Transport and Environment Committee

10.00am, Thursday, 14 October 2021

Edinburgh's Sustainable Rainwater Management Guidance

Executive/routine	**Executive**
Wards All	**All**
Council Commitments	1, 2, 15

1. Recommendations

1.1 It is recommended that Committee approves the 'Edinburgh's Sustainable Rainwater Management Guidance and Factsheets' that will form part of Edinburgh Design Guidance.

Paul Lawrence

Executive Director of Place

Contact: Julie Waldron, Senior Landscape Planner

E-mail: Julie.Waldron@edinburgh.gov.uk | Tel 0131 529 3532

EDINBVRGH
THE CITY OF EDINBURGH COUNCIL

Report

Edinburgh's Sustainable Rainwater Management Guidance

2. Executive Summary

2.1 Achieving net zero emissions and adapting the city to the impacts of climate change represents the greatest challenge of a generation. The City of Edinburgh Council has set an ambitious target for Edinburgh to become a net zero and climate-resilient city by 2030, as set out in the draft 2030 Climate strategy, which is currently out for public consultation

2.2 Edinburgh's Sustainable Rainwater Guidance (ESRG) is proposed to form part of the Edinburgh Design Guidance and Street Design Guidance. It aims to help achieve an objective of the Water Vision by providing guidance to developers, designers and Council officers. The ESRG will also help to explain the proposed new City Plan 2030 policies on surface water management.

3. Background

3.1 There is no longer any doubt that transformational change at scale is needed to manage Scotland's water environment to respond effectively to climate change, biodiversity decline and population growth. The climate is changing, and climate trends predict that we will experience milder and wetter winters. Summers are expected to become hotter and drier, and occurrences of extreme rainfall events are expected to increase both in frequency and intensity. Despite the overall trend, there will still be cold, dry winters, and cool, dry summers, as there is variability in the summers and winters seen today.

3.2 This has been widely recognised internationally and the United Nations set Sustainable Development Goals; thirteen out of seventeen of which link to water issues. The UK Committee on Climate Change also highlights flooding issues as one of the top risks to the country.

3.3 The Scottish Government recognised the need to take a regional approach to flooding, drainage, water quality and wider consideration of the water environment and established the Edinburgh and Lothians Strategic Drainage Partnership (ELSDP) in October 2018. The Partnership seeks to develop a co-ordinated and transformative approach across Edinburgh and the Lothians to drainage, water management and flooding issues. There will be a strong focus on water

management using above-ground drainage infrastructure (or Sustainable Drainage Systems; SuDS), increasing biodiversity, creating great places and supporting a climate-resilient city region.

3.4 In June 2021, the Council launched the draft 2030 Climate Strategy; Delivering a Net Zero Climate Ready City for consultation. This also embeds the work of the Water Vision and ESLDP. The aims of the ELSDP, the Water Vision and Climate Strategy also align with the Edinburgh Climate Change Commission which states that the city should become resilient to climate change, embed a collaborative approach to problem solving and be open to all best practice. This also accords with the Council's Edinburgh 2050 Vision of a sustainable, green, and safe city.

3.5 The Edinburgh Adapts Climate Change Adaptation Action Plan contains twenty-two actions that are linked to flooding and water and many others relating to biodiversity and greenspace actions. Action BE2 in the Action Plan is specifically to update guidance on sustainable rainwater management.

4. Main Report

4.1 The Edinburgh Sustainable Rainwater Management Guidance and factsheets have been developed to fulfil the Action BE2 (as set out above) and to provide developers and Council officers with information on how the guidance will be implemented in practice.

Summary of the Sustainable Rainwater Management Guidance

4.2 The guidance is split into three parts, with supplementary factsheets:

4.2.1 Part One explains how the guidance fits within the suite of documents that already exist that relate to rainwater and flooding and explains how Sustainable Drainage systems work and their importance;

4.2.2 Part Two explains the Edinburgh context; looking at geology, soils, flooding risk and the built environment. There is also an explanation of how the work fits into the street design guidance; and

4.2.3 Part Three explains principles of good design and can also be applied to all areas of Scotland. The work includes a look at Scottish Water's requirements to disconnect from the sewer network and provides guidance and advice ranging from the masterplanning scale to the householder context. Whole life costs, the understanding of a multifunctional business case and case studies form the last section of the document.

4.2 The factsheets that follow which support the guidance are more technical and will help to ensure that the Council develops, designs, and approves details which are cost effective to maintain and create more climate resilient places with a wide range of social and environmental benefits. Three factsheets have been prepared

covering ‘SuDS Trees’, ‘Raingardens’ and ‘Swales’ (see Appendix 2). Further factsheets will follow.

5. Next Steps

If approved, the next steps will be to communicate the new guidance within the Council and to all developers and clients, including making this available to other Local Authorities for information.

5.1 Future work for the guidance includes:

5.1.1 Completing the factsheet ‘Suds in Heritage Areas’ funded by Edinburgh World Heritage Trust;

5.1.2 Completing consultation for the ‘Maintenance Design’ factsheet; and

5.1.3 Sourcing funding to initiate the remaining factsheets:

5.1.3.1 Designing with Airport restrictions;

5.1.3.2 Detention basin design - hard and soft; and

5.1.3.3 Designing and specifying Green/blue roofs (part funding has been secured from NatureScot for this factsheet).

6. Financial impact

6.1 There is no financial impact at present.

6.2 The guidance will provide financial benefit as there will be a greater understanding of the needs of adaptation for intense rainfall. This increased understanding should save time and money on negotiation where currently opportunities may be missed because it is considered too late in the design process.

7. Stakeholder/Community Impact

7.1 SEPA, Nature Scot and Scottish Water and adjacent Local Authorities and officers in the Council have had a significant role in the preparation through consultation and workshops.

8. Background reading/external references

8.1 Climate Change Strategy

8.2 Edinburgh Adapts Climate Change Adaptation Action Plan and Progress reports

8.3 Edinburgh Climate Change Commission

8.4 SUDsnet – understanding Sustainable urban drainage

8.5 Climate change

8.6 Climate Change Summary for Scotland

8.7 Local Flood Risk Management Plan

8.8 Reducing emissions in Scotland - 2020 Progress Report to Parliament

8.9 Scottish Water Surface Water Policy

9. Appendices

9.1 Appendix 1: Sustainable Rainwater Management Guidance

9.2 Appendix 2: Factsheets

W1 - Suds Trees in Streets

Contents

What are SuDS Street Trees?

All Street trees in Edinburgh are environmental assets that take up rainwater, improve air quality, and cool urban heat effects while significantly contributing to well being and quality of life. However SuDS trees can attenuate significantly more rainwater than conventionally planted trees.

A SuDS street tree will appear visually similar to a typical street tree but differs below ground in the design of the planting system which will be designed to collect, store water and treat surface water (rainwater) runoff.

SuDS trees can be retrofitted as standalone features or designed as component in a wider sustainable drainage system. All SuDS tree systems should include good infiltration or underlying drainage to prevent waterlogging and allow excess water to drain away.

For SuDS trees in public space the type of construction, function, planting and related maintenance requirements should be agreed with the adopting authority as part of the planning and design process.

Figure 1. SuDS Dundee Trial Tree Pit | BlueGreen Urban

Figure 2. SuDS Dundee Trial Tree Pit | BlueGreen Urban

SUDS street trees contribute to surface water management by;

Interception - the canopy intercepts and absorbs rainfall, slowing and reducing the amount of surface water.

Transpiration - Water is absorbed by the roots and evaporated through the leaves.

Infiltration – increases the volume and rate of surface water moving into the soil

Technical references:

- Trees and Design Principles in ERWMG
- Edinburgh Design Guide Sections: 1, 2, 3 & 4
- Factsheets: F5 – Street Trees (unpublished)
- Factsheet -xx Utilities
- CIRIA The SUDS Manual V6: Part D, Technical Detail, Chapter: 19 Trees, p360
- CIRIA The benefits of large species trees in urban landscapes: a costing, design and management guide (C712D)
- TDAS, Trees and Hard Landscape, 2012
- New trees - BS 8545:2014
- BS 5837:2012 Trees in construction and Demolition

Fitting SuDS Trees into Streets

The Edinburgh Design Guidance 4.4 sets out a hierarchy of Design Principles based on street types and activity levels that identify where SuDS features might be used. Section B of the Edinburgh Sustainable Rainwater Guidance explains which type of feature could be considered in different contexts (such as for example high streets or residential areas). Associated street furniture like tree guards, grills, kerbs, and permeable paving should be designed with reference to the ESDGF and the EDG. In areas with heritage designations 'special ' EDG design principles will apply.

Street Trees located in the furniture zone

Figure 4. King's Road, Harrogate, North Yorkshire | DeepRoot

Relevant Factsheets:

Street Trees (F5)

Footway Zones (P3)

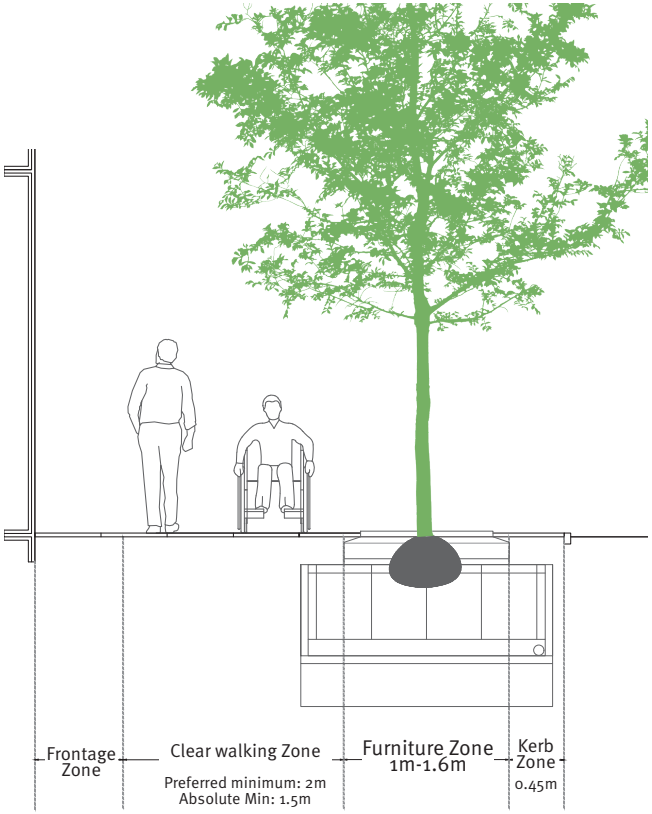


Figure 3. Fitting a SuDs Tree Pit into a street | Atkins

Technical references:

- ESRWMG - Section B Design Principles
- Edinburgh Design Guidance Section 1,2,3, & 4

Street Furniture (F1)

Street Geometry & Layout (G1)

Integrating Street trees with street furniture

Figure 5. Hull Town Centre | DeepRoot

Footway Materials & Surfacing (M1)

Fitting SuDS Trees into Streets

SuDS tree with Traffic calming and permeable paving

Street Trees located in a built out area

Figure 6. Street Tree, Fountainbridge Edinburgh | Google Maps

SuDS Tree pits can be incorporated into the design of parking bays, traffic calming or segregated cycleways.

