North Wales SuDS Guide

Rev 3 – Final Issue – March 2025

North Wales Flood Risk Management Group

Foreword

The North Wales Flood Risk Management Group (NWFRMG) is pleased to launch this, the North Wales SuDS Guide. The guide is a significant step forward in ensuring the quality of surface water drainage systems that are delivered across the region as we move towards more sustainable surface water management.

The implementation of Schedule 3 of the Flood and Water Management Act 2010 on the 7th January 2019 in Wales introduced fundamental changes to the design of surface water management systems and the administrative process of approval and adoption of these systems. It has proved challenging for all involved in the design, construction, operation and maintenance of SuDS across the region to adapt to the new ways of working.

This guide has been developed collaboratively by NWFRMG to promote regional consistency in interpretation of the legislation and best practice in the way local authorities carry out their role as SABs. The guide provides a comprehensive single source of reference for developers, designers, planners, and prospective owners by clearly setting out the expectations, requirements and processes involved with SuDS approval and adoption across the North Wales region. This is a significant departure from the previous arrangements and those that remain in place in other regions of the UK.

The importance of engaging and working with the SAB from the earliest opportunity cannot be overemphasised. Early consideration of SuDS design within the overall development design process can avoid later costly site layout changes. Our experiences to date tell us that engaging with the SAB prior to application provides the best results in delivering multiple benefits and cost-effective SuDS. Applicants who discuss and refine proposals with us prior to submission of a formal application significantly reduce risk of delay, wasted effort and costs for all parties.

Finally, we expect the guide to evolve as we continue to learn from shared experiences in delivering this new way of working. We welcome feedback from users of the guide to help inform future revisions and additions so that it remains a valuable resource to all involved in the design, construction and operation of SuDS across the region.

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Purpose of document
This document has been developed by members of the North Wales Flood Risk Management Group and Arup for the purpose of providing guidance to all persons involved in the design, construction, operation and future maintenance of all SuDS features within North Wales Flood Risk Management Group jurisdiction.

North Wales Flood Risk Management Group and Arup accept no liability for any costs, liabilities or losses arising as a result of the use of or reliance upon the contents of this guidance.

This guidance document was reviewed in 2025 by representatives from the six local authorities of North Wales. Please note that some parts of the document may be outdated. Readers are encouraged to consult with the respective local authorities for where their sites are located and to refer to local guidance specific to each local authority.

Revision history:

Revision	Date	Description	Originated	Checked	Approved	Reviewed	Authorised
0	8 Feb 21	Initial draft for FCC and Arup	C Leader	P Holt			
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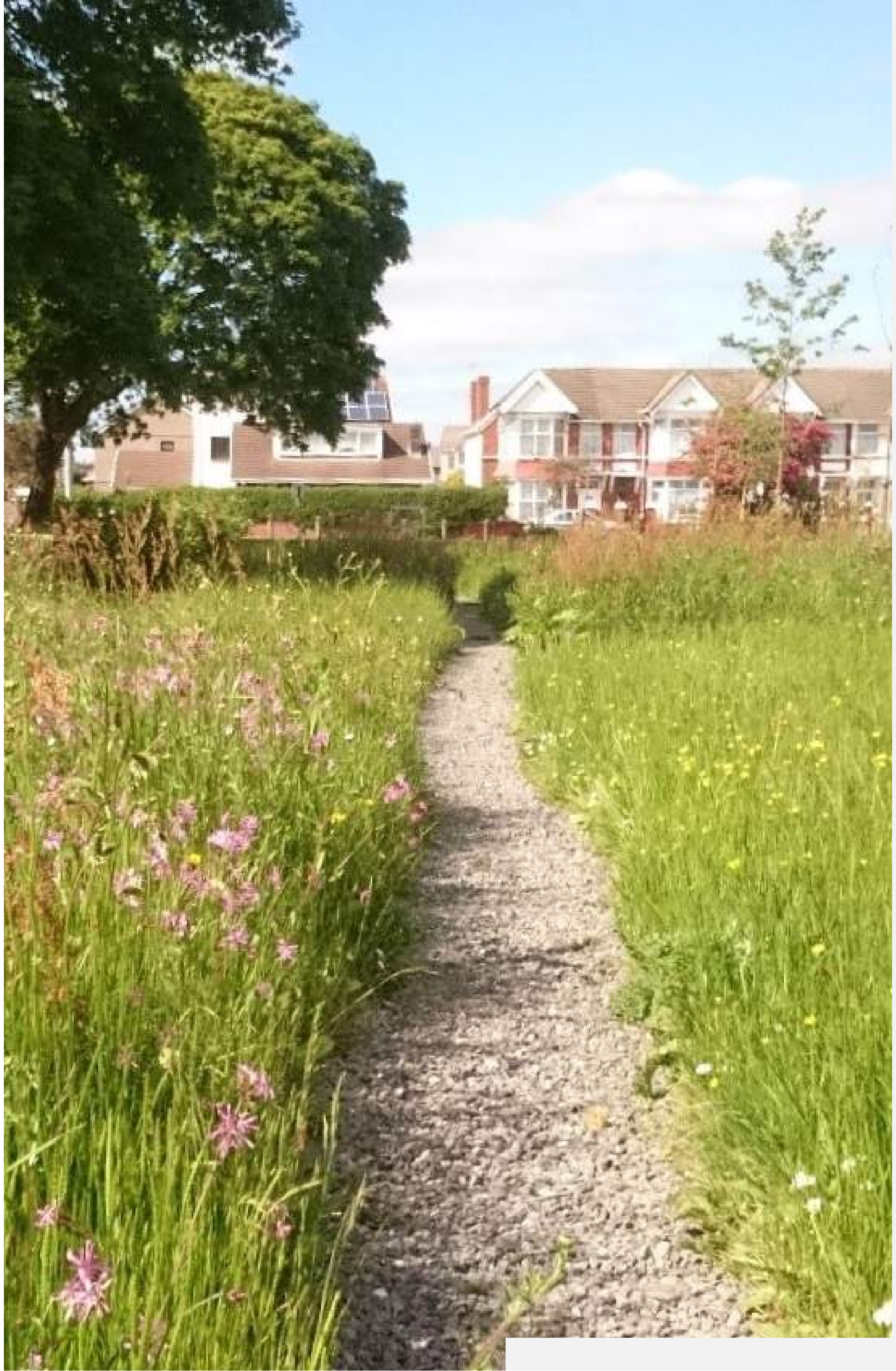

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Appendices

Introduction

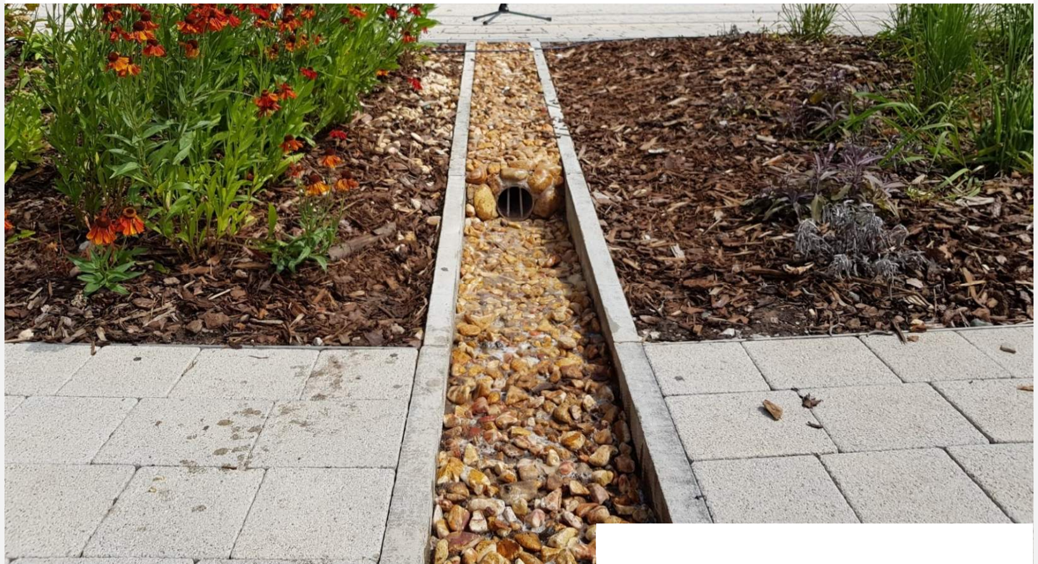
The enactment of Schedule 3 of the Flood and Water Management Act 2010 means sustainable drainage systems (SuDS) are now mandatory for most new developments in Wales and must be approved by the local SuDS Approving Body (SAB). This guide provides developers with an overview of the processes and design requirements for obtaining SAB approval in North Wales, for the six local authority SABs in the North Wales Flood Risk Management Group (NWFRMG):

- Isle of Anglesey County Council
- Gwynedd County Council
- Conwy County Borough Council
- Denbighshire County Council
- Flintshire County Council
- Wrexham County Borough Council

The guide is structured to follow the SAB application process and stages of design. It covers the legislation underpinning SuDS requirements and the steps involved in making a SAB application. The Welsh Government principles and standards which are measured against for SAB approval are summarised. A suggested design process for effective and compliant SuDS design is presented, along with recommendations for integrating SuDS into developments to maximise the likelihood of SAB approval. Design considerations specific to individual SuDS features are then provided, followed by key landscape, planting and ecology design considerations. Operation and maintenance requirements are summarised as these are a requirement of a SAB application. Finally, key aspects of the adoption and legal agreements process are then defined.

This guide provides an indication of things to consider for the SAB application process and to aid conceptual design. It is **not** intended as a design specification. For detailed SuDS design, further guidance referenced should be followed and the SAB consulted with.

The table opposite summarises relevant sections of the guide for each design stage.



Quick reference: What should I do now?

The following table directs the reader to the relevant sections of this guide depending on the development's stage.

Development stage	**Suggested next steps**
Inception	• Make sure whole design team know SAB approval needed and how it's separate from planning. • Read section 1 and 2
Outline design	In addition to the above; • Obtain early engagement and pre-application SAB advice • Read sections 3, 4 and 5 • Confirm adoption requirements for site.
Detailed design	In addition to the above; • Ensure design team are aware of SAB approval needed before <u>any</u> construction can begin • Read sections 6, 7 and 8
SAB application submitted	In addition to the above; • Ensure design team are aware of the development's SAB adoption and legal agreement requirements. • Read section 9
Construction begun	• Notify the SAB
Construction complete	• Notify SAB of the agreed maintenance period
Agreed maintenance period ending	• Notify SAB to obtain completion certificate • Finalise adoption requirements, if required.

List of abbreviations

The following abbreviations are used throughout this guide:

DEFRA	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
FEH	Flood Estimation Handbook
FWMA	Flood and Water Management Act
LFRMS	Local Flood Risk Management Strategy
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
NRW	Natural Resources Wales
NWFRMG	North Wales Flood Risk Management Group
PINS	Planning Inspectorate Wales
SAB	SuDS Approving Body
SuDS	Sustainable Drainage Systems
WBFGA	Well-being of Future Generation Act
WG	Welsh Government

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SECTION 1

LEGISLATION AND KEY STAKEHOLDERS

Raingarden, Greener Grangetown, Cardiff, CF11 7BJ

Schedule 3 of the Flood and Water Management Act 2010 (FWMA) came into effect in Wales in January 2019. It is the overarching legislation making SuDS a statutory requirement for new developments with construction area of at least 100 square metres.

1.1 Legislation

Schedule 3 of the Flood and Water Management Act (FWMA) 2010 is fundamentally different from the previous Welsh legislation (and the current legislation in England). It is separate to the planning process and has statutory sustainable drainage system (SuDS) requirements for developments.

Welsh legislation and guidance, under Schedule 3, specifies the following key points:

- SuDS are a statutory requirement for all new developments where the construction area is at least 100 square metres. SuDS must be designed and built according to the Welsh Government (WG) Statutory WG Standards [1]. The reference to more than one dwelling house in WG Standards is only applicable to the adoption of SuDS, see bullet point below.
- The Lead Local Flood Authority (LLFA) acts as the SuDS Approving Body (SAB) and must approve SuDS systems prior to construction.
- The SAB is required to adopt and maintain the system, subject to conditions, except where SuDS serve a single property or publicly maintained road. Details of the SAB's adoption duty conditions and exceptions are given in section 4 of the WG SuDS Statutory Guidance [2].

In addition to the statutory SuDS requirement of Schedule 3, individual local authorities may promote SuDS with local policies and supplementary guidance. These can be found in Appendix A.

Two pieces of WG legislation which supported the Schedule 3 enactment are the Well-being of Future Generations (Wales) Act 2015 (WBFGA) and the Environment (Wales) Act 2016.

- The Environment Act sets out public bodies' duty to make sustainable management of natural resources and biodiversity in Wales a central consideration in decision making.
- The WBFGA sets out seven well-being goals which specified public bodies must work towards. These public bodies include local authorities and Natural Resources Wales (NRW) which are stakeholders in the SAB application process. It is therefore useful for developers to understand these goals which the SuDS approval is looking to support. The goals are:
    - A globally responsible Wales
    - A prosperous Wales
    - A resilient Wales
    - A healthier Wales
    - A more equal Wales
    - A Wales of cohesive communities
    - A Wales of vibrant culture and thriving Welsh Language

1.2 WG SAB documents and statutory instruments

To assist those seeking SAB approval the WG published the following documents. It is recommended developers read these to assist the SAB application.

- Statutory Standards for Sustainable Drainage Systems 2018 [1] (WG Standards) – This details the principles and standards which must be adhered to for all drainage systems in Wales. Refer to section 3 of this guide for further explanation.
- Sustainable Drainage (SuDS) Statutory Guidance 2019 [2] (WG Guidance) – This was written to provide local authorities with an overview of the SAB application, approval and adoption process, including legal requirements.
- FAQs 2019 [3] (WG FAQs).

The WG considered the issues raised by consultees before Schedule 3 was enacted by publishing the following five statutory instruments to help SABs discharge their statutory duties. They are listed here for reference.

- The Sustainable Drainage (Approval and Adoption) (Wales) Order 2018
- The Sustainable Drainage (Approval and Adoption Procedure) (Wales) Regulations 2018 - Procedural matters relating to approval and adoption
- The Sustainable Drainage (Application for Approval Fees) Wales Regulations 2018
- The Sustainable Drainage (Enforcement) (Wales) Order 2018 - Enforcement of the requirement for approval by the SuDS Approving Body
- The Sustainable Drainage (Appeals) (Wales) Regulations 2018 - Appeals against decisions of the SuDS approving body.

1.3 SAB is separate to planning

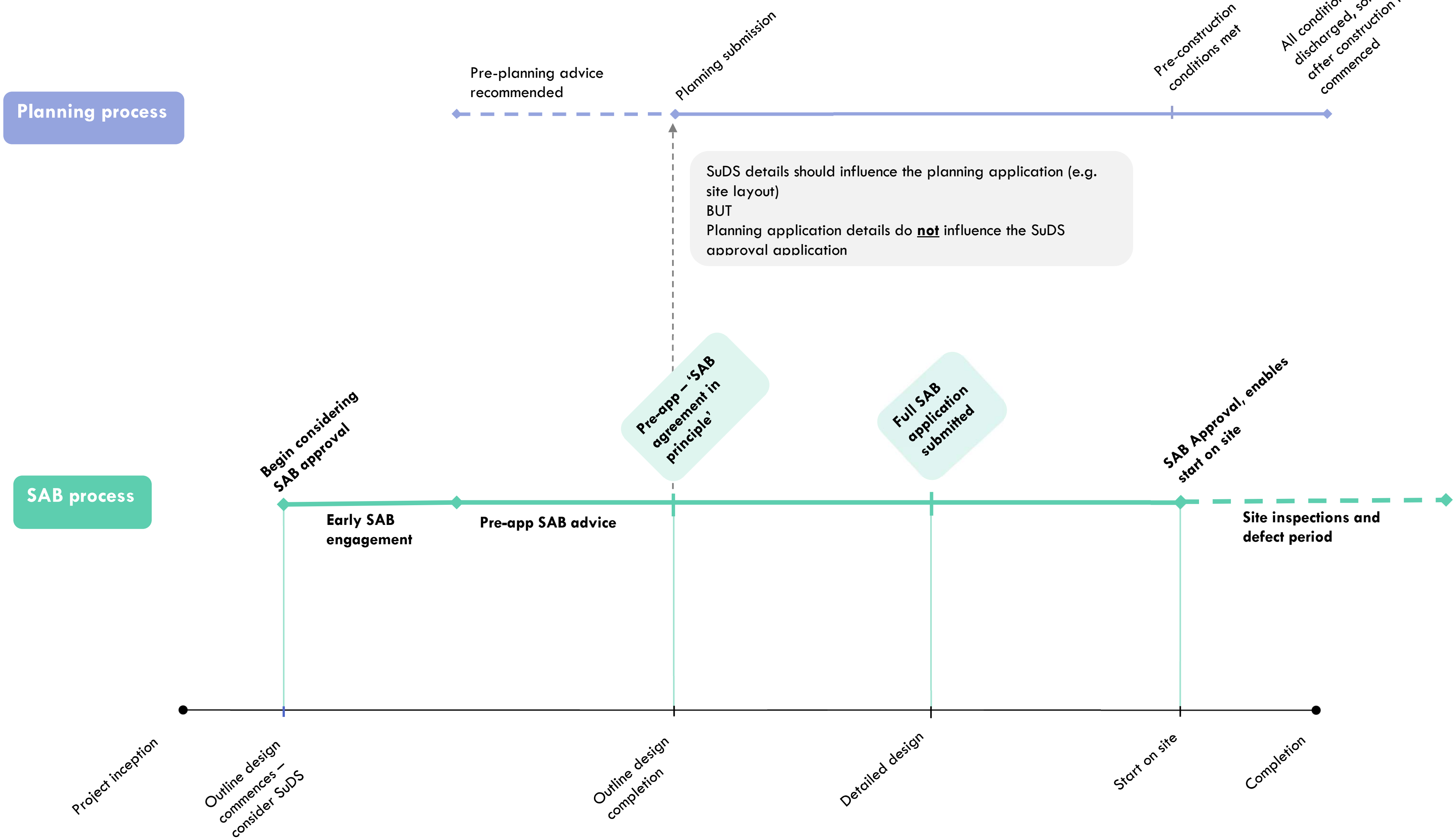
An application for approval of SuDS must be submitted to the SAB. This must be approved before any construction begins, unlike some planning conditions.

SAB applications can be submitted separately or together with a planning application. However, outcomes of each application are not dependent on the other. The planning application will be reviewed by the local planning authority (LPA) and the SAB application reviewed separately by the SAB.

The SAB application is different and separate to the planning application

The diagram on the following page outlines the SAB process in relation to the planning process. Early engagement with the SAB and other stakeholders listed below is critical to success of a SAB application. It is the responsibility of the developer to organise these early discussions.

Differences between SAB and planning applications



1.4 Stakeholders

The following organisations/roles have input to the SAB process.

SAB / LLFA

The SAB role is usually undertaken by the Lead Local Flood Authority (LLFA) and they must approve the SuDS system prior to construction. In addition, the LLFA may provide consultation on wider planning policy matters such as Local Development Plans and land allocations to their respective LPAs. The LLFA also provides functions other than that of the SAB, for example giving ordinary watercourse consent, Flood Investigations, Drainage Asset Management and Flood Alleviation Schemes. In the context of this guide, the role title "SAB" shall be used to avoid confusion.

Engagement with the SAB before submitting a SAB application, is strongly recommended and as early as possible. SuDS need to be considered as soon as possible before a predetermined development layout is finalised to avoid risking costly redesigns following rejection of a SAB application.

Early engagement with the SAB before applying is highly recommended

Statutory consultees

Stakeholders for SAB applications include statutory and non-statutory consultees. The SAB must consult with statutory consultees regarding each application which may impact that consultee. They will often also consult with the non-statutory consultees but are not legally required to. There may be local differences in how the SAB consults with each stakeholder. For such local details refer to Appendix A.

The statutory consultees are:

- **The relevant highway authority**
- **Natural Resources Wales (NRW)**
- **The relevant water and sewerage company**
- **Canal & River Trust**

It is the applicant's responsibility to have consulted with all stakeholders and obtained written agreements before applying to the SAB

Highway authorities

The relevant highway authority will adopt SuDS for the drainage of publicly maintained roads only. However, SAB approval is still required for these systems. The SAB and highway authority should therefore engage closely.

Natural Resources Wales (NRW)

NRW are a statutory consultee. They also approve flood activity permits for main rivers. Their role may also include operating as an Internal Drainage District dependant on the location of the site.

Canal & River Trust (C&RT)

If discharge is proposed to a watercourse which the C&RT manage, developers should consult with the C&RT early in the process. The SAB will require evidence of such consultation. Discharges to canals are likely to incur fees, hence early C&RT consultation is recommended.

Water and sewerage companies

Early consultation with the relevant water and sewerage company is essential for developers when discharge to an existing sewer system cannot be avoided and the SAB will require evidence of consultation and agreement with the water company.

Non-statutory consultees

LPA

There is no legal requirement for the LPA to contribute to SuDS approval. However, local SABs and LPAs are likely to align in their view of surface water management hence local policies should be referred to. These are found in Appendix A.

Planning approval does still require evidence of suitable surface water drainage provision and the LPA may consult with the SAB.

Developers

Official approval of SAB applications requires detailed plans and occurs relatively late in the design process. It is therefore strongly recommended developers themselves consult with stakeholders as early as possible before submitting an application. It is the responsibility of the developers to set up this pre-SAB-application engagement with stakeholders. The developer should provide evidence of this consultation to the SAB.

Land/property owners and occupiers

If the construction area is greater than 100 square metres, SAB approval is required according to paragraph 2.44 of the WG Guidance. For a single property, the SAB do not have a duty to adopt SuDS. The property owners and occupiers will be responsible for maintenance and operation of SuDS features for single property sites.

Bioretention planters, Greener Grangetown, Cardiff, CF11 7BJ

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SECTION 2

THE SAB APPLICATION PROCESS

2.1 Introduction

This section outlines the key elements of the SAB application process for approval and adoption across the North Wales Flood Risk Management Group (NWFRMG).

