor to successfully build the scheme as per the design.**

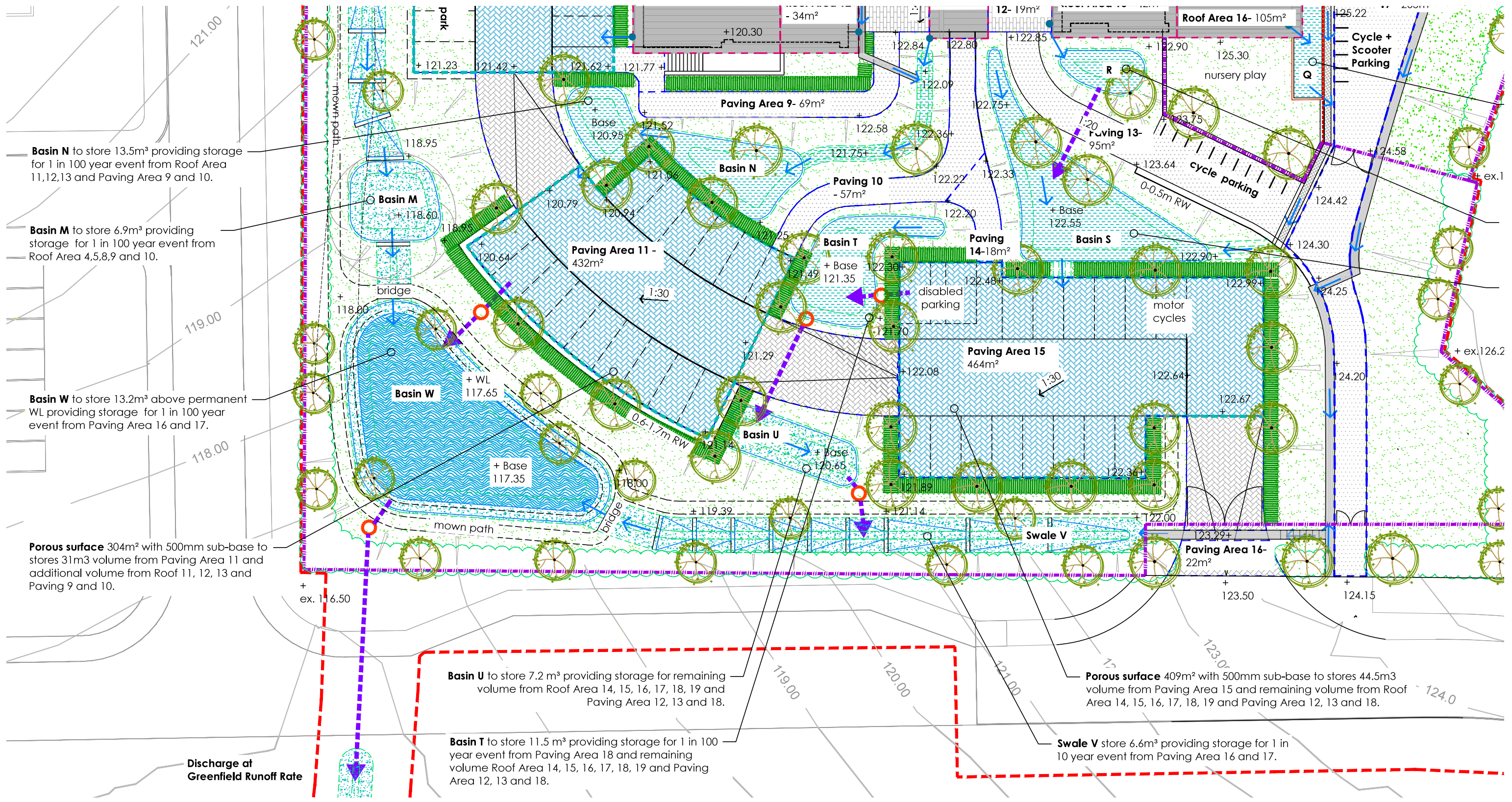


Image above: ***Example of a detailed SuDS Plan***

9.2 What Detailed Design should demonstrate

The SuDS Detailed Design considers in detail all the influencing factors on the scheme with over-arching requirements as follows:

- **the use of Source Control techniques provides a controlled flow of clean water through the site**
- **demonstrate that the modified flow route(s) provides for extreme flows and where possible connectivity corridors for biodiversity through the site**
- **carefully consider all site levels to ensure that the system will serve their intended function in 'day to day' and also extreme rainfall conditions (day to day functions may be for amenity use and not for attenuation of rainfall runoff)**
- **demonstrate that individual SuDS components meet respective design criteria**
- **proportionate analysis to confirm attenuation volumes with allowances for climate change and urban creep, and controlled flow rates for each sub-catchment and final site discharge rates**
- **materials and plant varieties specified accord with local landscape character**
- **demonstrate safe design for contractors, operatives and general users of the site**
- **design to consider how SuDS features prone to silt ingress and infiltration areas can be protected during the construction phase of the project.**
- **that SuDS which are being offered for taking in charge meet the standards of KCC.**

Design notes: Unforeseen information such as presence of previously unknown utilities can result in material changes to the design consented at planning stage. KCC Planners must be consulted in such instances.

An outline Construction drainage management plan should demonstrate how receiving watercourses can be protected from silt along with outlining how SuDS features will be constructed / protected during the construction phase.

9.3 Typical Detailed Design package

The Detailed Design package should be proportionate to the scale of the development and will generally encompass a design statement with accompanying drawings, design calculations, maintenance plan and risk assessment.

9.3.1 Drawing package

The SuDS drawing package should include the following:

Signpost: See KCC Landscape Design requirements

Design information drawings	Topographical survey of the site Coordinated constraints map identifying all potential design constraints including areas of flood risk (fluvial, pluvial and ground water), contaminated land, archaeological significance, poor ground conditions, presence of invasive species, protected habitats, Tree Preservation Orders (TPO) and root protection zones (RPZ), presence of existing basements or other underground structures. [note : list is not exhaustive] Existing and proposed utility services drawing. Details of existing and proposed site surface water drainage infrastructure and ownership established Plan of site detailing flow routes including exceedance flow routes, subcatchment boundaries, flow control locations, storage locations, contributing impermeable area, and phasing where appropriate; Drawing of site drainage catchment areas showing permeable and impermeable areas within defined subcatcatchments.
Design drawings	Detailed site layout at an identified scale (1:200 or 1:500 or as appropriate or any other scale agreed) including a North direction arrow. A scaled Landscape Masterplan with cross- sections showing the general layout and hard and soft landscape treatment of all external areas/spaces (including front and rear gardens), boundaries, structures and features. This shall be generally provided at a maximum scale of 1:200. Long sections and cross sections for the proposed SuDS system, including surrounding site level and proposed finished floor levels (where appropriate) Construction Details – inlets, outlets, flow controls, storage, edge details, connection details to receiving watercourse / sewers / public surface water sewers; All SuDS structures agreed to be taken in charge by KCC to be designed in adherence with 'KCC taking in charge' standards Planting arrangement and surface treatment / materials drawings where detailed not included on other drawings. Critical design levels should be identified on all relevant drawings.

9.3.2 Supporting information

Depending on the nature of the scheme, various investigations, tests and calculations may need to be performed along with obtaining necessary consents:

- **Ground investigation; including, infiltration test results, soil testing and groundwater monitoring as appropriate.**
- **Infiltration; groundwater monitoring for a minimum period of 6 months, detailed infiltration test results which are representative of the locations and invert levels proposed for infiltration.**
- **Design calculations which demonstrate compliance with the design criteria for the site including all hydraulic and structural calculations for permeable pavements and underground storage structures as appropriate.**
- **Details of any offsite works required, together with any necessary consents in place (or can be obtained).**
- **Confirmation that discharge consents are in place (or can be obtained)**
- **Section 50 Consent (OPW) may be required for works in, under, over or near a main river, works on or near a flood defence or for works in the flood plain of a main river.**
- **KCC consent where discharge is to a surface water sewer or road drain**
- **Discussions should be held with EPA for infiltration within Source Protection Zone areas or for sites where there is a high risk of pollution.**

Signpost: See OPW Consent requirements https://www.gov.ie/en/publication/957aa7-consent-requirements-constructionalteration-of-watercourse-infrastru/

- **Uisce Éireann consent to discharge where a connection to a combined sewer is required.**
- **Proposed maintenance schedule and confirmed management arrangements for all drainage which is not taken in charge. Identify any proposed split of the SuDS between private (curtilage) and public (open space or road) land.**
- **Habitat Management Plan and Arboriculture Assessment**
- **Designers hazard and risk assessment- to consider construction, maintenance and operation by personnel and day to day site use by public.**
- **Details of any informative signage proposed for SuDS.**

Design note: KCC WSP typically require that the groundwater regime is established by a groundwater monitoring programme of at least 6 months including a winter season. This should be carried out prior to submission of planning application. Where this is not achievable, the survey should be carried out to inform detailed design.

Signpost: See KCC requirements for existing Trees & Hedgerows

9.4 Critical levels

Levels are important in any drainage system and especially so for surface based SuDS. The proposed surface levels should align with the modified flow route analysis in providing a flow path across the site and storage volumes can be significantly affected by inaccurate levels.

The following levels should be evaluated when developing or reviewing a design:

- **the flow control invert level relative to storage - the flow control should not be situated above the base level of the storage component unless there is a requirement for permanent or semi-permanent water.**
- **The overflow level should demonstrate that the required volume of storage is contained between the flow control invert level and the overflow level.**
- **Areas contributing to a storage component should not be situated below the top level of storage as they may flood prior to the storage being filled.**
- **For storage components that are sloping, such as permeable pavements or linear basins, the 'effective' storage should be determined rather than the entire volume of the structure.**
- **A review of site levels should not identify any obvious obstructions along exceedance flow paths.**

Designer Note : KCC Water Services Department will carry out a high-level review of levels. Design liability is retained by the designer in all cases.

9.5 Importance of detailing

Competent design details ensure that runoff is collected, conveyed, cleaned, stored, controlled and discharged from site in an effective manner that provides wider benefits.