Relevant Factsheets:

Street Trees (F5)

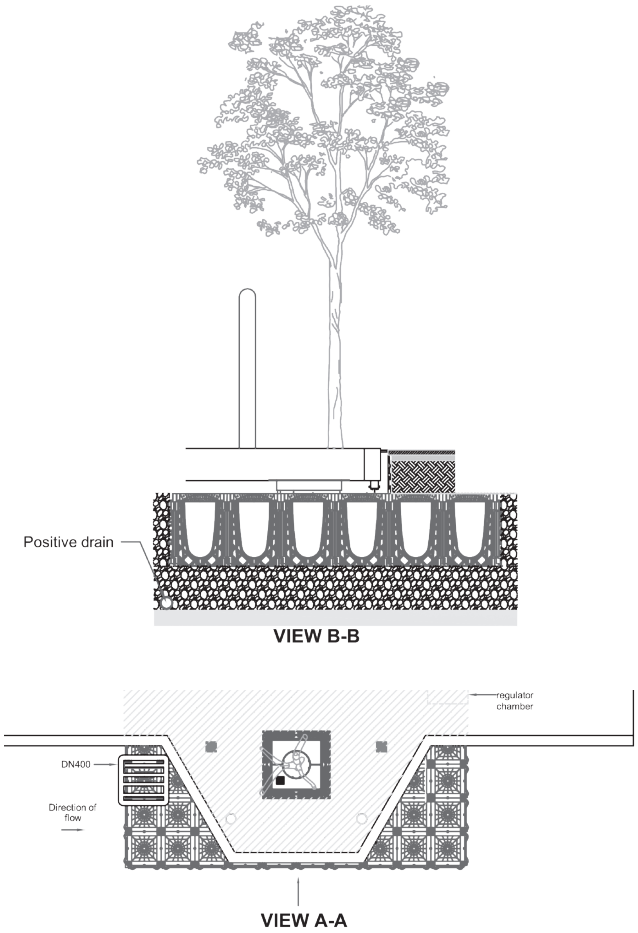


Figure 8. SuDS tree build out | GreenBlue Uran

Footway Zones (P3)

Street Furniture (F1)

Street trees in urban swales or bioretention

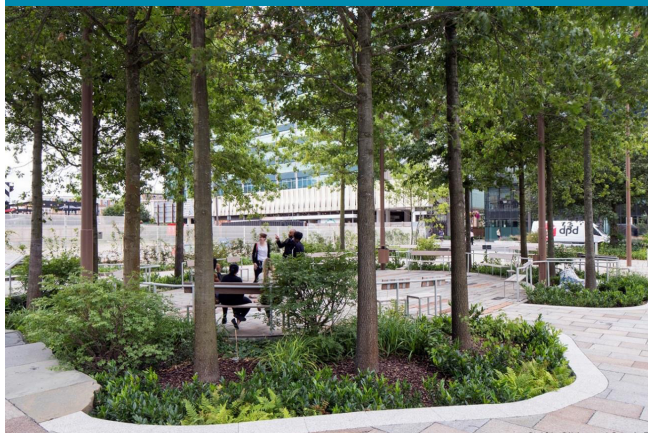


Figure 7. Ruskin Square, Croydon | J & L Gibbons

Street trees in urban swales or bioretention areas can be introduced as part of large scale developments or street improvements.

Swales and Rain gardens for Street Trees

Street trees in urban swales or bioretention areas in an inner-city urban environment can be a linear planted feature within a hard landscape.

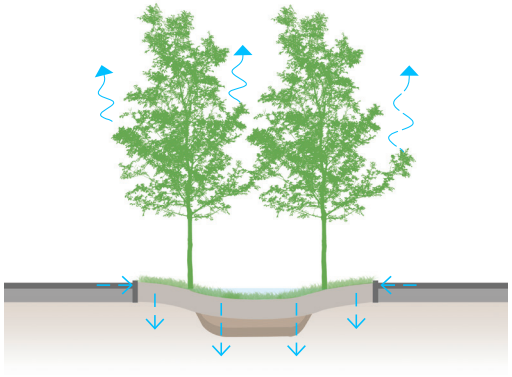


Figure 9. Swale/ rain garden with trees

Trees situated in a rain garden

Figure 10. Greener Grangetown, Cardiff | GreenBlue Urban

Trees situated in a damp swale

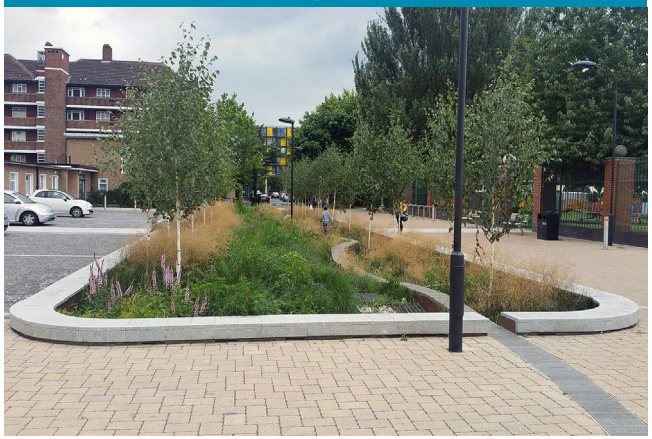


Figure 11. Damp Swale, Joyce Square, London | Robert Baray Associates

Trees situated in a shallow dry swale

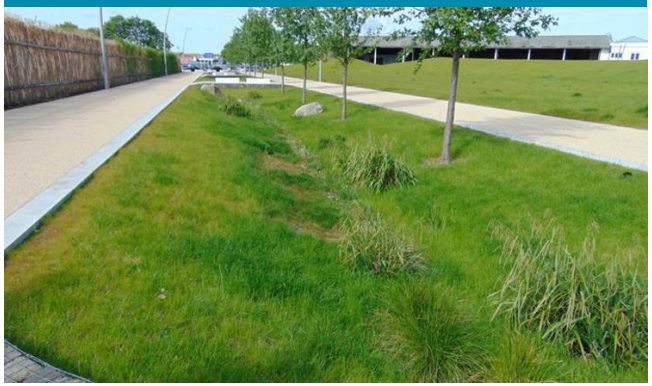


Figure 12. Dry Swale, Dalmarnock Strain Station | SNH

Relevant Factsheets:

Street Trees (F5)

Footway Zones (P3)

Street Furniture (F1)

Comparison of trees in swales and tree pits

Performance	Swale Tree Pit	Paved Tree Pit	Site Context	Swale Tree Pit	Paved Tree Pit
Peak flow reduction	Medium	Medium - High	Residential	Yes	Yes
Volume reduction (high with infiltration)	Medium - High	High	Commercial/ residential	Yes	Yes
Water quality treatment	High	Medium - High	High Density	No	Yes
Amenity potential	High	High	Retrofit	Yes	Yes
Ecology potential	Medium - high	Medium	Contaminated Sites / sites above vulnerable groundwater (with liner)	Yes	Yes
Treatment Train Sustainability	**Swale Tree Pit**	**Paved Tree Pit**	**Cost Implications**	**Swale Tree Pit**	**Paved Tree Pit**
source control	Yes	Yes	Land-take	High	Low
conveyance	No	No	Capital Costs	Low	High
Site Systems	Yes	Yes	Maintenance Cost	Medium	Medium
Regional System	No	No			
			Pollutant Removal		
			Total suspended solids	High	Medium
			Nutrients	Low	Medium
			Heavy Metals	High	Medium

Figure 13. Table adapted from *Green Blue Urban: Trees and Water Sensitive Urban Design*, p23

SUDS Systems for Street Trees

Street Trees in SuDS Tree pits and Trenches

The survival of a SuDS street tree is dependent on the initial establishment of the tree, soil, appropriate species selection and care throughout its lifecycle.

In sufficiently wide pavements SuDS trees in tree pits or trenches can be located within the furniture zone (ESDGF F1, Street Trees) or can be integrated into street layouts.

In a SuDS trench system a continuous connected underground structure provides attenuation and root training for a row or avenue of trees.

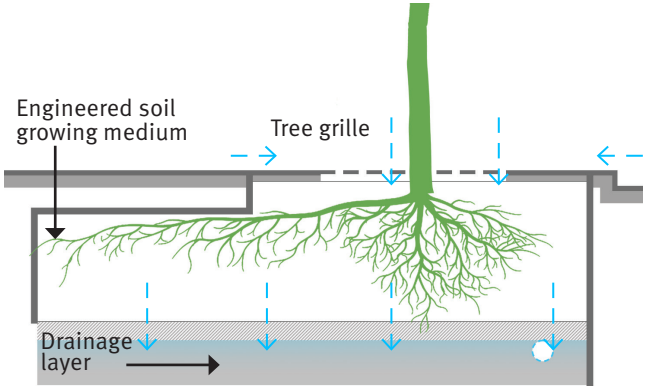


Figure 15. Tree Pit | Atkins

"Engineered soils are designed and manufactured to provide specific drainage and horticultural properties."