The NWFRMG includes the following six local authority SABs, who have come together to offer a regionally consistent approach:

- Isle of Anglesey County Council
- Conwy County Borough Council
- Denbighshire County Council
- Flintshire County Council
- Gwynedd County Council
- Wrexham County Borough Council

2.2 Local, regional or national?

The creation of the NWFRMG allows aspects of the SAB application process to be common regionally. However, some aspects must remain at national or local level. **Table 2.1** outlines which elements of the SAB application process are defined nationally, regionally and locally. Local authorities may have individual application requirements and processes, for which it is recommended to consult with the relevant SAB. Additional specific local guidance can be found in Appendix A.

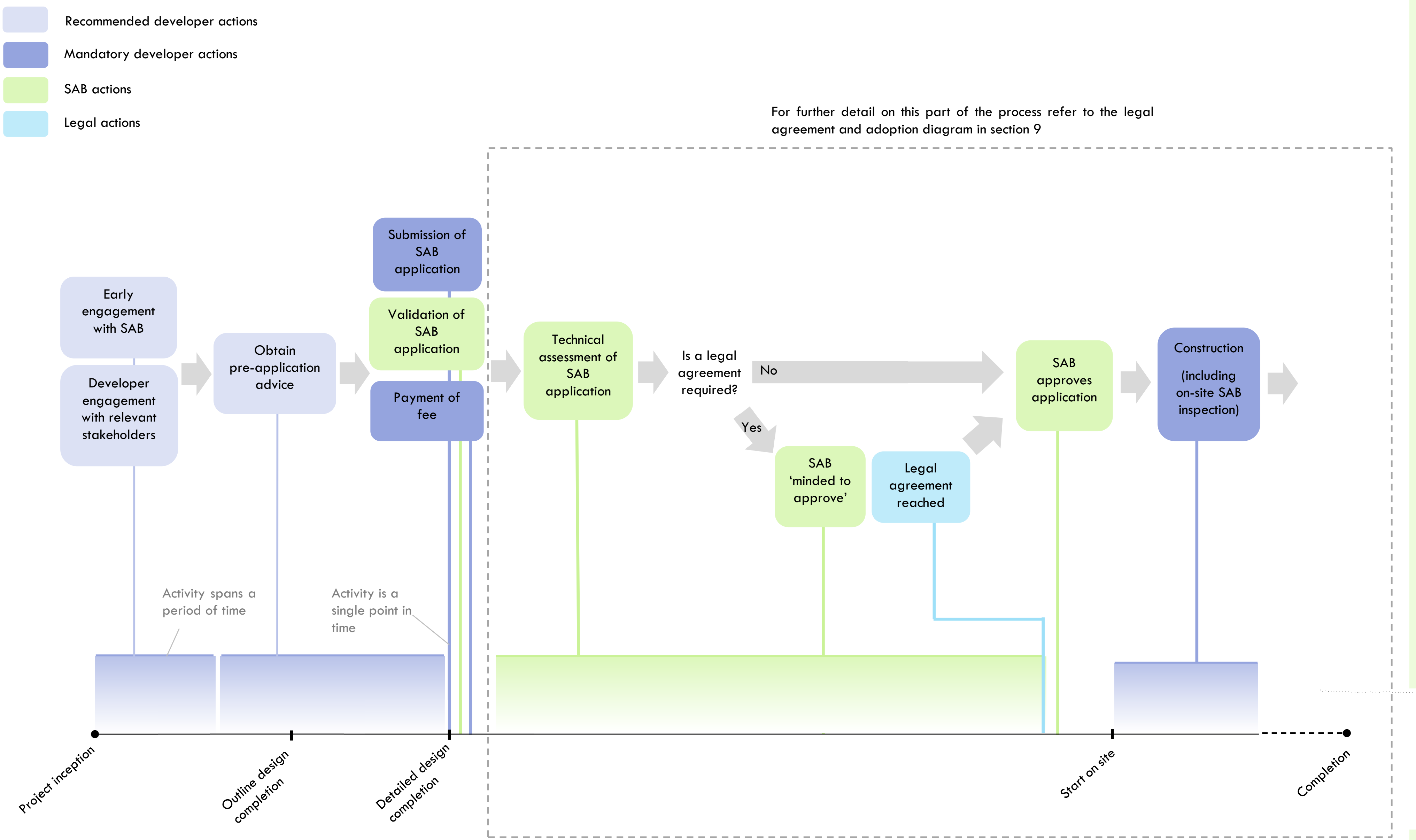
Table 2.1. Elements of the SAB application process defined nationally, regionally or locally.

Early engagement and pre-application advice	Locally	Appendix A or consult local SAB
Application process	Locally	Appendix A or consult local SAB
Application validation requirements (e.g. pro formas)	Regionally	Refer to Appendix B
Application fees	Nationally	WG Guidance 2019. WG36849. [2]
WG Standards	Nationally	WG Standards 2018. WG36005. [1]
Regional standards such as climate change, lifetime of development etc.	Regionally	Section 6 of this guide
SuDS features design requirements	Regionally	Section 6 of this guide
Legal and adoption agreements, process and fees	Regionally	Section 9 of this guide
Inspection requirements and protocol	Locally	Section 2 below and Appendix A or consult local SAB
Enforcement	Locally	Appendix A or consult local SAB

2.3 SAB application process overview

The SAB application process is different to the planning application process. The **diagram on the following page** has been developed to give an overview of the stages involved in a typical successful application. It includes the difference in processes dependant on whether the SuDS is adopted by the SAB. The stages in the diagram are described in more detail in the pages below.

SAB application process overview



2.4 Key SAB application stages

Early SAB engagement

All NWFRMG SABs provide a limited amount of free early engagement advice to discuss the high level aspects of a SAB application. A developer should contact the SAB themselves to access this at the earliest opportunity. Developer engagement with the SAB throughout the development process is essential to minimise costly delays for all parties and help produce better outcomes.

Please contact the relevant local SAB and refer to Appendix A to confirm the specific details of the level and type of early engagement advice available.

The early engagement is high level advice and will not include review of site-specific proposals. Regarding more detailed advice, refer to pre-application advice below.

Stakeholder engagement

It is the applicant's responsibility to have consulted with all stakeholders and obtained agreements in writing before applying to the SAB. The SAB will contact all statutory consultee stakeholders as part of the application assessment.

Pre-application advice

The pre-application advice is advice specific to the proposed development's SuDS scheme. Developers are encouraged to seek pre-application advice from the SAB prior to making a full application.

Pre-application advice is highly beneficial as it gives an early, formal indication of whether a SuDS scheme is likely to be approved and where any issues may lie. It also allows for early consideration of SuDS design within the overall development design process which is essential to avoid unforeseen and potentially costly site layout changes. The pre-application advice can effectively lead to a ***'SAB agreement in principle'***. The full application therefore becomes a formality with significantly reduced risk of delay, wasted effort and costs for all parties involved.

At the time of this document's issue, some of the NWFRMG SABs are yet to set fees for pre-application advice but it is intended that all will apply charges in time. Details of fees and payment methods for each authority can be found in Appendix A. The fee will vary depending on the size of the site and between local authorities.

Submission of full application

The amount of detail needed for a full SAB application should not be underestimated

The SAB application process is independent of planning application procedure. A full application should be made once the developer is satisfied that the WG Standards have been met, relevant stakeholder agreements have been obtained and the required level of design detail is available.

The application should be made according to the relevant local procedures outlined in Appendix A and using the application form with the checklist in Appendix B provided to help the developer. Please note, if any aspects of the checklist are not able to be answered then it is unlikely that an application is going to be approved.

Validation of full applications

Once submitted, applications will be checked by the SAB to ensure they are valid with the required information submitted. Incomplete applications can be refused by the SAB. The SAB aims to validate applications within 10 working days of receipt.

The SAB will then confirm the fee according to size of development, as detailed below, and request payment. Validation will be provided upon receipt of payment. It is at this point of validation that the approval process timescales begin, as defined in the WG Guidance and detailed below.

Technical assessment of full applications for approval of SuDS

Applications will be technically assessed within 7 weeks unless an Environmental Impact Assessment (EIA) is needed, in which case this becomes 12 weeks. These timescales are prescribed in the legislation. Full approval, however, can only be given once the adoption and legal agreements are complete.

Upon validation SABs have 7 weeks for technical assessment or 12 weeks where an EIA is required

The application is likely to be refused where there are concerns which can only be addressed through fundamental changes to the design. In this instance a new application would have to be made for reassessment requiring further time for validation and technical reassessment, plus application fees. Details of resubmission fees are given in the WG FAQs section 6.8 [3]. It is recommended to contact the SAB and follow the pre-application process to reduce the risk of refusal.

If a SAB does not meet the statutory timescale detailed above or if the application is not approved, the developer has the right to appeal as specified in section 5 of the WG Guidance. The appeal will be made to the Welsh Ministers and will be handled on their behalf by the Planning Inspectorate Wales (PINS). It is recommended the applicant stays in contact with the SAB during the technical assessment period to understand anticipated timescales. This may avoid the need for time-costly appeals.

The SAB will carry out the technical assessment and where all other requirements of local and national standards are met will advise the applicant that it is ***'minded to approve'***. This ensures the technical SuDS design is feasible prior to entering into discussion of legal agreements.

Adoption

Subject to satisfying any conditions, the SAB must adopt SuDS that serve two or more properties. The duty to adopt does not apply if the system serves a single property site, i.e. controlled by a single person or two or more persons together (e.g. social housing, schools, university campuses).

As detailed in paragraphs 4.16 and 4.18 of the WG Guidance, where the SAB has a duty to adopt it is responsible for ensuring the adopted drainage system is maintained in accordance with WG Standards. In order for the SAB to approve the SAB application and adopt the system, the developer must cooperate with the SAB and stakeholders to develop a maintenance plan. This includes identification of sources of funding for SuDS maintenance for the lifetime of the development.

How individual SABs discharge their adoption responsibilities will vary from council to council. Refer to Appendix A for specific details or discuss with the relevant SAB for the development.

Further detail on adoption of SuDS is provided in section 9 of this guide (which defines the NWFRMG regional position) and in the WG Statutory Guidance section 4.

Highway authority

The SAB is exempt from adopting SuDS which the highway authority is already or could become responsible for maintaining. The highway authority is required to consider for adoption the SuDS approved by the SAB. Where the highway authority adopts a road and its drainage, it must act in accordance with the approved drainage design, including the maintenance regime, in compliance with the WG Standards.

Timescales related to adoption and legal agreements

Full SAB approval is only granted when both the technical assessment and legal or adoption agreements have been completed. In many instances the timescales associated with addressing legal or adoption agreements (Standard S6) will be longer than the timescales prescribed within the legislation for the approval of the SAB application.

Regulation 7 of the Sustainable Drainage (Approval and Adoption) (Wales) Order 2018 allows extensions of this time period to enable legal agreements to be addressed when agreed between both parties beforehand. Full and final SAB approval is provided upon confirmation of an acceptable legal agreement being in place.

Where required, if a legal agreement is not reached the SAB application will result in an overall refusal.

Construction commencement

Unlike with certain planning conditions, **construction must not commence until legal agreements are finalised and full SAB approval is granted.**

Inspection requirements and protocol

On-site inspections by the SAB are conditioned in the SAB approval. The number and frequency of inspections will be determined on a case by case basis. These can be before, during and after construction.

The cost of inspections is covered by the developer and is in addition to the application fee. The Sustainable Drainage (Application for Approval Fees) (Wales) Regulations 2018 specifies that £168 can be charged per inspection.

Construction completion and adoption by SAB

Where applicable, upon completion of the development and where the findings of any SAB inspections have been addressed, the SuDS will be adopted by the SAB.


Bioretention swales and attenuation basin, Newcastle Helix, NE4 5TF

2.5 Fees and costs

Application fees

SAB full application fees are defined nationally in the statutory guidance and depend on the size of the construction area (the same as the planning 'red line boundary'). These figures may change in future so the most recent WG Guidance should be referred to. At the time of this guide's publication, the fees are as follows:

- £350 per application, plus (up to a maximum of £7,500):
  - for every 0.1 ha up to 0.5 ha - £70
  - for every 0.1 ha between 0.5 ha and 1 ha - £50
  - for every 0.1 ha between 1 ha and 5 ha - £20
  - for every 0.1 ha above 5 ha - £10

Worked fee example

Site of 1.2ha construction area:

Flat fee = £350

First 0.5ha = 5 x £70 = £350

From 0.5ha to 1ha = 5 x £50 = £250

From 1ha to 1.2ha = 2 x £20 = £40

Total cost for 1.2ha = £990

Legal costs

In addition to the SAB application fee, the developer will be required to cover all SAB costs associated with legal agreements and the adoption process.

Refer to section 9 for further details on legal costs.

Inspection fees

The cost of inspections is covered by the developer and is in addition to the application fee. The Sustainable Drainage (Application for Approval Fees) (Wales) Regulations 2018 specifies that £168 can be charged per inspection.

2.6 Additional information

Single property developments

In this context, 'single property developments' refer to developments with a drainage system that is owned, managed and controlled by a single person or two or more persons together such as social housing.

For single property developments, the SAB is not under any duty to adopt the drainage system (or any part of a drainage system). However, a legal agreement is likely to be required to address the potential that the buildings may be sold off in future as individual units and to safeguard the long term maintenance considerations. These elements are discussed in more detail in section 9.

Matters which delay/prevent SAB approval

The processes defined in the SAB application process diagram and detailed in the paragraphs above represent the ideal SAB application process in which approval is granted without refusal or delay. However, delay or refusal of an application are possible. Examples of some of the common pitfalls and their impact on the application are:

- Incomplete application form = Application not validated.
- Drainage hierarchy skipping (e.g. no infiltration testing undertaken) = Application refused or delayed.
- Design detail not sufficiently established = Application refused or delayed.
- Lack of pre-application liaison with a relevant third party e.g. connection to public sewer = Consultee objection; application refused or delayed.

SAB responsibilities

A successful SAB application requires the developer and SAB to work together. Understanding what responsibilities the SAB does or doesn't have may assist in managing expectations.

- Contacting the developer ✗ It is the developer's responsibility to begin engagement
- Providing advice, either early engagement or pre-application (on payment of small fee) ✓
- Obtaining agreements from relevant stakeholders ✗
- Completion of application forms and compilation of evidence ✗
- Assessment of application's validity ✓
- Technical assessment of application ✓
- Contacting statutory consultees as part of an application ✓
- Ongoing commentary on the application's progress ✗ The SAB will respond to reasonable requests for updates during the application process
- Draw up legal or adoption agreements ✗ The SAB will liaise with the relevant council's legal department who will deal with the developer's own legal representatives
- Pay legal fees ✗
- Approve SAB application and notify developer ✓ Upon completion of legal and adoption agreements
- Know when construction has started or finished for inspection purposes ✗ It is for the developer to keep the SAB informed

Detention basin, Llanelli, SA15 1EN

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SECTION 3

PRINCIPLES & STANDARDS OF SUSTAINABLE DRAINAGE

SuDS should manage and treat runoff as close to the source and ground surface as possible, using vegetation and mimicking the natural water cycle as closely as possible. Biodiversity and amenity benefits should be maximised.

3.1 SuDS basics

What are SuDS?

Sustainable drainage systems (SuDS) manage surface water with the ability to maximise the benefits of water quality, amenity, biodiversity as well as water quantity. SuDS can take many forms, both above or below ground and can consist of open water, planted or hard landscaped features.

For more background on SuDS please refer to The SuDS Manual [4].

Why are SuDS required in Wales?

Use of SuDS in Wales is important as developed areas expand, resulting in higher proportions of impermeable area. This allows less infiltration and evapotranspiration and results in an increase in surface water runoff. In turn this increases the risk of flooding and water pollution. Flood risk will also be exacerbated by climate change.

Therefore, SuDS provide an opportunity to create more resilient developments in Wales as they help mitigate the existing and future flood and pollution risks. In addition, well-designed SuDS provide developments with added amenity and biodiversity value. It is for this reason that the Welsh Government has passed legislation to mandate developers to use them as described in section 1.

The Statutory WG Standards

The WG Standards *"are aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment."*

They define the requirements of a SuDS design from which a SAB will assess an application. They provide principles and six standards which need to be demonstrated in the application.

3.2 Principles

The list of principles underpin the design of surface water management schemes to meet the Standards. They are found in the WG Standards and are listed below. A developer seeking SAB approval must demonstrate in their application how they have complied with these principles or provide justification for any departure.

According to the WG Standards, SuDS schemes should aim to:

- manage water on or close to the surface and as close to the source of the runoff as possible;
- treat rainfall as a valuable natural resource;
- ensure pollution is prevented at source, rather than relying on the drainage system to treat or intercept it;
- manage runoff to help protect people from increased flood risk, and the environment from morphological and associated ecological damage resulting from changes in flow rates, patterns and sediment movement caused by the development;
- take account of likely future pressures on flood risk, the environment and water resources such as climate change and urban creep;
- use the SuDS Management Train, using SuDS features in series across a site to achieve a robust surface water management system (rather than using a single "end of pipe" feature, such as a pond, to serve the whole development);
- maximise the delivery of benefits for amenity and biodiversity;
- seek to make the best use of available land through multifunctional usage of public spaces and the public realm;
- perform safely, reliably and effectively over the lifetime of the development taking into account the need for reasonable levels of maintenance;
- avoid the need for pumping where possible; and
- be affordable, taking into account both construction and long term maintenance costs and the additional environmental and social benefits afforded by the system.

The SuDS management train

The principles encourage the developer to consider the drainage of a site as a whole system of different SuDS features to create a resilient system rather than just using single features to manage a whole development (e.g. ponds or tanks). Its use maximises water treatment and attenuation in all parts of a system to help minimise the size of any final downstream storage. This SuDS management train concept, as it is known, is a hierarchy where the management of surface water should be considered in the following order from where the rain falls:

Prevention – The use of SuDS features that prevent runoff being generated e.g. rainwater harvesting, pervious pavements, infiltration features.

Source control – where prevention is not possible or practicable, manage runoff as close to source (where it falls) as possible, e.g. rain gardens, bioretention planters

Site control – where it is not possible to manage the water using only prevention or source control, convey any remaining water to a feature that manages surface water away from where it falls. Typically, the water is collected from a small number of different areas e.g. runoff is conveyed from a cul-de-sac's roofs and road SuDS to a nearby basin or soakaway.

Catchment control – where it is not possible to manage the water using only source or site control, convey and manage any remaining surface water away from where it falls. Typically, water is collected from a large number of areas, e.g. water is conveyed from different site control SuDS to a final basin or pond.

3.3 Six WG Standards

The SAB will assess whether an application's design achieves the 6 WG Standards:

S1. Surface water runoff destination
S2. Surface water runoff hydraulic control
S3. Water quality
S4. Amenity
S5. Biodiversity
S6. Design of drainage for construction, operation, and maintenance

To help a development's design achieve each of the six standards and maximise the multiple benefits SuDS can offer (as required by the SAB), it is strongly recommended that a SuDS design is considered from the start of and throughout the design process of a development. Refer to section 4 of this guide for more details.

The six standards for SAB approval are summarised below to give an overview. Developers should refer to the WG Standards for further details and specific requirements of each standard.

S1. Surface water runoff destination

S1 defines a drainage hierarchy for surface water runoff destination. As much runoff should be directed to the highest priority level possible before considering lower levels. Level 1 is the highest priority and Level 5 the lowest.

Level 1 – Collected for use
Level 2 – Infiltrated to ground
Level 3 – Discharged to surface water body
Level 4 – Discharged to surface water sewer, highway drain or other drainage system
Level 5 – Discharged to combined sewer

If a high priority level cannot be achieved, fulfilment of specified exception criteria must be demonstrated. The following paragraphs of the WG Standards define the specific exception criteria:

Level 1 – G1.4
Level 2 – G1.8
Level 3 – G1.31
Level 4 – G1.32

S2. Surface water runoff hydraulic control

S2 requires flood risk management to be provided including control of peak runoff rate and volume to protect people, developments and receiving water bodies. It applies to discharges to surface water bodies, surface water sewers and combined sewers.

Interception of the first 5mm

- Where possible, there should be no discharge from the site for rainfall events of less than 5mm. This reduces pollutant load.
- Vegetated and soil-based features are particularly effective at achieving this.
- Interception is not always possible (e.g. in saturated soils), so probabilistic criteria are used. This is often compliance with interception of the first 5mm rainfall for 80% of summer and 50% of winter events. SuDS features with assumed interception compliance for smaller sites are given in Table G2.1 of the WG Standards.

Protection of receiving surface water bodies' morphology

- Control the 1 in 1 year event (or agreed equivalent) runoff rate to minimise morphological damage to the watercourse.
- For further details, refer to G2.17-G2.21 of the WG Standards.

Mitigation of flood risk for receiving surface water bodies

- Control the 1 in 100 year event (or agreed equivalent) runoff rate and volume. Refer to section 6.3 of this guide for further details.
- Runoff rates should aim to equal greenfield runoff rates.
- For volume control aims and design, refer to G2.25-G2.33 of the WG Standards.

Site flood protection

- There should be no internal flooding of properties for the 1 in 100 year event.
- There should be no flooding of roads or other access areas for the 1 in 30 year event.
- The storm events should include appropriate consideration of climate change as detailed in section 6 of this guide.
- Further details are given in G2.34-G2.36 and G2.5 of the WG Standards.

Exceedance event surface water runoff management

- Events greater than the 1 in 100 year event should be considered. Conveyance routes should be understood so anticipated future changes will not obstruct safe routing.

Evaluation of failure impact

- System failure scenarios should be considered. These include blockages; pump failure; impediments across flood routes.

S3. Water quality

S3 requires treatment of surface water runoff to protect receiving waters and drainage systems.

The most effective treatment systems are ones that maximise runoff volume reduction, and use vegetation and surface treatment as close to the source of pollution as possible.

A management train approach should be used to ensure robust treatment. The design process to help define this should be:

1. Characterise land use
2. Assess pollution hazard level
3. Design management train to treat the water

Refer to the requirements in WG Standards Tables G3.1 and G3.3, as well as Appendix E, for further details on design for water quality.

Contaminants should be removed to acceptable levels for all events up to the 1 in 1 year event. (Larger events dilute pollutants further hence have less associated risk.)

Runoff from high level hazards may not be allowed and NRW should be consulted, detailed in G3.18 of the WG Standards.

Discharge to sensitive receiving water bodies (detailed in G3.21 and Table G3.2 of the WG Standards) may require a higher level of treatment. The LPA should also be consulted in this instance.

