

March 2015 – Issue Version 1

West of England Sustainable Drainage Developer Guide Section 2 Bristol Local Sustainable Drainage Design Guidance



At-Bristol Centre green roof retrofitted onto an existing flat concrete roof in 1999



Southmead Green Streets - concept visualisations © Ove Arup and Partners Ltd

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This guide has been prepared by Bristol City Council and is supported by the Environment Agency, the Lower Severn Internal Drainage Board and Wessex Water who have all been involved in its preparation. Technical assistance has been provided by Ove Arup and Partners Ltd and design by Bristol City Council.

Information on flood risk is available at www.bristol.gov.uk/page/environment/flooding-and-drainage

The document was endorsed by Bristol City Council in February 2015.

This is a living document and will kept under regular review. User feedback is welcomed through:
development.drainage@bristol.gov.uk

West of England Guide – **Section 2** Bristol Annex - Sustainable Drainage Planning Practice Guidance Note

West of England Guide – **Section 2** North Somerset Sustainable Drainage Design Guidance

Variations and details of other consents

Variations to Sub-regional Requirements

Each authority in the sub-region has reviewed the appropriateness of the non-statutory technical standards for sustainable drainage systems in conjunction with the National Planning Policy Framework and Planning Practice Guidance against their individual Local Plans, Local Flood Risk Management Strategies and supporting evidence bases.

The following individual variation from the sub-regional requirement for Bristol City Council is highlighted.

Electronic data formats

The Council's preference is for electronic rather than hardcopy submissions. Electronic CAD drawings should be in AutoCAD compatible formats, and GIS mapping in Arc GIS compatible formats.

No.	Non-statutory technical standards for SuDs in conjunction with NPPF and PPG	Local Variation to Sub-regional Requirement
S7	The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the development for a 1 in 30 year rainfall event.	As stated.

Other Consents

Other consents may be required under the Water Resources Act or Land Drainage Act for works in or near a watercourse. The granting of planning consent does not relieve the applicant of the need to apply for any such consent. For details of consents required contact the Environment Agency (work in or near a main river), internal drainage board (work in or near an ordinary watercourse in a drainage board area) or LLFA (work in or near an ordinary watercourse outside a drainage board area). For further information see: www.bristol.gov.uk/page/environment/carrying-out-work-watercourse



Our Vision

Our vision for sustainable drainage

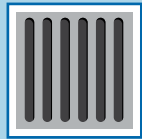
We consider sustainable drainage (SuDS) to be more than just a number of drainage techniques, systems or devices. Rather it is an approach to drainage that aims to drain a site in a sustainable way with consideration to water quantity and water quality, biodiversity and amenity. Our vision can be summarised through seven guiding principles:



Blue green corridors should be included within sites to provide physical links and multiple benefits. Consider the movement of water and its interaction with space at the earliest stage of design for efficient sustainable drainage. Identifying and enhancing drainage paths are an essential part of the master-planning stage.



Source control – managing runoff at source is the starting point for SuDS design



Drainage and urban design should be integrated in site development. Sustainable drainage should be integrated into urban realm design. Sustainable drainage provides an opportunity to create great places to live and work whilst managing water better.



No space is useless – Sustainable drainage is flexible. All areas of the site should be considered for inclusion of surface water management measures - roofs, landscaped areas and public open space all provide opportunities.



Cumulative impacts, both positive and negative, should be considered. Benefits should be provided no matter how small so that over time, the cumulative impact becomes significant.



Water quality mitigation and improvement are important considerations. Bristol intends to improve the quality of its watercourses. Discharge from all development sites should include water quality mitigation measures.



Innovation is encouraged. While certain design standards must be met, innovative approaches to managing surface water will be encouraged and considered on their merits.



Manage all risks on site through a proportionate risk based approach.

Area character

Topography, hydrology and principal drainage features

Bristol's city centre is a low lying area located at the confluence of the Rivers Avon and Frome within the tidal extent of the River Avon, originally tidal marsh. The city now extends north and east onto the adjacent hills rising to typically 90m AOD, and to the south to Dundry Hill at approximately 200m AOD. The River Avon flows from the central area towards the Severn Estuary 10km to the north-west through the Avon Gorge.