Failure of individual detailed elements of the design can:

- **invalidate expected storage volumes and flow rates**
- **prevent adequate treatment or removal of pollutants**
- **negatively impact or miss opportunities to contribute to amenity use**
- **create hazards to wildlife or miss opportunities to support biodiversity**
- **cause local ponding, flooding and inconvenience to the public**
- **increase maintenance difficulty and cost**
- **create safety issues for the public or site maintenance personnel.**

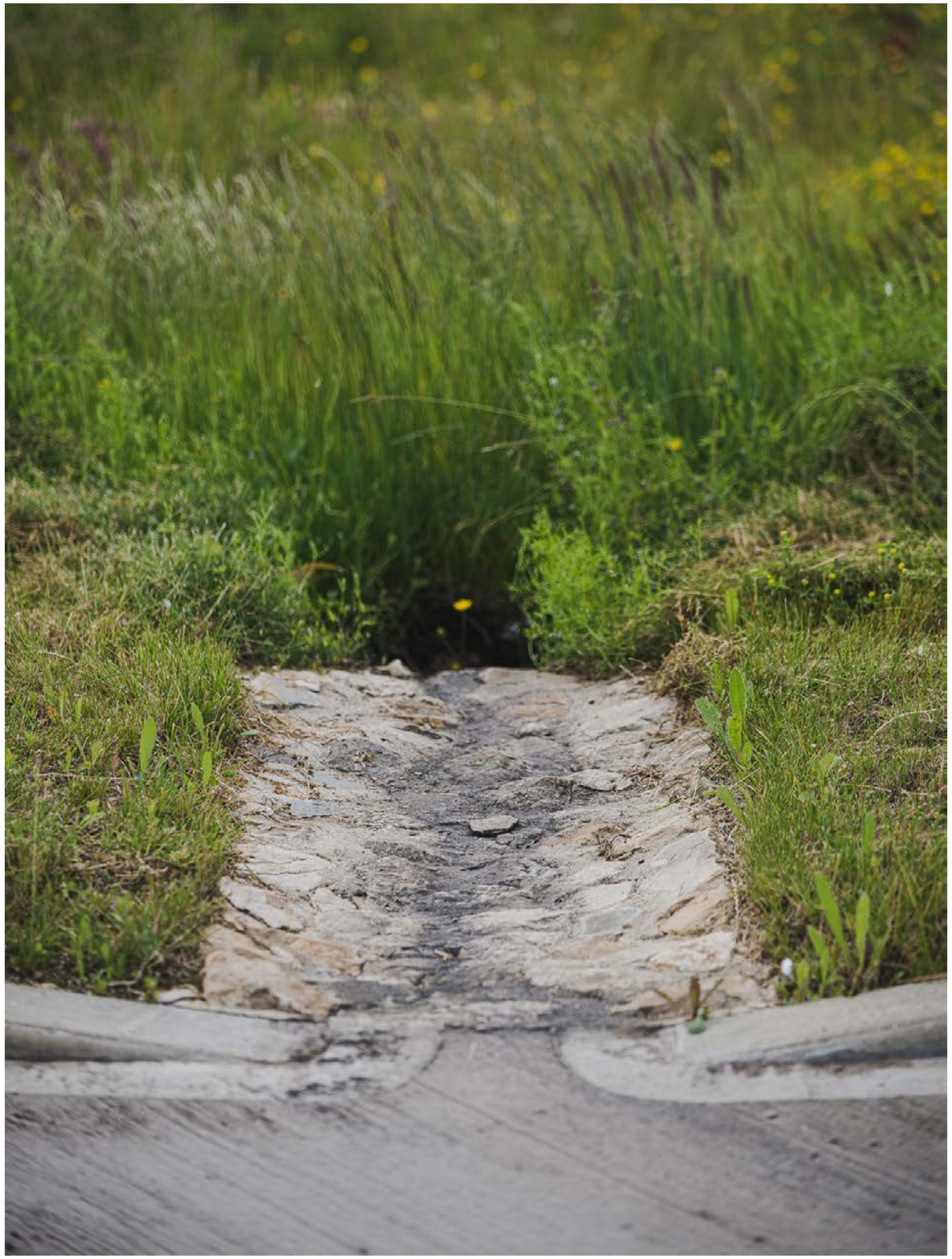
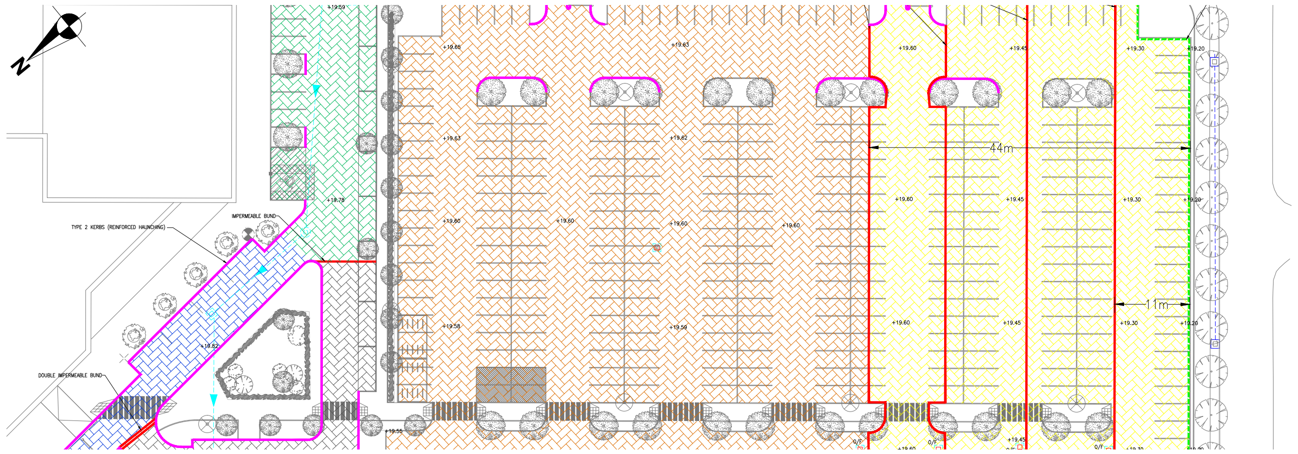


Image right: ***Example of drop kerb and erosion control***



9.6 Case Study - Limerick Permeable Paving Scheme

Concrete Block Permeable Pavement was used extensively across the trafficked areas of this scheme to provide collection of runoff at source and allow for direct infiltration to ground.

Key challenges which had to be considered included:

- **No release to the combined sewer up to the 1 in 100 year rainfall (with allowance for climate change)**
- **Low permeability infiltration rates (Circa. 1x10^6m/s)**
- **Sloping gradient across part of the site**

Design inputs included:

- **Maximising the use of infiltration across the site by compartmentalising areas along contours using internal geo-composite barriers**
- **Reinforced haunching at points where lateral forces (turning movements) were likely to be experienced.**

The scheme was inspected during construction to ensure any compacted subgrade was scrapped of and materials and construction profiles were to specification.

Image above: ***Landscape Plan***

Image below: ***Landscape construction 1.***

Image above: ***Landscape construction 2.***

Image right: ***Landscape construction 3.***

Image below: ***Post completion***

SuDS Components

Note: Ⓢ Symbol indicates SuDS Components are considered suitable for single house development.

SECTION 10.0

Competent design and detailing of SuDS components ensure that runoff is collected, conveyed, cleaned, stored, controlled and discharged from site in an effective manner.

10.1 SuDS Components

The general principles of SuDS component design are considered in the SuDS Manual (2015) Sections 11-23. The purpose of this section is to outline some of the key considerations, experiences and practical detail solutions of commonly used SuDS components.

The following classifications are not rigid, for example a permeable pavement can be considered as both source control and site control where it provides the required site storage:

Image above: ***A retrofit downpipe shoe and brick channel into a raingarden.***

10.1.1 Source Controls providing storage

Providing storage throughout the site (distributed storage components), means that every opportunity for storage across the site is exploited, greatly reducing the overall volume and size of site controls.

Source controls remove most silt, heavy metals and heavy oils from runoff, allowing basins, wetland and ponds to be designed as site assets.

- **rain harvesting** Ⓢ
- **green/ blue roofs** Ⓢ
- **raingardens and raingarden planters** Ⓢ
- **bioretention**
- **permeable pavement** Ⓢ
- **SuDS treepits**
- **soakaways** Ⓢ

10.1.2 Collection and connection

Where runoff is collected from roofs, conveyance to the SuDS component may be required. Historic urban design shows us a number of surface collection methods including spouts, surface channels and rills.

How runoff is collected and conveyed under crossing points such as footpaths and roads is a primary consideration of any SuDS design. Design details such as road gullies can artificially increase the depth and cost of SuDS.

- **channels & rills** Ⓢ
- **filter strips**
- **pipe connections**

10.1.3 Source Controls providing collection & conveyance

Water must either be kept at or near the surface to allow runoff to flow into SuDS structures, or it must be collected through permeable surfaces.

The simplest method of collection of runoff from an impermeable surface is to intercept it as sheet flow from a hard surface. Where runoff flows directly from hard surfaces to filter strips or swales then runoff must leave the hard surface effectively without the risk of ponding.

- **swales** Ⓢ
- **under-drained swales** Ⓢ
- **filter drains**

Image above: ***Low risk access road with 1.2m wide filter strip source control and conveyance swale.***

10.1.4 Site Controls

Where runoff is collected at the surface, a depression in the ground, mimicking hollows in the natural landscape, is the easiest and most cost effective way to manage large volumes of water in the landscape.

Where landscape is limited, storage opportunities within pavements and on roofs should be explored.

Careful design can maximize opportunities with different design volumes in different places providing maximum opportunities for multi-functional use and biodiversity.

- **basins**
- **wetlands**
- **ponds**
- **storage structures**

Image above: ***Detention Basin in public open space - Elsmore Naas***

10.2 Using SuDS structures for attenuating rainfall

The following table is intended to provide an initial guide of the potential storage available within various types of SuDS structures. Effective use should be made of available storage within SuDS structures throughout the management train, which will result in a more cost effective design.

Table note: The figures presented by this table are indicative and suitable for concept design. They cannot be relied upon for outline / detailed design and the designer must provide site specific storage design calculations.