CIRIA: Guidance on the Construction of SUDS p110

Engineered soils for SuDS trees should have:

- Adequate load bearing root volume
- Quality engineered soil which can cope with intermittent water logging without loss of structure
- Overflow provisions (exceedance)
- Maintainable inlets
- Drainage base
- Aeration to maintain soil health

Street Tree in SuDS pit

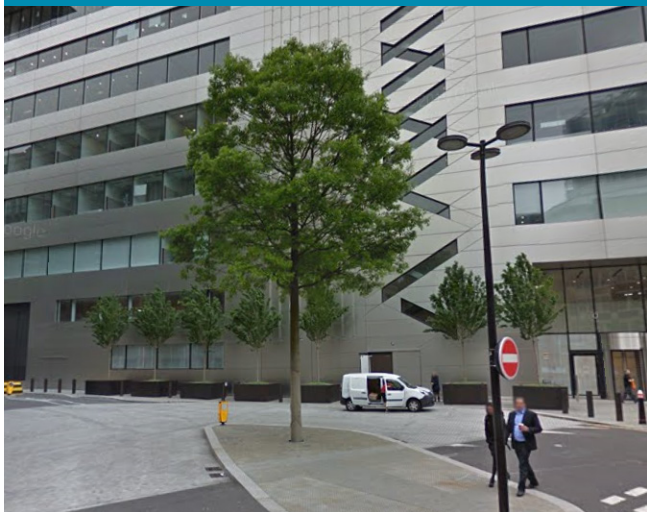


Figure 16. 5 Broadgate, Sun Street, London | GreenBlueUrban

Street Trees in SuDS trenches

Figure 14. Fletton Quays | GreenBlue Urban

Relevant Factsheets:

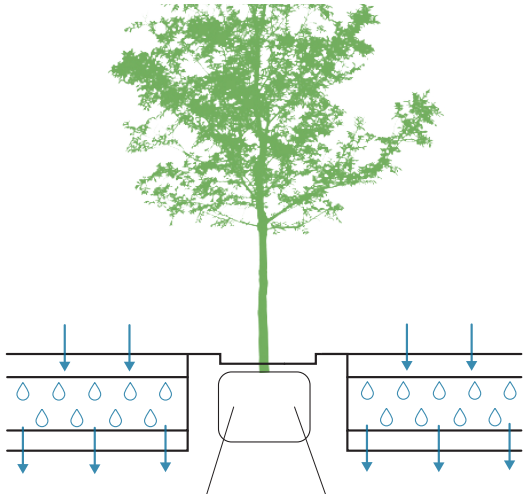
Street Trees (F5)
Footway Zones (P3)
Street Furniture (F1)

Key Design Considerations:

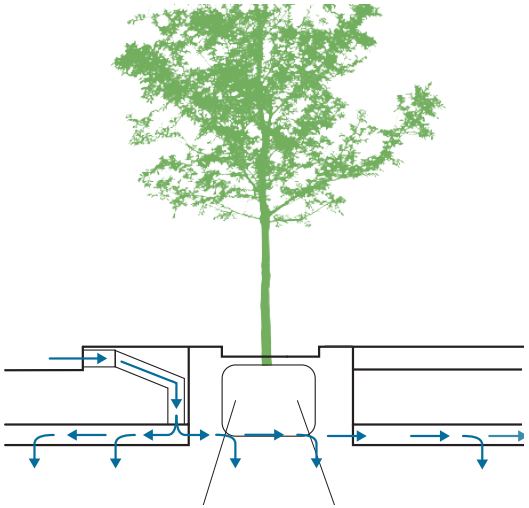
- ☑ **DO**, establish existing drainage and rainfall volumes to determine the drainage requirements
- ☑ **DO** survey the site to establish ground levels, street character and context to inform the design choices
- ☑ **DO** consult the design guidance in the EDG, ESRWMG and Factsheets to inform the locations of trees within the street layout design.
- ☑ **DO** ensure enough space to successfully accommodate long-term root growth
- ☑ **DO** establish location of utilities and services to avoid conflicts and if required provide root barriers/ root training.
- ☑ **DO** consider whether the location and future growth of the tree will conflict with CCTV or lighting.
- ☑ **DO** determine water availability and ensure the appropriate catchment area for each tree
- ☑ **DO** provide an appropriate volume of fertile, uncontaminated, free draining engineered soil with an open structure (as propriety SuDS soils).
- ☑ **DO** include suitable water inlets allowing were possible multiple inlet points.
- ☑ **DO** establish where any excess water drained from the tree pits/ trenches will discharge and ensure technical requirements are met and any necessary permissions obtained.
- ☑ **DO** ensure that during an extreme weather events if the tree pit/trench reaches water capacity, excess surface water can flow away safely
- ☑ **DO** specify robust tree specimens appropriate to on street locations and tolerant of periodic waterlogging or dry periods as described in this factsheet
- ☑ **DO** design associated street furniture like tree guards, grills, kerbs, and paving with reference to the ESDG Factsheets and the EDG. In areas with heritage designations ‘special ‘ EDG design principles will apply.
- ☑ **DO** ensure a regular maintenance regime for inlets/ outlets and any filter mediums.
- ☒ **DON’T** forget to provide establishment watering during dry weather in the first 2-5 years after planting
- ☒ **DON’T** allow construction of new SuDS features to negatively impact established mature trees, avoid root damage or compaction of soil within the rootzone of existing trees. Mature trees are important environmental assets and retaining existing trees should be a fundamental consideration in every development.

Alternative Methods of water inlet for SuDs Tree pits

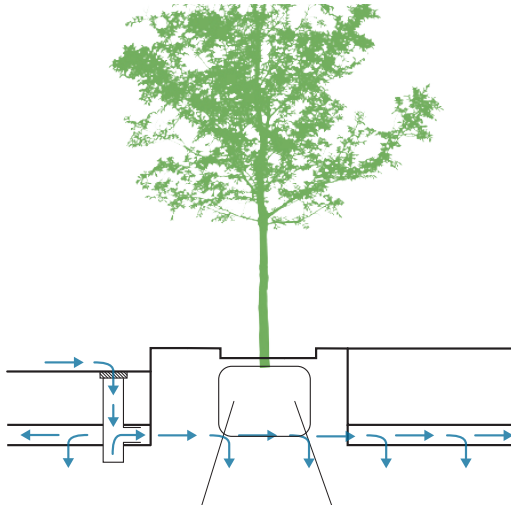
There are a range of options for water inlets ranging from simple weir curbs with gaps where surface water drains directly from a paved area onto the surface of a tree pit to more complex below ground systems connecting with road gulleys. Care should be taken that the appropriate amount of water drains to the tree pit to enable growth without prolonged waterlogging. All tree systems need adequate drainage to remove excess water.



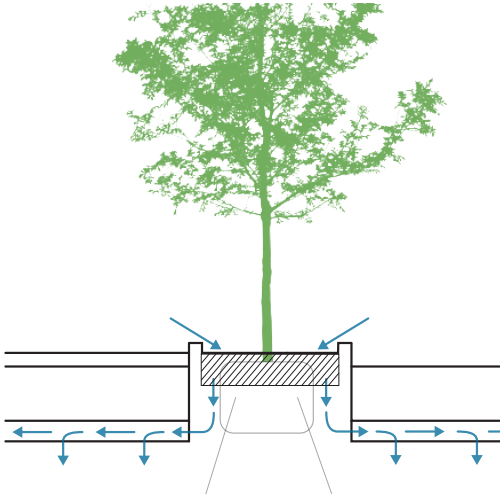
Permeable surface



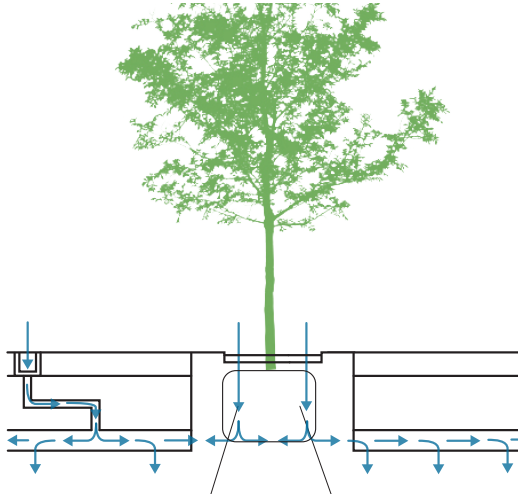
Kerb inlet



Traditional Gutter



Weir Inlet



Slot Drain

Figure 17. Methods of water inlet | Adapted from Green Blue Urban

Specifying SuDS Trees in Treepits and Trenches

Trees in SuDS treepits or trenches need to be tolerant of not only harsh dry and very wet conditions, they need to be able to adapt to sudden changes from dry to very wet.

Many of the examples should come from areas where sudden and extreme weather changes are frequent or are hybrids or cultivars, selected because of their tolerance for harsh urban environments.

SuDS trees planted in streets and paved areas also need to satisfy the same requirements of any street tree, to be tough, attractive, pollution tolerant and with an upright habit and clear stem. They will need to be robust healthy specimens of a sufficient size to resist accidental damage or deliberate vandalism.

While climate change predictions suggest more frequent hot summers and mild wet winters, Scotland is likely to continue to experience periodic cold snaps that will also require a greater degree of hardiness than trees in the southern UK.

Species which produce large quantities of pollen likely to increase allergy problems are not acceptable as street trees in Edinburgh.

Relevant Factsheets:

Street Trees (ESDG F5)

Latin Name	Common Name	Form	SuDS Tolerance
Examples Suitable for both very dry and wet conditions in hard landscapes (paved areas)			
Quercus bicolour 'Regal Prince'	White Swamp Oak (upright cultivar)	Large round crowned tree,	Very good SuDS tree, tolerant of everything including wide range of temperatures
Gleditsia triacanthos 'Sunburst	Honey Locust (thornless cultivar)	Medium/ large tree open structure	Very good SuDS tree, tolerant of everything including wide range of temperatures
Acer x freemanni	Freemans Maple	Large round crowned tree	Good SuDS tree
Quercus palustrus	Pin Oak	Large round crowned tree	Good SuDS tree tolerant of pollution and short periods of waterlogging
Examples Suitable for free draining soils (where waterlogging is rare or brief) in hard landscapes (paved areas)			
Ginkgo biloba	Ginko 'Maiden Hair Tree'	Large round crowned tree	SuDS tree tolerant of pollution and salt
Ulnus 'New Horizon'	Elm (Hybrid resistant to Dutch Elm Disease)	Large columellar tree,	SuDS tree tolerant of pollution and salt
Acer campestre 'Streetwise'	Field Maple	Medium Tree	SuDS Tree suitable only in free draining conditions
Malus (many cultivars)	Crab Apple	Small Tree	SuDS tree suitable for damp conditions were waterlogging is rare

The example species list is not exclusive

Other tree or shrub species could be considered if they are sufficiently robust, environmentally and climatically tolerant of conditions on site. Specification in general should follow the principles set out in the Edinburgh Design Guide Ch3.

Specifying Shrub and Tree Species for Bioretention Areas

Most rain gardens will be very free draining with very brief waterlogged periods therefore the examples listed have some resilience in dry and drought conditions.

Small trees, shrubs or multi- stemmed specimens are suitable for bioretention areas and can include some native and non-native species not suitable for SuDS tree pits. Raingardens that are persistently damp could accommodate a range of different species.