The catchment of the River Avon, sometimes called the Bristol Avon, is some 2300km². The main geological features of the catchment are the limestone Mendip Hills, the oolitic limestone Cotswolds and the chalk downs in the east, all of which are major aquifers affecting the hydrology of the catchment. Impermeable clays lie between the west-sloping strata of the limestone and the chalk, while sandstone and mudstone are exposed in the west of the catchment. The 1 in 100 (1%) annual chance fluvial flows are estimated at approximately 540m³/s in central Bristol¹. The flow regime of the River Avon is tidally influenced as far upstream as

Keynsham Lock. High tides often exceed Netham weir in the east of Bristol.

The River Frome rises on the west side of the Cotswold scarp slope near Chipping Sodbury to the north east and drains a predominantly clay and mudstone catchment, but also includes significant urban areas at Yate, Chipping Sodbury and the urban expansion of Bristol, particularly Bradley Stoke and Emersons Green. The catchment area of the River Frome to central Bristol is approximately 175km² and the 1% AEP (1 in 100yr) fluvial flows are estimated at approximately 70m³/sec at Eastville where the river enters the urban area².

The Floating Harbour is a man-made impounded water body stretching from Netham weir in the east of the city to Cumberland Basin in the western central area. It was constructed in the 19th century by diverting the tidal River Avon through a man-made tidal canal – the River Avon New-Cut. The water level within the harbour is maintained at a constant level of 6.2m above ordnance datum. The Floating Harbour main



¹ CAFRA workstream 3 Appendix E

² CAFRA workstream 3 Appendix E

inflow is from the River Avon at Netham Lock, the River Frome discharges to the harbour at St Augustine's Parade. The flow into the harbour is balanced by culverts and sluices at Underfall Yard which discharge into the River Avon New Cut. The Junction Lock stop gates and Netham lock gates are closed for every tide forecast to reach or exceed the normal harbour operational level.

Within the urban area, major drainage works have been undertaken in past years, most notably the Northern Storm Water Interceptor (NSWI) from Eastville to Black Rocks in the Avon Gorge, and the Malago Interceptor Tunnel in the southern parts of the city. These schemes are designed to collect and divert flows direct to the tidal section of the River Avon that would otherwise pass through low lying areas in the centre of the city. At present, the Malago Interceptor Tunnel and associated collecting tunnel system is considered to have adequate capacity to receive direct discharge of the upstream catchments.

Ashton, Malago and Brislington Brooks are small tributaries flowing into the River Avon from the south, draining heavily urbanised catchments approximately 17km², 16km² and 11km² respectively.



Surcharged surface water sewer in Withywood, November 2012



Surface water flooding at Whiteladies Road, November 2012

Ashton Brook is culverted in its lower reaches and discharges through flapped outlets into the tidal River Avon. The Malago has a storm water interceptor diverting flows from the upper catchment through culverts into the River Avon. The 'Airport Road tunnel' links the upper Brislington Brook catchment to the Malago interceptor and conveys further flow into the Malago interceptor system. The principal watercourses and drainage features in Bristol are shown in figure 3.

Watercourses are named on: www.bristol.gov.uk/sites/default/files/assets/documents/big-blue-map-of-bristol.pdf

References

Bristol Avon CFMP (2012)³, Bristol Frome FMS (2005)