SuDS structure	Indicative Attenuation storage (m3 of storage per m2 of SuDS structure)	Suitable for infiltration (Yes / No)
Blue roofs	0.05-0.1	No
Rain water harvesting	0	No
Swales	0.15-0.4	Yes
Permeable pavements	0.05-0.15	Yes
Filter Drains	0.15-0.5	Yes
Rain Gardens	0.3	Yes
Tree pits	0.4	Yes
Detention basins	0.6	Yes
Ponds	0.6-1.2	No
Wetland	0.3-0.9	No
Underground storage	0.4-2.0	Yes

Designers should be mindful of:

- **how site factors will influence the design and the storage.**
- **SuDS structures often have to be designed for structural performance (eg. Permeable pavement) which may require greater depths that what is required hydraulically.**
- **SuDS structures can be increased in size to meet hydraulic requirements. Safety considerations and designing as part of a multi-functional landscapes will factor into the consideration of maximum depths of open SuDS structures such as swales, basins, ponds and wetlands.**

10.2.1 Designing ancillary structures

Inlets and outlets structures form an integral part of SuDS features. These structures should be at or near the surface and designed to be easily maintained and integrate with the host landscape.

Inlets are designed to reduce the risk of erosion and collect polluted silts washed off the adjacent surfaces. Small slabs or small concrete aprons are commonly used at concentrated inflow points.

Flow controls will be required to demonstrate that flow is being retained within the SuDS structure and should be designed to ensure that they are protected from blockage (See Section 8.5). In most situations an opening as small as 10-20mm diameter can be used where there is a method of filtering debris and silt from flow in advance of the flow control.

10.2.2 Confirming drain down mechanism

SuDS components always have a way of emptying, either through a free release outlet, a flow control or infiltration. The ability to fully drain down SuDS treepits and bioretention areas ensures that road salt does not become an issue as the salt will dissolve during rainfall and be washed through the structure and exit via the outlet.

Generally, SuDS structures should have 50% of their storage capacity available 24 hours after rainfall has stopped. In some instances, a faster drain down time may be desired and the flow control can be sized to achieve this.

10.2.3 Connecting SuDS to the combined sewer

Connection to the combined sewer will be subject to Uisce Eireann connection application

Where connection is to the combined sewer an **odour trap** should be located between the SUDS feature and the point of connection to the sewer.

Non-return values will not normally be required. Where there is a risk of surcharge from the combined sewer, the flow control will protect the SuDS structure from debris within combined sewerage. Any polluted flow which enters the SuDS feature should therefore be free from debris and the treatment processes present within nature-based SuDS features will naturally break down with any residual organic pollution which remains.

Image above: ***Green roof on the Bord Gaís Networks building, Finglas***

10.3 Green & blue roofs

A green roof is a roof or podium deck onto which vegetation is grown, or habitats for wildlife are established. There are various types of green roofs including: extensive and intensive roofs, semi-intensive, roof gardens, biodiverse roofs and brown roofs. Green roofs can also serve an amenity function where designed for this purpose.

Blue roofs hold rainwater runoff on roofs and podium decks and release rainfall slowly through a 'flow control'. Blue roofs do not have to be vegetated. Flow can be stored within open or closed hard landscape structures on roofs and podium decks. Storing rainwater that falls on the roof provides the potential to reduce or remove the requirement for attenuation storage elsewhere on a development.

1. A minimum 100mm soil depth is recommended for drought resilience and this design is particularly suitable for a natural dry grassland vegetation.

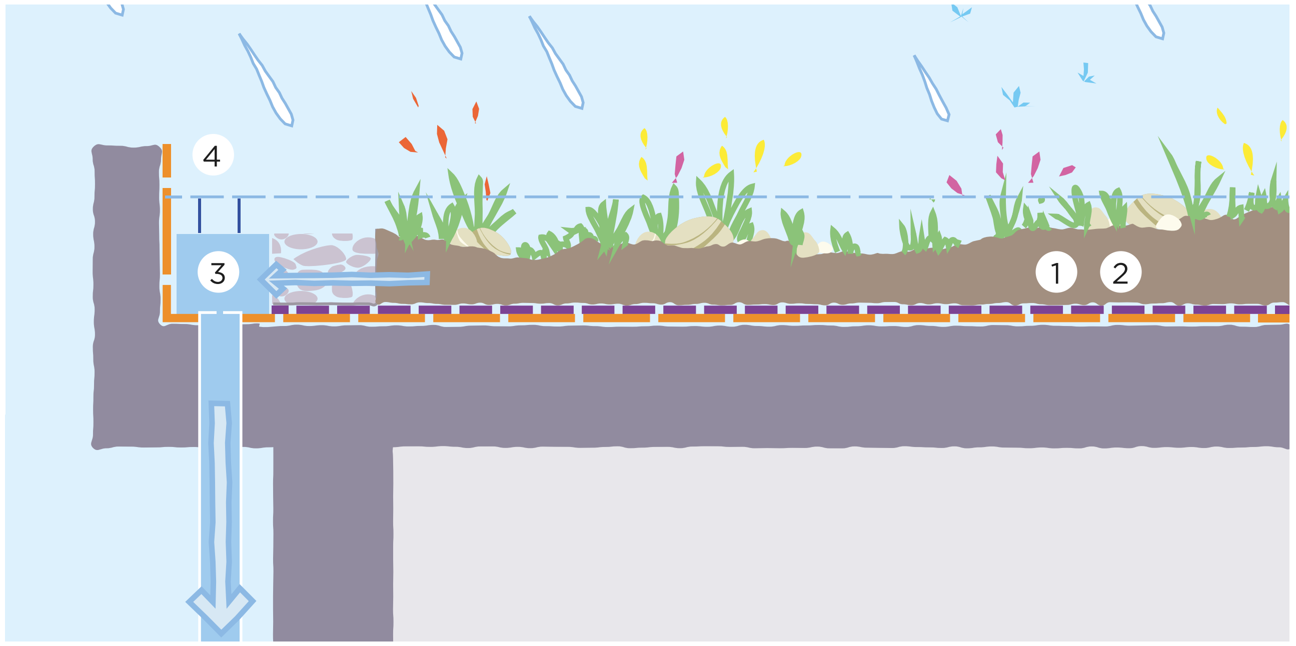
2. Most green and blue roof substrates have a water storage capacity of between 30-40% void ratio.

3. A simple orifice control together with overflow arrangements provides an ideal opportunity to retain water on the roof meaning that it does not have to be stored again at or below ground level. This arrangement is particularly important for urban redevelopment where the building footprint may take up all the site. This would be referred to as a blue roof.

4. Provide a suitably sized overflow / exceedance route

Image above: ***Residential Green Blue Roof - Cannock Mill Cohousing, Colchester***

Image below: ***Typical green & blue roof profile***



Design note: All green blue roofs shall be designed in consideration of current fire safety requirements.

Signpost: The GRO Green Roof Code

Note: S Symbol indicates SuDS Components are considered suitable for single house development.

10.4 Rain harvesting S

Rain harvesting systems come in a variety of forms, ranging from simple water butts, to larger more complex systems (with underground tank collection systems, filters, throttles, valves and pump). Rainwater from roofs and hard surfaces can be stored and used, although runoff from roofs is normally targeted due to reduced pollution risk.

Suitable used for harvested rainwater include:

- **garden watering**
- **irrigation of larger amenity areas such as playing fields or gold courses**
- **toilet flushing**
- **car washing**
- **fire suppression or emergency use water**

Some aspects to consider:

- **potential for pollution in runoff being collected**
- **sizing of rain harvesting facility and the likely demand by users**
- **regularity of demand - will demand fluctuate and how does this compare with local rainfall patterns**
- **provisions for ongoing maintenance.**

Signpost: See 2015 CIRIA SuDS Manual (C753) Chapter 11 for further information.

Signpost: BS 8515:2009 covers the design, installation, water quality, maintenance, and risk management of Rainwater Harvesting systems. (Rainwater Butts are not covered by the standard)

Image below: ***Typical water butt*** S

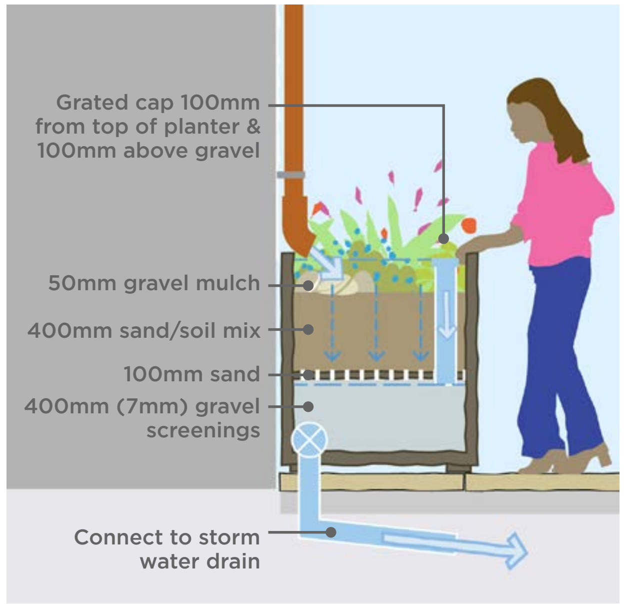


Image above: ***Typical raingarden planter profile***

10.5 Rain Planters S

A rain planter box makes the area around a downspout more attractive whilst also storing rainwater.

Designer Note: Use plants that will tolerate both drought and saturation.

Here are some ideas for constructing a rain garden planter with key essentials in mind:

- **Use an old wine barrel to create a planter. It allows plenty of room for gravel and drainage soil.**
- **Build a container of your own design using scrap wood.**
- **You can also get creative and grow veggies in a downspout planting bed. Just be sure to provide adequate drainage for this type of garden.**

Signpost: The guidance in the following links provide a step-by-step approach to designing and installing your own rain planter:

How to Create a Rain Garden Planter

Downspout Garden Planters

Images left: ***Examples of raingarden planters***

Note: Ⓢ Symbol indicates SuDS Components are considered suitable for single house development.

10.6 Raingardens Ⓢ

Raingardens are designed to collect and manage reasonably clean water from roofs and low pollution risk drives and pathways. They are generally installed where community or private maintenance is available to upkeep these attractive features.