Trees in raingardens and bioretention areas should be underplanted with suitable perennial groundcover.

The selection of species should be site specific to suit the conditions and context of the raingarden e.g. is it:

- size and depth
- formal/ informal
- exposed/sheltered
- sunny/shady
- persistently damp or dry
- is there salt or pollution?

Species which produce large quantities of pollen likely to increase allergy problems are not acceptable in on street environments in Edinburgh. This restriction does not apply to greenspace and garden locations

Latin Name	Common Name	Form	SuDS Tolerance
Examples of small trees and shrubs suitable for free draining raingardens in hard landscapes with brief periods of waterlogging			
Acer rubrum	'Autumn Flame'	Small to medium Tree.	Dry tolerant
Cratagus x media	Hawthorn 'Paul's Scarlet'	Small tree,	Dry tolerant
Cratagus mo-nogyna	Hawthorn	Medium shrub	Dry and exposure tolerant
Viburnum Opulus Roseum	Guelder Rose	Small shrub	Reasonably dry tolerant. prefers semi shade
Fushia mangellica	Hardy Fushia	Small to medium shrub	Dry, exposure and salt tolerant
Buddlia davidi	'Nano Purple'	Small to Medium shrub,	Tolerant of a wide range of conditions
Sambucus nigra (and cultivars)	Elder	Small to Medium shrub,	Tolerant of a wide range of conditions

The example species list is not exclusive

Other tree or shrub species could be considered if they are sufficiently robust, environmentally and climatically tolerant of conditions on site. Specification in general should follow the principles set out in the Edinburgh Design Guide Ch3.

Relevant Factsheets:

Street Trees (ESDG F5)

Raingardens (ESRWG W3)

Maintenance for SuDS Trees in Tree Pits and Trenches

Once established the level of maintenance needed by SuDS Trees in paving is similar to any other kind of street tree with the addition of twice yearly checks on vents and inlets and small amount of annual or bi- annual maintenance on surface drainage components.

Figure 18. Birch Street Tree Goldhawk Road, London | Google Maps 2019

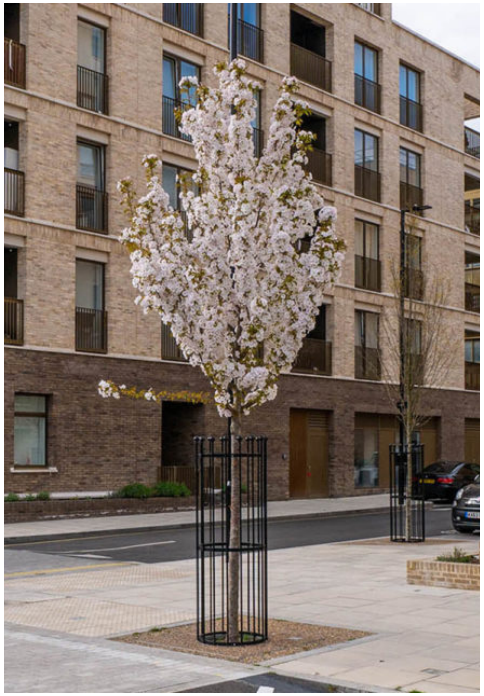


Figure 19. Kings Crescent, London | GreenBlueUrban

Technical references:

- CIRIA The SUDS Manual V6: E: Supporting Guidance, Chapter: 32: Operation and Maintenance, p690

The Maintenance Plan

All SuDS features will require a maintenance plan that should include detailed specifications, frequency, timing, equipment and annual costs. SuDS features be regularly inspected and the maintenance monitored by a competent professional.

For all SuDS elements the contract maintenance period after construction should be 5 years.

Indicative Maintenance for SuDS Tree pits and Trenches	
Water new trees regularly in dry periods during establishment period (2-5 years)	Every 2 weeks in summer months as required
Water established trees in prolonged dry periods	As required
Check and clear water inlets and soil aeration vents	6 monthly
Clear leaf debris from water inlet channels	Annually (late November)
Remove grills (if used) and clean accessible water channels	Annually
Inspect, check and clean filter media in trough systems	Bi- Annually
Manage tree growth	Pruning as required

Relevant Factsheets:

Street Trees (F5)

Raingardens (W3)

Maintenance For Trees and Shrubs in Bioretention Areas

Once established the level of maintenance needed by SuDS Trees in bioretention areas is similar to any other kind of new tree or shrub with the addition of annual checks on inlets and small amount of annual maintenance on surface drainage components.

SuDS Trees and Shrubs in Raingardens and Bioretention areas	
Water trees in dry periods during establishment	Every 2 weeks in summer months as required
Water established trees in prolonged dry periods	as required
Inspect regularly	3- 6 monthly
Remove litter and leaf debris	3- 12 monthly depending on location and amount of litter (include late November for dead leaves)
Replace or top up mulch layer (if used)	Annually or as required
Manage vegetation	As required to maintain attractive healthy planting, allow for pruning back shrubs in autumn
Remove self -seeded invasive species and woody seedlings such as sycamore.	6 monthly
Soil spiking and scarifying	As required (depending on sediment levels and soil type) every 5- 10 years

Relevant Factsheets:

Street Trees (F5)

Raingardens (W3)

Figure 20. Trees in bioretention Areas | Arup/Landscape Institute

All SuDS features will require a maintenance plan that should include detailed specifications, frequency, timing, equipment and annual costs. SuDS features should be regularly inspected and the maintenance monitored by a competent professional.

For all SuDS elements the contract maintenance period after construction should be 5 years.

Technical references:

- CIRIA The SUDS Manual V6: E: Supporting Guidance, Chapter: 32: Operation and Maintenance, p 690

Frequently Asked Questions and Clarifications

1. What is a SuDS tree?

A SuDS tree is a tree planted as a functioning part of an engineered drainage system and as a result has different requirements to conventional urban tree planting.

- **Street trees in proprietary SuDS tree pits or trenches** will include drainage layers or piped inlets, root support/ root training, engineered soils, and under drainage allowing surplus water to discharge.
- **Street Trees and shrubs in large raingarden**s, which may be lined or unlined and will include engineered soils, drainage layers and underdrains allowing surplus water to discharge. (can also include root support / root training structures).
- **SuDS Trees in open greenspace** – where land drains to damp woodland planting within a low lying area. Very damp sites include appropriate drainage to allow surplus water to discharge avoiding waterlogging).

2. What are the benefits of SuDS trees?

SuDs trees can play a significant role in helping to manage surface water on site.

While all trees provide environmental benefits, SuDS trees also provide significantly greater levels of rain water management.

3. Should SuDS trees replace conventional tree planting ?

No, not all trees are or need to be SuDS trees. SuDS trees should be planted where they can make an effective contribution to surface water management in addition to conventional urban trees.

Some locations may not need the extra drainage capacity of a SuDS system or for example in a conservation area may require locally characteristic tree planting not suitable for SuDS (such as small leaved Lime).

However when planting conventional street trees reduced water benefits can still be gained by including SuDS elements (such as permeable paving) as part of

4. Do SuDS trees need to be replaced every 20 years?

No, there is no need to remove established trees for maintenance.

If planted in tree pits constructed to an appropriate standard SuDS trees in engineered systems should have a natural lifespan. The tree pit should be of sufficient size to allow the tree to reach maturity (concrete sewer rings are not acceptable).

5. How much extra maintenance do SuDS trees require?

Maintenance for SuDS trees is largely the same as a conventional urban tree with the addition of occasional inspections of water inlets and any surface drainage mediums.

6. Why does the example specification not include more native species?

In some locations or type of SuDS feature it will be possible to include native species, in others hybrids or trees from harsher climates may be more suitable. This factsheets deals specifically with urban trees in hard landscapes:

- **Street trees in proprietary SuDS tree pits or trenches** need to be to adapt to sudden changes from very wet to very dry. Few native tree species (adapted to our mild damp climate and gradual seasonal shifts) have that capability. Of those few (such as Alder) most need to be excluded from Edinburgh on street environments due to their high allergenic pollen production.
- **Street trees and shrubs in large raingardens** can include native and non-native small trees, shrubs or multi- stemmed specimens if appropriate to site conditions.
- **SuDS Trees in open greenspace** can include a range of native and non-native shrubs and trees that tolerate damp and occasionally waterlogged ground.

Image References

Figure 1. SuDS Dundee Trial Tree Pit | BlueGreen Urban
Image courtesy of GreenBlue Urban. [taken n.d.]

Figure 2. SuDS Dundee Trial Tree Pit | BlueGreen Urban
Image courtesy of GreenBlue Urban. [taken n.d.]

Figure 4. King's Road, Harrogate, North Yorkshire | DeepRoot
Image courtesy of DeepRoot. Deeproot, (2015), *Kings Road Street Trees* [ONLINE]. Available at: https://www.flickr.com/photos/deeproot/18904470586/in/album-72157652418555073/ [Accessed 1 December 2019].

Figure 3. Fitting a SuDs Tree Pit into a street | Atkins
Diagram courtesy of Atkins

Figure 5. Hull Town Centre | DeepRoot
Image courtesy of DeepRoot. DeepRoot, (2017), *Street Trees. Hull Capital of Culture* [ONLINE]. Available at: https://www.flickr.com/photos/deeproot/36468498982/in/album-72157685182639414/ [Accessed 1 December 2019].

Figure 6. Street Tree, Fountainbridge Edinburgh | Google Maps 2019
Google Maps, (2018), Bainfield Drive, Fountainbride [ONLINE]. Available at: https://www.google.co.uk/maps [Accessed 1 December 2019].

Figure 7. Ruskin Square, Croydon | J & L Gibbons
Image courtesy of J.L Gibbons / Sarah Blee
Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/031_18_04_24_susdrain_suds_awards_ruskin_square_croyden.pdf. [Accessed 1 September 2029].

Figure 8. SuDS tree build out | GreenBlue Urban
Diagram courtesy of GreenBlue Urban. Available at: https://www.greenblue.com/na/resource-centre/trees-and-water-sensitive-urban-design/

Figure 9. Swale/ rain garden with trees
Diagram courtesy of Atkins

Figure 10. Greener Grangetown, Cardiff | GreenBlueUrban
Image courtesy of GreenBlue Urban. [taken n.d.]

Figure 11. Damp Swale, Joyce Square, London | Robert Bray Associates
Brobert Bray Associates, 2018. *Bridget Joyce Square, London.* Available at: https://robertbrayassociates.co.uk/ [Accessed 1 September 2019]

Figure 12. Dry Swale, Dalmarnock Strain Station | SNH
Image courtesy of Scottish Natural Heritage [taken n.d.]