Details on discharging to groundwater are given in G3.26-G3.36 of the WG Standards.

S4. Amenity

S4 requires SuDS design to maximise amenity benefits which include improved well-being and climate resilience.

Visible open water and vegetation are preferable. Multifunctional SuDS (e.g. sports pitches) can promote recreation. High amenity value can lead to community buy-in to projects.

SuDS can increase property value for developments with attractive multifunctional systems. Incorporation of SuDS early in and throughout the design process is essential for this.

S5. Biodiversity

S5 requires SuDS to maximise biodiversity benefits. Use of blue and green space can increase habitat opportunities and connectivity. SuDS can contribute to protection of local species and delivery of local biodiversity objectives.

Biodiversity should be considered from the start of the design process to maximise benefits. Visible SuDS at the surface and with vegetation are most effective. Consideration should be given to existing sensitive habitats to avoid damage, including avoiding invasive species. Information on invasive species can be obtained from DEFRA.

Details on SuDS design for biodiversity can be found in G5.1-13 of the WG Standards and in section 7 of this guide. Key features which can aid biodiversity in SuDS are:

- Horizontal and vertical planting variability
- Biodiverse planting and open water
- Areas of grassland and wet woodland
- Gentle slopes and shallow water gradients

S6. Design of drainage for construction, operation and maintenance

S6 requires design of robust SuDS which can be constructed, maintained and operated safely, sustainably, cost-effectively and in a timely manner.

Impact on natural resources should be minimised and embodied carbon reduced.

G6.1-19 of the WG Standards must be referred to for design requirements for the sections below.

Construction

A Construction Plan should be provided to those responsible for construction. For details on producing this plan refer to The SuDS Manual.

Operation and maintenance

Clear information should be provided to the occupiers and operators/maintainers of the development on:

- The role of the drainage system
- Expected observations for the system under different rainfall conditions
- Operational requirements

The design should include a Maintenance Plan covering maintenance requirements for system function, vegetation establishment and management and sediment removal. For further details refer to section 8 of this guide.

Structural integrity

Any rehabilitation of SuDS features required during the lifetime of development should be covered in the Maintenance Plan including consideration of funding.

Safety

The Construction (Design and Management) Regulations 2015 (CDM 2015) [5] places responsibilities on the designer to consider the design from the perspective of cleaning, maintenance and demolition, as well as its initial construction.

West Gorton Park, Manchester, M12 5BE

SECTION 4

SUGGESTED SUDS DESIGN PROCESS

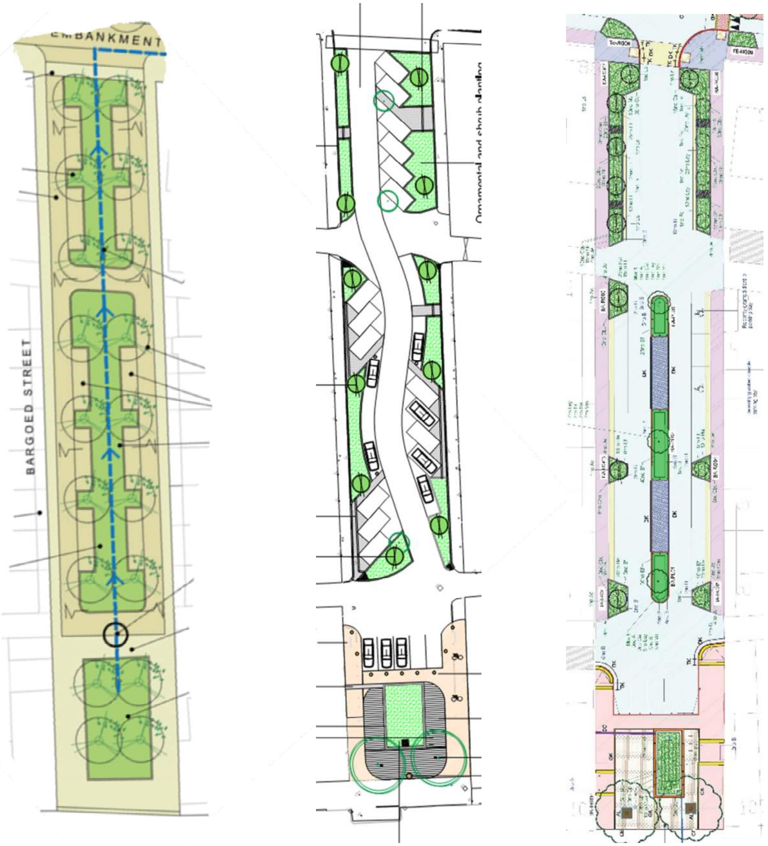
Contents

4.1 Suggested design process overview

SuDS design needs to be considered as a key part of a whole development. It should be neither a latter consideration of the project nor the one aspect that dictates all others. A holistic development design will enable an efficient and successful SAB application to help the development maximise the multiple benefits of SuDS. The following SuDS design process is suggested to help developers to achieve this. Extra description to each stage is given on the following pages.

1. Understand the current SuDS and SAB requirements
2. Evaluate existing site conditions and constraints
3. Engage with relevant stakeholders
4. Early engagement with SAB and initiation of pre-application advice
   Optional but highly recommended
5. Develop SuDS design for SAB approval
6. Obtain SAB pre-application advice and refine design accordingly
   Optional but highly recommended
7. Submit final design for SAB application

Construct, operate and maintain for the development lifetime



4.2 Design stages

1 – Understand the current requirements of SuDS and the SAB

SuDS requirements in Wales follow the national legislation described in section 1 of this guide. The specific requirements needed for a SAB application are summarised in section 2. Details on the requirements can be found in the WG Guidance and WG Standards and are summarised in section 3 of this guide.

Specific local requirements or recommendations should also be understood and can be found in Appendix A.

These requirements for SuDS in Wales should be communicated to the development's wider design team as soon as possible, to avoid decisions being taken that could hinder the delivery of a holistic design.

2 – Evaluate existing site conditions and constraints

The existing site should be evaluated to gain an understanding of which SuDS designs may be appropriate and how existing risks can be addressed and opportunities capitalised upon. Consideration at this stage also avoids problems further into the process when trying to incorporate SuDS into a more progressed design. It should be emphasised that some site constraints may not be physical such as obtaining permissions e.g. where water can be discharged.

All the relevant data should be reviewed, and stakeholders consulted with, to gain the best possible understanding of the site as the SuDS strategy is developed. The following non-exhaustive list identifies items to be considered:

- Topography
- Existing flood risk
  - From all potential sources, including surface water (see surface water risk mapping section below)
- Existing overland flow paths/blue corridors
- Existing ground conditions
  - Required to understand infiltration rates/potential, groundwater depth and contamination
- Existing land drainage
- Existing drainage network
- Existing watercourses and/or culverts
- Existing easements
- Where surface water could be discharged (i.e. the drainage hierarchy)
- Existing services
- Existing habitats and species
- Physical restrictions to construction, access/maintenance e.g. existing development
- Non-physical restrictions e.g. discharge permissions
  - This will likely involve engagement with the relevant stakeholders (Stage 3) to understand.

Surface water risk mapping

Surface water risk to the site should be assessed using the NRW flood risk maps for surface water which are available online. However, surface water flooding is difficult to predict, hence any further sources of local knowledge or historical flooding in the area should also be investigated if possible.

3 – Engage with relevant stakeholders

It is the applicant's responsibility to have consulted with all stakeholders and obtained agreements in writing before applying to the SAB. The SAB will contact all statutory consultee stakeholders as part of the application assessment.

Early engagement with relevant stakeholders is particularly important where permissions must be gained. The relevant stakeholders to engage with will depend on the site's discharge arrangements which should follow the drainage hierarchy levels defined in Standard S1:

- Infiltration to ground – discussion with the SAB

- Discharge to surface water body
  - Main rivers – NRW
  - Canals – C&RT
  - Ordinary watercourses - landowners and SAB
  - Sea – Crown Estates may need to be consulted
  - Note that landowners should be consulted where their land must be crossed to access the watercourse
- Discharge to a highway drain – the local highway authority
- Discharge to surface water or combined sewer – water and sewerage company

4 – Early engagement with SAB and/or initiation of pre-application advice

Obtaining early engagement and pre-application advice is strongly recommended. There is no specified time at which pre-application advice should be sought, however, it is recommended the process is initiated early with the SAB, allowing the advice to be obtained in step 6 of this suggested design process once the design has been developed. The process for obtaining early engagement or pre-application advice varies between local authorities, details of which can be found in Appendix A.

5 – Develop SuDS design for SAB approval

A SuDS design must be developed in line with the WG Standards which form the basis of the SAB's assessment. To select the appropriate SuDS features, consideration must be given to all information obtained about the existing site's conditions and constraints, and the engagement with stakeholders and the SAB.

The design should use appropriate SuDS features such as those detailed in section 6 of this guide. It should consider how these features can work holistically to achieve the maximum benefits for the development. These include biodiversity and amenity as well as surface water quantity and quality control. The design must also consider operation and maintenance.

Early coordination with the development's wider design team to maximise the benefits of SuDS is recommended.

6 – Obtain SAB pre-application advice and refine design accordingly

Where pre-application advice has been sought the SAB can provide site-specific feedback to a proposed SuDS design. Providing the SAB with as much information at the time of seeking this advice enables the maximum benefit to be gained. Pre-application advice includes a formal response from the SAB and can effectively lead to obtaining a 'SAB agreement in principle' before the formal application. Feedback from the pre-application advice should be incorporated to refine the design.

Details on how to obtain pre-application advice for the specific local authority can be found in Appendix A or by contacting the SAB.

7 – Submit final SuDS design for SAB application

The formal SAB application should be submitted once the design is finalised following the pre-application advice when the developer is confident they have the required level of information. Details of the process and how to submit a full application can be found in section 2. A checklist in Appendix B is provided to help developers assess if they have sufficient information.

Construct, operate and maintain for the development lifetime

Construction can only commence once full SAB approval is obtained, including completion of the adoption and legal agreements. It is the developer's responsibility to ensure the design is constructed as specified for approval. The SAB will undertake some on-site inspections, as conditioned in the approval.

Only upon completion of the development and where the findings of any SAB inspections have been addressed, will the SuDS be adopted by the SAB where applicable. The SAB is then responsible for ensuring the adopted system is maintained in accordance with WG Standards for the lifetime of the development. Refer to section 9 for more details on adoption.

Contents

SECTION 5

INTEGRATING SUDS INTO DEVELOPMENTS

5.1 Integrating SuDS into developments

This section provides examples of how SuDS can be integrated into different sites and addresses common site constraints which are often misunderstood to be barriers to SuDS.

Swale, University of York Campus East, YO10 5GY © Giles Rocholl

5.2 Management Train

The principles encourage the developer to consider the drainage of a site as a resilient system of different SuDS features rather than using a single feature (e.g. ponds or tanks) to manage a whole development. Multiple different SuDS features can maximise water treatment and attenuation in all parts of a system to help minimise the size of any final downstream storage. This SuDS management train concept is a hierarchy where surface water should be managed as close as possible to where the rain falls. For more details refer to section 3.2.

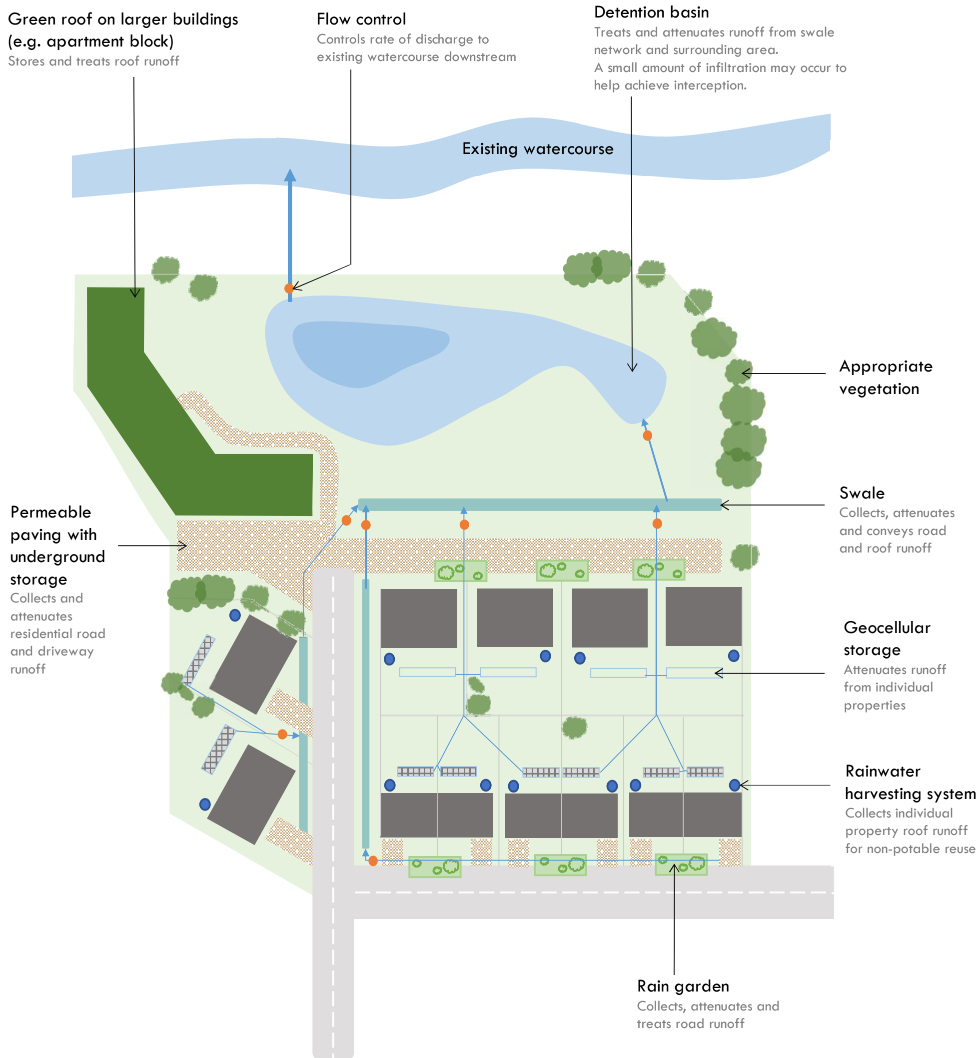
5.3 Example development layouts for different site conditions

Whilst each site is different, the following provides some examples of how a site could be laid out to best integrate SuDS into the development. These layouts are based on the principles and standards utilising the Management Train concept. This enables the selection of SuDS features which can be optimised for the specific site.

Example development overlying **high infiltration** rate soils

Example development overlying **low infiltration** rate soils

Interception and infiltration of water landing on a development are key consideration when selecting SuDS features to help minimise the volume of water that has to be managed. Infiltration should not be discounted for sites with little infiltration potential, as even minimal infiltration can help achieve the requirement of Standard S2 to intercept the first 5mm of rainfall where possible. The example below shows how a combination of SuDS features can be used, all working together to minimise the volume of storage needed at the downstream end (the oversized pipes or the detention basin).



5.4 Common questions relating to SuDS

For a successful SAB application the principles and standards must be demonstrated in a development's surface water drainage design. As emphasised throughout this guide, common issues can be avoided if surface water drainage and SuDS are considered from the very inception of a project. Some commonly misunderstood issues are detailed in the following section.

Clay soils

Clay soils do not prevent use of SuDS, they only impact the choice and/or design of specific features. While infiltration may not be possible, features such as swales, ponds or lined SuDS features can be used to store water at a higher level and help with interception.

Sites located in floodplains

SuDS designed to balance flow or store runoff volume required for the drainage system to function in a 1 in 100 year plus climate change event should not be located in any floodplain defined by the NRW flood maps.

However, SuDS designed to only provide water quality treatment, biodiversity or amenity benefits can be located within low risk floodplain.

Groundwater contamination

Groundwater contamination does not prevent the use of SuDS, it only impacts the choice and/or design of features. If infiltration is not possible due to groundwater contamination risk, SuDS features lined with impermeable membranes can still be used, for example.

Shallow groundwater levels

Shallow groundwater does not prevent the use of SuDS, it only impacts the choice and/or design of features. Where groundwater is shallow, SuDS features at or close to the surface should be used, using impermeable membranes with consideration for uplift. The use of such lined SuDS can still provide interception of the first 5mm, runoff attenuation, runoff treatment and added biodiversity and amenity benefits.

Fitting SuDS in a development

To ensure an effective SuDS system can fit within a development, SuDS design must be considered from the outset. SuDS can therefore help inform the development layout instead of having to fit in around plots once a layout has been fixed. Not being able to accommodate SuDS into a development is not a sufficient reason not to incorporate them as they should be considered from the outset.

Higher density developments can incorporate lower land-take features such as green roofs, RWH and swales. They can also maximise multifunctional space with SuDS in recreational spaces.

Not being able to accommodate SuDS into a development due to space constraints is not a sufficient reason not to incorporate them as they should be considered from the outset.

Flat sites

On flat sites, management of runoff as close to the surface and the source as possible is most effective. Conveyance mechanisms can include kerbs and swales. Pumping should be a last resort.

Steep sites

On steep sites, SuDS should include check dams and storage and can be staggered on slopes. This reduces runoff velocity and increase attenuation and infiltration, creating a more effective SuDS system.

Preventing clashes with existing infrastructure

Early consideration of SuDS in the project design process will allow clashes with other site infrastructure to be avoided. Existing drainage, for example, should be understood to influence efficient SuDS design. SuDS design should consider the location of all other infrastructure, plus their access and maintenance requirements, to avoid clashes.

Integrating SuDS with existing ecological areas

Selection of appropriate SuDS features with suitable vegetation species can contribute to biodiversity and enhance ecology. SuDS should be designed and appropriately planted to protect areas of interest including designated areas for nature conservation and areas with protected species and habitats. Local ecology should be well understood to inform SuDS design and aid biodiversity.

SuDS in small developments

Schedule 3 of the FWMA 2010 makes SuDS a statutory requirement for all new developments of more than one dwelling house or where construction area is at least 100 square metres.

The SAB recognise that a risk-based approach commensurate with the scale and nature of the development is needed. It is the SAB's intention to provide a set of 'deemed compliant' specifications for SuDS features that could be implemented on very small, low risk sites such as single dwellings. As this is not available at present, it is recommended for minor development developers to make use of the free early engagement and/or pre-application advice to gain insight into what the SAB would be expecting from a small site.

Retrofitting SuDS

As stated in the WG Guidance paragraph 1.1:

"*Schedule 3 to the Flood and Water Management Act 2010 (the 2010 Act) provides a framework for the approval and adoption of surface water systems serving new developments. It does not apply to retrofit and existing drainage systems.*"

However, it is strongly advised to incorporate SuDS into retrofit schemes as they can provide multiple benefits and sustainably achieve local requirements for surface water management. Therefore, whilst SAB approval is not required, consultation with the SAB may provide additional benefit.

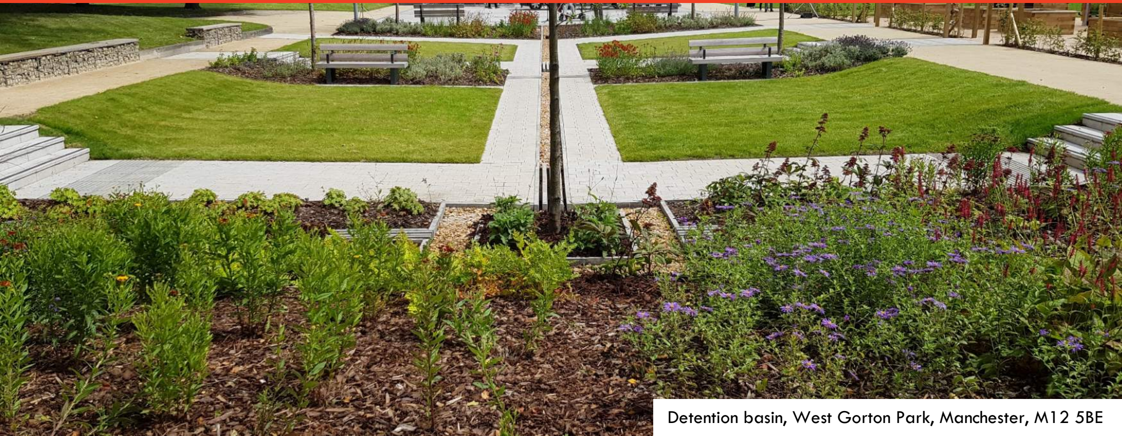
How do I achieve interception on a small site?

SuDS features with assumed interception compliance for smaller sites are given in Table G2.1 of the WG Standards.

Contents

SECTION 6

SUDS FEATURE DESIGN CONSIDERATIONS



Detention basin, West Gorton Park, Manchester, M12 5BE

6.1 Selection of appropriate SuDS features

Different SuDS features will be appropriate based on the existing and proposed site conditions. It is intended that the following feature-specific details will be used as part of Stage 5 of the suggested design process. Here, feature-specific details must be considered alongside site evaluation information to design a system which maximises all potential benefits in accordance with the WG Standards required for SAB approval.

SuDS features should be designed to the recommendations of the CIRIA SuDS Manual (C753).

The SuDS features summarised in this section follow the order listed in Table 6.1 below, which follows the order of Part D of The SuDS Manual. The sections below summarise key design considerations but are not intended to be the only points of reference used in the design of SuDS. Developers should design their surface water drainage to meet the full recommendations of The SuDS Manual and/or Sewers for Adoption 7th Edition [1] [6].

Table 6.1 – Suggested SuDS features and drainage components to be used in drainage design

SuDS feature
Rainwater harvesting
Green and brown roofs
Soakaways
Infiltration basins
Detention basins
Proprietary treatment systems*
Filter strips
Filter drains and infiltration trenches
Swales
Bioretention systems
Trees and tree pits
Pervious pavements • Permeable block paving • Porous asphalt
Attenuation storage tanks
Ponds and wetlands
Conventional pipework**
Pumping**

* Oil separators or similar. A good SuDS design will minimise need for proprietary treatment systems. If they are required (e.g. on high pollution risk sites), discussion with the SAB during pre-application advice is recommended. Their maintenance requirements can be significant and must be considered.