Key aspects of raingarden design include:

1. gentle side slopes with water collected at the surface

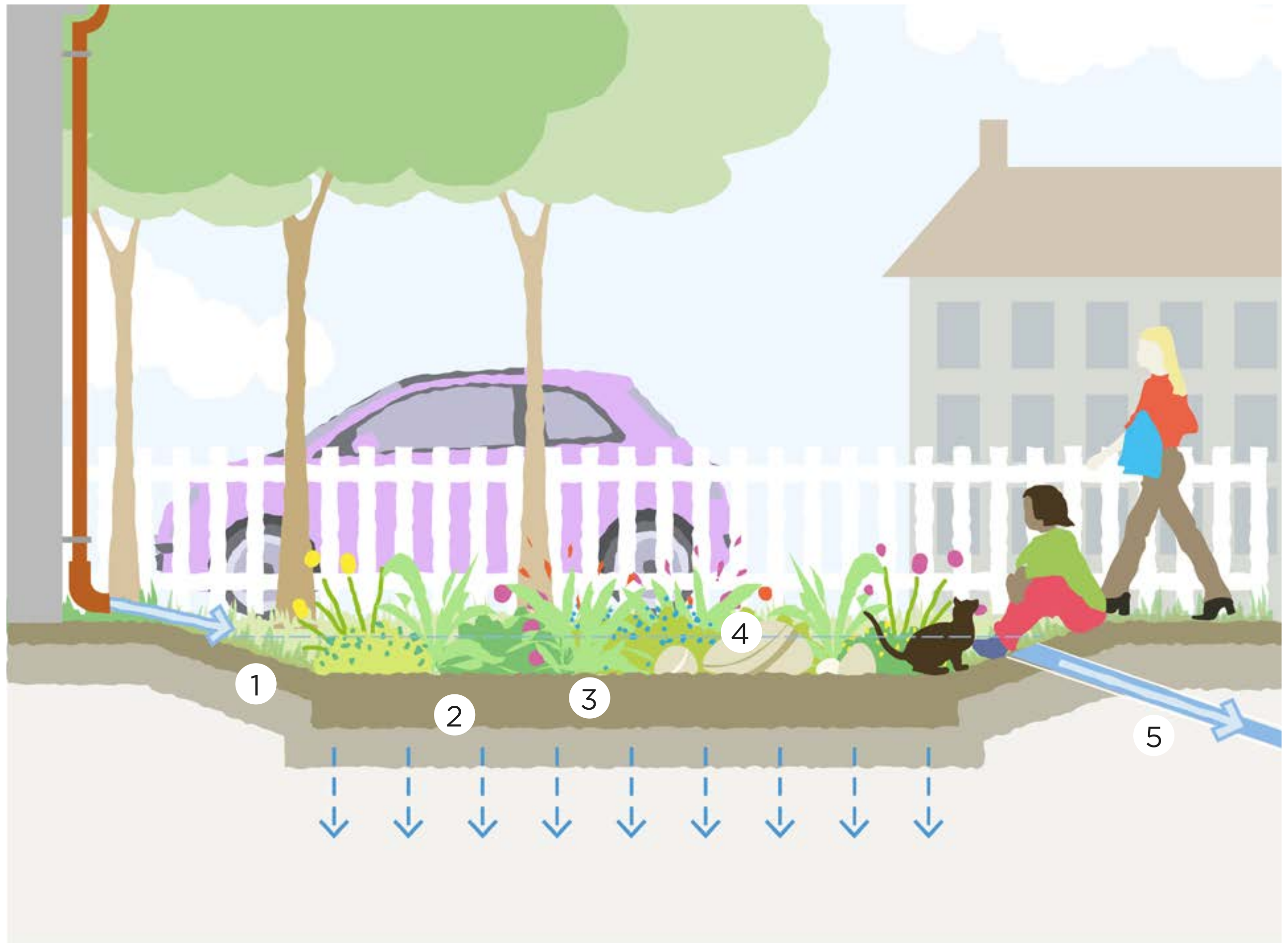
2. a free-draining soil, sometimes with an underdrain to avoid permanent wetness

3. a minimum of 450mm improved topsoil with up to 20% coarse compost

4. garden plants that can tolerate occasional submersion and wet soil – this includes most garden plants other than those particularly adapted to dry conditions

5. an overflow in case of heavy rain or impeded drainage.

Image below: ***Typical raingarden profile***



10.7 Bioretention Raingardens

A bioretention structure differs from a raingarden in that it employs an engineered topsoil and is used to manage polluted urban rainfall runoff in street locations and carparks. These features can contribute significantly to the urban scene so should be designed to meet urban design standards.

The runoff entering bioretention features will normally carry silt and pollution from vehicles and urban street use. Therefore, some maintenance should be expected to remove the build-up of inorganic silt.

The free-draining nature of engineered soils leads to the washing away of nutrients from the soil. The proportion of organic matter should be relatively high and replenished yearly by the application of a mulch layer of well composted green waste or shredded plant matter arising from maintenance.

Key design aspects for bioretention raingardens include;

1. silt collection in forebays – using a small apron or slab to allow for easy removal of silt

2. space above the soil profile for water collection and stilling before infiltration through the engineered soil

3. a surface mulch of organic matter, grit or gravel protects the infiltration capacity of the soil

4. a free draining soil, 450 -600mm deep, with 20-30% organic matter cleans, stores and conveys runoff to a drainage layer

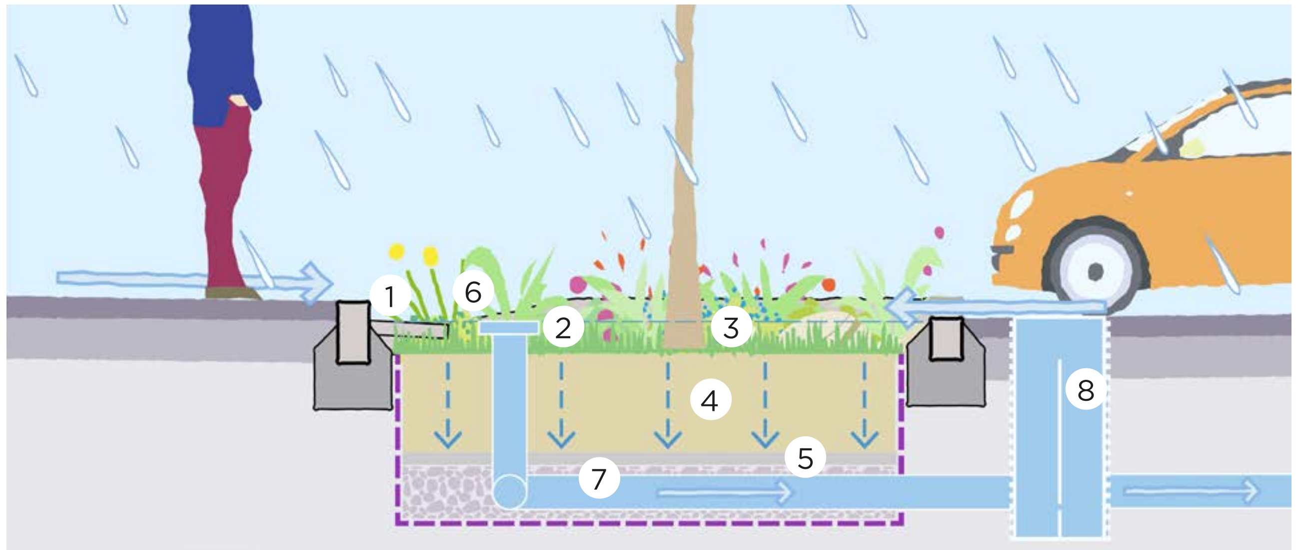
5. a transition layer of grit and/or sand protects the under-drained drainage layer

6. a surface overflow for heavy rain or in the event of blockage.

7. perforated land drain to allow for full drain down

8. flow control to ensure that storage is utilised (particularly on larger bioretention areas)

Image below: ***Typical Bioretention raingarden profile***



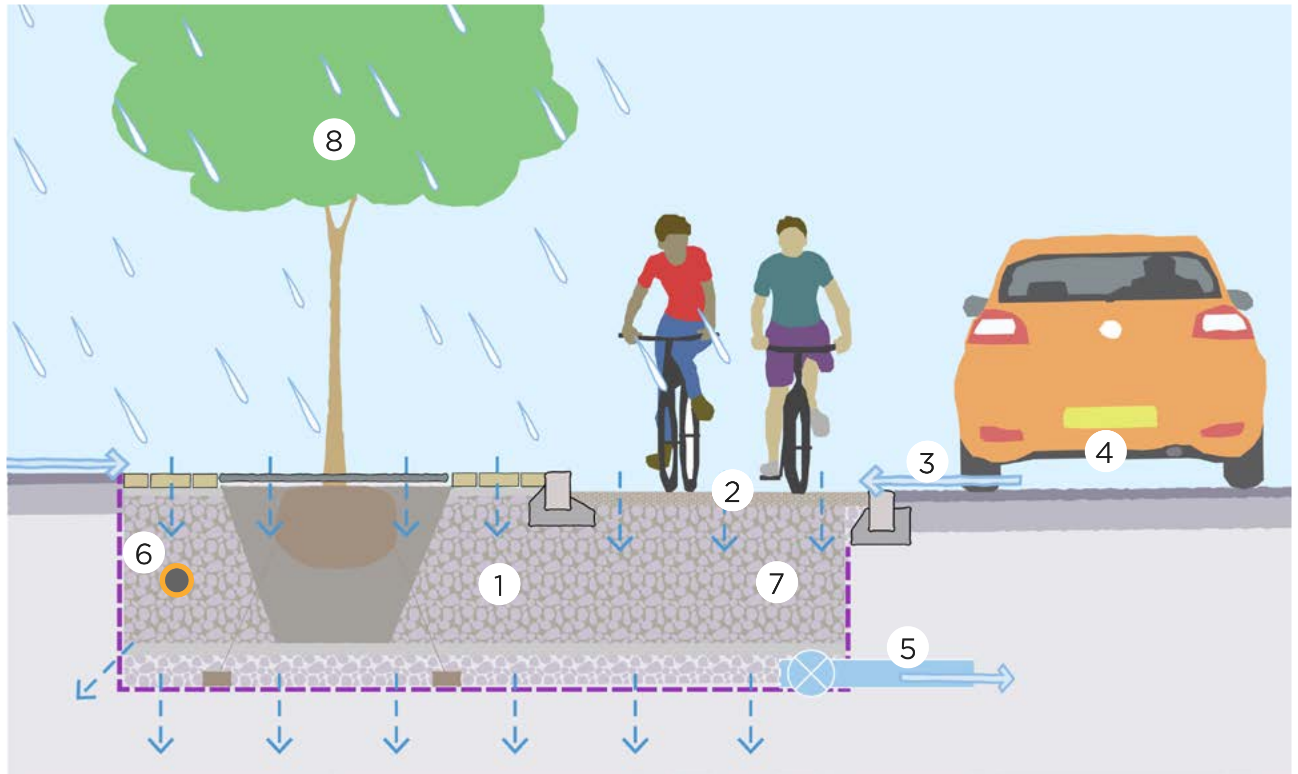


Image above: ***Typical SuDS tree pit profile***

10.8 SuDS Tree pits

SuDS tree pits are designed to collect runoff from the surrounding landscape. They can be integrated into both new development and urban renewal enabling large trees to thrive by being watered every time it rains. Healthy trees also need sufficient soil to grow, and this growing medium can also be used to store water before being released slowly to the next part of the drainage system. SuDS trees can contribute significantly to the Climate Action Plan and the size of the proposed tree canopy should be carefully considered to achieve maximum benefits.