Figure 13. Table adapted from GreenBlue Urban: Trees and Water Sensitive Urban Design, p23
GreenBlue Urban, 2019. *Trees & Water Sensitive Urban Design*.p23 [online] Available at: https://www.greenblue.com/na/resource-centre/trees-and-water-sensitive-urban-design/

Figure 14. Fletton Quays | GreenBlue Urban
Image courtesy of GreenBlue Urban. [taken n.d.]

Figure 15. Tree Pit | Atkins
Diagram courtesy of Atkins

Figure 16. 5 Broadgate, Sun Street, London | GreenBlueUrban
DeepRoot, (2016), *Tree of Ludgate Hill: London 2016* [ONLINE]. Available at: https://www.flickr.com/photos/deeproot/31067537995/in/album-72157654939186725/ [Accessed 1 December 2019].

Figure 17. Methods of water inlet | GreenBlue Urban
GreenBlue Urban, 2019. *Trees & Water Sensitive Urban Design*.p16 [online] Available at: https://www.greenblue.com/na/resource-centre/trees-and-water-sensitive-urban-design/

Figure 18. Birch Street Tree Goldhawk Road, Lonodn | Google Maps 2019
Brobert Bray Associates, 2018. *Project: Goldhawk Road.* Available at: https://robertbrayassociates.co.uk/ [Accessed 1 September 2019]

Figure 19. Kings Crescent, London | GreenBlueUrban
available at: https://greenblue.com/gb/case-studies/kings-crescent-estate-london/ [accessed: October 2020]

Figure 20. Trees in bioretention Areas | Arup/Landscape Institute
Project: Greener Grangetown [online] Available at: https://my.landscapeinstitute.org/case-study/greener-grangetown/6ebfbcae-c8e5-e911-a812-00224801c242 [accessed October 2020]

Swales

Contents

What are Swales?

A swale is a grassed or vegetated shallow linear feature similar to a ditch that can gather, attenuate, and/ or convey surface water within a site.

Some swales will retain some water all year round while others may contain water at times of high rainfall. A swale can be used to gather and slow surface water allowing it to infiltrate the ground or may be lined and convey water to the next stage of the SuDS management train. The vegetation in the swale acts to slow water allowing sediment to settle out and reducing pollutants.

Small check dams in the form of earth mounds, rocks or kerbs can increase the storage capacity of a swale allowing water to slowly seep through the barrier into the next section. Steeply sloping sites check pools can be incorporated to create a form of terraced swale.

Biodiverse swales can be attractive landscape features providing wildlife habitat while carrying out practical drainage functions. Check dams can help to create a variety of damp or wet habitats supporting a range of native wetland plants and grasses.

The type of construction, function, planting and related maintenance requirements should be agreed with the adopting authority as part of the planning and design process.

Figure 1. Dry Swale, Queen Margaret University | Raeburn Farquhar Bowen

Figure 2. Wet Swale, Heriot Watt University | Raeburn Farquhar Bowen

Advantages of Swales

Swales are versatile features that can be tailored to carry out several SuDS functions in a variety of contexts

Swales are particularly useful for draining linear features like paths and roads

A well designed swale can be integrated into overall landscape design as an attractive feature

With appropriate design swales can provide valuable wildlife habitat

Disadvantages of Swales

Although low maintenance they do require regular maintenance including vegetation management.

As a shallow surface feature, a swale requires sufficient space so retrofit opportunities can be limited in narrow urban streets.

Biodiverse swales with established wetland planting (such as sedges and Iris) are less suitable for areas with frequent high flows.

Technical references:

- Edinburgh Design Guidance 4.
- Edinburgh's Sustainable Rainwater Management Guidance
- CIRIA The SUDS Manual section
- SUDS for Roads 4
- CIRIA Guidance on the Construction of SUDS

Typical Locations where Swales are used

Swales can form part of a SuDS network within the greenspace of a new development or provide drainage for linear features like roads or paths.

Swales in an inner-city urban environment may also be a linear green feature within a hard landscape with permeable paving or perforated kerb inlets. Guidance on fitting swales into urban streets can found in the ***Edinburgh Design Guidance section 4*** and ***Edinburgh's Sustainable Rainwater Management Guidance section B.***

Examples:

- Residential Developments
- Commercial/industrial Developments
- Roads and surfaced paths
- High density (dependent on design and available space)
- Retrofit (dependent on design and available space)
- Contaminated sites (with liner)
- Sites above vulnerable groundwater (with liner)

Swale in a residential setting

Figure 3. Upton, Northamptonshire | Susdrain, CIRIA

Swale situated in a car park

Figure 4. Swale in a car park | CIRIA

Swales in educational setting

Figure 5. Bridget Joyce Square | Robert Bray Associates

Relevant Factsheets:

Street Trees (F5)

Footway Zones (P3)

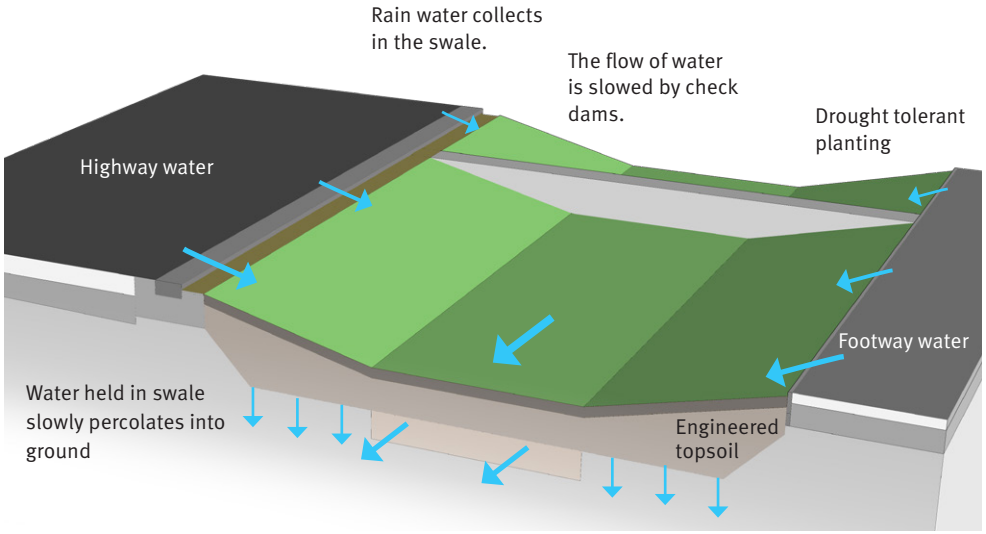
Street Furniture (F1)

Street Geometry & Layout (G1)

Alternative Types of Swale Construction

A swale is designed to collect sheet flow (rainwater moving over the ground surface) rather then as an "end of pipe" feature.

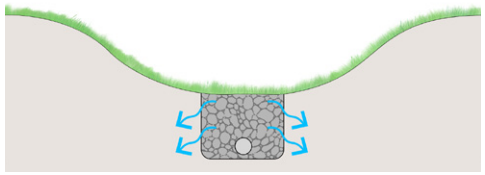
Water can enter a swale through inlets or 'over the edge' along the length of the swale. The type of swale construction will depend on its primary function (e.g.. infiltration, conveyance etc.), context and site conditions.



Technical references:

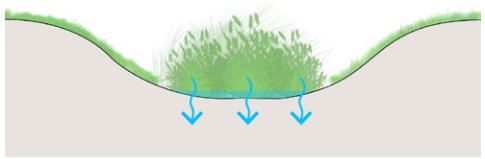
- Edinburgh's Sustainable Rainwater Management Guidance
- CIRIA The SUDS Manual (C753), Chapter 17: Swales, p312
- Guidance on the construction of SuDS C768, Chapter 30: Swales, p195

Dry Swale



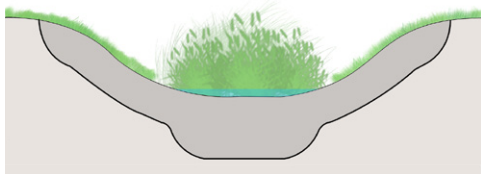
A dry grassy swale remains dry for most of the year and are used to manage surface water during high rainfall. Water is attenuated and soaks away into the soil.

Wet Swale



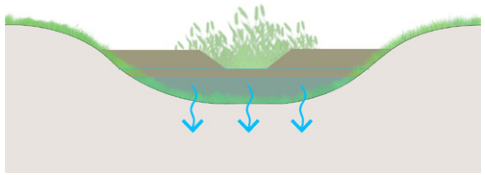
A wet swale is a, linear shallow biofiltration or linear wetland treatment system used to attenuate surface water. The wetland planting helps to filter sediment and nutrients, reduce water quantity and slows water flow. Useful in areas where soil is poor draining and flat areas.

Lined Swale



A lined swale would be used where infiltration is not possible either due to the nature of the soil or the surface water run off or where there is danger of ground water contamination. A lined swale can attenuate and convey water while using planting acts to filter and reduce water flows

Biodiverse Swale



A biodiverse swale may have lined and unlined sections to maximise habitat diversity. Large shallow biodiverse swales can include trees and shrubs.

Methods of Water Inlet

The simplest and most effective way for water to enter a swale is over the edge along its length. Water can also enter through a filter strips along a swale edge filtering sediment and pollutants. In hard surface areas 'over the edge' inlets be achieved by using perforated or flush chamfered kerbs. Water can also enter through a piped inlet (for example from a filter drain) if the depth of the pipe is sufficiently shallow.