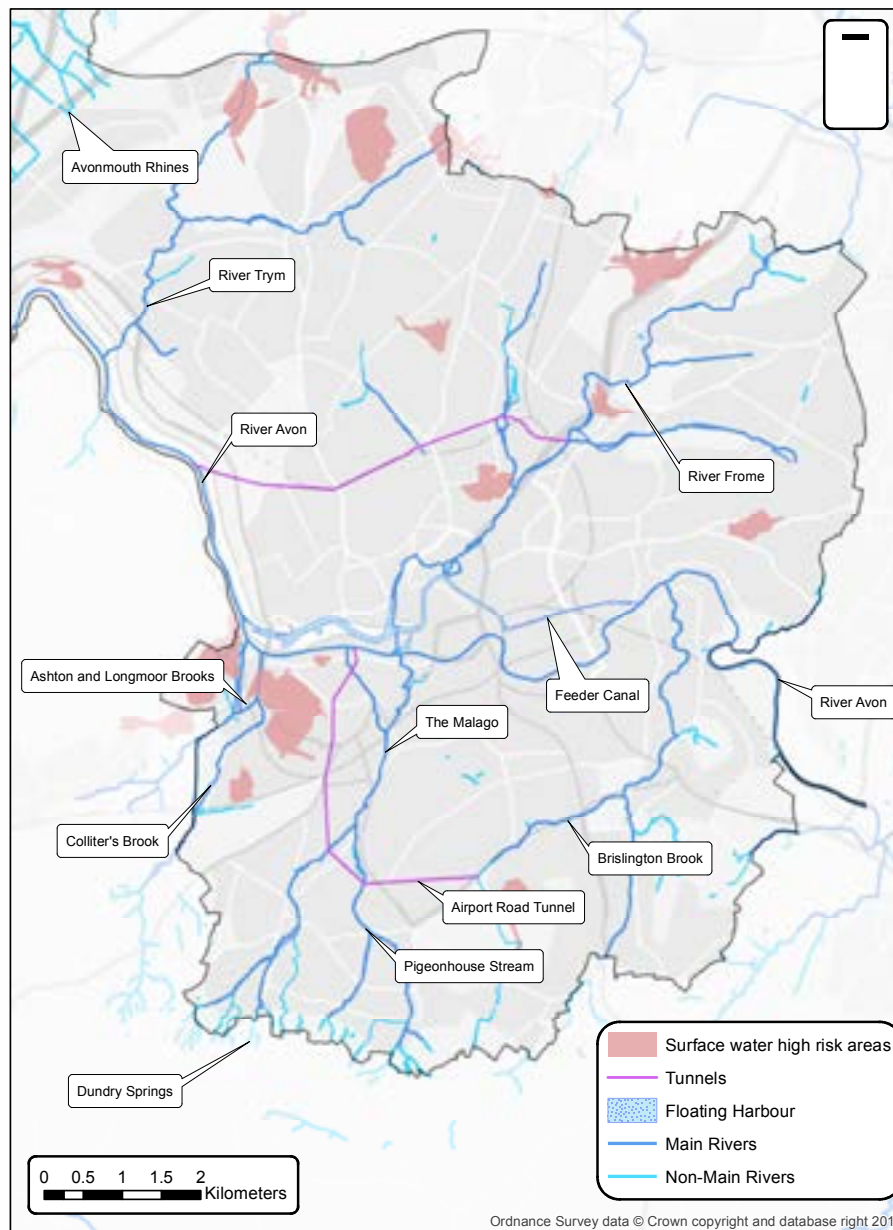


Figure 3: Plan showing main rivers and principal watercourses in Bristol (source: Bristol City Council), and Surface Water High Risk Areas (area identified as being at high risk to surface water flooding by the Surface Water Management Plan).

³ www.gov.uk/government/uploads/system/uploads/attachment_data/file/294182/Bristol_Avon_Catchment_Flood_Management_Plan.pdf

Surface Water Flood Risk

The predominant flood risk in the city central is from the tidal River Avon. Rising sea levels expected due to the effects of climate change will significantly increase this risk.

There is also a risk of flooding from a combination of tide and fluvial flows in either the River Avon or the River Bristol Frome. The River Avon's large catchment size delays peak flows from being experienced in Bristol until approximately 35 hours after the storm event, although the track of the storm can affect this. In the smaller River Frome catchment, peak flows are generally experienced some 12 hours after the storm event.

The city is also susceptible to flooding from severe rainstorm events such as that experienced in July 1968 when many catchments within the urban area were severely affected. This risk of surface water flooding within the urban conurbation is likely to increase as climate change increases storm intensity and frequency in the future. As described above, major interceptor tunnels were constructed in the 1970s to help to reduce the risks from these medium sized catchments to the lower central areas both north and south of the River Avon.

A Surface Water Management Plan (SWMP) has been produced to provide an assessment of potential surface water flooding that could arise from very heavy rainfall in the city. It identified the problem of drainage systems transferring additional runoff into the Ashton Gate area which exacerbates its surface water flooding problems. Other high risk areas were also identified in other areas of the city. The SWMP hazard maps can be viewed GOV.UK⁴.