The runoff entering bioretention features will normally carry silt and pollution from vehicles and urban street use. Therefore, design will have to carefully consider how this can be intercepted and some maintenance should be expected to remove the build-up of inorganic silt.

Key design aspects for SuDS tree pits include;

1. Trees should have a growing medium of between 10-30m3 depending upon the tree species.

2. A number of tree pits can be linked along a trench to optimize the volume available to each tree.

3. Robust silt removal must be incorporated within the tree pit design to allow runoff from roads to be permitted into the SuDS tree pit.

4. Positioning and specification of trees to be in accordance with Design Manual for Urban Roads and Streets

5. Drain down pipe must be provided to ensure there is no prolonged waterlogging of roots and no build-up of road salt within the SuDS tree pit.

6. Service trenches can be provided through the tree pit (in agreement with KCC). Suitable services include most water, gas and drainage systems. Consider requirement for replacement if the utility is old. Electrical supply or telecoms with a joint box located in the SuDS feature are not recommended. Reference should be made to Reference to utility providers design guidelines

7. SuDS tree pit should cater for anticipated loading conditions to ensure that soils do not become compacted. This can be delivered using structural tree soils or structural pavement support systems.

8. Selection of tree species to be agreed with KCC.

Image above: ***Example SuDS tree pit in public realm***

10.9 Permeable surfaces S

Permeable surfaces enable SuDS designers to direct rainfall straight into a SuDS structure for cleaning and storage or infiltration into the ground.

There are several permeable surfaces available. Systems such as concrete block permeable pavement, porous concrete and porous asphalt should have in common:

1. a pervious surface to allow water through the pavement surface

2. an open-graded sub-base layer that provides structural strength to the pavement with about 30% by volume available for water storage. The sub-base needs to be designed structurally and hydraulically.

3. Silt washed off adjacent landscape areas can lead to localised surface clogging. This risk can be managed through design detailing as follows:

- **slope adjacent landscape areas away**
- **use paved or turfed surfaces to adjacent areas**
- **soil in adjacent planting beds should be min. 50mm below the pavement edge adjacent planting should include dense ground cover to bind the soil in place slopes running toward permeable surfaces should have a depression and ideally an underdrain before reaching the pervious surface.**

4. Infiltration test to be undertaken at formation level (where system is proposed to infiltrate). Design to be based on saturated CBR values.

The design and construction of pervious pavements are covered by guidance in the 2015 SuDS Manual (Section 20) and the Interpave website www.paving.org.uk

There are no reported issues with surface clogging under normal use. Maintenance may be required after 10 to 20 years of use comprising a brush and suction removal of grit joints and joint replacement. Permeable paving should receive an annual (as a minimum) cosmetic sweep to clear any build up of litter, leaf drop or other organic waste from the surface.

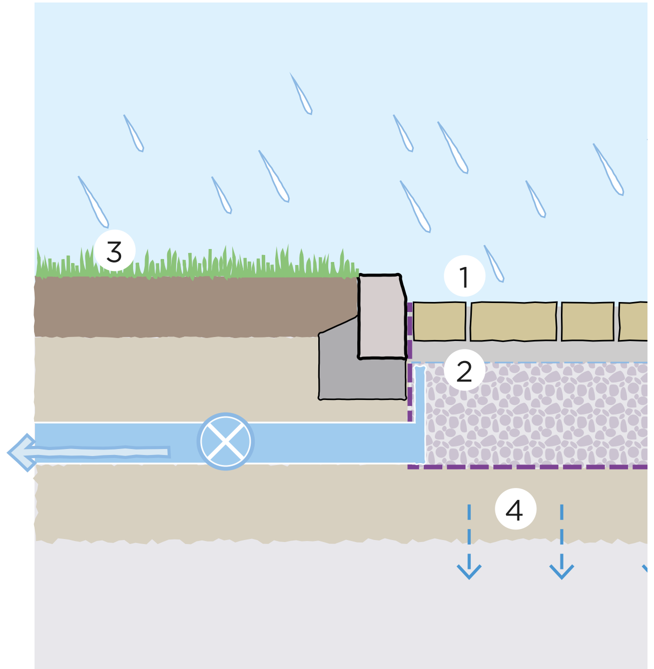


Image above: ***Typical permeable paving profile***

Note: Grass concrete and grass grid systems may have different specifications and designers are advised to check with product supplier to define makeup.

Note: S Symbol indicates SuDS Components are considered suitable for single house development.

Signpost: Design manual for Concrete Block Permeable Paving

Image above: ***Void Structured Concrete paving - Cannock Mill, Colchester***

Image above: ***Reinforced grass paving area - The Curragh Racecourse, The Curragh, Co. Kildare***

Image above: ***Concrete Block Permeable Paving - Aldi Stores, Main Street, Newbridge***

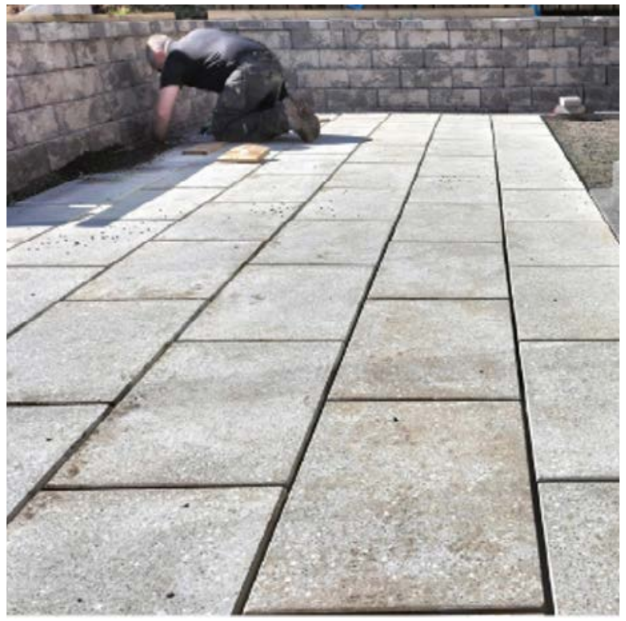


Image above: ***Permeable paving being installed in rear patio using normal slabs with 10mm plastic spacers. Joints are infilled with 4mm grit.***

10.10 Soakaways S

Most SuDS features can allow natural soakage of water into the ground.

Soakaways are described as buried structures and can take the various forms;

- **stone filled pits,**
- **concrete ring,**
- **geocellular plastic 'crates' wrapped in a geotextile fabric.**

For soakaways to work properly there has to be;

- **free draining soils.**
- **sufficient storage volume within the soakaway to temporarily store rainfall to allow it to soak into the ground.**

Designer note: Many areas of Kildare County have soils which provide free draining conditions, providing opportunity for infiltration. Don't assume that the soil at your property will infiltrate. Always carry out an infiltration test to establish how quickly rainwater soaks away.

Current Building Control Regulations does not provide guidance on the separation distance for infiltration and building foundations or property boundaries. It is advised that you seek the guidance of a suitably qualified engineer where you are thinking of using soakaways / infiltration to manage rainfall from your property.

Soakaways are sized based upon how quickly the soils will allow rainfall to soak into the ground.

The BRE Digest 365 provides technical information on how to undertake a soakaway test and size a soakaway.

Signpost: Building Control guidance on drainage

Image above: ***Example soakaway feature during construction***

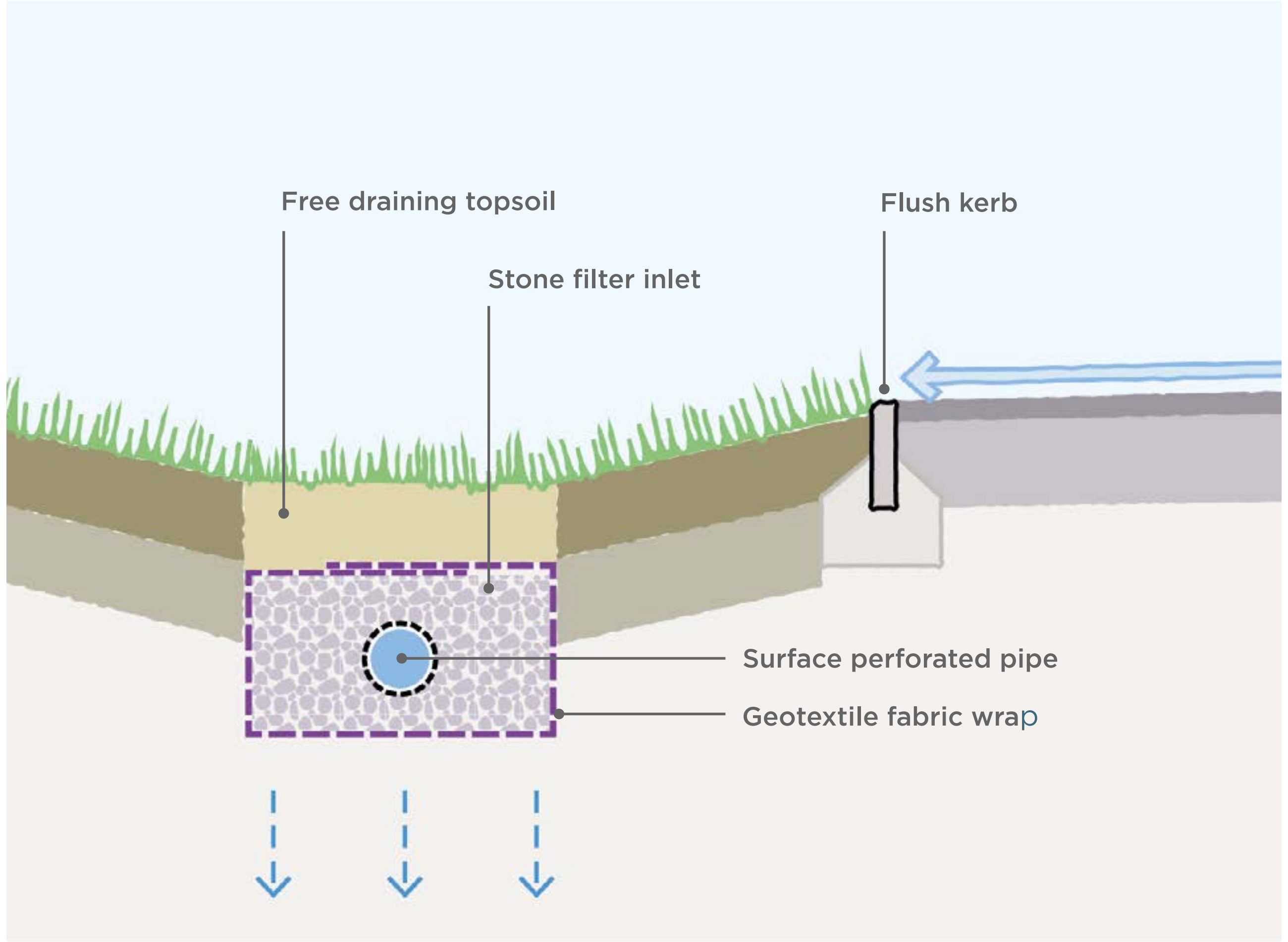
Note: S Symbol indicates SuDS Components are considered suitable for single house development.