Simple 'Over the edge ' water inlet

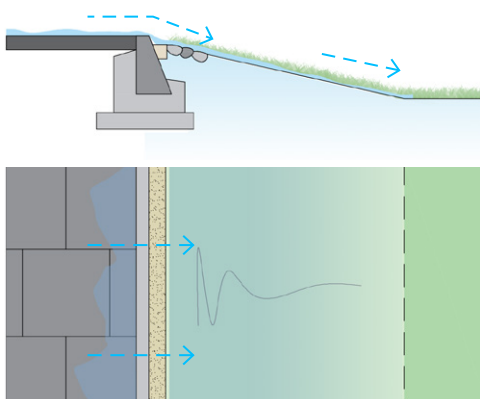


Figure 6. 'Over the edge' inlet | SNH

Using a filter strip to reduce pollutants

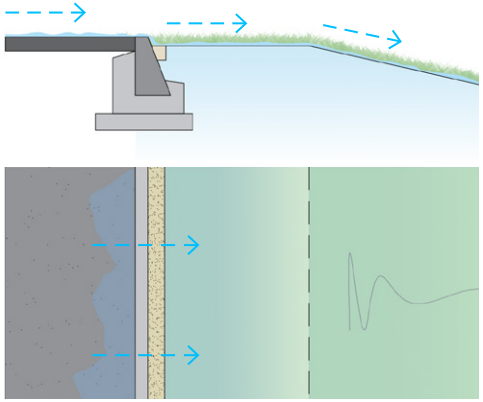


Figure 7. Swale with filter strip | RaeburnFarquhar-Bowen

Water inlets using kerb openings

Water inlets using disconnected down pipes

Figure 8. Queen Caroline Estate, London | Susdrain

water inlet via a piped connection

Technical references:

- CIRIA The SUDS Manual (C753), Chapter 28: Inlets, Outlets & Flow Control, p605
- Guidance on the construction of SuDS C768, Chapter 30: Swales, p179
- Susdrain.org

Key Design Considerations

Designing a swale

- ☑ **Do** consider SuDS design at from the outset of a project to maximise benefits and efficient land use.
- ☑ **Do** integrate the swale into the landscape design making it an attractive feature.
- ☑ **Do** make sure that levels and gradients allow water to move gently through the system avoiding ponding or rapid flows. The maximum flow velocity should be less than 2m/s, and less that 1m/s where possible.
- ☑ **Do** consider the Manning's roughness value of the type vegetation for the purpose of hydraulic design. (Typically, a Manning's roughness value of 0.250 should be use for treatment flows to 150mm depth, reducing to 0.100 for flow at the design depth of say 600mm (full capacity). For biodiverse swales with reeds and sedges this value will be higher).
- ☑ **Do** allow for a minimum 1 in 30 year rainfall event in the swale design.
- ☑ **Do** ensure that depths and gradients work for 'over the edge 'surface water flows from surrounding areas.
- ☑ **Do** ensure planting is appropriate to the habitat, soil type, moisture or water level (the base of a swale may require different planting to the drier banks).
- ☑ **Do** ensure inlet, outlet and weir designs are integrated into the landscape design as they may otherwise detract from the appearance of the scheme and be more vulnerable to damage.
- ☑ **Do** ensure that the swale base width is between 900mm and 2m.
- ☑ **Do** create consider silt and sediment traps at inlet and outlet points.

Don't design a swale with a linear gradient steeper than 1/40.

- ☒ **Don't** make the sides steeper than 1/4 for a planted swale or 1/6 for a grassed swale as they will be difficult to maintain, reduce the water storage and may be a safety hazard.
- ☒ **Don't** create a swale with a maximum flow velocity of more than 2m per second, wherever possible this maximum figure should be less than 1m per second.

Designing a Biodiverse Swale

- ☑ **Do** use soft naturalistic slopes and linear curves fitting the swale into the contours of the landscape.
- ☑ **Do** provide a variety of wet, damp and dry habitat.
- ☑ **Do** provide some planted areas along banks away from paths and disturbance to encourage wildlife
- ☑ **Do** ensure water quality that will allow plants and wildlife to thrive by providing some pre-treatment (filtering) of potential contaminants in the SuDS management train.
- ☑ **Do** use appropriate native planting of Scottish provenance
- ☑ **Do** consider mixing native and appropriate non native planting to increase biodiversity and improve climate resistance
- ☒ **Don't** plant invasive species such as Bulrush (Typha)

Construction Considerations

Construction checklist

- ☑ **Do** use good quality topsoil of the right depth and specification to allow vegetation to grow
- ☑ **Do** construct the swale near the end of a building project to reduce the likelihood of damage or contamination
- ☑ **Do** ensure the swale, inlets and outlets are at the correct depth to the to avoid unintentional ponding
- ☑ **Do** ensure the right geotextiles and pipes are installed
- ☑ **Do** allow vegetation to establish before connecting drainage into a swale to allow it to resist water flows, alternately use turf or seeded mats to prevent erosion during establishment.
- ☒ **Don't** allow the build-up of sediment during construction
- ☒ **Don't** compact soil during construction
- ☒ **Don't** construct a swale within the rooting zone of established trees, if the swale is within 5m of established trees consider if a root protection barrier is required

Figure 9. Swale during Construction | Sheffield City Council

Figure 10. Swale during Construction with erosion prevention | ARUP

Technical references:

- ESRWMG Section B
- EDG Chapter: 1,2,3 & 4
- Edinburgh's Biodiversity Action Plan
- RSPB guide
- CIRIA The SUDS Manual (C753), Chapter 17: Swales, p312
- Guidance on the construction of SuDS C768, Chapter 30: Swales, p195

Establishing Vegetation

Avoid exposing newly seeded or planted areas to rapid water flows that may wash away soil and seeds (allow one year for establishment).

Where there is an unavoidable danger of erosion before vegetation can be established banks can be turfed or covered in pre-seeded jute, coir or hessian mats to provide short term protection and aid soil stability while the plants establish.

Principles of Planting Specification

General Principals of Planting Specification

Suitable planting will depend on the type of swale, the context and the amount of ground moisture or retained water levels.

Amenity, visual appearance and biodiversity value may also be considerations. Swales next to busy roads may also need planting that has some tolerance to salt.

For all types of swale it is important to protect planting from erosion during establishment. (see *Construction Considerations p6*).

Various types of planting may be acceptable as an integral part of a wider landscape design if they satisfy the requirements of a SuDS system and are appropriate to the local context (see EDG3).

Technical references:

- ESRWMG Section B
- EDG Chapter: 1,2,3 & 4
- CIRIA The SUDS Manual (C753), Chapter 17: Swales, p312
- Guidance on the construction of SuDS C768, Chapter 30: Swales, p195

Use an appropriate professional to design and specify planting or seeding.

Shrubs and Trees

Large unlined biodiverse swales can include shrubs or trees that can tolerate a range of dry to damp conditions with short periods of waterlogging. Trees and shrubs are unsuitable in or in close proximity to lined swales due to potential for root damage to the liner. Trees and shrubs can also be planted along the banks of unlined swales to create a riparian corridor.

Tree species with potential to cause pollen allergy problems such as Birch should not be used in on street locations.

Figure 12. Vegetated swale at Queen Margaret University, | Raeburn Farquhar Bowen

Planting: Dry Swales

A dry swale can be planted with suitable low growing groundcover. In Edinburgh all grassed swales must have slopes no greater than 1/6 to allow future maintenance.

Grassy swales that are dry for most of the year need regular mowing or can be seeded with a slow growing low maintenance grass or native wildflower meadow that will need twice yearly or yearly mowing. All wildflower seed should be of Scottish provenance.

Planting: Wet Swales

In damp or wet swales marginal and emergent planting like sedges, iris and other wetland plants can be planted along the base with a dry meadow wildflower grass mix along the banks. Consider using plug planting (or a mix of seeding and plug planting) in boggy or wet sections of swale for faster establishment.

Figure 11. Dry Grassy Swale | Scotia Seeds

Maintenance

Routine maintenance will include removal of debris, clearing inlets and outlets, vegetation or grass management and periodic removal of silt.

In grounds under single ownership the maintenance of a swale is usually the responsibility of the landowner and may be managed by a factor or specialist contractor. For swales in public space or in association with roads or buildings in multiple ownership early consultation with the adopting authority is advisable.

Figure 13. Wet swale populated with invasive bull rush, Heriot Watt Campus | SNH

Technical references:

- CIRIA Guidance on the Construction of SUDS Section F chapter 30

The Maintenance Plan

All SuDS features will require a maintenance plan that should include detailed specifications, frequency, timing, equipment and annual costs. SuDS features be regularly inspected and the maintenance monitored by a competent professional.

For all SuDS elements the contract maintenance period after construction should be 5 years.

Typical Maintenance Requirements for a Swale

Action	Frequency
Remove debris and litter	Monthly for first year then 3 times a year
Inspection and clearance of inlets, outlets, overflows	Monthly in first year then three times a year
Grass cutting	In grassy swales cut monthly between spring and autumn – maintain at 100mm height. (Alternately plant low a maintenance SuDS mix or meadow grass and cut twice a year).
Removal of invasive species such as Bulrush (Typha)	Monthly in first year then three times a year
Vegetation management including replacement or reseeding of dead or damaged vegetation	Annually
Repair erosion or other damage, reinstate design levels and re-turf or replant	Every 5 years
Scarify and spike topsoil to improve infiltration and break up silt deposits	As required
Removal of silt build up to restore capacity (and if necessary, replant and reseed)	As required

Image References

Figure 1. Dry Swale, Queen Margaret University
Image courtesy of RaeburnFarquharBowen [taken n.d.]

Figure 2. Wet Swale, Heriot Watt University
Image courtesy of RaeburnFarquharBowen [taken n.d.]

Figure 4. Swale in a car park
Illman,S. Wilson, S, 2017. *Guidance on the Construction of SuDS C768*. p193

Figure 3. Upton, Northamptonshire
Susdrain, (2012), *Swale at Upton* [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/26098485748/in/album-72157669002326149/ [Accessed 1 December 2019].

Figure 5. Bridget Joyce Square
Robert Bray Associates, 2018. *Bridget Joyce Square, London*. Available at: https://robertbrayassociates.co.uk/ [Accessed 1 September 2019]

Figure 6. 'Over the edge' inlet
Image of swale at Dalmarnock Train Station courtesy SNH. [taken: n.d]

Figure 7. Swale with filter strip
Image of swale at Heriot Watt University courtesy of RaeburnFarquharBowen [taken n.d.]

Figure 8. Queen Caroline Estate, London
Susdrain, (2016), Queen Caroline Estate Image 3 [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/25100416897/in/album-72157689917356882/ [Accessed 1 December 2019].

Figure 9. Swale during Construction
Image courtesy of Sheffield City Council [taken. n.d.]

Figure 10. Swale during Construction with erosion prevention
CIRIA, 2015. Figure: 17.16 *Swale during construction*. p327. The SuDS Manual.

Figure 11. Dry Grassy Swale
Scotia Seeds, (2019), Dry Meadow Mix [ONLINE]. Available at: http://www.scotiaseeds.co.uk/shop/dry-meadow-mix/ [Accessed 1 December 2019].

Figure 12. Vegetated swale at Queen Margaret University
Image courtesy of RaeburnFarquharBowen [taken n.d.]

Figure 13. Wet swale populated with invasive bull rush, Heriot Watt Campus
Image of swale courtesy SNH. [taken: n.d]

Rain Garden

Contents

What are Rain Gardens?