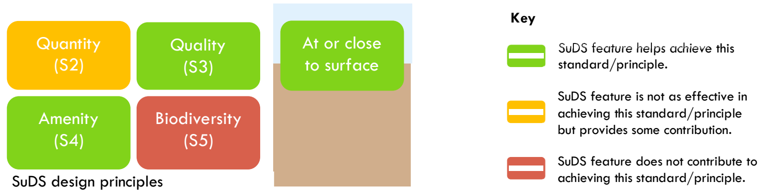
** Conventional pipework and pumping, whilst not specifically SuDS features, may be required as part of a development's drainage system. Typically the SAB requirements follow Sewers for Adoption 7th Edition [6] [1] or if part of an adoptable highway then in accordance with the local Highway Authority's requirements.

[1] Due to differences in the Welsh legislation from the English regarding mandatory adoption and the SAB, Welsh Water continue to use Sewers for Adoption 7th Edition across all their operating area. In England, Sewers for Adoption has been replaced by the Design and Construction Guidance (DCG) which is applicable to companies based wholly or mainly in England.

The SuDS features covered by this section are not an exhaustive list of all possible features but are intended to be an indication of those commonly used in drainage design. Developers are not limited to only using the features in the table; SABs welcome discussions where site-specific solutions present opportunities for developers to manage surface water in a different way.

Welsh Government Statutory Standards and Design Principles

The SAB will assess the design of each SuDS feature, as well as the whole system, against the statutory WG Standards. To aid the reader, the following diagram is included for each SuDS feature as an indication of how well they achieve significant statutory principles and WG Standards S2-S5.



SuDS design principles
(with reference to specific standards)

Note that S1 (runoff destination) and S6 (construction, operation and maintenance) are not included here as they are not feature-specific but are instead addressed through overall system design. The location at which surface water is managed is included in the diagram as a key principle not explicitly addressed in the standards.

Deviation from design parameters

To be approved by the SAB, all SuDS must be designed according to the WG Standards. Key parameters set out by the SAB for specific SuDS features (discussed in the following sections) should also be applied and are specific to the NWFRMG. Deviations from these parameters will need to be justified but will be considered by the SAB on their own merits. It is highly recommended that deviations first be discussed with the SAB through the pre-application advice service prior to the submission of a full application.

Infiltration and Interception

Infiltration

When selecting SuDS features, potential for infiltration should be a primary consideration. Discussion with the SAB should be undertaken to check if the site is suitable for infiltration e.g. considering drinking water protection zones.

As specified in Standard S1, infiltration to ground has the second highest priority level (after collection for use onsite). As for many types of development it is unlikely that all runoff will be able to be collected for use, SuDS features dealing with the remaining runoff should therefore maximise infiltration.

Interception

Infiltration should not be discounted for sites with little infiltration potential, as even minimal infiltration can help achieve the requirement of Standard S2 to intercept the first 5mm of rainfall where possible. Table G2.1 in the WG Standards lists SuDS features which are assumed to comply with this level of interception for 80% of summer and 50% of winter events, subject to specified design details. These include rainwater harvesting, green roofs, soakaways, infiltration and detention basins, permeable surfaces, swales, infiltration trenches, bioretention systems and ponds.

Safety and access

Consideration of health and safety should be paramount during SuDS design and as required in law with the Construction (Design and Management) Regulations 2015 (CDM) [5]. Both regular public use and less frequent maintenance requirements should be considered.

Safety and access requirements specific to each SuDS feature are outlined in the following sections with more extensive requirements given in The SuDS Manual (C753) [4]. General items which should be considered include risks associated with open water (drowning; bird colonisation near airports) and steep slopes. Many of these risks can be mitigated through good design without the need to just resorting to fencing off SuDS, which detracts from their amenity benefits. Education boards and lifesaving equipment can be used to mitigate significant risks.

6.2 Global design parameters

The following are some of the hydraulic design parameters that apply to the design of all surface water drainage, regardless of the specific feature.
This information is required for the submission of hydraulic design calculations contained in Appendix D.

Climate change allowance

The SAB requires a **30%** climate change allowance for peak rainfall intensity to be applied. This takes account of the latest guidance (at time of publication) on the impacts of climate change on extreme rainfall as detailed within “Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales” (2017) [7]. This guidance gives a central estimate of 20% and an upper estimate of 40%. From this, the NWFRMG has concluded that 30% should be applied across the region for consistency.

If more recent guidance is available at the time of reading this should be used and climate change allowance confirmed with the SAB.

Urban creep allowance

A 10% increase in the impermeable surface area must be applied during drainage design to account for future expansion within the development. This is in line with the best practice approach described in section 24.7 of The SuDS Manual.

Design storm return period

In accordance with the WG Standards paragraph G2.34, drainage systems should be designed to ensure protection against internal flooding of properties for the 1 in 100 year return period storm (or greater) plus climate change and creep as stated above.

In accordance with Standard S2, areas of the site away from properties should be protected to this same standard where practicable, in particular critical infrastructure. As a minimum, there should be no flooding of roads or other access areas for the 1 in 30 year return period event. Discussion with the SAB is required where this is not practicable.

Exceedance events greater than the 1 in 100 year return period event or failure scenarios (e.g. blockage) shall be considered to prevent flooding entering properties or leaving the site boundary in a way that could cause nuisance to neighbouring properties. This is in accordance with Standard S2.

Critical design storm

The SAB requires consideration by the developer of a range of storm durations to demonstrate that the design has taken into account the critical storm duration.

Hydrology (the use of FEH or FSR)

For North Wales SuDS design, the SAB expect the FEH method to be used to determine rainfall, rather than FSR. This is because the FEH method is more up to date with a longer data period and it provides more conservative values in North Wales.

If, however, FSR has been used, please apply a 50% climate change allowance (i.e. an additional 20% on the required 30% allowance) to account for the reduced rainfall. If using FEH apply 30% climate change allowance as specified in Section 5 of this guide.

Infiltration rates

Refer to chapter 25 of the SuDS Manual for further information on infiltration rates, including Table 25.1 discussing infiltration rates of different soils.
Where infiltration testing determines rates are 10^{-6} m/s or worse then this shall be deemed unsatisfactory to rely on infiltration as the only surface water management mechanism. However, even with rates such as these the designer should still consider opportunities for interception, as explained above.
An appropriate factor of safety, in line with best practice, should be used for all infiltration designs.

6.3 Additional design requirements

Setting and location of SuDS features

SuDS features in enclosed gardens or significantly built up spaces can be difficult to inspect and maintain. The SAB therefore prefer adoptable SuDS features within enclosed private property to be limited and features located where possible in public open spaces. If this is not possible, the developer is expected to provide justification for departing from the SAB's preferred position and seek to minimise the risk to the adopting SAB.

Lifetime of development and design life

For a residential development, the lifetime of development is taken by the SAB to be 100 years for the purpose of approval and adoption. For a commercial development, the lifetime of development is generally taken by the SAB to be 75 years. For either to be altered, the developer would need to provide justification.

It is important to note that the lifetime of development is not the same as the design life of the SuDS features. For example, a specific SuDS feature within the drainage design may have a design life of 25 years, so the design must consider required replacement of that feature as part of the Maintenance Plan, as the design life is shorter than the lifetime of development. Both lifetime of development and design life need to be reflected in the Maintenance Plan and in the maintenance funding requirements for adoption.

Drain down times

In accordance with best practice guidance, all drainage elements that perform storage functions should be designed to half empty within 24 hours to ensure sufficient storage is available for any subsequent storms.

Easements

Easements are required to demonstrate that the SAB and its authorised representatives can carry out inspections and maintenance of adopted SuDS features without obstruction. The developer must demonstrate the easements are defined and included in the legal agreement with the SAB and also via local land charges on the title deeds of individual plots where applicable.

Greenfield runoff rates

For previously undeveloped (greenfield) sites, the SAB requires the developer to calculate the specific site's existing greenfield runoff rates and discharge off site should be as close as reasonably practicable to these rates. The SAB would expect to see the existing greenfield runoff rates replicated. **It is typical for SuDS designs to be limited to the 1 in 1 year return period greenfield runoff rate.** Developers should speak to the SAB if they have reason to depart from this convention.

The SAB requires the developer to calculate the greenfield runoff rates using either the Institute of Hydrology IH 124 method or the Flood Estimation Handbook (FEH) method.

Brownfield runoff rates (betterment)

For previously developed (brownfield) sites, the SAB requires the developer to calculate the existing brownfield runoff rates and seek to improve the existing situation. This should be as close as reasonably practicable to greenfield runoff rates. This is in accordance with Standard S2 (paragraph G2.24 of the WG Standards).

If it cannot be demonstrated that previously developed land has functioning positive drainage or the details of components cannot be ascertained (even if there are known outfalls), an assumption should be made that the system is no longer operational and the site should be treated as an "undeveloped site".

Where functioning positive drainage has been demonstrated then the existing brownfield runoff rate for the 1 in 1 year event must be determined. The maximum allowable post development rate will be this value reduced by 30% (irrespective of the storm return period).

Ground contamination risks

The use of infiltration techniques can potentially mobilise contaminants where their presence in the ground has been identified, which could result in the pollution of groundwater. Infiltration will only be considered on sites with ground contamination where it can be demonstrated to the SAB that there would be no adverse effect of their use if the levels of contamination are within statutory limits.

All SuDS designed for infiltration shall meet criteria set out in the EA's Groundwater Protection Position Statements.

Runoff volume control

It is important that not only runoff flow rate but runoff volume shall be controlled to manage flood risk.

In accordance with G2.26 of the WG Standards, runoff volume should not exceed the greenfield runoff volume for the same rainfall event, where possible. This remains the case when developing previously developed sites. As stated in G2.27, methods such as infiltration and rainwater harvesting can provide volume control.

The SAB requires evidence of runoff volume control in order to approve a SuDS system as explained in G2.28 to G2.31. However, where greenfield volumes cannot be achieved, early discussion with the SAB is essential to identify opportunities to reduce volumes as much as possible.

Overland flow routes

As prescribed in G2.33 of the WG Standards, the drainage design should consider flow routes onto the site from outside the development up to the 1 in 100 year return period event.

In accordance with WG Standards G2.37 and G2.38, overland flow routes for exceedance events above the 1 in 100 year return period event should also be considered and managed to mitigate risk to people and property. Conveyance routes should be established which are unlikely to be interrupted by future developments on site.

Geotextile and membrane lap lengths

The design of any membranes or geotextiles should incorporate appropriate lap lengths to the manufacturers' recommendations or a minimum of 500 mm. Geotextiles should be approved by a geotechnical engineer.

6.4 Rainwater harvesting

SuDS design principles
(with reference to specific standards)

Rainwater harvesting (RWH) systems collect water from where it falls within the site boundary, such as roofs and surrounding surfaces. The water collected is usually reused on site, normally for non-potable applications, and meets the highest priority level in Standard S1. They reduce runoff volume and are an example of collection for use onsite. They can range from RWH systems to simple water butts.

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design tank storage according to BS EN 16941-1:2018 [8] (or most up to date guidance). Where demand for the collected water is sufficient and reliable, it may be possible to design the RWH to provide attenuation using BS 8515.
- Water butts can play a part too for very small developments. The designer should consider simple methods to help provide a proportion of the water butt ready for the next storm. For example, a simple hose connected mid-way up the butt and discharging into the garden away from the property. The water below the connection can remain for the homeowner to use.

Structural and spatial design

- Account for load of water on structure if water stored at height.
- Geotechnical investigation of soil and groundwater level (floatation risk) if tanks are to be placed in ground.
- If the tank is close to a building, check depth of foundations and that the tank is watertight.
- Tanks should be designed by a suitably qualified engineer.

General design

- Consider pollutant load of runoff before it enters the tank. Try to avoid collecting polluted waters.
- Primary screening device needed (e.g. silt trap).
- Careful overflow design required.
- Private water supplies must be in accordance with Private Water Supplies Regulations 2009 [9].
- Refer to The SuDS Manual (C753) Chapter 11 for further design information.

Construction, operation and maintenance

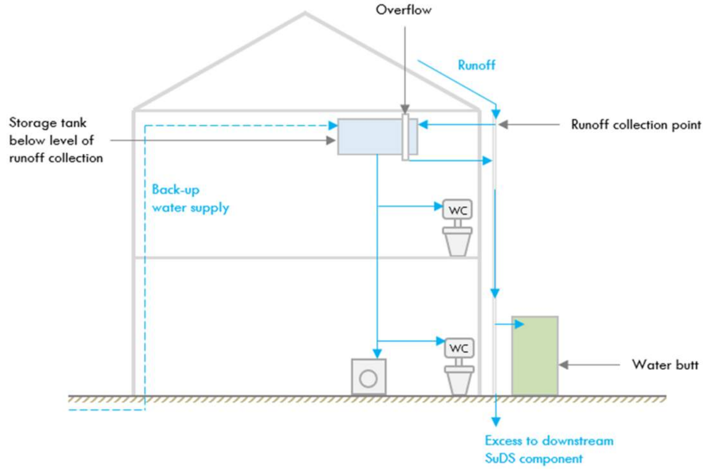
- Follow manufacturer's construction guidelines and guidance in BS EN 16941-1:2018 [8].
- Properties with RWH need information provided on its safe operation and maintenance requirements.
- Maintenance required depends on water source and use – refer to manufacturer and The SuDS Manual Table 11.6.
- Quarter yearly inspections of filter system recommended.
- Access to tank needed for inspection and maintenance.

Adoption

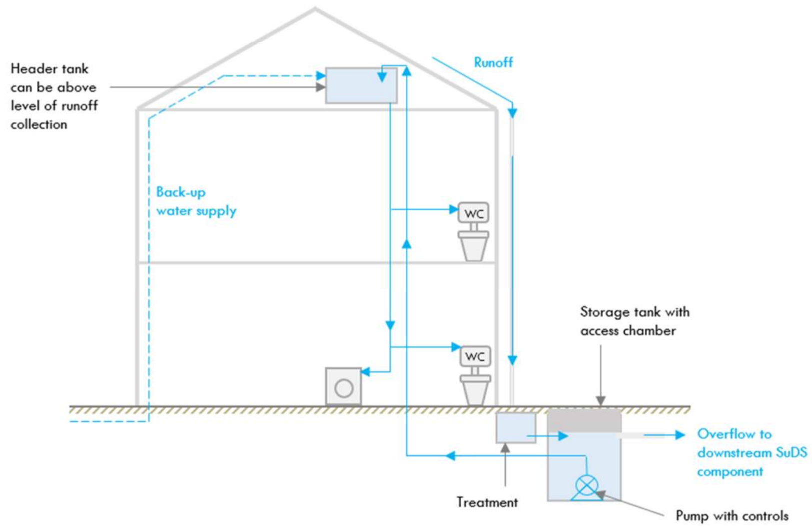
- It should be noted that with the exception of very few cases, the SAB will not adopt RWH systems as they are likely to be located on private properties.

Gravity and pumped systems

Gravity RWH system concept

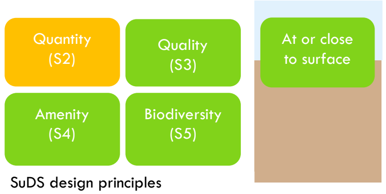


Pumped RWH system concept



6.5 Green and brown roofs

Green roofs are roofs with a substrate and vegetation layer. They retain and attenuate rainwater, as well as providing some treatment and encouraging evapotranspiration. Designed well, green roofs aid biodiversity and provide appealing aesthetics for added amenity value. There are two main types – extensive (shallow substrate and simple planting) and intensive (deeper substrate and wider planting variety). Intensive roofs are generally better for surface water control and amenity but have increased roof loads and maintenance requirements. Brown roofs feature aggregates and soil providing habitat for different soil-dwelling species.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design according to The SuDS Manual (C753) Chapter 12.
- Design to BS EN 12056-3:2000 [10] (further information in BS 6229:2018 [11]).
- Typically can only attenuate a 1 in 2 year storm event so has limited impact on quantity control.

Structural and spatial design

- Account for roof load when roof is saturated with water.
- Account for live loads of maintenance staff and the public/recreational activities if relevant.
- Roof pitch – steeper means less storage, faster runoff and less treatment unless the drainage underlayer is carefully designed.
- Design roof falls to 1 in 40 with consistent grade for minimum finished falls of 1 in 80. Design advice needed if steeper than 1 in 10 (max. fall 1 in 3).
- Design outlet to be separate from growing medium.
- At least 2 outlets to reduce blockage risk.

Landscape and biodiversity

- Consult with landscape architect.
- Plant species appropriate to the roof environment e.g. exposure to hot and cold, sunlight, wind, poor soil.
- Use native or appropriate species considering local biodiversity objectives and existing habitats.
- For extensive roofs, species should require little to no aftercare once established.
- Vary substrate depth for increased biodiversity (80-150 mm).

General design

- Coordination needed between structural engineer, drainage engineer, landscape architects, ecologists, architects etc.
- Fire resistance to external spread of fire according to Building Regulation B4 [12].
- Substrate with less than 20% organic matter and 1m wide slab fire break every 40m for fire resistance.

Construction, operation and maintenance

- Access and safe working require stairs, perimeter barriers and safe paths to relevant standards if access needed by people, including maintenance. Intensive roofs require more maintenance.
- Activities working at height must be compliant with current regulations.
- Access needed for roof inspections and seasonal cleaning of outlets in case of blockage.
- Consider need for irrigation, particularly during initial growing seasons.
- Refer to The SuDS Manual Table 12.5 for maintenance requirements.

Adoption

- It should be noted that with the exception of very few cases, the SAB will not adopt green or brown roofs as they are likely to be located on private properties.

Case Study Engie offices, Mold

This development incorporates approximately 1000m2 of shallow substrate sedum based green roof system on multiple pitched roofs across several buildings.

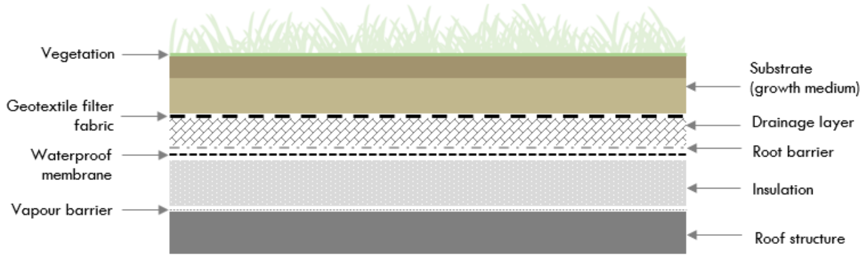
As well as providing some treatment this encourages evapotranspiration and some retention of rainwater.

Both roof and car park drainage are conveyed to a swale where further treatment and attenuation is provided ahead of an onward connection to short length of surface water system discharging to an adjacent watercourse.

Image: Flintshire County Council

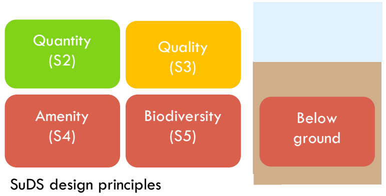
Typical detail

Green roof



6.6 Soakaways

Soakaways are point source infiltration systems for runoff. They reduce runoff rate and volume and aid groundwater recharge. They are excavations filled with a high-void-ratio material in which runoff is stored before infiltrating. Soakaways are commonly constructed from geocellular units or perforated concrete rings. For single properties they can be a pit filled with a suitable granular backfill.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design according to The SuDS Manual (C753) Chapter 13 and BRE 365 [13].
- Design for half drain down within 24 hours.

Hierarchy of location

- Preferred location in open public space. A less-preferred alternative is in the highway verge. The least preferred is under the highway carriageway itself, being as tight to one side of the carriageway as possible.
- Do not place in the highway footpath because this is reserved to convey buried utilities/services.

Structural and spatial design

- Minimum 1m unsaturated soils between base and maximum likely groundwater level. This can be demonstrated with a deeper trial pit next to the test pit (refer to Appendix C).
- If the site is sloping, use multiple on stepped plateaus.
- Account for construction and design life loads, particularly if traffic-bearing.
- Place at least 5m from structural foundations and 3m from boundaries. At least 10m between soakaways.
- The SAB will typically not adopt soakaways exceeding 3.5m in depth due to the maintenance equipment required.

Landscape and biodiversity

- Consider risk of root intrusion to void space.

General design

- Ground investigation required to check ground infiltration rates, stability and groundwater flood risk.
- Complete a risk assessment to ensure runoff will not contaminate groundwater.
- Designs for infiltration to meet criteria set out in the EA's Groundwater Protection Position Statements [14].
- Upstream pre-treatment required to remove silt and sediment to avoid clogging e.g. silt traps; settling chambers. Adequate volume, particularly minimum depth, to suit impermeable area draining to the soakaway (e.g. for a house, simple trapped gullies feeding to the soakaway). For areas of highway an appropriately sized catchpit chamber with a 500mm sump.
- Provide adequate depth ('sump') from base to lowest perforations to minimise clogging due to silt accumulation.

Construction, operation and maintenance

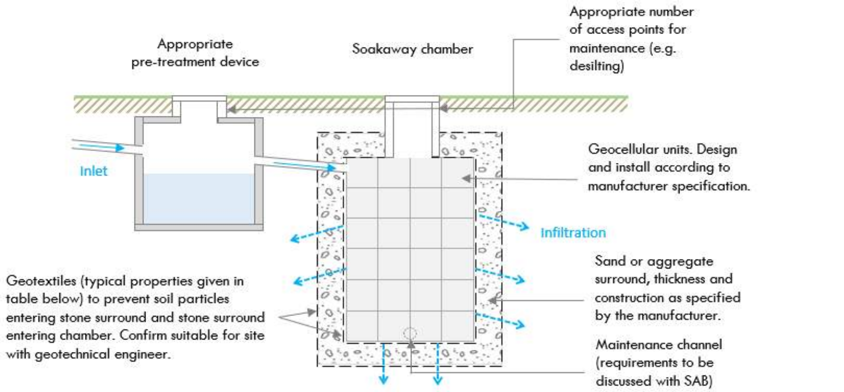
- Large soakaways require discussion of internal maintenance channels with the SAB (e.g. on every other run of cells).
- Careful construction needed to avoid damage to soil structure and infiltration potential. Follow The SuDS Manual section 13.11 for best practice.
- Consider easements for maintenance access if multiple properties drain to one soakaway.
- Regular vacuuming to remove silt from perforated concrete ring soakaways.
- Refer to the SuDS Manal Table 13.1 for maintenance requirements.