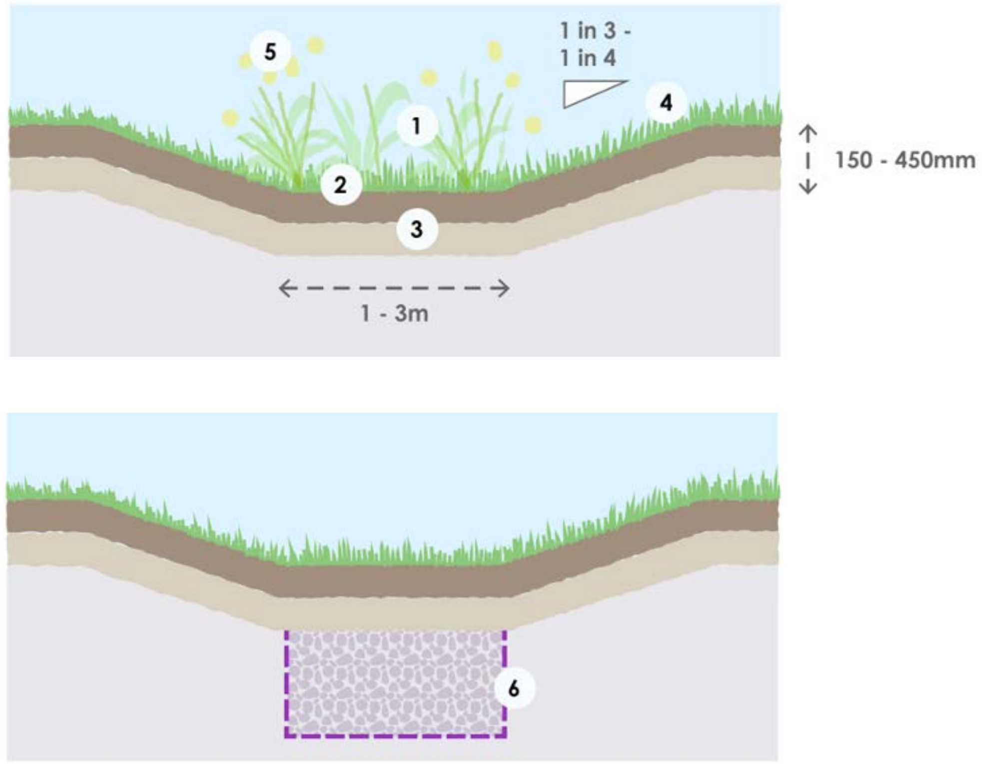
Signpost: More advice on building a soakaway

One of the issues with a soakaway is that over time it can fill with silt and no longer function. Where rainwater runoff can be filtered through soil this filter out silt and considerably lengthen the lifespan of the soakaway.

In the diagram below rainfall is allowed to shed off the impermeable surface into a small depression and then filters into the underlying storage where it will soak into the surrounding soils.

Image below: ***Example soakaway profile***





Images above: ***Typical swale profile***

10.11 Swale S

Swales are shallow, flat bottomed vegetated channels which can collect, treat, convey and store runoff.

1. The basic profile is a 1 in 3 or 1 in 4 side slopes to a flat base falling at no more than 1 in 50 to prevent erosion. Checkdams or terraced swales can be used to mitigate risk of erosion where 1 in 50 falls cannot be achieved.

2. Base width less than 1m wide will increase the risk of erosion and ditch forming, conversely, base width wider than 3m a meandering channel can develop.

3. 150mm clean topsoil over subsoil. Ripping or light harrowing will improve establishment of the swale by providing a key for the topsoil, encourage deep rooting and assist infiltration.

4. Where swale vegetation is kept less than 100mm, the shoulders at the top of the swale can be 'scalped' leaving bare soil. The shoulders should therefore be rounded to prevent this happening.

5. Swale can be vegetated with more biodiverse plants to attract pollinators etc.

6. Swale can be under-drained using a filter drain to create a dry swale

Performance criteria

Max. velocity at peak capacity – 1m/s

Max. velocity at low flow – 0.3m/s

Travel time (low flow) – 9 minutes

Design Note: The dimensions and slopes of a swale need to be considered to facilitate maintenance by a ride on mower, strimmer, hand mower. Where appropriate the shape and alignment of the swale should be as natural as possible and avoid an engineered aesthetic.

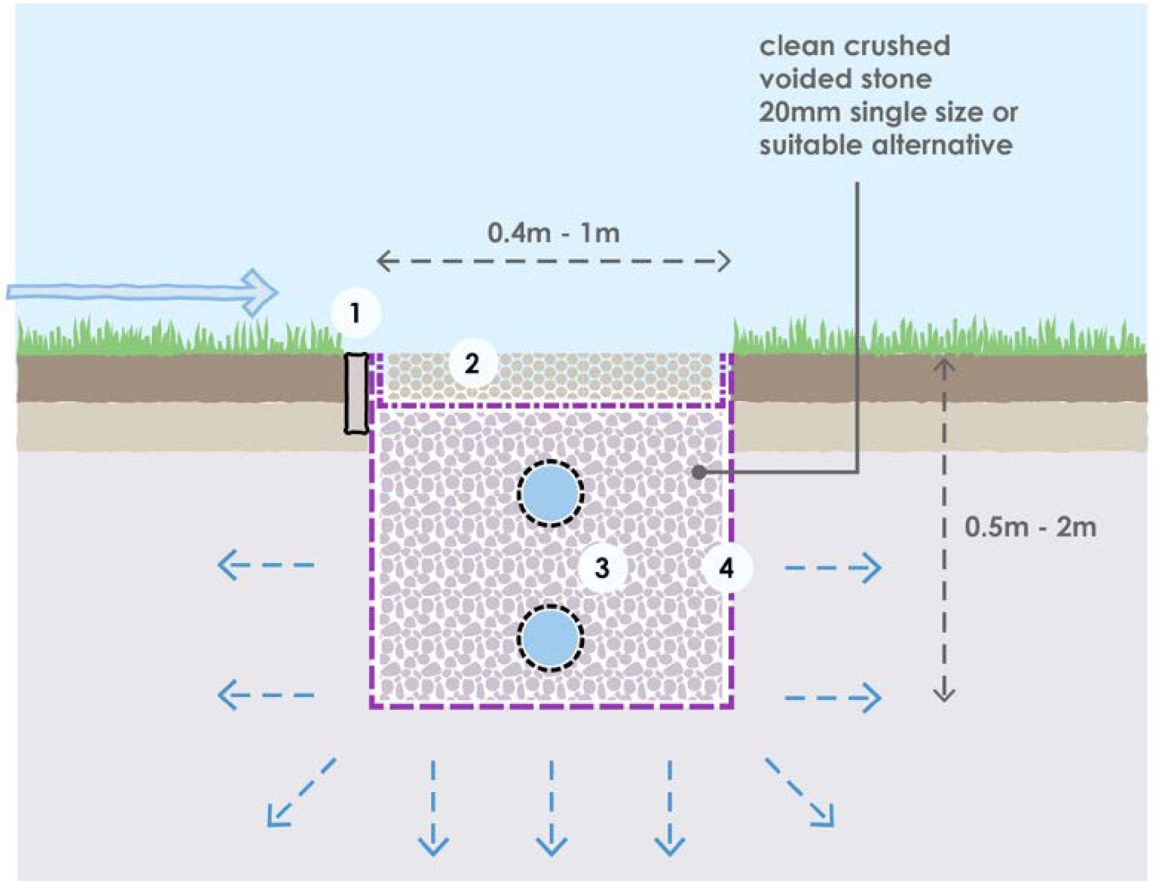


Image above: ***Typical filter drain profile***

10.12 Filter drains

Filter drains, sometimes called a French drain, is an open stone filled trench. Sizing of filter drains will depend on several factors and capacity can be considered for both conveyance and temporary storage requirements.

1. Runoff should ideally cross the long edge of the trench as a sheet. This may require a temporary level timber board along the leading edge to prevent erosion of unconsolidated soil.

2. A sacrificial top layer may be considered at the top of the drain to trap any silt for simple removal. Alternatively, a grass filter strip placed in front of the filter drain will reduce potential for clogging.

3. A lower perforated pipe will assist discharge and an upper perforated pipe can act as an overflow. However, neither may be necessary depending on the design and location.

4. Most filter drains are designed with geotextile lining. Many geotextiles are susceptible to blinding from fine materials in soils and specialist advice should be sought for specification. Alternatively consider hessian liner which will biodegrade over time by the time soils around the filter drain will have stabilised.

10.13 Channels and rills

Sett Channels and rills keep rainwater at or near the surface. This is important as it allows water to flow directly into SuDS features reducing cost, trip hazards and the inconvenience of deep structures in the landscape.