References/Links:

In Bristol, surface water high risk areas (areas identified as being at high risk to surface water flooding by the Surface Water Management Plan) are available on our mapping portal: <http://maps.bristol.gov.uk/pinpoint/?service=localinfo&layer=Surface+water+high+risk+areas>

www.bristol.gov.uk/page/planning-and-building-regulations/flood-risk-evidence-planning-policy – Strategic Flood Risk Assessment, Surface Water Management Plan

www.bristol.gov.uk/page/environment/local-flood-risk-strategy-investigations-and-assessment – Local Flood Risk Management Strategy, Preliminary Flood Risk Assessment

Relevant Local Plan Policies:

- Core Strategy Policy BCS13 (Climate Change)
- Core Strategy Policy BCS16 (Flood Risk and Water Management)



Surface water flooding in November 2012 in Southmead

⁴ watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?lang=_e&topic=ufmfsw&layer=0&x=360500&y=175500&scale=10&location=Bristol%2c+City+of+Bristol#x=360503&y=175515&scale=7



Geology and Infiltration Potential

The British Geological Survey provide detailed published records of the Bristol area⁵.

These indicate that the solid and drift materials are very variable within our area. Broadly, the geology comprises Carboniferous, Triassic and Jurassic sedimentary materials, in filled with recent Quaternary deposits, particularly around the city centre and out towards the Severn Estuary.

Within the SuDS discharge hierarchy, infiltration is advocated as the first route of disposal of surface water runoff to be considered when developing runoff management options. Infiltration should be used where conditions allow and where it is safe⁶. The infiltration potential of a drainage system is governed primarily by the permeability of the surface geology. Whilst much of our area is likely to be unsuitable for any form of surface level infiltration drainage, due to the generally low permeability of much of the material, up to half may have some opportunity for infiltration, and a quarter has good opportunities for infiltration.

The outcrops of Carboniferous limestone north-west of the city centre are likely to be broadly suitable for infiltration style drainage providing the material is suitably

fractured. However, the practicalities of excavating through this material should be considered in parallel with the drainage design. If the material is locally less fractured, the permeability will decrease accordingly.

Some low permeability materials contain limestone and sandstone bands which could provide limited soakaway capacity if they are present on any particular site. Similarly, the Triassic sandstone outcrops and (although variable), the Carboniferous coal measures are likely to have some potential for soakaway drainage.

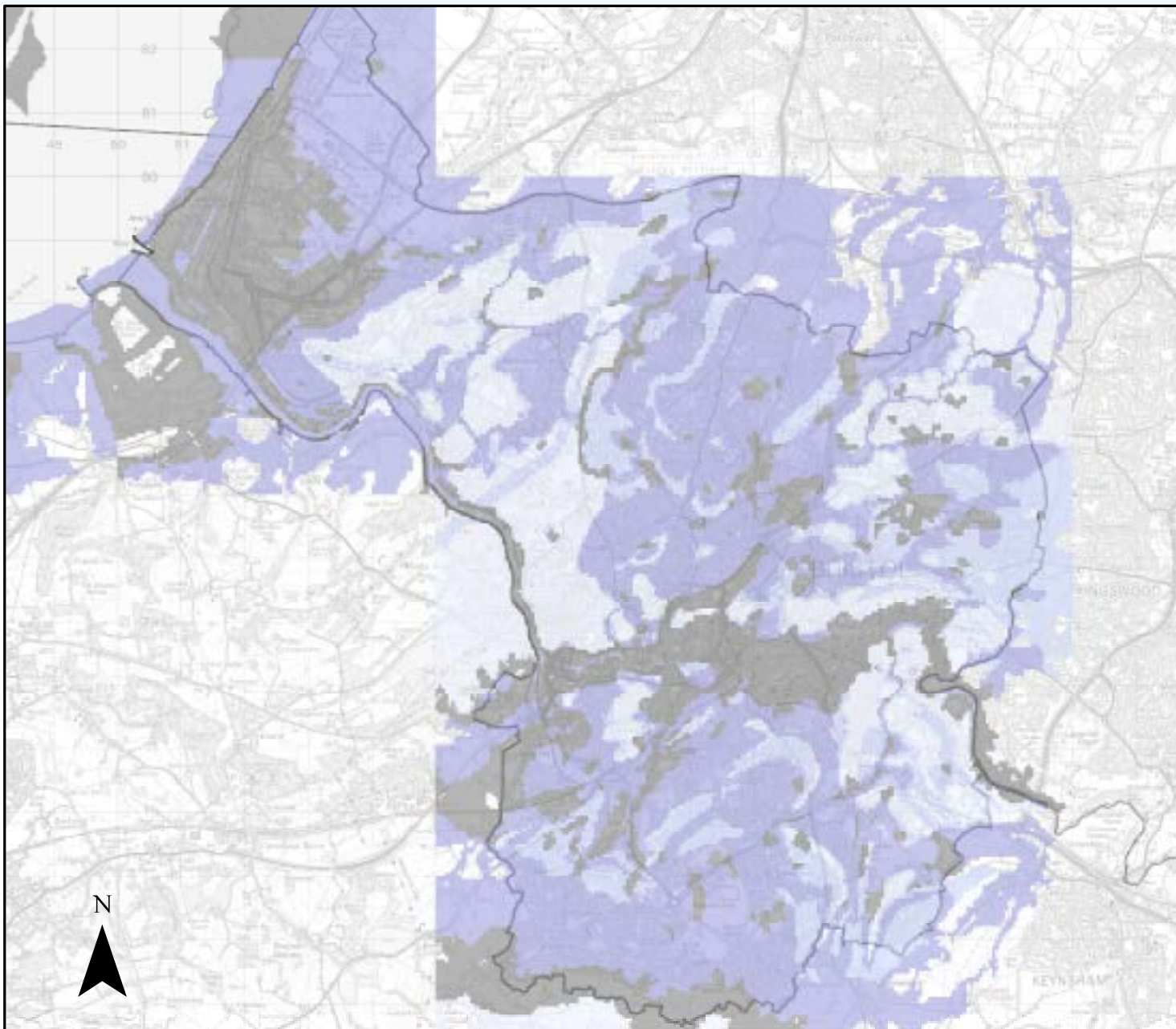
Figure 4 shows an outline summary for infiltration SuDS potential⁷. This map is not for local assessment and does not provide specific subsurface data or state the limitations of the subsurface with respect to infiltration. Site specific assessment should be made as required to determine the infiltration potential. This should be in the form of soakaway tests conforming to the procedure established in BRE Digest 365 – Soakaway design⁸, or various other permeability assessment techniques.