Adoption

- Provision of maintenance access is key for adoption.
- Design life should be considered in relation to lifetime of the development and plans made for replacement costs where necessary.

Typical details

Soakaway – geocellular units with pre-treatment device



Soakaway – perforated concrete ring with pre-treatment device

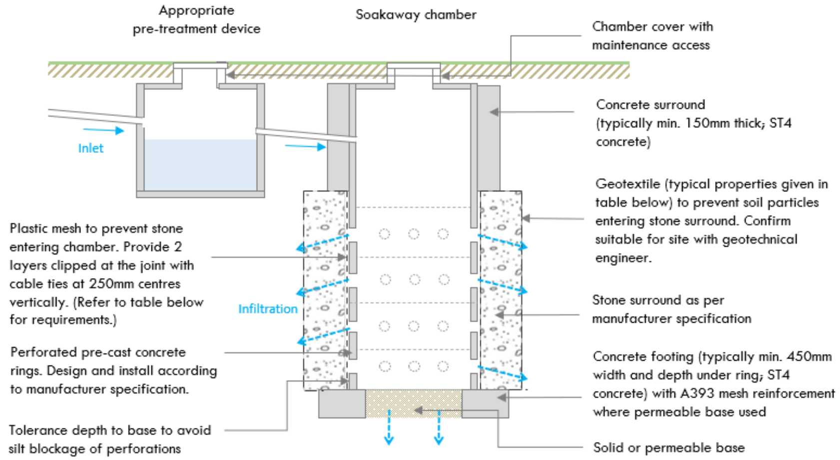


Table 6.2. Recommended geotextile membrane properties

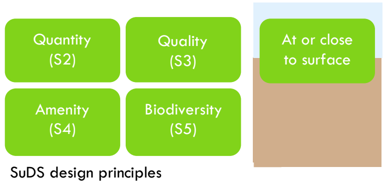
Geotextile membrane	Tensile strength (kN/m)	Tensile elongation (%)	CBR puncture resistance (N)	Service life (years)	Permeability (l/m²/s)
	14.5	60	2750	100	55

Table 6.3 Recommended plastic mesh properties

Plastic mesh (also known as grass-reinforcement mesh)	Tensile strength (kN/m)	Mesh aperture (mm)	Minimum weight (kg/m²)	Yield point (% elongation)
	6.2-7.5	22-27	0.66	40

6.7 Infiltration and detention basins

Infiltration basins are landscaped depressions for temporary runoff storage. Through infiltration they can reduce runoff rate and volume, filter some waterborne pollutants and aid groundwater recharge. Detention basins similarly provide storage to reduce runoff rate but do not infiltrate so have limited volume reduction. Both basins can be landscaped into a site with varied planting or hard paving for habitat and recreational space. They are not typically used for source control and are generally located at the end of a site's drainage network.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Impermeable detention basins only to be used where groundwater contamination or flooding is an issue.
- Design according to The SuDS Manual (C753) Chapters 13 and 22.
- Design for exceedance e.g. weir overflow.
- Max. depth of water in line with risk assessment considering public/user safety.
- Freeboard of 150 mm above maximum designed water level (can be reviewed in discussion with SAB).

Structural and spatial design

- Minimum of 1m unsaturated soils between base and maximum likely groundwater level if infiltrating.
- Flat base if infiltrating for even ponding and infiltration (tolerance of 10 mm in 3 m).
- Maximum side slope of 1 in 3 for safe maintenance access and stable vegetation; 1 in 4 preferred. Avoid steps to avoid creating a hazard when containing water.
- 2:1 to 5:1 length to width ratio range for filtration in a detention basin.

Landscape and biodiversity

- Incorporate into overall development design for added amenity e.g. recreational areas.
- Ensure vegetation can cope with both waterlogging and extended dry periods.
- Consider risk of root intrusion from larger vegetation which can reduce voids.
- Avoid fertilisers and herbicides to minimise pollutants/nutrients in groundwater.

General design

- Ground investigation required to check permeability, stability and groundwater flood risk.
- Upstream pre-treatment to be considered particularly where contamination risk is more significant e.g. from highways.
- Designs for infiltration to meet criteria set out in the EA's Groundwater Protection Position Statements [14].
- Velocity reduction measures at inlets to reduce erosion e.g. flow spreaders/grass reinforcement.

Construction, operation and maintenance

- Avoid damage to soil structure and infiltration potential during construction. Follow The SuDS Manual section 13.11.
- Access required for regular maintenance and inspection. Locate inlets and outlets visibly and with easy access.
- Consider temporary soil reinforcement while vegetation establishes to prevent erosion.
- Grass length maintained at 75-150mm.
- Increased maintenance/infiltration factor of safety if used by people due to compaction of soil.
- Risk assessment required for frequency and rate of flooding to ensure users' safety. If fencing is required, keep it low to allow maintenance activities and wildlife to cross.
- Refer to The SuDS Manual Tables 13.2 and 22.1 for maintenance requirements.

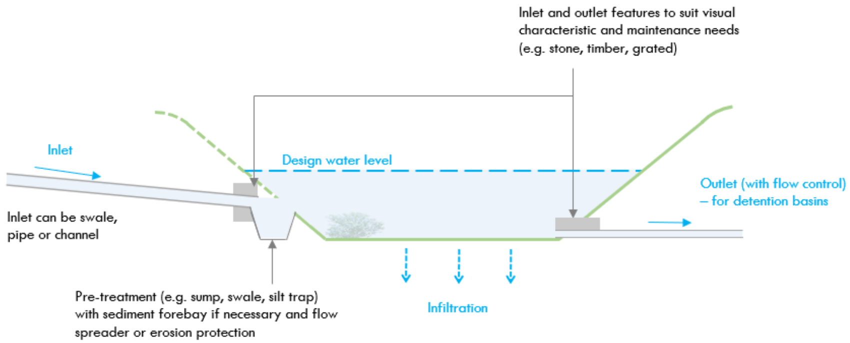
Case Study West Gorton, Manchester

A new community park in an urban residential area designed to use nature based solutions to combat the effects of climate change and reduce storm water flooding.

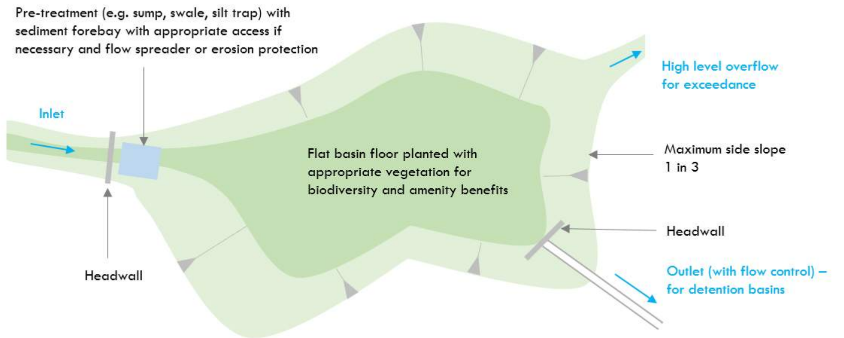
Paths and hard surfaces have been replaced by permeable paving, additional areas of highway storm water runoff are drained into infiltration ponds and rain gardens which are planted with biodiverse vegetation and allow residents to enjoy.

Typical details

Basin section

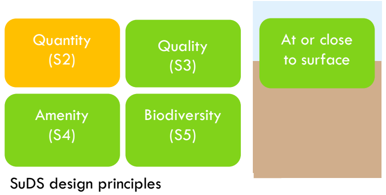


Basin plan



6.8 Filter strips

Filter strips are vegetated, gently sloping runoff conveyance strips. They allow infiltration into underlying soil as runoff flows slowly across them. They filter sediment and silt and are often used as pre-treatment between impermeable area and receiving SuDS features. Filter strips can contribute to interception but do not have a significant impact on runoff rate or volume. They can be used in poorly infiltrating soils, aiding the slowing of runoff rates, but collection of the water downstream should be considered.



SuDS design principles (with reference to specific standards)

Hydraulic design

- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Only use impermeable liners where groundwater contamination or flooding an issue.
- Design according to The SuDS Manual (C753) Chapter 15.
- Flow velocities should be minimised for effective treatment and for erosion control.
- Suits lateral inflow rather than point inflows to minimise erosion. Suits flush kerbs (or similar) draining hardstanding areas e.g. roads/car parks.

Structural and spatial design

- Minimum 1 m width.
- Minimum slope along flow direction of 1% for ponding prevention. Level spreaders required if greater than 5% slope for channelling prevention.
- Top and bottom of slope at lower end of allowable slope range to reduce erosion by reducing velocity.
- Minimum 50 mm drop from pavement to filter strip to stop sediment lip forming.

Landscape and biodiversity

- Landscape to minimise pedestrian usage.
- Plant with appropriate grass mixture or turf. A wider vegetation range for increased biodiversity can also be used.
- Mix of wet- and dry-area grasses needed which can prevent erosion and can grow through silt deposits.
- Dense deep-rooted vegetation needed to bind soil.
- Do not locate where conditions limit grass growth e.g. overshadowed.
- Avoid fertilising to avoid nutrient loading of receiving system.

General design

- Flow spreader recommended at top of slope to distribute flows and avoid point sources. Silt traps can also be considered along with their maintenance requirements.
- Maximum groundwater level at least 1m below base if unlined. If lined to prevent infiltration, maximum groundwater level must be below liner.
- Ground investigation required to check permeability, stability and groundwater flood risk. Infiltration should be permitted where possible, even if permeability is low.
- Designs for infiltration to meet criteria set out in the EA's Groundwater Protection Position Statements [14].

Construction, operation and maintenance

- No vehicles near strip to avoid compaction. Design considerations to discourage vehicles may be needed e.g. bollards/boulders.
- Consider the temporary case whilst vegetation establishes e.g. no runoff flows over strip or erosion protection.
- Regular inspection and maintenance required e.g. litter removal, mowing.
- Occasional sediment removal required.
- Keep vegetation at 75-150mm on treatment surface for filtration.
- Refer to The SuDS Manual Table 15.1 for maintenance requirements.

Case Study School, Melton Mowbray

The strips convey runoff from an impermeable car park to a swale, which then connects into an infiltration basin.

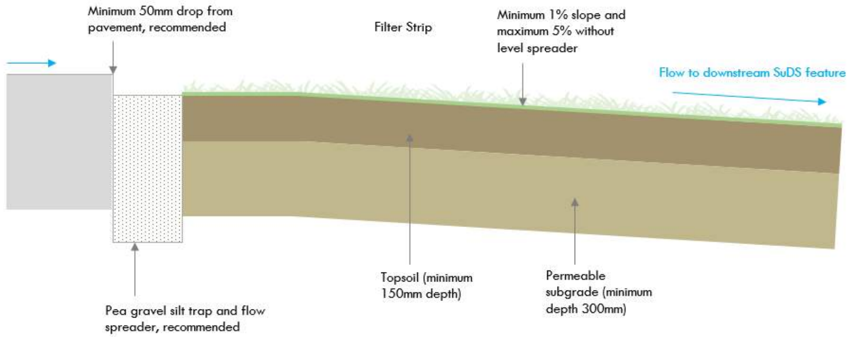
Filtration provided by the filter strip, in combination with the swale and basin downstream, form a treatment train. This allowed the design to avoid the need for oil separators.

Filter strips kept the design as simple and close to the surface as possible, avoiding outlets with headwalls.

Although in clayey soil, some infiltration does occur, aiding runoff reduction.

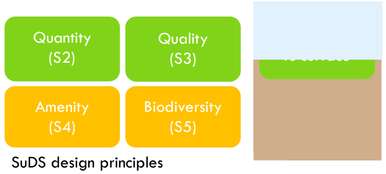
Typical detail

Filter strip



6.9 Filter drains and infiltration trenches

Filter drains are trenches of permeable material, often containing a perforated pipe at the base. They convey, attenuate and filter runoff. They can be unlined to allow infiltration or lined, which can still contribute a small amount of interception. They are linear by nature and generally drain small impermeable areas.
Infiltration trenches are linear soakaways similar to filter drains but are not used to convey water, only to allow it to infiltrate away.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Only use impermeable liners where groundwater contamination or flooding an issue.
- Design according to The SuDS Manual (C753) Chapters 13 and 16.
- Design exceedance flow routes to protect the trench and convey flow safely.
- Consider filter aggregate percolation rate (flood risk vs. pollutant removal) and storage capacity.
- Permeability of granular fill must be high enough for percolation rate required and to reduce risk of blockage (minimum 30% void ratio).

Structural and spatial design

- Maximum slope along direction of flow of 2% to keep velocities low; consider the use of check dams if steeper.
- Maximum groundwater level at least 1m below base.
- Typically 1-2 m depth.
- Minimum 0.5 m depth of filter aggregate between inflow and outfall for pollutant removal.

Landscape and biodiversity

- Can plant some species on top of a filter drain if it does not significantly impact hydraulic performance, e.g. grass in a fast draining soil matrix to replace the surface aggregate.

General design

- Try to avoid placing on sites with significant slopes, unless placed parallel to contours.
- Avoid direct discharge of polluted water into filter drains to avoid clogging – often a vegetated filter strip of minimum 1 m width can provide some pre-treatment.
- Typical geotextile properties given in Table 6.2
- Perforated pipes greater than 10m long should incorporate access sumps/catch pits for cleaning. These should be at changes in direction and gradient, typically no more than 60 m apart.
- Ground investigation required to check permeability, stability and groundwater flood risk. Infiltration should be permitted where possible, even if permeability is low.
- Generally used where no other SuDS features are appropriate.
- Designs for infiltration to meet criteria set out in the EA's Groundwater Protection Position Statements [14].

Construction, operation and maintenance

- Protect open trenches before completion and before upstream areas stabilised.
- No vehicles on filter drain to prevent compaction.
- If access sumps needed, these should be accessible and identifiable.
- Access needed for maintenance and inspection e.g. litter removal, pipe jetting.
- Refer to The SuDS Manual Table 16.1 for maintenance requirements.

Case Study Met Office Headquarters, Exeter

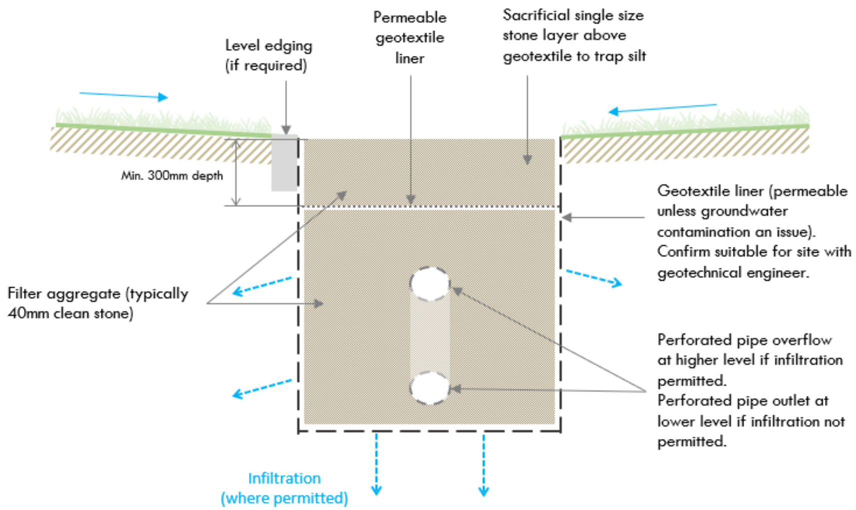
This landmark headquarters building was built on a 3Ha site.

The site and building are drained by an extensive site wide SuDS network, employing the management train extensively. Permeable block paved car parks, filter strips and drains to several ponds.

As the photograph shows, the filter drains take runoff from adjacent hard surfaces and steep grass slopes, conveying the water downstream to the ponds.

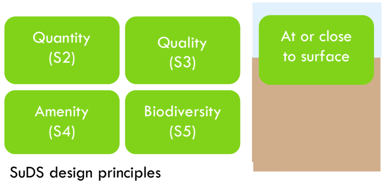
Typical detail

Filter drain



6.10 Swales

Swales are shallow vegetated channels which provide treatment, attenuation and can infiltrate. Swales can be used for source control and/or conveyance.
They are generally used to drain roads and car parks but can be used to convey flows close to ground level from source to the next SuDS feature.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Only use impermeable liners where groundwater contamination or flooding is an issue.
- Design according to The SuDS Manual (C753) Chapter 17.
- Minimise velocities for safety and to minimise erosion (soil dependent). Velocities of < 0.6 m/s to maximise sedimentation for treatment.
- Ideally runoff should enter laterally (i.e. along the edge) not at a single point. Where point discharges are required, design to prevent erosion.

Structural and spatial design

- Base width generally 0.5-2 m. If wider than 2 m, a flow spreader is needed. Narrower is acceptable to maintain a suitable bank gradient.
- Longitudinal slope 0.5-10 %. Check dams required if steeper than 3 %.
- Length of any swale section between culverts is typically greater than 5 m for maintenance access.
- Minimum 150 mm freeboard.
- Maximum side slope of 1 in 3 for safe maintenance access and stable vegetation; 1 in 4 preferred.
- Normal maximum depth 400-600 mm.
- Maximum groundwater level at least 1m below base of swale if infiltration is proposed.

Landscape and biodiversity

- Native planting best for durable cover and appropriate habitat.
- Vegetation should be able to cope with waterlogged and drought periods.
- Avoid fertilisers to reduce nutrient load on receiving environment.
- Can be used to increase connectivity between green space where possible.
- Provide a suitable depth of growing medium (e.g. topsoil) to support the planting.

General design

- Pre-treatment recommended to reduce pollutant load and maintenance.
- Ground investigation required to check permeability, stability and groundwater flood risk. Infiltration should be permitted where possible, even if permeability is low.
- Do not locate in overshadowed area since grass growth needed.

Construction, operation and maintenance

- Temporary soil reinforcement required whilst vegetation establishes to prevent erosion, e.g. biodegradable erosion protection blanket. Consider potential for large sediment loads.
- Vegetation maintained at 75-150 mm across treatment surface.
- Plant vegetation when successful growth without irrigation most likely (ideally November – March; avoid summer).
- No vehicles close to swale to avoid compaction.
- Refer to The SuDS Manual Table 17.1 for maintenance requirements.

Adoption

- A key matter for adoption of swales will be the provision of access for maintenance.

Case Study What not to do!

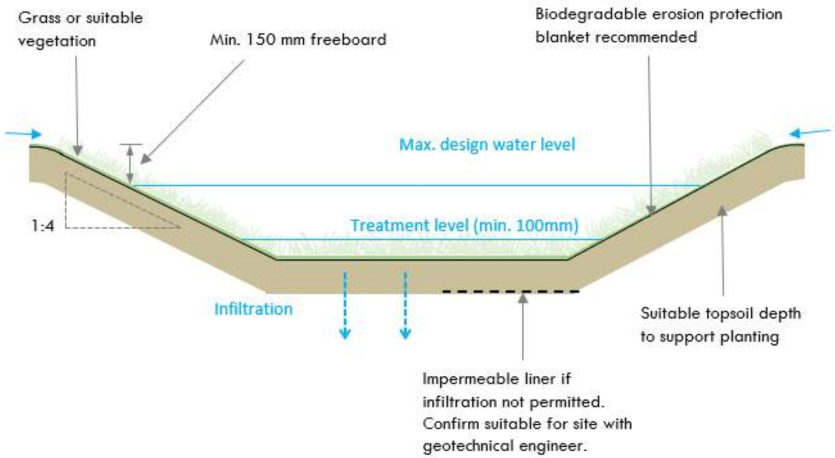
Consideration must be given to how the swales vegetation will be expected to establish without failing.

Care to be taken when using turf, as shown here, as poorly considered or constructed turf can lead to the turf strips peeling back and dying. Pegging of the strips and good irrigation during initial weeks is needed to prevent this.

Consider sowing seed onto the slopes with a biodegradable erosion protection blanket pinned on top. This provides erosion resistance in the short term but allows the vegetation to grow through as it establishes.

Typical detail

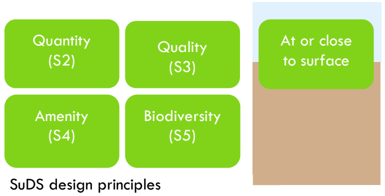
Conveyance/attenuation swale



6.11 Bioretention systems

Bioretention systems are shallow, planted depressions that temporarily collect and treat runoff and often allow infiltration. They include rain gardens and enhanced tree pits. They can make use of traditionally hard paved space, grass verges or unused public realm areas, for example traffic calming islands.

They consist of vegetation in an engineered soil mix overlying a high voids storage layer (e.g. coarse graded aggregate or geocellular storage).



SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Only use impermeable liners where groundwater contamination or flooding is an issue.
- Design according to The SuDS Manual (C753) Chapter 18.
- Provide sufficient area to store the Water Quality Treatment Volume, where possible.
- Maximum depth of standing water on surface of planter 150 mm during critical storm event.
- Maximum inlet inflow velocity 0.5 m/s to prevent significant erosion (1.5 m/s for the 1 in 100 year event).
- Emergency or high level overflow points should be included in the system to manage exceedance events, where required.
- The ratio of catchment to bioretention area is a key factor in the performance of the bioretention in providing attenuation.

Landscape and biodiversity

- Provide sufficient soil depth to enable planting to establish (at least 500mm but greater than 1m if using trees).
- Soil medium should be specified to be sufficiently free draining to prevent the soils hindering hydraulic performance.
- Plants must be suited to both dry and periodic wet conditions with extensive root systems best for treatment. Ideally low maintenance plants. See section 7 for more information.
- Plant species to enhance local area aesthetics and biodiversity, using native plants wherever possible. Ornamental species may be appropriate in urban areas.
- Planting can vary in size from small vegetation to trees.

General design

- Silt management needs to be considered to help prevent clogging of the soils and build-up of the surface soil levels. Design consideration can make the task easier.
- Careful design of inlets is required to prevent erosion and enable spread of flow across surface. Additional erosion protection may be required.
- Maximum groundwater level must be at least 1m below base of unlined systems. If a liner is used, it must be no higher than the base without consideration of floatation risk.
- Where there is a high risk of ground contamination, sealed systems (using an impermeable liner) may be used whilst still providing the system with water treatment and storage benefits.
- Buried service protection should be considered for any that have to cross beneath, e.g. street lighting, a recommendation is provision of protected 'service corridors' into the design.
- Engineered filter medium soils can be purchased readymade through bioretention system manufacturers.