In some places a grated surface channel may be more appropriate, but the mesh size should not be too small, or the grating will be prone to blockage.

Collecting runoff from a road can be more difficult where there is a path present, and a flush kerb inlet or chute gully may be needed.

Image above: ***A granite sett channel collecting and conveying runoff***

Image above: ***A planted rill in a School Science Block***

10.14 Use of pipes

Although SuDS are delivered without the requirement for extensive piped networks, short lengths of pipe can still be very useful in providing connections under roads, footpaths and other crossing points. Key points to consider are as follows:

- **Short lengths of pipework should allow direct rodding from one end of the pipe to the other without the need for internal chambers.**
- **Inlets and outlets should be designed so that they are not prone to blockage.**
- **An exceedance flow path should be integrated into the development surface above pipework to ensure that unpredictable flows are directed SuDS immediately after the crossing.**
- **The depth of the downstream component should not be artificially increased due to a requirement for structural cover over pipework. Different pipe materials or concrete surround can be considered to minimise cover - as used for driveway crossings at the Devonshire Hill project below.**

Image above: Concrete pipe surround has been used here to provide minimal cover for a driveway crossing

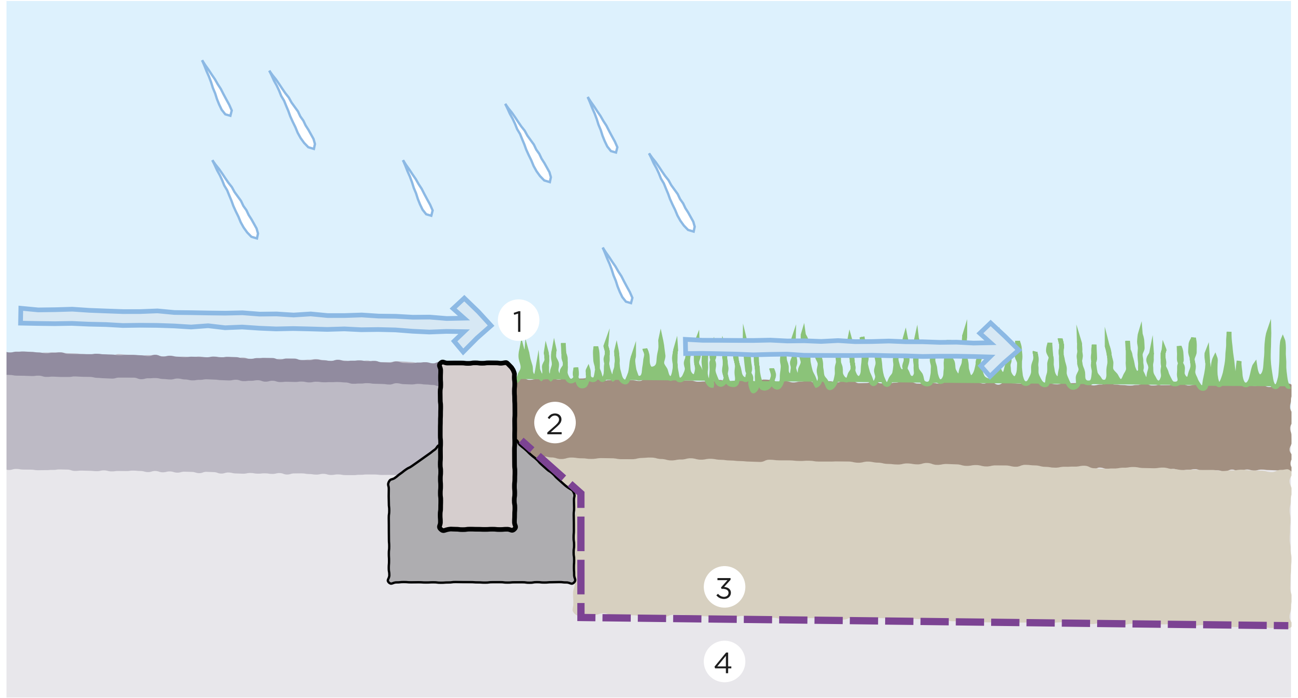


Image above: ***Typical filter strip profile***

10.15 Filter strips

The hard edge from a pavement to a filter strip is generally defined by a kerb. Filter strips are effective at removing silt at source and will connect to SuDS feature such as a swale after a short distance. Where runoff is introduced as sheet-flow noticeable silt build up is only likely after a prolonged period (10 years +).

1. Provision of a small drop across the edge of the kerb (circa 25mm) allows runoff to move freely off the pavement.

2. The concrete haunch should be finished at minimum of 100mm below the surface to ensure good grass growth up to the edge of the pavement.

3. Free draining soils - a protective liner should be situated at least 300mm below clean sub-soil for an agreed distance offset from the pavement to prevent pollution migrating through subsoils to groundwater. The liner should extend laterally until the risk of contamination is suitably mitigated (circa 2-3m is suggested)

4. Clay soils - runoff will flow across the surface with limited potential for infiltration negating the requirement for a liner.

Image below: ***Example of topsoil washout. The haunching is set near the top of kerb allowing for minimal topsoil to be placed, therefore prone to erosion over time.*** Credit KCC

10.16 Basins, wetlands and ponds

Image above: ***Typical basin profile***

1. Reasonably clean water, through use of source control, should flow into site control components at or near the surface in a channel or swale.

2. Where a pipe connection is unavoidable they should flow through a safe and visually neutral headwall, such as a mitred concrete headwall or stainless steel gabion basket inlet.

3. Small aprons (slab or similar) at points of entry and exit for collection of silt.

4. Suitably sized overflow

5. Basin

Avoid using riprap as a form of erosion control, as loose stones easily move around and cause a nuisance for maintenance teams. **KCC would encourage designers to avoid engineered symmetrical crater type basin designs.**

Image above: ***Springhill Co-housing, Stroud - This basin can be used throughout the year.***

Image left: ***Oldtown Wood, Oakley Park, Celbridge***

Image right: ***An example of 'safety by design': these children are doing a dance and movement class in a SuDS storage area at a primary School.***

The safety considerations in basin, wetland and pond design should be considered carefully.

1. The profile of the structure should allow easy and safe access for people and maintenance machinery. Slopes should not exceed 1 in 3 or 1 in 4 and in larger basins access ramps with a gentler slope should be considered. The idea of a series of slopes and level benches is now accepted as an appropriate detailing for SuDS basins and ponds.

2. The overall depth of temporary storage should not normally exceed 600mm as this depth is critical for a feeling of safety in water. The bottom of the temporary storage dry basin should slope gently so that most of the time the base is firm and dry. Shallow micropools and wetland habitat should be integrated carefully into the basin as they will not be visible when the basin is full of water.

3. Permanent pond depth need not exceed 600mm as this is a common depth of natural ponds and where most biological activity occurs. However, a depth 600mm without regular maintenance means that vegetation will cover the pond in time. Most wetland edge plants cannot colonise beyond 1.2m depth of permanent water. Therefore, a deeper area in the centre of the pond, with surrounding shallower benches can be considered if open water is desired. Effective storage of 600mm over permanent water depth of 1.2m provides a total potential stored depth of 1.8m and the design must take this into account.

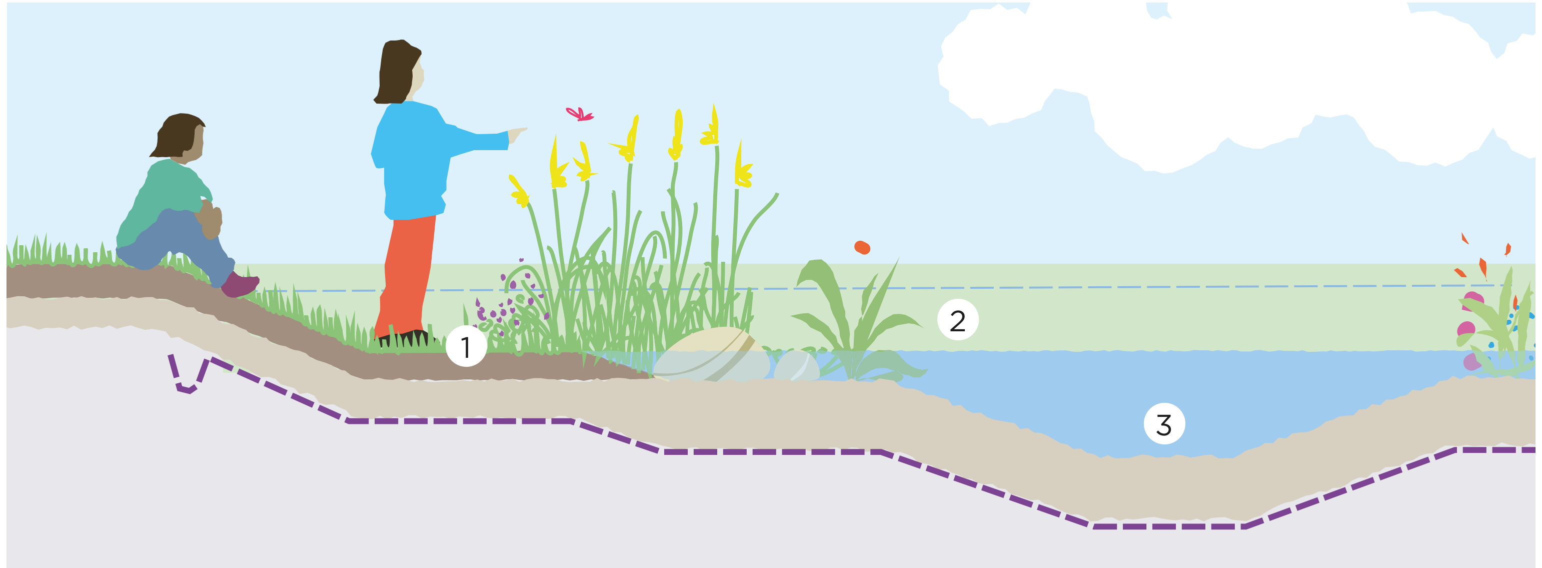


Image above: ***Typical pond edge profile***

Image below: ***This project failed to adequately consider health and safety when designing attenuation features into a residential pocket park. There is now no public access allowed. There should be no need for such measures if properly designed.***

Further design safety considerations

All hard engineered structures should be set back 1m from permanent water edge, which will prevent drowning in the event of concussion.