Rain gardens are bio retention systems that are used to treat and manage frequent rainfall events by collecting water on the surface and filtering it through planting and drainage layers into the underlying soil. Alternately if infiltration is not possible or undesirable, then the rain garden can be lined and connected to an underlying drainage system.

A small rain garden can be used by a single property or integrated into public realm as part of new developments or improvements to existing streets. Larger examples can include small trees and shrubs. Rain gardens are usually less engineered than other bioretention systems and serve a small catchment from a road, pavement or roof. Rain gardens vary in scale and design, although they all follow the same design principles. The design and maintenance of rain gardens in public streets and spaces should be discussed with Edinburgh Council at an early design stage.

Although individually rain gardens may provide attenuation for relatively small quantities of surface water run off, wide implementation can cumulatively reduce water quantity while improving water quality. Rain gardens can also provide other amenity and health benefits turning urban rainwater management from a problem to a potential asset.

Pros	Cons
Can be easily retro fitted	Usually small in size and may have a limited individual impact on volume reduction
Can be attractive features within the urban realm	Not suitable for sites with steep slopes
Can reduce runoff rates	must be regularly maintained to work effectively
Open to creative design options	

Figure 1. Alma Road Rain Garden, London | Susdrain

Figure 2. Nicoll Circus, Millbrook Park | Google Maps 2019

Figure 3. Ruskin Square, Croydon | J & L Gibbons

Technical references:

- Edinburgh Design Guidance: Section 1, 2 & 3
- CIRIA The SUDS Manual V6: Part D, Technical Detail, Chapter 18 p386
- CIRIA Guidance on the Construction of SUDS C768

Fitting Rain Gardens into Streets and Urban Spaces

The design of a rain garden is flexible and can be scaled to the space available. This means that they are simple to retrofit into inner city streets revitalising small underused spaces, as part of street improvements or within the street furniture zone of wider pavements.

Rain gardens can also be community assets as part of a school, housing or play area or built in private gardens to manage roof run off.

Guidance on fitting SuDS (including rain gardens) into urban streets can found in the Edinburgh Design Guidance section 4 and Edinburgh's Sustainable Rainwater Management Guidance Section B.

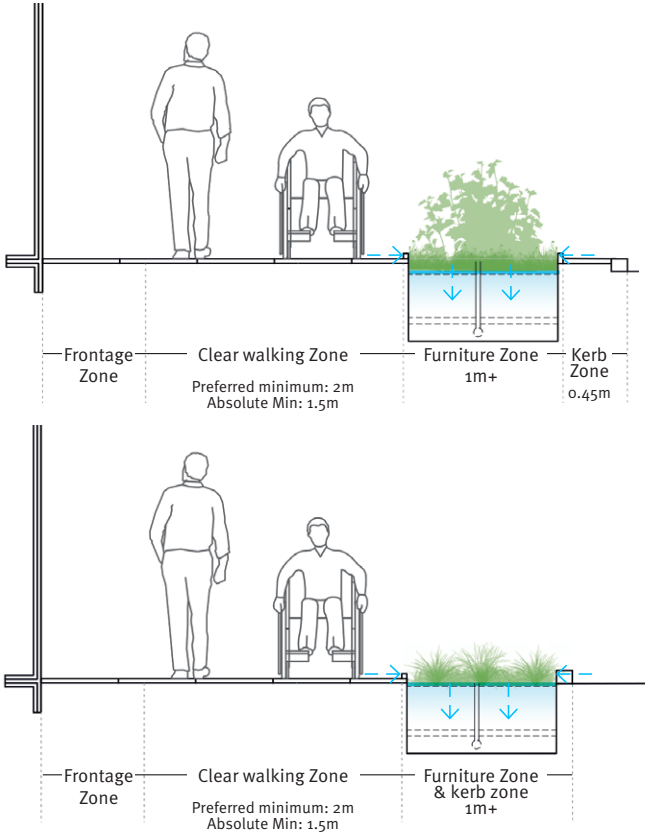
Figure 4. Basic, Levels of intervention | City of Edinburgh Council

Relevant Factsheets:

Street Trees (F5)

Footway Zones (P3)

Rain gardens can form part of traffic calming, parking bay or cycle lane separation designs. To comply with the clear curb zone set out in the EDSDGF planting in rain gardens adjacent to or within the road edge should not exceed 300mm in height.



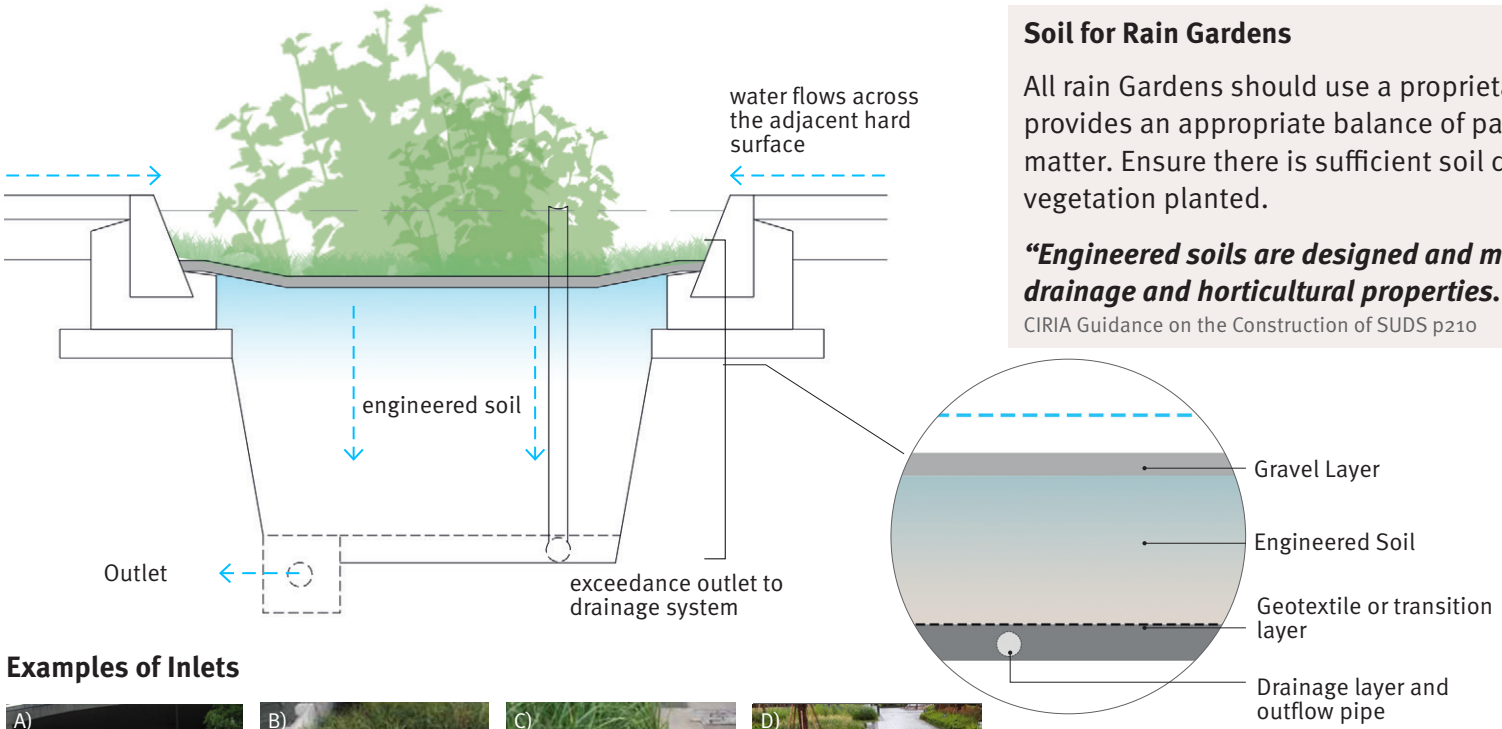
Street Furniture (F1)

Figure 5. Before - July 2012 Bridge Street, Sheffield | Google Earth

Figure 6. Before - May 2019 Bridge Street, Sheffield | Google Earth

Street Geometry & Layout (G1)

Construction Methods for Rain Gardens in Hard Landscape



Soil for Rain Gardens

All rain Gardens should use a proprietary engineered SuDS soil that provides an appropriate balance of particle size, nutrients and organic matter. Ensure there is sufficient soil depth to support the type of vegetation planted.

"Engineered soils are designed and manufactured to provide specific drainage and horticultural properties."

CIRIA Guidance on the Construction of SUDS p210

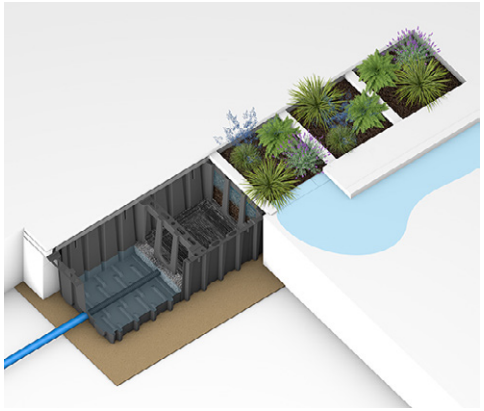


Figure 7. Modular rain garden | GreenBlueUrban

Examples of Inlets

Figure 8. Examples of kerb inlets - see reference list

Technical references:

- CIRIA The SUDS Manual V6: Part E, Supporting guidance. Chapter 28: Inlets, Outlets and flow control systems p605
- CIRIA Guidance on the Construction of SUDS C768. Chapter 12 Bioretention System, p187

Relevant Factsheets:

Street Trees (F5)

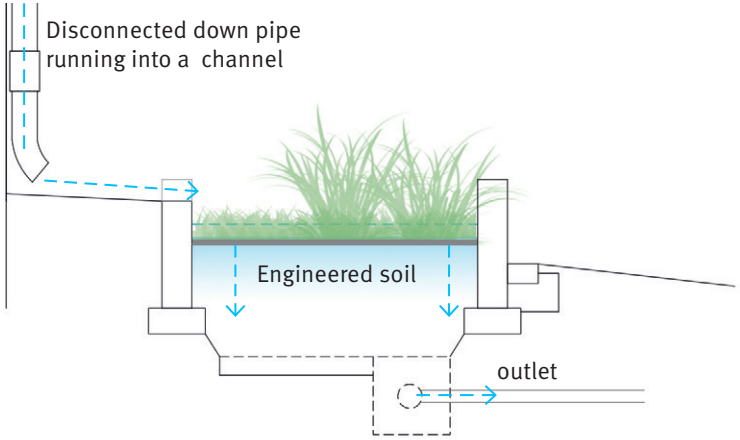
SuDS Trees (W1)