Construction, operation and maintenance

- Refer to The SuDS Manual Table 18.3 for maintenance requirements.
- Avoid vehicular compaction of infiltrating soils.

Case Study Grey to Green, Sheffield

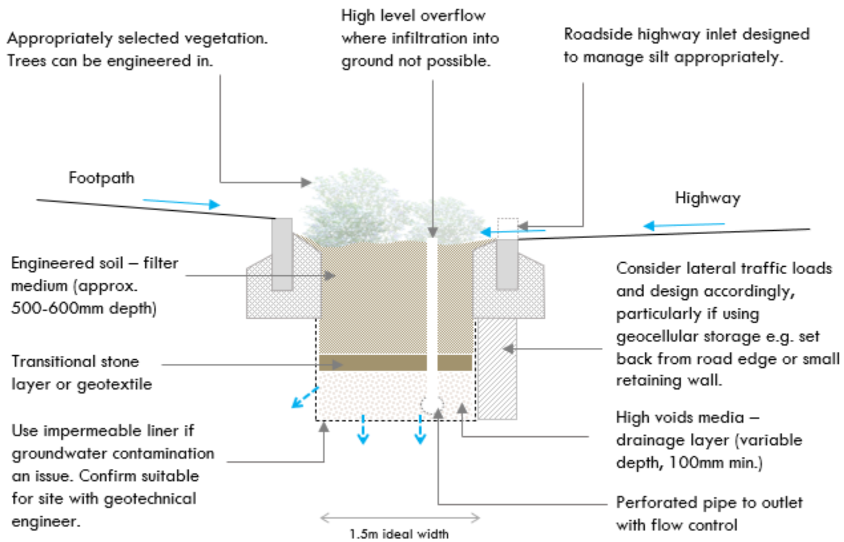
The Grey to Green bioretention rain gardens were installed in 2016 along a 250 m long corridor in the city centre before draining back to the river.

The choice of plants was carefully chosen to cope with the conditions, provide year round interest and minimise maintenance. The topsoil was specified to minimise weed growth whilst being suitably fast draining.

Plant maintenance of the rain gardens involves one major cutting back in February and weeding every three to four weeks throughout the spring and summer growing period.

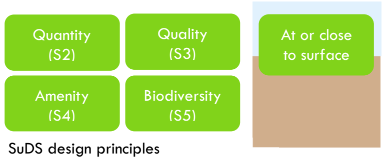
Typical detail

Bioretention system



6.12 Trees and tree pits

Trees can be incorporated into SuDS features such as bioretention, infiltration basins and swales. They increase interception and infiltration to reduce runoff volumes and can add biodiversity and amenity value.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- Refer to Bioretention systems section above for main related items.
- Linked tree systems can provide better runoff management than single trees.

Landscape and biodiversity

- Design according to BS 8545:2014 [15]; TDAG (2014) [16]; The Urban Tree Manual [17].
- Consult with a landscape architect to select trees appropriate to the site conditions and biodiversity.
- Consider space, soil properties, rooting volume, gas exchange and water supply requirements of the tree.
- Maximise the rooting environment. Beneath paved surfaces, use load-bearing systems to avoid soil compaction around roots e.g. structural growing media, modular structures, raft systems, tree planters.
- Soil volume required depends on tree size and species. Consultation with local guidance and a landscape architect is required. Typical requirement for a medium sized UK tree in an urban setting is approximately minimum 12 m^3.
- Aeration pipes should be included to ensure sufficient aeration of the soil.
- Refer to Bioretention systems section above for other items.

Root cells

- Root cell systems are often recommended as they can help provide sufficient soil volume and ensure soil does not become too compacted from applied loading (e.g. traffic loads). Compaction prevents sufficient aeration of the soil.
- Root cells do not have to be used if soil volume is sufficient <u>and</u> the soil is not likely to become compacted. If it is not possible to include root cells, smaller tree species can be specified which require less soil volume.
- Design and install root cells according to manufacturer specification.

General design

- Irrigation pipes should be included to allow irrigation if required in times of drought, to avoid damage or death of the tree.
- Soil surface profile and overflow levels to ensure no ponding of water within the highway.
- Engineered filter medium soils can be purchased readymade through tree pit system manufacturers.
- Refer to Bioretention systems section above for main items.

Buried services

- Buried services (e.g. water; electric) should be coordinated/surveyed as tree pits often require use of ground volume extending under the highway/footpath where services are planned/exist.
- Root cells can allow buried services to run through them to avoid clashes. This must be negotiated with the utilities provider.
  If clashes with existing services are encountered, tree size and soil volume required can be reduced.

Construction, operation and maintenance

- Avoid vehicular compaction of infiltrating soils.
- Maintenance requirements can be reduced:
  - through selection of tree species e.g. reduced pruning; evergreens with no leaves dropped or species with light and thin leaves for reduced blockage risk.
  - tree location should be considered, in particular location of dropped leaves to reduce maintenance.
  - by using an anchoring system instead of stakes and ties. This uses wires attached from the trunk to the root bowl and anchored down below. Stakes and ties will require tightening and removal.
- Refer to The SuDS Manual Table 19.3 for maintenance requirements.

Case Study Greener Grangetown

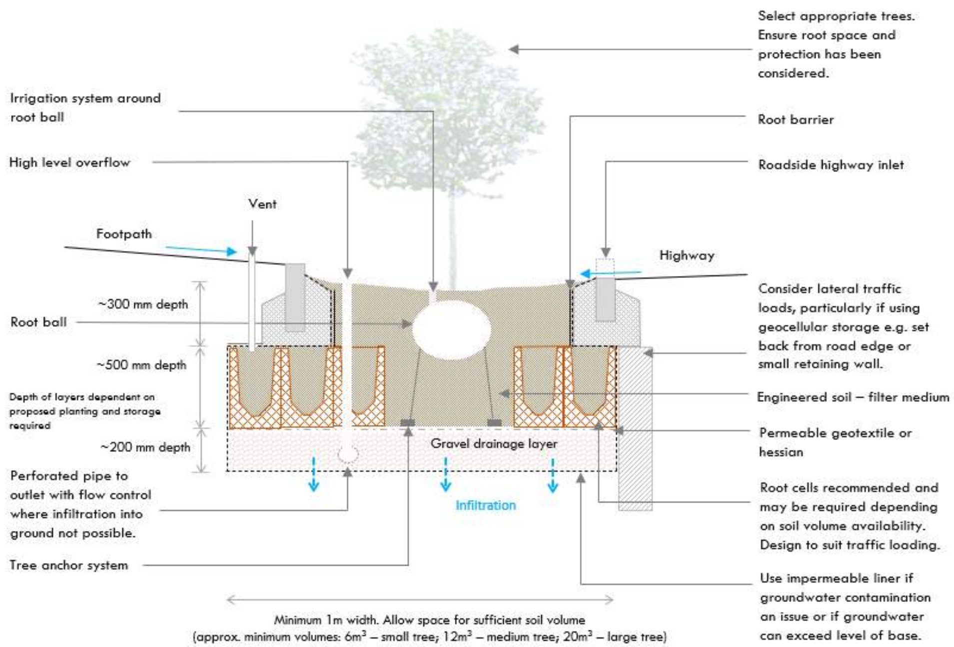
Greener Grangetown is a retrofit SuDS project in Cardiff.

A mixture of 107 tree pits with root cells (righthand image) and rain gardens were used to intercept runoff from the residential streets.

Due to the nature of the made ground and high water table the tree pits included an impermeable liner.

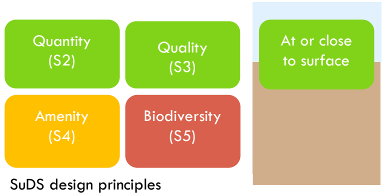
Typical detail

Tree pit



6.13 Pervious surfaces

Pervious surfaces are hardstanding areas which allow infiltration through the surface. The runoff can then either be routed to another system or stored and infiltrated to the underlying soil. They can be classified into 3 systems A, B and C based on the amount of infiltration allowed. The pervious surface is generally either made of permeable block paving or porous asphalt.



SuDS design principles
(with reference to specific standards)

System Type

- Select appropriate system type based on site conditions, as described in BS 7533-13 [18].
  - **System A** – total infiltration into ground
  - **System B** – partial infiltration, where the ground is not very permeable.
  - **System C** – no infiltration, lined and piped
- If possible, design as an unlined system (A or B) to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2).
- Only use impermeable liners where groundwater contamination or flooding is an issue.
- Design according to The SuDS Manual (C753) Chapter 20.

Hydraulic design

- Design subsurface storage volume to allow required infiltration and/or discharge.
- Consideration of the impact of the future traffic loading on the design ground infiltration rates.
- Consider the limitations on surface infiltration rate due to clogging and geotextile membrane and soil infiltration rates. Design surface infiltration rates are generally much larger than design rainfall intensities.
- Maximum design water depth must remain below top of subbase.
- Consider exceedance flow routes if pavement becomes fully saturated.
- Where possible lay the base of the paving system flat to maximise storage. If installed on a sloping site, baffles should be considered to slow flows within the pavement structure and maximise infiltration.

Structural and spatial design

- Design to withstand proposed traffic loads.

General design

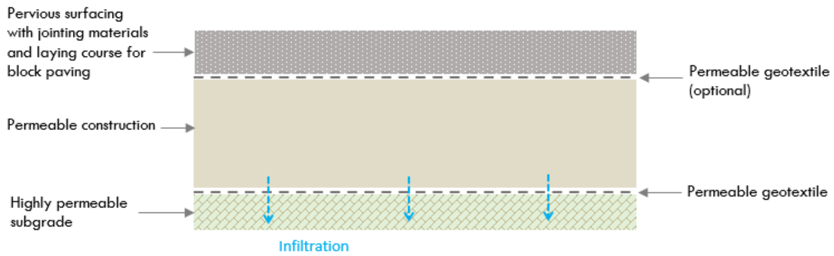
- The SAB require details of full pavement construction to be submitted as drawings in the SAB application including type of system (A, B or C), any products and material specification.
- At the time of writing, Welsh Water do not permit pervious pavements to be built over their sewers or the easement either side of their pipes, including lateral connections that are public. Contacting Welsh Water may enable a bespoke build-over agreement that could, for example, reduce the easement widths on one side.
- Buried services consideration should be demonstrated particularly for future excavation access requirements. The use of "service corridors" is recommended by SuDS for Roads guide for Scotland [19], along with keeping the majority of buried services within footways paved with conventional surfacing for easy replacement in future.
- Maximum groundwater level must be at least 1m below base for unlined systems (A and B). If a liner is used (C), it must be no higher than the base without consideration of floatation risk.
- Systems B and C – provide sufficient outflow piping, using appropriate geotextiles minimise the risk of fines migrating.
- The use of geotextiles can help achieve water treatment requirements.

Construction, operation and maintenance

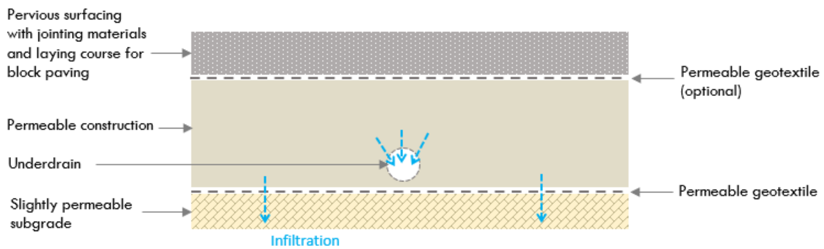
- Regular sweeping and vacuuming required.
- Refer to The SuDS Manual Table 20.15 for maintenance requirements.

Typical details – Systems A, B and C

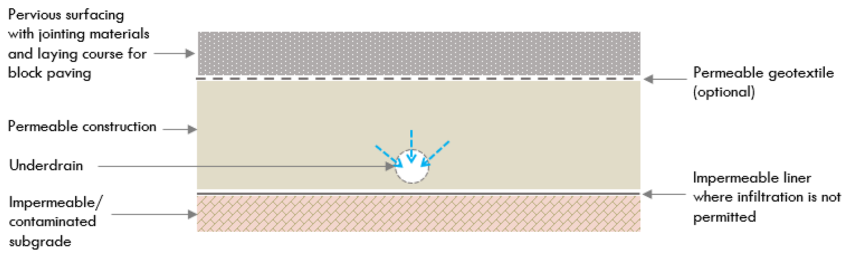
System A (total infiltration)



System B (partial infiltration)



System C (no infiltration)



Permeable block paving

Permeable block paving is a surfacing which allows infiltration of water through the gaps at the edge of each paving block, usually filled with free draining grit or similar. These pavements can be designed to allow infiltration into the underlying ground or can be lined and runoff piped back to a sewer, thus conveying and attenuating storm flows.

General design

- Design in accordance with BS 7533-13 [18]; Interpave – Design and construction of concrete block permeable pavements 7th Edition [20]; The SuDS Manual (C753).

Performance

- The Interpave permeable pavement guide [20] provides information on the design, construction, and maintenance of a permeable block pavement. section 7.1.1 – Hydraulic design factors states that the amount of water that can pass through a block permeable pavement is dependent on the infiltration rates of joint filling, laying course, and sub-base materials, and that a newly laid block paving can be expected to have a typical percolation rate of 4,000 mm/hour.
- Pavement percolation rate is expected to decrease over the life of the pavement and to stabilise at a lower rate which should be factored into the design percolation rate used. German and American guidance suggests that a design percolation rate of 10 percent of the initial rate should be used to account for this reduction with age.

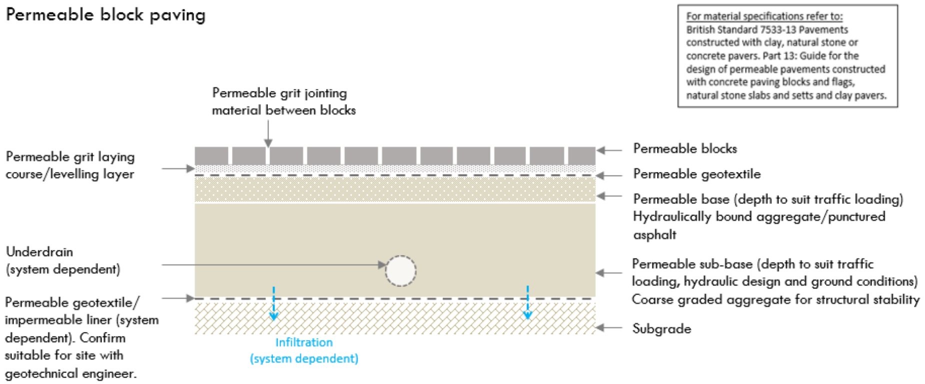
Construction

- Block permeable paving will not perform as designed if quality control is not enforced during construction. CIRIA C698 [21] and CIRIA C768 [22] outline construction issues associated with SuDS and construction planning to avoid these issues.

Maintenance

- Interpave outlines guidance on maintenance of block permeable paving. The document 572/1560 [23] lists the current routine maintenance regimes recommended by the association. The regime consists of annual brushing of the surface, visual inspections, winter de-icing as per a standard road, and spot treatment for weed control.

Permeable block paving



Porous Asphalt

Porous asphalt is made with an aggregate mix which omits fine aggregates. As a result, the remaining aggregate particles leave voids in the structure of the asphalt and allow water to flow through the pavement. This asphalt overlies a subsurface gravel layer, allowing either attenuation (in a sealed system with an outlet to the stormwater network) or infiltration of the runoff into the surrounding soil.

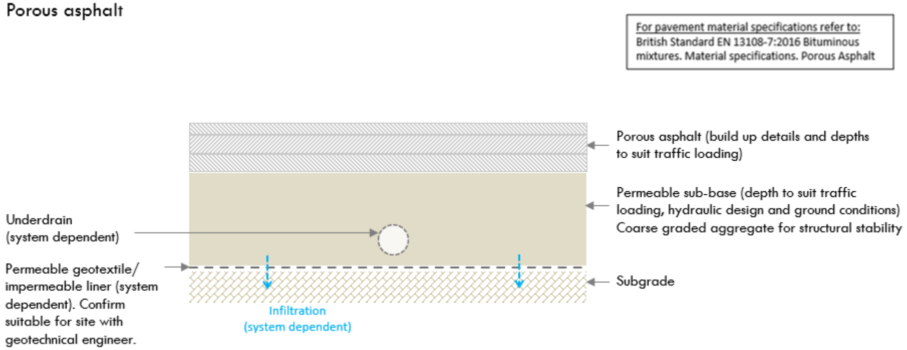
General design

- Design in accordance with BS EN 13108-7:2016 [24]; DMRB Design for pavement maintenance [25]; The SuDS Manual (C753).

Maintenance and operation

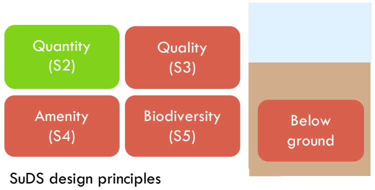
- Porous asphalt can be cleaned and partially unclogged using water jetting followed by brushing and suction to remove the silt-laden water. The optimal water pressure was found to be about 35 MPa [26].
- While trials showed that cleaning can improve the hydraulic conductivity, it still deteriorated to less than a quarter of its initial value. The CIRIA SuDS Manual suggests that despite the reduction over time, the available evidence indicates that even the long-term reduced rate is sufficient to handle any rainfall intensities likely to occur in the UK.
- De-icing of porous asphalt must be handled differently to traditional asphalt. Grit is not recommended as it can block the pores over time. The use of de-icing salts must consider where the dissolved salt will infiltrate to. Local approval should be sought if required to ensure dissolved salts will not pollute the groundwater.

Porous asphalt



6.14 Attenuation storage tanks

Attenuation tanks are structures which provide storage below ground in voids used in conjunction with flow control devices to attenuate peak flows. They can infiltrate water into the ground. They do not generally treat the water, hence need upstream treatment features to capture pollutants.
Geocellular units are prefabricated plastic crates with very high void ratios. Alternatives include buried storage tanks or oversized pipes.
They are not preferred by the WG Standards so should only be used when no alternative can be demonstrated.



SuDS design principles
(with reference to specific standards)

Hydraulic design

- Design as an unlined system to permit some infiltration to occur even if ground is not very permeable. Even little infiltration is beneficial and can help achieve assumed compliance with interception criteria (S2). Only use impermeable liners where groundwater contamination or flooding is an issue.
- Design according to The SuDS Manual (C753) Chapter 21.
- Provide sufficient volume to store water for design event specified.
- Comply with site-specific infiltration and discharge requirements.
- Consider exceedance events and include with overflow points, if required.

Structural and spatial design

- Design according to CIRIA C737 Structural and geotechnical design of modular geocellular drainage systems [27].
- Design to proposed loads e.g. traffic. Vertical and particularly lateral loading must be approved by SAB.
- Geocellular units are usually manufactured from polymers (e.g. plastic). The use of recycled polymers may not be appropriate when the geocellular units are proposed to receive some form of vehicular or other significant structural loading. If in doubt, the developer should provide confirmation from the manufacturer that the proposed units are fit for purpose.

General design

- Design and install according manufacturer's instructions.
- Geocellular tanks should preferably be sited under non-trafficked areas but can be installed under roads with careful loading consideration.
- Maximum groundwater level must be no higher than the base without consideration of floatation risk. If infiltrating then it must be at least 1 m below base.
- Siltation can reduce effectiveness and volume. Design pre-treatment to remove silts and/or other pollutants, e.g. silt traps.
- Use an impermeable geotextile membrane where there is a high risk of groundwater contamination or flooding and infiltration is not permitted.
- Design to consider the likelihood of future buried utilities to prevent utility companies damaging the units, e.g. provision of extra ducts/space.

Landscape and biodiversity

- Incorporate tree pits where possible with appropriate tree species (refer to section 6.12 of this guide).

Construction, operation and maintenance

- Sufficient access points are required for inspection and maintenance, particularly to allow future jetting. Access points to be provided over significant incoming and outgoing pipes.
- Regular inspection required of all parts (e.g. silt traps, manholes, pre-treatment devices, pipework).
- Refer to The SuDS Manual Table 21.3 for maintenance requirements (e.g. silt and debris removal).

Case Study Castell Alyn High School, Hope

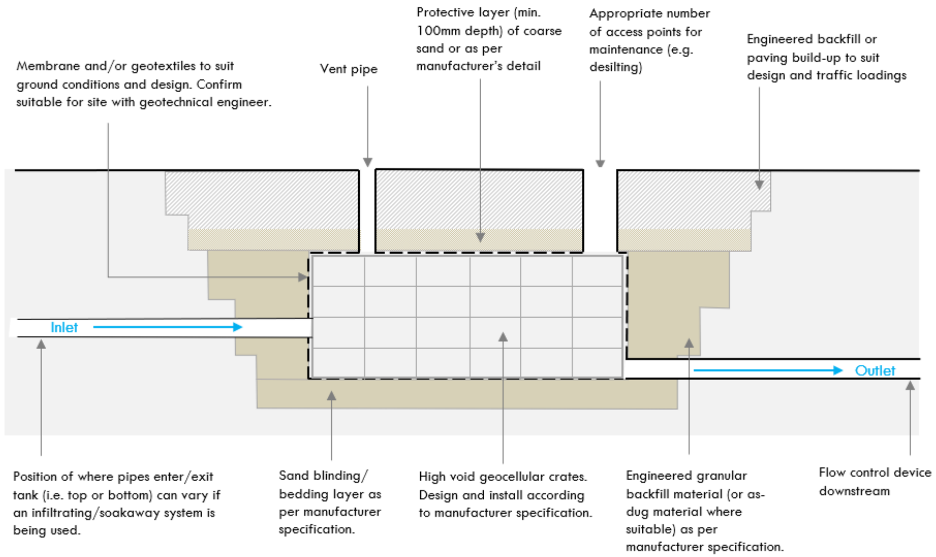
This development involving an extension to the main school building and creation of additional staff parking. It used geocellular crates as storage tanks to provide attenuation volume for the surface water generated by both the new and some of the existing development.

The lefthand image shows the crates covered with the geotextile and the protective layer prior to backfilling. The righthand image is during the crates being placed.