Protective fencing will not keep children out of ponds and merely acknowledges a dangerous condition. Well designed ponds should be easy to exit and accessible for rescue if this is required.

Pond depths and profiles should not be designed for ease of open water swimming. This can be achieved by varying the profile of the pond throughout.

Where **unsupervised toddlers may be expected (such as in proximity to play areas in preschool or nursery for example)** a 600-700mm picket fence should be considered as this stops most toddlers and allows adults to easily step over the fence for rescue. A fence is not expected in normal public realm situations where toddlers would be expected to be supervised.

There must be an acceptance by the community that open water is part of a landscape character. It is useful to sensitively communicate health and safety messages identifying the presence of permanent and temporary water using well designed informative signage.

The use of 'danger – deep water' signs and lifebuoys should be avoided, as they imply that risks have not been sufficiently catered for by design.

10.17 Storage structures

Simply providing underground tanks should not be confused with a full SuDS approach; however, they can form part of the SuDS management train.

KCC Development Plan Objective IN O24 indicates that designers should "Only consider underground retention solutions when all other options have been exhausted. Underground tanks and storage systems will not be accepted under public open space, as part of a SuDS solution."

The introduction of geocellular structures is still relatively recent in the construction industry and the long term implications of their use is still being understood. The 2015 SuDS manual (Section 21.1) clarifies that:

- ***Where storage is in an underground tank, failures and blockages tend not to get noticed, which may mean that the consequences of failure can be catastrophic.***
- ***Underground storage tanks do not have inherent treatment capacity and therefore require integration with a SuDS management train.***
- ***Geocellular systems and plastic arches tend not to be easily accessible for inspection or cleaning, so very effective upstream treatment is required to ensure adequate sediment removal.***
- ***The structural design of geocellular systems tends to be more complex and there have been a number of collapses of these systems caused by inadequate design. (see Mallett et al, 2014, and O'Brien et al, in press) (see C737)***

In addition, to the statements from the SuDS Manual the following should also be considered:

- **There are risks of structural failure due to construction loading, which may exceed design life loading that the designer may not be aware of.**
- **There are a wide range of attenuation products each with its own loading characteristics. Surety must be provided that a specified product is not swapped for one of inferior quality during the construction phase.**
- **Guarantees and warranties are dependent on the survival of product manufacturers.**

Where underground storage is preferred after a full exploration of the available options the designer should demonstrate that:

- **Robust silt removal has been provided through means of filtration (bioretention, permeable pavement) or other source control SuDS components. Catchpits will not be accepted as a demonstrable form of silt removal. The 2015 SuDS manual (Section 4.1) clarifies that sediments within catchpits can be remobilised and washed downstream. Equally, gully pots are suggested by Table 26.15 to provide negligible to zero treatment (Ellis et al, 2012).**
- **Underground structures require structural design consideration even if they are not receiving vehicular loading. CIRIA report C737 outlines the design requirements for geocellular tanks. The SuDS Manual (Table 21.1) provides a summary of the structural design requirements using a risk classification system (Scored between 0-3). Designers should demonstrate that the classification system has been followed and present the appropriate level of design information accordingly.**

Signpost : [Structural and geotechnical design of modular geocellular drainage systems (C737)]

Design Note: Where the stated design life of the tank does not meet the design life of the development, the design should demonstrate how the structure will be replaced whist maintaining the functionality of the drainage system and the scheme. Consideration should also be given to funding mechanism for undertaking these replacement works.

KCC Advice Note : underground storage systems should only be considered as a last resort.

Management of the SuDS landscape

SECTION
11.0

11.1 The principles of SuDS management

All designed landscapes require some level of management. Where maintenance is not carried out development will evolve towards woodland or an urban wasteland.

SuDS should be designed with future maintenance as a key consideration. Well designed SuDS will ensure that much of the care for SuDS is site management rather than dedicated SuDS maintenance.

Hydrocarbons and other organic based pollution that washes off hard surfaces is broken down by natural processes (**natural breakdown of organic pollutants**), within many SuDS components meaning that there is no long term build-up of organic pollution. Heavy metals and inorganic pollutants are trapped within Source controls at low concentrations and therefore form no threat to amenity features or aquatic environments.

This is different to 'intervention' maintenance which is required for conventional drainage to remove toxic liquor from gully sumps or oil and grit from interceptors and separators which can be costly and in many cases not completed, rendering the treatment function redundant. Intervention maintenance can also be required for SuDS to remove silt, however using source controls this requirement will be minimised.

Importantly, where SuDS form part of a landscape (which would be present regardless of SuDS), this minimal attention should be considered as site care and not dedicated SuDS care. The cleaning of gullies and pipe work is not needed which reduces overall management costs.

Image below: ***Polluted silts collecting from a busy road at an inlet apron allows for easy removal***

Image above: ***A light tracked excavator removes aquatic vegetation to de-water next to the wetland, before moving to a wildlife pile***

11.2 The SuDS Management Plan

A SuDS Management Plan is a document that describes the development, the place of SuDS in managing rainfall and can include landscape maintenance. It will describe the aspirations for the development and expected changes over time including any future expansion or redevelopment.

Design Note: A copy of the management plan should be included with the planning application.

The plan will provide a brief explanation of SuDS, how the SuDS infrastructure on the site operates and the benefits of retaining functionality of SuDS. Diagrammatic layouts of the SuDS scheme should have flow arrows to indicate flow direction so that the scheme can be more easily understood by lay readers.

SuDS management will be explained including anticipated changes over time.

The management plan will include a Schedule of Work covering the following:

- **maintenance tasks identifying frequency of undertaking**
- **waste management requirements**
- **a pricing schedule for the maintenance contractor where appropriate with any specification notes required to explain technical details.**

Site management usually requires an element of regular site attendance, often monthly, which corresponds with most SuDS maintenance. Occasional and potential remedial maintenance should also be covered by the plan.

Image below: ***Example of SuDS diagram***

Image above: ***Example SuDS features at a Primary School receiving regular maintenance.***

- **Regular maintenance – SuDS visits should be at a monthly frequency to match everyday site management visits.**
- **Occasional maintenance – covers tasks where the frequency cannot be predicted accurately or is infrequent.**
- **Remedial maintenance – covers work that cannot be anticipated or is a result of design failure. Damage may include, for instance, rutting where unexpected vehicle access has occurred on wet ground. Replacement of items which have a defined lifespan, such as geocellular tanks should be covered here or provisions made elsewhere.**

Design Notes: Grass clippings or green waste should be disposed of in a planned location that is considered as part of the SuDS / site management plan. Maintenance crew should ensure that clippings are not disposed within SuDS components (basins, swales etc.) as this increased the risk of blockage and reduces the performance of the system

Information in the management plan should be conveyed in a manner that is understandable to Site Operatives. Use of technical terms and unnecessary information should be avoided.

The Maintenance Schedule and key plan identifying locations of key features should not exceed a double sided A4 which can be laminated and retained in the operatives work van.

Design Note: It is anticipated that permeable pavement should only required dedicated SuDS maintenance every 10-15 years.

11.3 Example of SuDS and Site Maintenance

Type	Activity	Normal site care (Site) or SuDS-Specific maintenance (SuDS)	Suggested frequency
Regular Maintenance			
Litter	Pick up all litter in SuDS Landscape areas along with remainder of the site - remove from site	Site	1 visit monthly
Grass	Mow all grass verges, paths and amenity grass at 35-50mm with 75mm max. Leaving cuttings in situ	Site	As required or 1 visit monthly
Grass	Mow all dry swales, dry SuDS basins and margins to low flow channels and other SuDS features at 100mm with 150mm max. Cut wet swales or basins annually as wildflower areas - 1st and last cuts to be collected	Site	4-8 visits per year or as required
Grass	Wildflower areas strimmed to 100mm in Sept or at end of school holidays - all cuttings removed Or Wildflower areas strimmed to 100mm on 3 year rotation - 30% each year - all cuttings removed	Site	1 visit annually
Inlets & outlets	Inspect monthly, remove silt from slab aprons and debris. Strim 1m round for access	Site	1 visit monthly
Permeable paving	Sweep all paving regularly to keep surface tidy	Site	1 visit annually or as required
Occasional Tasks			
Permeable paving	Sweep and suction brush permeable paving when ponding occurs, replace grit in joints with same specification of material	SuDS	As required - estimate 10-15 year intervals
Flow Controls	Annual inspection of control chambers - remove silt and check free flow	SuDS	1 visit annually
Wetland & pond	Wetland vegetation to be cut at 100mm on 3-5 year rotation or 30% each year. All cuttings to be removed to wildlife piles or from site	SuDS	As required - estimate 10-15 year intervals
Silt	Inspect swales, ponds, wetlands annually for silt accumulation	Site & SuDS	1 visit annually
Silt	Excavate silt, stack and dry within 10m of the SuDS feature, but outside the design profile where water flows. Spread, rake and overseed	Site & SuDS	As required
Native planting	Remove lower branches where necessary to ensure good ground cover to protect soil profile from erosion.	SuDS	1 visit annually
Remedial Work			
General SuDS	Inspect SuDS system to check for damage or failure when carrying out other tasks. Undertake remedial work as required	SuDS	Monthly As required

11.4 Silt and waste management

Silt and sediment removal is often considered a major element of SuDS management. In most cases where SuDS features are located at the surface silt accumulates slowly and can be removed easily. Management of silt becomes more difficult and costly at the end of the management train, particularly in ponds and wetlands.

Where silt has accumulated in SuDS components downstream or the design has specifically included a silt collection feature, it is important to monitor silt accumulation visually and remove on a periodic basis before it impacts drainage capacity.

Silt removed from most low to medium risk sites can be de-watered and land applied within the site but outside the SuDS component profile.

Silt management and removal from site should follow the protocols set out in the 2015 SuDS Manual Chapter 32 p699

SuDS vegetation green waste can be managed in the same way as site green waste, either on site in wildlife piles, compost arrangements or taken off site.

The use of composted green waste or chipped woody material should be considered for raingardens, bioretention or any other planted feature on site.

Any waste considered to be contaminated should be evaluated as set out in the SUDS Manual Chapter 33 – Waste management p709

Image above: ***Naas Lakes, Co. Kildare***

Comhairle Contae Chill Dara
Kildare County Council

McCloy Consulting

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