Footway Zones (P3)

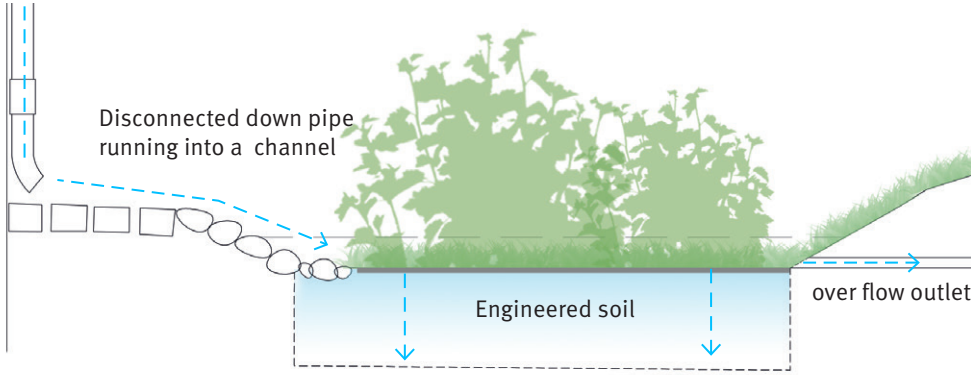
Street Furniture (F1)

Street Geometry & Layout (G1)

Construction Methods for Rain Gardens with Disconnected Downpipes



Rain garden with a disconnected down pipe where infiltration is not possible.



Rain garden with a disconnected down pipe with infiltration into the surrounding ground

Figure 9. Rain garden | sudsnet, Abertay University

Figure 10. Ashby Grove, London | CIRIA

Figure 11. Queen Caroline Estate, London | susdrain

Infiltration close to roads and buildings

- Check soil type and check that infiltration will not adversely affect any adjacent foundations of buildings roads or structures
- If suitable take a cautionary approach and half line the rain garden to drain away from foundations of buildings or structures

- ESRWMG Section B
- S.Wilson, Using SuDS close to buildings, Susdrain Fact sheet, September 2012

Design Considerations

Designing a rain garden

- ☑ **Do** design edge protection, typically, a rain garden is set below surface level and can hold standing water. Potential trip hazards or traffic hazards should be avoided.
- ☑ **Do** consider suitable entry and exit points for the water.
- ☑ **Do** consider erosion, control surface water runoff to through the rain garden. E.g. check dams, erosion matting and planting.
- ☑ **Do** consider site conditions in plant selection, including the need for pollution or salt tolerance (for example in road run off).
- ☑ **Do** test soil infiltration on site and ensure it is effective.
- ☑ **Do** consider where water can flow away safely if the rain garden is overwhelmed during heavy storms (exceedance).
- ☑ **Do** establish where water entering an under-drainage system will outfall and ensure you meet with appropriate standards and obtain permissions where necessary.
- ☑ **Do** insure that inlets are placed appropriately in relation to the camber of the road or pavement.
- ☑ **Do** consider the need for routine maintenance from the outset of design to prevent blockage and over sedimentation.
- ☒ **Don't** specify light organic mulches as they may cause blockages, gravels are more suitable.

Figure 12. Engineered soil used in rain gardens for Sheffield Grey to Green Scheme | Sheffield City Council

Construction checklist

- ☑ **Do** ensure geotextiles have the right level of porosity, if the membrane is too fine it may clog causing waterlogging which will kill the planting.
- ☑ **Do** insure that soil type for the rain garden is a suitable engineered SuDS soil that meets specifications.
- ☑ **Do** ensure the base of the rain garden is free draining before construction and backfilling.
- ☑ **Do** ensure that any under drainage is laid to the correct depth and gradient and meets relevant standards.

Technical references:

- ESRWMG Section B
- EDG Chapter: 1, 2, 3 & 4
- ESDGF
- Edinburgh's Biodiversity Action Plan
- CIRIA The SUDS Manual (C753), Chapter 18: Bioretention Areas, p332
- Guidance on the construction of SuDS C768, Chapter 31: Bioretention , p186

Planting Rain Gardens

Engineered soil for rain gardens and bioretention areas are free draining therefore planting needs to be robust, tolerant of dry conditions and occasional short periods of waterlogging.

- Planting schemes should consist of hardy low maintenance plants tolerant of prolonged damp and dry periods.
- Planting along very busy streets watered by road run off may need to have some resistance to pollution, road salt and exposure.

Depending on the context the planting in a rain garden may have a formal, informal or decorative character. Appropriate planting will also depend on the scale, depth of the rain garden and available light.

- Simple informal schemes might use low maintenance groundcover planting to provide interest and biodiversity value,
- larger schemes may include shrubs and trees, and
- more formal urban schemes may include decorative non-native planting.

Figure 14. Greener Grange Town Rain Garden Planting | Arup

Figure 13. Rain garden planting, Sheffield | Sheffield City Council

Planting for Wildlife Benefits

Where appropriate to location native plants, trees and meadow grasses in rain gardens can provide important natural resources. Ensure the selection of plants is suitable to the levels of light, moisture and exposure available.

Formal or decorative planting schemes can also provide biodiversity benefits by using cultivars of native species and non-native planting that provides flowers and berries.

Native wildflower seed or plug plants should be of Scottish provenance.

Planting Specifications

A wide range of plants could be considered acceptable as part of a wider landscape design if they satisfy the requirements of a rain garden and are appropriate to scale and local context.

Plant Specification should follow the principles set out in **EDG 3**.

Use an appropriate professional to design and specify planting or seeding.

Relevant Factsheets:

Street Trees (F5)

SuDS Trees (W1)

Maintenance

Routine maintenance of raingardens will include vegetation or grass management, annual removal of debris, clearing of inlets and the periodic removal of silt (if required).

Rain gardens on private property or within the grounds of institutions should be cared for as part of part of grounds or garden maintenance. No maintenance plan would be required for a single small domestic raingarden in private gardens.

The Maintenance Plan

All SuDS features will require a maintenance plan that should include detailed specifications, frequency, timing, equipment and annual costs. SuDS features to be regularly inspected and the maintenance monitored by a competent professional.

For all SuDS elements the contract maintenance period after construction should be 5 years.

Technical references:

- CIRIA The SUDS Manual (C753), Chapter 18: Bioretention Areas, p332
- Guidance on the construction of SuDS C768, Chapter 31: Bioretention , p186

Typical Maintenance Requirements for Rain Gardens	
Water new planting regularly in dry periods during establishment • 1 year for meadow grasses and short-lived perennials • 2 years for perennials and small shrubs • 3- 5 years for trees and large shrubs	Weekly or as required between spring and Autumn
Inspect regularly	3-6 months
Water established vegetation during prolonged dry periods	As required
Clear litter and leaf debris from water inlet channels and mulch	Annually (late November) or as required depending on location and amount of litter
Replace or top up mulch layer (if used)	Annually or as required
Manage vegetation including replacement or reseeding of dead or damaged plants	As required to maintain attractive healthy planting, allow for pruning back shrubs in autumn if required
Remove self -seeded invasive species and woody seedlings	Every 3- 6 months
Scarify and spike topsoil to improve infiltration and break up silt deposits	5 yearly or as required
Removal of silt build up to restore capacity (and if necessary, replant or reseed)	5 yearly or as required

Image References

Figure 1. Alma Road Rain Garden, London | Susdrain
Susdrain, 2018. Figure:9. p7 [online]
Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/alma_road_rain_gardens_london_v2.pdf [Accessed: 1 November 2019]

Figure 2. Nicoll Circus, Millbrook Park | Google Maps 2019
Google Maps 2019. Available here: https://www.google.co.uk/maps [Accessed: 1 November 2019]

Figure 3. Ruskin Square, Croydon | J & L Gibbons
Image courtesy of J.L Gibbons / Sarah Blee [taken: n.d]
Available at: https://www.susdrain.org/case-studies/pdfs/suds_awards/031_18_04_24_susdrain_suds_awards_ruskin_square_croyden.pdf. [Accessed 1 September 2029].

Figure 4. Basic, Levels of intervention
Diagram courtesy of Sheffield City Council [taken. n.d.]

Figure 5. Before - July 2012 Bridge Street, Sheffield | Google Earth
Google Maps, July 2012. Google Street View 2020. Available here: https://www.google.co.uk/maps [Accessed: 10 January 2020]

Figure 6. Before - May 2019 Bridge Street, Sheffield | Google Earth
Google Maps, May 2019. Google Street View 2020. Available here: https://www.google.co.uk/maps [Accessed: 10 January 2020]

Figure 7. Modular Raingarden | GreenBlueUrban
Image courtesy of GreenBlue Urban. [taken n.d.]

Figure 8. Examples of kerb inlets - see reference list

A) Alma Road
B) Ciria
C) Ciria
D) Unknown
E) Grey to Green, Sheffield
F) Queens Promenade | Atkins https://atkinsbookoflandscapes.com/posts/kingston.html
G) rue Garibaldi, Lyon | http://www.tdag.org.uk/uploads/4/2/8/0/4280686/garibaldi.pdf
H) Grey to Green, Sheffield

Figure 9. Rain garden | sudsnet, Abertay University
Image courtesy of Sudsnet, Abertay University
Alison Duffy, (2016), Rain Garden in Malmö, Sweden [ONLINE]. Available at: https://www.abertay.ac.uk/business/services/sudsnet/sudsnet-photos/rain-gardens/ [Accessed 1 December 2019].

Figure 10. Ashby Grove, London | CIRIA
Image courtesy of Susdrain, CIRIA

Figure 11. Queen Caroline Estate, London | susdrain
Susdrain, (2016), Queen Caroline Estate Image 18 [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/39260445824/in/album-72157689917356882/ [Accessed 1 December 2019]

Figure 12. Queen Caroline Estate, London
Susdrain, (2016), Queen Caroline Estate Image 18 [ONLINE]. Available at: https://www.flickr.com/photos/139555361@N08/39260445824/in/album-72157689917356882/ [Accessed 1 December 2019]

Figure 13. Rain garden planting, Sheffield | Sheffield City Council
Image courtesy of Sheffield City Council.[taken. n.d.]

Figure 14. Greener Gangetown Rain Garden Planting | Arup
Arup. 2020. Available online: https://my.landscapeinstitute.org/case-study/greener-grangetown/6ebfbcae-c8e5-e911-a812-00224801c242