Image: Flintshire County Council

Typical detail

Geocellular storage in storage & attenuation mode



6.15 Ponds and wetlands

Ponds are landscaped depressions with a permanent pool of water. Wetlands are ponds with a larger proportion of shallow zones. Ponds and wetlands attenuate and treat surface water runoff with potential for significant biodiversity and amenity value. For maximum quality benefit they should be made up of a series of smaller connected components (ponds). They are normally located at the end of a site's drainage network.

Quantity (S2) | Quality (S3) | Amenity (S4) | Biodiversity (S5) | At or close to surface

SuDS design principles
(with reference to specific standards)

Hydraulic design

- This feature can be assumed compliant with the S2 interception criteria subject to the conditions described in Table G2.1 of the WG Standards.
- Design according to The SuDS Manual (C753) Chapter 23.
- Do not locate in a flood plain if aim is to reduce flood risk.
- Permanent pool must have sufficient volume for treatment of runoff.
- Typical maximum depth of permanent pool of 1.2 m (can be increased up to 2 m if safety risk acceptable).
- Include multiple zones for effective treatment e.g. sediment forebay, permanent pool, storage volume, aquatic bench.
- For long term water health include some depths of at least 1m.
- Include an aquatic bench with maximum depth of 0.4 m below permanent water level.
- Temporary offline storage may be required for attenuation in large events.
- A high level overflow is recommended.

Structural and spatial design

- Maximum side slope gradient of 1 in 3 for safe maintenance access and stable vegetation; 1 in 4 preferred.
- Minimum length to width ratio 3:1 and preferably 4:1 or 5:1 to prevent hydraulic short-circuiting.
- Avoid corners to avoid creating dead zones.

Landscape and biodiversity

- Plant species appropriate to wetland conditions, particularly on aquatic bench.
- Design to maximise public amenity and habitat creation.
- Areas of less heavy planting needed to allow wildlife access.
- Mimic natural forms in natural setting. More linear design may be suitable in a more urban setting.
- Consider recirculation systems if aesthetic water quality is important (e.g. a feature lake).

General design

- Ground investigation required to check underlying soil is adequately impermeable to maintain permanent pool water level. If it is not, a suitable impermeable geotextile membrane or a clay layer can be used. Ground stability should also be checked.
- Use a suitable impermeable geotextile membrane where there is a high risk of groundwater contamination.
- Pre-treatment required. Recommended pre-treatment includes a sediment forebay.
- Maximum groundwater level must be below temporary detention zone.
- Outfall must be operational at the maximum groundwater level.

Construction, operation and maintenance

- Carefully assess the risk of open water to public, particularly children. A vegetated aquatic bench, safety bench and side slopes can help mitigate risk to children.
- Regular inspection and maintenance required e.g. litter removal, inlet and outlet cleaning, sediment removal, vegetation control.
- Refer to The SuDS Manual Table 23.1 for maintenance requirements.

Case Study St David's Park, Ewloe

This large pond is used for surface water management at this business park in North Wales.

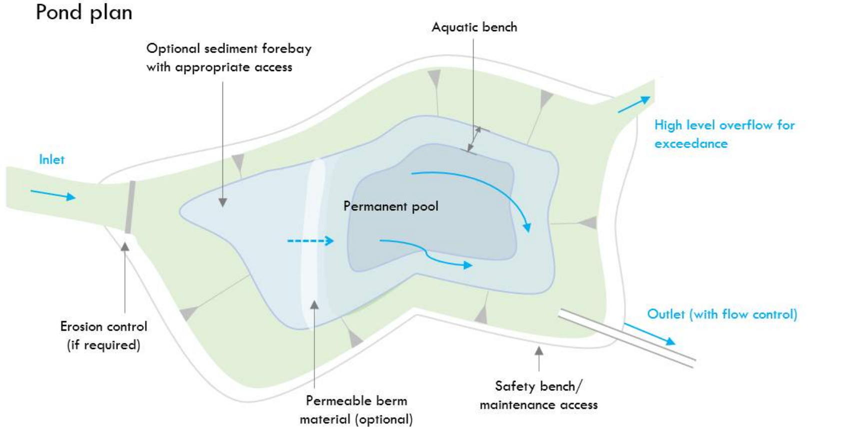
It was built in the 1990s at the same time as the business park to attenuate flow and is now well established.

It provides surface water management of quantity and quality, increased biodiversity benefits and amenity for locals and employees at the park.

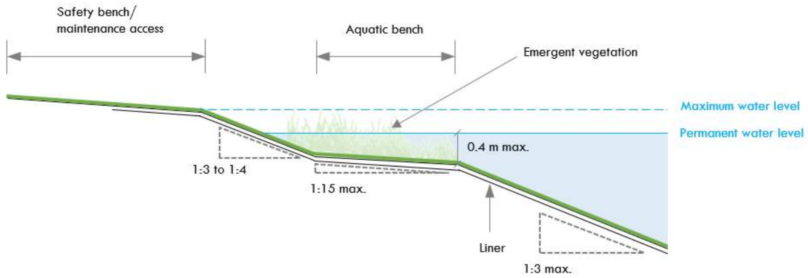
Image: Flintshire County Council

Typical details

Pond plan



Pond edge detail



Contents

SECTION 7

LANDSCAPE, PLANTING AND ECOLOGY

Heslington East campus, University of York, YO10 5DD © Giles Rocholl

7.1 Why landscape must be considered

SuDS features should be designed to respond to both the hydraulic needs and local context of a site. Collaboration between developers, engineers and landscape architects is therefore essential. Consideration of landscape, planting and ecology is required for the reasons listed below and expanded upon in the following text.

- It is a requirement of the WG Standards under S4 (amenity) and S5 (biodiversity)
- Effective landscape, planting and ecology design can help achieve the remaining WG Standards, as described below.

WG Standards favour SuDS features that use landscape, planting and ecology at ground level.

Hydraulic control (S2) – Effective planting can increase water uptake from roots and increase interception. Landscaping and use of vegetation can increase flow paths and slow flows.

Water quality (S3) – Effective landscaping and use of vegetation can increase sedimentation and filtration of pollutants.

Amenity (S4) – Effective landscaping and planting will add placemaking and health and wellbeing benefits to the users. This improved amenity can also increase property value.

Biodiversity (S5) – Any increase in biodiversity is beneficial. The greatest benefits come from wet systems and are particularly valuable when designed to add to or improve the value of existing habitats around the proposed development. This should not discourage developers from embedding biodiversity in small scale SuDS schemes or in more urban, high-density developments, as local benefits can be achieved from all scales if designed well. Planting of any type (native or ornamental species) as part of a SuDS feature will provide opportunities for wildlife (for example as sources of pollen and nectar for insects).

Operation and maintenance (S6) – Poorly selected plants are more likely to die which increases risk of clogging, ineffective operation and increased maintenance.

7.2 When to consider it

It is important to review the site before designing SuDS. This allows landscape, planting and ecology benefits and/or constraints which should be incorporated into the design to be identified. Consultation with a landscape architect at the start of and throughout the design process is strongly advised to maximise planting opportunities and creation of habitats, increasing biodiversity. The landscape and engineering aspects of the design can therefore be developed together, maximising placemaking and biodiversity opportunities.

The process should also be linked to other schemes, guidance or policies regarding biodiversity opportunities within, but not exclusive to, North Wales including:

- Flintshire SPGN No 8 Nature Conservation and Development [28]
- Wales Biodiversity Partnership [29]
- Local Nature Partnership (North East Wales Biodiversity Network)
- Flintshire County Council Guidance note on Invasive Non-native Species [30]
- Biodiversity and Ecosystem Resilience Duty Delivery Plan [31]

7.3 Integrated landscape design

The most efficient SuDS designs can be achieved when drainage is incorporated into the landscape, and vice versa. The use of a landscape architect can enhance a development and provide expertise to maximise all available benefits for the development including the drainage system hydraulics, water treatment, amenity and biodiversity.

Drawings

Landscape masterplans should incorporate SuDS features so that the landscape can be viewed holistically. This also encourages landscape architects and engineers to work together.

SuDS which incorporate planting should be included in all planting condition proposals and shown on all planting plans.

Where drainage features require easements and/or specific layout arrangements these should be highlighted on planting plans.

7.4 When to plant

Collaboration with landscape architects and consideration of planting from project inception is essential to plan for appropriate planting timings of vegetation. This is important as planting at inappropriate times of year can result damage or death of the vegetation. As a result, the SuDS system will not function as designed and the WG Standards may not be achieved.

Communication with a landscape architect will be required to determine the optimum timing and conditions for planting specific vegetation. Planting season is generally from November to March since most plants at this time are dormant and are less likely to be damaged when moved. There is also less chance of drought. Some ornamental grasses may require planting in spring. Summer should be avoided for planting as there is increased risk of drought.

7.5 How to increase biodiversity value

Biodiversity (standard S5) is a key benefit that the use of appropriate SuDS features can help a development achieve. The following items can help increase biodiversity value.

1. **Avoid use of nutrient rich topsoil** – seek advice from a landscape architect on appropriate soil. This can help to:
   - Alleviate downstream algal blooms.
   - Encourage natural colonisation and reduce over-competition of species with lower biodiversity value.
   - Enable more faunal species to thrive.

2. **Allow natural colonisation.** If planting is necessary, use locally native species, referring to local flora guides (e.g. Flintshire County Council Guidance note on Invasive Non Native Species [30], Flora of Flintshire: The Flowering Plants and Ferns of a North Wales County [32]). This can help to:
   - Avoid accidental planting of invasive* species.
   - Ensure the longer-term success of the vegetation – it may take slightly longer to grow but will be more suited to the local conditions.

3. **Source plants from reputable nurseries,** which guarantee quality of the planting and that no invasive species are inadvertently present.

4. **Prioritise provision for water features which hold 500mm to 100mm of water.** The top 100mm supports the most lifeforms. This can help to:
   - Reduce pollutant retention and build up potential.
   - Increase local biodiversity.

5. **Separate surface water based on pollutant load** e.g. separate features attenuating clean rainwater and those collecting road run off (these contain hydrocarbons etc.). Note that pollution interceptors may still be required if the treatment provided by the planting is not able to sufficiently remove pollutants.

6. **Design SuDS using a treatment train** (a series of SuDS features with a range of treatment processes to incrementally improve water quality through each feature), to reduce pollution when these connect to natural systems.

7. **Use buffer strips for any adjacent areas of nutrient rich soil** (e.g. regularly fertilised grassland or planting beds) to define the nutrient rich area and allow the nutrients to be absorbed before they cause run off.

* Invasive species in this context relate to those listed on Schedule 9 Part 2, Section 14 of the Wildlife and Countryside Act 1981 (as amended). It is illegal to cause the listed plant species to spread in the wild. A further amendment to this legislation currently prevents the sale of some of these species.

8. **Try not to be restricted to formal landscape design** but rather encourage naturalistic landscape design as part of a scheme. SuDS with varied topography can be better suited for wider variety of plants and animals.

9. **Ensure drainage control features such as weirs do not present areas of entrapment** for species such as amphibians or small mammals. This should be given early consideration at the start of the design process to avoid issues later in the process when designs are less flexible. Amphibian ladders are recommended on areas of potential entrapment e.g. manholes.

10. **Provide a variety of open, lightly shaded and shaded areas.** This allows a larger variety of planting to be supported and therefore increases habitats available.

11. **Incorporate areas of dead wood into the wet areas** to provide habitat for a variety of species, particularly for dragonflies and other insect species.

12. **Develop a naturalistic landscape management and maintenance plan that encourages biodiversity.** This could encourage wildflower growth instead of low biodiversity value grasses (e.g. amenity grass).

13. **Review designs and planting at least after 1 and 2 years of planting.** This enables:
    - Identification of the introduction of any invasive species. This allows plans to be made for their control/management.
    - Habitat edges and management plans to be altered to maximise biodiversity value.
    - Assessment of how the SuDS are performing relative to the predicted benefits.

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7.6 Planting species

The lists below suggest species which are likely to be suitable for SuDS schemes in North Wales. However, the list is not exhaustive and discussion with a landscape architect is important since the specific vegetation selected will depend on individual site conditions (e.g. light availability; microclimate; soil properties; existing local habitats). The plants listed here provide biodiversity benefits with little need for regular maintenance, so are well suited for use in SuDS.

Plants and seeds should be locally sourced where possible. As a minimum, they should be of UK origin and grown in the UK. It is worth noting that some plants require early discussion with the supplying nursery to understand which seasons they can be supplied in, to help manage lead in times.

Aquatics

Submerged and floating plants, e.g. ponds. Plant with weights or weighted down in a permanently wet zone.

- *Potamogeton pectinatus* (Fennel Pondweed)
- *Potamogeton natans* (Broad-leaved Pondweed)
- *Myriophyllum spicatum* (Spiked Water-milfoil)
- *Sparganium emersum* (Unbranched Bur-reed)
- *Ceratophyllum demersum* (Hornwort)
- *Hippuris vulgaris* (Mare's-tail)
- *Potamogeton crispus* (Curled Pondweed)
- *Iris pseudacorus*
- Carex otrubae

Dry zone

Plant on upper slopes and bank top as seed.

- *Festuca rubra* (Red Fescue)
- *Anthoxanthum odoratum* (Sweet Vernal-grass)
- *Cynosurus cristatus* (Crested Dog's-tail)
- *Briza media* (Quaking-grass) – prefers calcareous conditions
- *Deschampsia cespitosa* (Tufted Hair-grass)
- *Prunella vulgaris* (Selfheal)
- *Rhinanthus minor* (Yellow-rattle)
- *Filipendula ulmaria* (Meadowsweet)
- *Lathyrus pratensis* (Meadow Vetchling)
- *Lotus corniculatus* (Common Bird's-foot-trefoil)
- *Centaurea nigra* (Common Knapweed)
- *Plantago lanceolata* (Ribwort Plantain)
- *Potentilla anserina* (Silverweed)
- *Rumex acetosa* (Common Sorrel)
- *Knautia pratensis* (Field Scabious)
- *Leucanthemum vulgare* (Oxeye Daisy)
- *Stipa tenuifolia*
- *Carex buchanii*

Damp zone

Inundation-tolerant. Plant up to 250 mm above anticipated normal water level as plugs in groups of 5-10N° plants to create stands. E.g. sides of pond above normal water level.

- *Caltha palustris* (Marsh-marigold)
- Acorus gramineus 'Variegatus'
- Deschampia cespitosa
- *Veronica beccabunga* (Brooklime)
- *Angelica sylvestris* (Wild Angelica)
- *Lythrum salicaria* (Purple-loosestrife)
- *Lotus pedunculatus* (Greater Bird's-foot-trefoil)
- *Lycopus europaeus* (Gypsywort)
- *Myosotis scorpioides* (Water Forget-me-not)
- *Nasturtium officinale* agg. (Water-cress)
- *Berula erecta* (Lesser Water-parsnip)
- *Lychnis flos-cuculi* (Ragged-Robin)
- *Mentha aquatica* (Water Mint)
- *Cardamine pratensis* (Cuckooflower)
- *Ranunculus flammula* (Lesser Spearwort)
- *Juncus articulatus* (jointed Rush)
- *Stachys palustris* (Marsh Woundwort)
- *Scrophularia auriculata* (Water Figwort)
- Juncus effuses
- Juncus inflexus
- Luzula sylvatica
- Luzula nivea
- Allium ursinum
- Lythrum salicaria

Wet zone

Emergent vegetation. Plant in 0-250 mm of water as plugs to create stands in groups of 5-10N°. E.g. lowest point of detention basin

- *Potamogeton pectinatus* (Fennel Pondweed)
- *Potamogeton natans* (Broad-leaved Pondweed)
- *Myriophyllum spicatum* (Spiked Water-milfoil)
- *Sparganium emersum* (Unbranched Burreed)
- *Ceratophyllum demersum* (Hornwort)
- *Hippuris vulgaris* (Mare's-tail)
- *Potamogeton crispus* (Curled Pondweed)
- *Equisetum japonicum*
- *Miscanthus sinensis*
- Glyceria maxima 'Variegata'
- Crocosmia x crocosmiiflora

Unsuitable or invasive species

The following plants are deemed to be unsuitable for SuDS or are classified as invasive species (*) and should not be used.

To be avoided in all developments.

- *Phragmites australis* (Common Reed) – NB: This is suitable for large-scale schemes or designated filtration beds.
- *Cirsium vulgare* (Spear thistle)
- *Cirsium arvense* (Creeping thistle)
- Rumex obtusifolius (Broad leafed dock)
- Rumex crispus (Curled Dock)
- Sensecio jacobae (Common Ragwort)
- *Typha latifolia* (Bulrush / Greater Reedmace)
- *Persicaria amphibia* (Amphibious Bistort)
- *Apium nodiflorum* (Fool's-water-cress)
- *Sparganium erectum* (Branched Bur-reed)
- *Glyceria fluitans* (Floating Sweet-grass)
- *Glyceria maxima* (Reed Sweet-grass)
- *Phalaris arundinacea* (Reed Canary-grass)
- *Impatiens glandulifera* (Himalayan Balsam)*
- *Azola filiculoides* (Water Fern)*
- *Crassula helmsii* (New Zealand Pigmyweed / Australian Swamp Stonecrop)*
- *Myriophyllum aquaticum* (Parrot's-feather)*
- *Hydrocotyle ranunculoides* (Floating Pennywort)*
- *Ludwigia peploides* (Creeping Water Primrose)*
- *Lysichiton americanus* (American Skunkcabbage)
- *Lagarosiphon major* (Curly Waterweed)*
- *Mimulus guttatus* (Monkeyflower)
- *Elodea canadensis* (Canadian Waterweed)*
- *Elodea nuttallii* (Nuttall's Waterweed)*

Swale, West Gorton Park, Manchester, M12 5BE

Contents

SECTION 8

OPERATION AND MAINTENANCE

8.1 Introduction

Without question, all infrastructure requires some form of maintenance over the lifetime of the development. Effective design for operation and maintenance is a statutory requirement as specified in S6 of the WG Standards and contributes to longer lasting infrastructure with cheaper whole life costs. The developer and/or designer are critical to ensuring SuDS features are designed in a way to minimise maintenance as far as is practicable and in a safe manner.

Effective design for operation and maintenance is a statutory requirement as specified in S6 of the standards.

8.2 CDM 2015 requirements

The Construction (Design and Management) Regulations 2015 (CDM 2015) [5] places responsibilities on the designer to consider the design from the perspective of cleaning, maintenance, and demolition, as well as its initial construction. This extends to the information provided with the designs, "*A designer must take all reasonable steps to provide, with the design, sufficient information about the design, construction or maintenance of the structure [component], to adequately assist the client, other designers and contractors to comply with their duties under these Regulations.*"[2]

[2] Managing health and safety in construction, Construction (Design and Management) Regulations 2015 Guidance on Regulations. Regulation 9, Page 26

8.3 SAB application requirements

Details of the long-term maintenance regime and arrangements for the lifetime of the proposed development must be provided in a 'Maintenance Plan' to comply with Standard S6 to enable full SAB approval to be granted.

Maintenance Plan

The plan to be provided in the SAB application should be in a format which can be easily understood by the future owners who will be responsible for arranging and/or undertaking the maintenance.

Appendix F provides a pro forma which the developer may use for the application.

For the NWFRMG the Maintenance Plan must:

- Provide/incorporate a **simplified site drainage layout plan** drawing clearly identifying the locations of all the SuDS features and drainage components.
- **List each type of SuDS feature or drainage component separately**.
- For each type of SuDS feature and/or drainage component, **itemise the inspection or maintenance tasks** to be undertaken, and the frequency at which they are to be performed over the lifetime of the development. Notes this must include remedial works where the SuDS feature or drainage component, or elements of it, have a design life less than the lifetime of the proposed development.
- **Provide details of the practicalities of access** for appropriate personnel, plant and machinery is achieved for each type of SuDS feature or drainage component, where not immediately obvious. Particularly provide details where safety could be an issue. For example, how access to a silt trap is designed.
- **Details** of additional cleansing, repair and maintenance **following exceedance storm/flooding events**, particularly where SuDS features are located in a designated flood zone. This should include consideration of sediment management.
- **Details** of proposed **contingency plans** where failure of the SuDS feature or drainage component could present a hazard to people.
- **Include any relevant manufacturer's information** such as BBA certificates, manuals or recommended maintenance guides for specified products e.g. attenuation systems, flow controls etc.
- **Party/organisation responsible** for the maintenance

Lifetime of development and design life

For a residential development, the lifetime of development is taken by the SAB to be 100 years for the purpose of approval and adoption. For a commercial development, the lifetime of development is generally taken by the SAB to be 75 years. For either to be altered, the developer would need to provide justification.

It is important to note that the lifetime of development is not the same as the design life of the SuDS features. For example, a SuDS feature within the drainage design may have a design life of 50 years, so the design must consider a required replacement of that feature as part of the Maintenance Plan, as the design life is shorter than the lifetime of development. Both lifetime of development and design life need to be reflected in the Maintenance Plan and in the maintenance funding requirements for adoption.

SECTION 9

THE ADOPTION PROCESS AND LEGAL AGREEMENTS

Contents

9.1 Introduction

This section gives an overview of the legal agreements and adoption process. It explains when adoption and/or legal agreements may be required, including the legislation underpinning the requirements. Key items included in the legal agreements are also listed. A summary of the adoption and legal agreement process is shown in section 9.4.

A legal agreement will be required if the SAB is adopting the system.

9.2 What is adoption?

Adoption means that the SAB becomes responsible for maintaining the drainage system in accordance with the National Standards for Sustainable Drainage. [3]

However, this does not necessarily mean the SAB must physically maintain an adopted drainage system (though the SAB can do so if that is agreed). The maintenance plan submitted as part of the SAB application for SuDS approval will be considered by the SAB. It may be agreed that a management company, or even in certain circumstances the landowner/developer, will maintain the drainage system in perpetuity. The SAB will retain ultimate responsibility for the maintenance of the drainage system, hence the SAB will require a landowner to enter into a legal agreement to ensure it has the appropriate rights to intervene and recover its costs in the event of any breakdown in the arrangements for maintenance. See further details on legal agreements in section 9.6.

Section 9.3 sets out when adoption is required. Discussion with the SAB of whether adoption will be required should take place during pre-application advice.

[3] Paragraph 22(1) of Schedule 3 of FWMA 2010

9.3 SAB adoption duty legislation

Schedule 3 of the FWMA 2010 places a statutory duty on the SAB to adopt a drainage system which satisfies the following conditions: [4]

(i) Condition 1 is that the drainage system was constructed in pursuance of approved proposals;

(ii) Condition 2 is that the SAB is satisfied either:

a. That the drainage system was constructed, and functions, in accordance with the approved proposals (including any conditions of approval); or

b. That the SAB can issue or has issued a certificate that the drainage system has been constructed in a manner that is not in accordance with approved proposals or is unlikely to be completed;

(iii) Condition 3 is that the drainage system is a sustainable drainage system (i.e. those parts of a drainage system that are not vested in a sewerage undertaker pursuant to an agreement under Section 104 of the Water Industry Act 1991).[5]

Exceptions to the duty to adopt

A SAB will not be under any duty to adopt the drainage system (or any part of a drainage system) which:

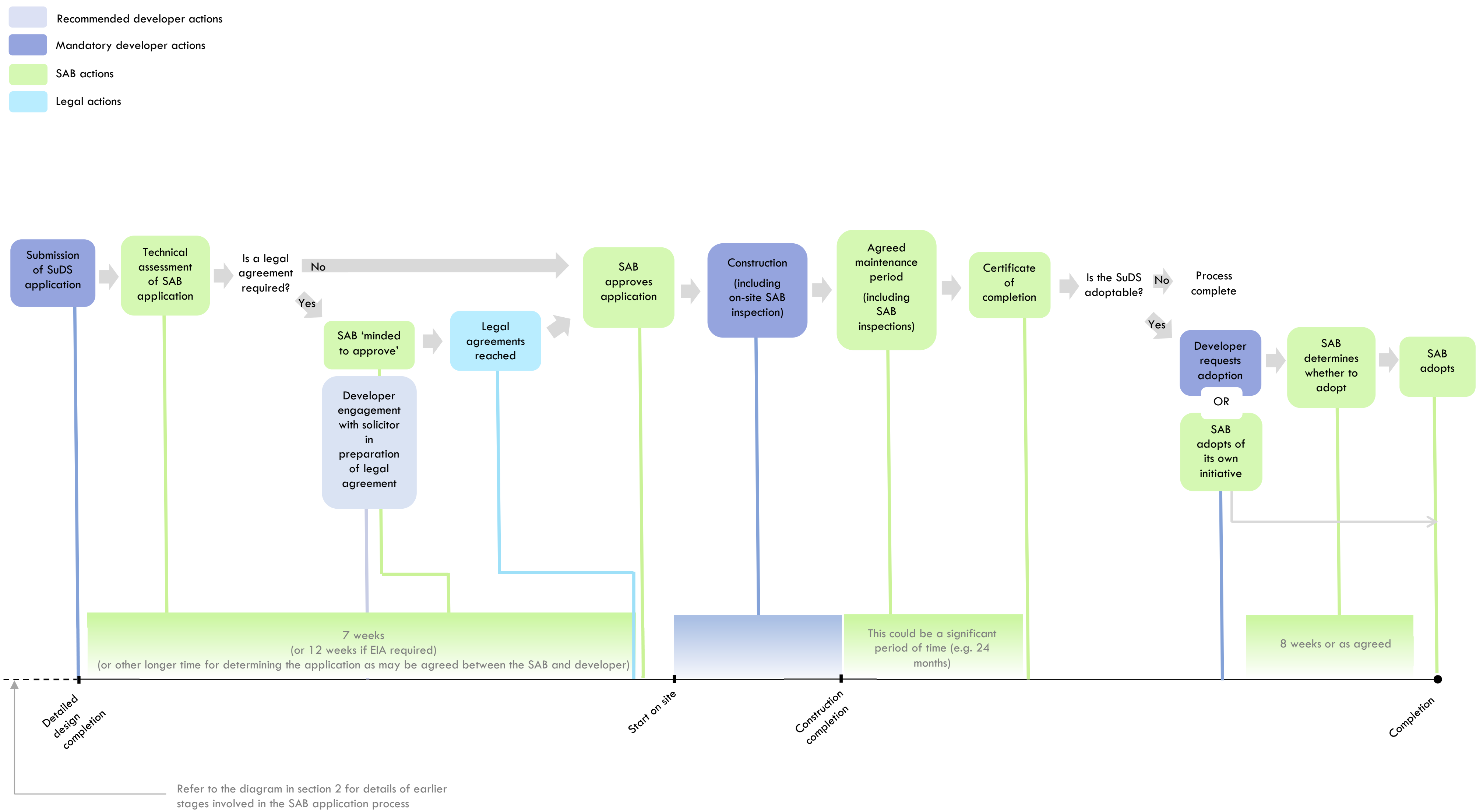
- Provides drainage for any buildings or other structures that, following completion of the work, will be owned, managed or controlled by a single person or two or more persons together (the Single Property Exemption). [6] This may include the part of the drainage system which serves only a single dwelling house that is owned and occupied by the same person. Or,
- Is part of a publicly maintained road. These will include parts of the drainage system which are within the footprint of an adopted highway, and serve a highway drainage function, since the highway authority will be responsible for such parts of the system and may be included as part of a Highways Agreement pursuant to Section 38 of the Highways Act 1980 (the Highway Exemption). Or,
- Are constructed by a sewerage undertaker under Section 114A of the Water Industry Act 1991 (the Sewerage Undertaker Exemption).

Voluntary adoption

The SAB may in any case exercise its powers to voluntarily adopt a drainage system where it is not under any statutory obligation to do so, [7] for example those drainage systems that are caught under the Single Property Exemption. If the SAB decides to voluntarily adopt a drainage system, then it will notify the developer of its decision as soon as practicable. [8]

[4] Paragraph 17 of Schedule 3 of FWMA 2010
[5] Regulation 2 of The Sustainable Drainage (Approval and Adoption Procedure) (Wales) Regulations 2018
[6] Paragraph 18 of Schedule 3 of FWMA 2010, and Regulation 9 of Sustainable Drainage (Approval and Adoption Procedure) (Wales) Regulations 2018
[7] Paragraph 21 of Schedule 3 of FWMA 2010
[8] Regulation 11 of Sustainable Drainage (Approval and Adoption Procedure) (Wales) Regulations 2018

9.1 Adoption and legal agreement process overview



9.5 The adoption process

The adoption process should be considered separate to the process of SAB approval of a SuDS system. It requires evidence that the system has been properly constructed and functioning in accordance with the approved proposals for an agreed maintenance period (for example, 24 months following completion of construction). [9]

It is important to think about adoption as a separate process to SAB approval

Is adoption required?

The developer should discuss with the SAB whether adoption is likely to be required during pre-application advice, so they can prepare for the relevant legal agreements.

The potential for future adoption will be considered by the SAB when the developer submits a SAB application. It may not be clear at the time the SAB application is submitted whether the drainage system will be subject to adoption (for example, the ownership arrangements of the site may be somewhat fluid or it may not be known whether a road will be adopted as highway maintainable at the public expense). In this case, the SAB is likely to require the developer to enter into a legal agreement, prior to granting SAB approval, to support future adoption by the SAB. This will include provisions relating to adoption (and any other relevant provisions), should the duty to adopt, or the decision to voluntarily adopt, arise.

Requesting adoption

The SAB may adopt a drainage system either of its own initiative or at the request of the developer, [10] although it is expected that the developer would actively request adoption where it considers that the conditions for adoption have been met. Whether the developer is to request adoption or the SAB will adopt of its own initiative will be determined as part of the legal agreement.

If the developer is to request adoption, a formal request to the SAB for adoption should be made after the agreed maintenance period, in order to provide evidence the system operates as approved. The legal agreement will specify when after the maintenance period adoption shall be requested.

Where the SAB receives a request to adopt it has 8 weeks to make a decision, although an extended period for determination may be agreed with the developer. [11] The SAB will notify the developer of its decision on adoption within those timescales, or, if it adopts on its own initiative, as soon as is reasonably practicable. [12] A developer has a right of appeal about decisions taken by the SAB about the duty to adopt. [13]

[9] Note that the SAB will be under a duty to adopt if it can issue or has issued a certificate under paragraph 12(2) of Schedule 3 of FWMA 2010 that the drainage system has been constructed in a manner that is not in accordance with approved proposals or is unlikely to be completed
[10] Paragraph 23 of Schedule 3 of FWMA 2010
[11] Article 7(1) of the Sustainable Drainage (Approval and Adoption) (Wales) Order 2018. The request is deemed to have been refused if the SAB fails to determine a request within the statutory timescales – paragraph 7(2) of the Sustainable Drainage (Approval and Adoption) (Wales) Order 2018.
[12] Paragraph 23(5) of Schedule 3 of FWMA 2010
[13] Paragraph 25 of Schedule 3 of FWMA 2010

SAB responsibilities

Where the SAB adopts the drainage system then, as set out above, it becomes responsible for maintaining the system and it must: [14]

- (i) Ensure that the notice specifies the extent of the drainage system being adopted;
- (ii) Copy the notice to: the relevant sewerage undertaker; any person who owns or occupies land on which the drainage system is; relevant consultees; and any person who owns or occupies land from which water will be drained by the drainage system.
- (iii) Arrange for the inclusion of the drainage system in the registered of structure of features likely to have a significant effect on the flood risk in an area under Section 21 of FWMA;
- (iv) Release any non performance bond;
- (v) Arrange for the designation under Schedule 1 of FWMA of any part of the drainage system which is not owned by the SAB and is eligible for designation; and
- (vi) Designate under Section 63 of the New Roads and Street Works Act 1991 any adopted part of the drainage system that is a street.

[14] Paragraph 23(6) of Schedule 3 of FWMA 2010

9.6 Legal agreements

The SAB may require the developer (and anyone having an interest in the land) to enter into a legal agreement prior to the grant of SAB approval. This provides a formal means of setting out the detailed arrangements for the construction and functioning of the drainage system for the lifetime of the development, together with other relevant provisions.

The SAB will require a legal agreement to be entered into if the drainage system will be ultimately adopted by the SAB. Where the drainage system will not be adopted by the SAB, then a SAB may still require step-in rights to allow the SAB to enter the site and maintain the system should the landowner or management company fail to do so and to allow the SAB to recover its costs.

Non-performance bonds

The SAB may require the deposit of a non-performance bond (bond). Where a bond is required, SuDS approval will only take effect if and when the developer provides the bond. The kind and value of the bond will be specified by the SAB in the condition and further particulars e.g. release of bond, confirmed as part of a legal agreement.

When is a legal agreement not required?

There are very few circumstances where the SAB may not require a legal agreement. This may include, for example, single properties where the risk that maintenance will not be performed is low. Discussion with the SAB will enable a developer to understand if their development is exempt.

Return of the non-performance bond

The legal agreement will specify when the non-performance bond will be released to the developer. It is anticipated this will be returned once the SAB has adopted the system if adoption is required, or at the certificate of completion for those systems with a legal agreement but not requiring adoption.

Costs

It is expected that SAB costs involved in drawing up the legal agreement will be covered by the developer.

Legal agreement content

The content of the legal agreement will largely depend upon the maintenance and funding proposals that are agreed with the SAB as part of the application process. For example, if it is agreed that a management company will maintain the drainage system, the legal agreement will likely impose obligations on the landowner to establish the management company (if it is not already established), impose obligations on the management company to maintain the drainage system in accordance with the approved proposals, and include appropriate step-in rights. Alternatively, if it is agreed that the SAB will maintain the drainage system post-adoption then the legal agreement will likely require the payment of a commuted sum by the developer or landowner prior to adoption.

That said, the legal agreement is likely to include (but may not be restricted to) the following provisions:

- A prohibition on the commencement of construction until the developer has, for example, paid to the SAB or secured a non performance bond and obtained the necessary statutory consents;
- Provisions dealing with the construction of the drainage system, such as requiring that it is constructed in accordance with the approved proposals, to an appropriate standard, and within an agreed timescale. The agreement will also likely cover minor variations to the design of the system, materials sampling and testing and the requirement for technical advice;
- Access arrangements for the SAB to allow them to have free access to the site at all times and to undertake any works in default;
- Inspection (though this is also likely be dealt with by way of SAB condition);
- The issue of a Certificate of Substantial Completion. This will be followed by a maintenance period during which the developer will maintain the drainage system, for example, 24 months (although this will likely tie in with the issue of a Certificate of Substantial Completion issued pursuant to a Highways Agreement, if applicable);
- The issue of a Final Certificate. Prior to the issuing of a Final Certificate, the SAB will need to be satisfied that the drainage system has been properly maintained and is functioning as designed. The SAB will also likely at this stage require the landowner to enter into a deed of grant and covenant, to ensure that the agreement remains binding on successors in title, and any relevant deeds of easement, and that the management company has been constituted and funded or that the commuted sum has been paid to the Council (as applicable);
- If the drainage system is to be maintained by the landowner/developer or a management company, provisions which the developer is required to include in the transfers of individual plots to ensure that the SAB can exercise its rights to carry out works in default and recover the costs of doing so from the plot owners;
- Circumstances in which the bond may be called upon and the release of the bond;
- Provisions relating to adoption e.g. requirement on the developer to request adoption (if appropriate);
- Transfer of the drainage system to the SAB (if appropriate);
- Other provisions such as relevant indemnities to the SAB, insurance and dispute resolution procedures.

SECTION 10

SUPPLEMENTARY GUIDANCE

Cascading (stepped) bioretention verge raingardens, Grey to Green, Sheffield, S3 8NL

10.1 Supplementary guidance

The following section lists guidance documents which are relevant to SuDS design. This guide acts as an overview of SuDS in North Wales hence more detailed guidance should be used where appropriate, as referenced throughout the guide and in this list. This list is non-exhaustive and is up to date at the time of publication.

National guidance

- Welsh Government, *Statutory Standards for sustainable drainage systems - designing, constructing, operating and maintaining surface water drainage systems*, 2018.
- Welsh Government, *Sustainable drainage (SuDS) statutory guidance,* 2018.
- Welsh Government, *Implementation of Schedule 3 to the Flood and Water Management Act 2010 for mandatory Sustainable Drainage Systems (SuDS) on new developments – Frequently Asked Questions*, 2019.
- UK Government, Highways Act 1980.

SuDS general design

- CIRIA The SuDS Manual (C753). 2015
- CIRIA Site handbook for constructing SuDS (C698). 2007
- CIRIA Planning for SuDS – making it happen (C687). 2010
- CIRIA Rainwater and greywater reuse in buildings: best practice guidance (C539). 2001
- CIRIA Designing for exceedance in urban drainage – good practice (C635). 2006
- www.susdrain.org (lists further specific SuDS guidance)
- Scottish Water, *Sewers for Scotland – a technical specification for the design and construction of sewerage infrastructure*, Version 4.0, 2018.
- Environment Agency Drainage Details.
- Highway Agency Drainage and Construction Details.
- Individual local authority biodiversity guidance (e.g. Biodiversity Action Plans).
- DEFRA WT1505, Final Surface Water Drainage Report, WSP. 2013.
- Kellagher RBB and Lauchlin CS, Use of SuDS in high density developments, defining hydraulic performance criteria. HR Wallingford Report SR 640.
- Kellagher RBB and Lauchlin CS, Use of SuDS in high density developments, guidance manual. HR Wallingford Report SR 666.

Specific SuDS feature design

- Urban Design London - Designing Rain Gardens: A Practical Guide 2018
- CIRIA Structural and geotechnical design of modular geocellular drainage systems (C737).
- CIRIA Source control using constructed pervious surfaces: Hydraulic, structural and water quality performance issues (C582).
- CIRIA Building greener. Guidance on the use of green roofs, green walls and complementary features on buildings. C644. 2007.
- Environment Agency Green roof toolkit 2009.
- British Standard BS 7533-13: 2009. Pavements constructed with clay, natural stone or concrete pavers. Guide to the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers.
- BS EN 13108-7:2016. Bituminous mixtures - material specifications. Porous asphalt.
- Interpave, Understanding permeable paving and SuDS. Edition 6. 2020
- Interpave, Design and construction of concrete block permeable pavements. Edition 7. 2018.
- BRE Digest 365, Soakaway design. 2016.
- The Urban Tree Manual, Forestry Commission, 2018.

Glossary

The following table provides the relevant definitions of words as they are used in this guide

1 in 1 year event	A design storm with a 1 year return period.
1 in 100 year event	A design storm with a 100 year return period.
1 in 30 year event	A design storm with a 30 year return period.
Adoption	The process of the SAB becoming responsible for maintaining the drainage system in accordance with the National Standards for Sustainable Drainage.
Amenity	Benefiting the public by providing useful qualities to the local area such as extra green space or vegetation, helping to improve air quality etc
Attenuation	Storage of stormwater flows typically releasing flows over a longer period of time
Biodiversity	The diversity of plant and animal life.
Blue corridor	A strip of land where overland surface water flow concentrates and is channelled.
Blue space	Areas of open water.
Brownfield site	Previously developed land.
Buried utilities/services	Underground utility infrastructure (e.g. gas mains; electricity cables)
Catchment	The area contributing surface water flow to a specified point.
Climate change	Long-term changes in temperature and weather worldwide due to natural and/or human causes.
Combined sewer	A sewer with flow contributions from both surface water and foul sewage.
Critical storm duration	The duration of a design storm causing the highest peak flows or levels at a specified location.
Design life	The period of time for which a component should function as designed for, for the specified purpose.
Design storm	A theoretical rainfall event of specified duration and return period, determined statistically, used for the drainage system design.
Design storm return period	The likelihood of a specified design storm occurring e.g. a 100 year return period storm is the storm which occurs, on average, every 100 years and has an annual probability of exceedance of 1%.
Developer	A person or organisation, and/or their advisors, undertaking a development
Development	A site which has been or is being developed by construction.
Discharge	Flow rate of water.
Drainage component	An element of a drainage system which forms part of an overall drainage design. This could be a SuDS feature or other element.
Drainage hierarchy	The order of priority for location of discharge of surface water.
Drainage system	A structure designed to receive rainwater except (a) a public sewer, or (b)a natural watercourse (river or stream). The reference to a structure includes a reference to (a) any part of an existing or proposed structure, and (b) any feature or aspect of a design that is intended to receive or facilitate the receipt of rainwater.
Early engagement	Recommended discussion between the developer and SAB (and any other relevant third party) at an early stage which is likely to be free of charge (subject to individual local council policies).
Emergent vegetation	Vegetation often located on an aquatic bench in an open water feature which is partly submerged in water.
Environmental impact assessment	A study into the environmental impact of certain types of development as required for the planning application process
Evapotranspiration	Process of loss of moisture from soil, by evaporation, and/or by uptake and transpiration by plants.
Exceedance event	An event which has a greater storm return period than the guidance requires. An acknowledgement that there will always be a larger storm and to consider the effects of this.

Freeboard	The vertical height above a design water level to add a margin of safety due to uncertainties.
Geocellular units	Modular plastic crates with a high void ratio, normally used below ground for storage of surface water runoff.
Geotechnical investigation	Investigation by a geotechnical engineer into the underlying soil and rock properties of a site.
Geotextile	Permeable fabric commonly used in construction for separation of soils, aggregates and/or filtration.
Greenfield runoff rate	Peak runoff rate for a site which would occur if the land was undeveloped, for a specific return period storm.
Greenfield site	Land which is undeveloped apart from agricultural or recreational use.
Groundwater	Water below ground level in aquifers and streams.
Highway authority	The authority responsible for maintenance, including drainage, of public roads.
Hydraulic performance	How well a drainage system stores, conveys and controls flows.
Impermeable area	Area which does not allow water to pass through.
Infiltration	The movement of surface water into the ground.
Interception	Runoff prevention for most low return period (small and frequent) rainfall events.
Lead local flood authority	Local authority with the responsibility for managing flood risk through development and implementation of a local flood risk management strategy.
Lifetime of development	The period of time for which a development is anticipated to function as designed for.
Live loads	Loads caused by the use and/or occupancy of a structure or drainage component (e.g. pedestrians; vehicular traffic).
Local development plan	A plan used by LPAs to assess a planning application. It illustrates the authority's intended development proposals into the future including buildings, conservation and land use.
Local planning authority	The authority legally responsible for control of local planning and development through the planning system.
Main river	Main rivers are usually larger streams and rivers but also include some smaller watercourses. In Wales, main rivers are legally designated by NRW. Riparian owners are responsible for their maintenance and management. The NRW is responsible for overseeing the management of works on main rivers.
Ordinary watercourse	An ordinary watercourse is a small stream or ditch which drains away water and is not a main river. Riparian owners are responsible for the maintenance and management. The LLFA is responsible for overseeing the management of works on such watercourses, including granting consent for works.
Ordinary watercourse consent	Consent required before undertaking any work or construction of structure that will affect the flow of water or cross-sectional area of an ordinary watercourse. This applies to both temporary and permanent changes. The LLFA grants consent.
Overland flow	Flow of water across the ground which occurs when rainfall cannot completely infiltrate into the ground due to saturated soil or insufficient infiltration rate of the soil.
Permeability	How easily a fluid can pass through a specified material.
Point source	Comes from a single, identifiable source.
Positive drainage	Drainage network that relies on pipes or other culverts to carry water away rather than infiltration into the ground.
Potable	Water that has been treated suitable for drinking.
Pre-application advice	Highly recommended SAB advice specific to the proposed development's SuDS scheme. It is more detailed than early engagement advice and has a fee.
Resilience	The quality of being able to cope with and recover quickly from an event.
Retrofit SuDS	SuDS which are incorporated into the existing built environment or benefit existing drainage systems.

Runoff rate	The calculated rate which water flows over the ground surface, which has not entered the drainage system. The rate is highly dependant on the conditions of the ground surface at the time of the event.
Runoff volume	Total volume of surface water collected by a drainage system following a storm event.
Sedimentation	The settling of suspended material carried in a fluid.
SuDS Approving Body	The local authority body which assesses applications for SuDS ('SAB applications') on developments.
SuDS feature	One of a range of features to manage stormwater using sustainable drainage principles and forming part of an overall drainage system design (e.g. a swale; infiltration basin, soakaway etc.)
Surface water runoff	See 'overland flow'.
Surface water sewer	A sewer with flow contributions only from surface water.
Sustainable drainage system	A system which manages surface water quantity, quality and with amenity and biodiversity benefits.
Urban creep	The increase in impermeable area within areas already defined as part of an urban area e.g. due to building extensions.
Water company	A company which provides water supply and wastewater services including operation and maintenance of publicly owned sewers.
Water table	The typical groundwater level below which the ground is saturated with water.
Watercourse	A river, stream or ditch which conveys surface water

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