³ British Geological Survey. (2004). 1:50,000 Geology Series England and Wales Sheet 164 - Bristol. Solid and drift geology. Keyworth, Nottingham: British Geological Survey

⁶ www.susdrain.org/files/resources/SuDS_manual_output/paper_rp992_19_infiltration_assessment_checklist.pdf

⁷ www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html

⁸ BRE Digest. (2007). Soakaway Design. Bracknell: IHS BRE Press



Information displayed has been reproduced from the British Geological Survey Infiltration SuDS Map: Detailed Licence no. 2012/068SuDS

- Legend**
- Highly compatible for infiltration SuDS
 - Probably compatible for infiltration SuDS
 - Opportunities for bespoke infiltration SuDS
 - Very significant constraints are indicated

Drainage Summary

Drawn By: MS Date: 10 June 2014

Drawing No. 2014.06.10_BGS_1

0 0.75 1.5 3 km

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Figure 4: BGS Infiltration SuDS map⁹

⁹ www.bgs.ac.uk/products/hydrogeology/infiltrationSuds.html

Water Quality

The Water Framework Directive (WFD) establishes a common approach to managing water within the European Community and aims to achieve 'good' water ecological status for all water bodies and no deterioration.

Key actions to improve water quality are described in the Severn River Basin Management Plan¹⁰. Other strategies such as Bristol's Local Flood Risk Management Strategy and the Bristol Avon Catchment Flood Management Plan will have multiple benefits that will also help to improve water quality.

Since Bristol is at the lower end of the Bristol Avon catchment water quality is significantly influenced by the upstream water quality of the River Avon and its tributaries. However the urban environment of the Bristol area does exert its own particular stresses on the water quality of watercourses from sources that include diffuse pollution from the runoff from impermeable surfaces, storm water overflows and drainage misconnections. The sewerage systems within these urban areas often accept combined flows of foul sewage and storm water run-off and are under increased pressure during times of heavy rain and flooding. The sewerage system

in Bristol is a mixture of combined and separated systems, with most of the city centre on a combined system. At times of heavy rainfall, in order to avoid flooding of built-up areas, the combined system discharges excess flow into watercourses. These flows therefore have temporarily

greater faecal contamination than normal. The main source of water supply to the Floating Harbour (FH) is the River Avon from Bath, together with surface water systems discharging directly to the FH from the River Frome via Castle Ditch and St. Augustine's Parade.

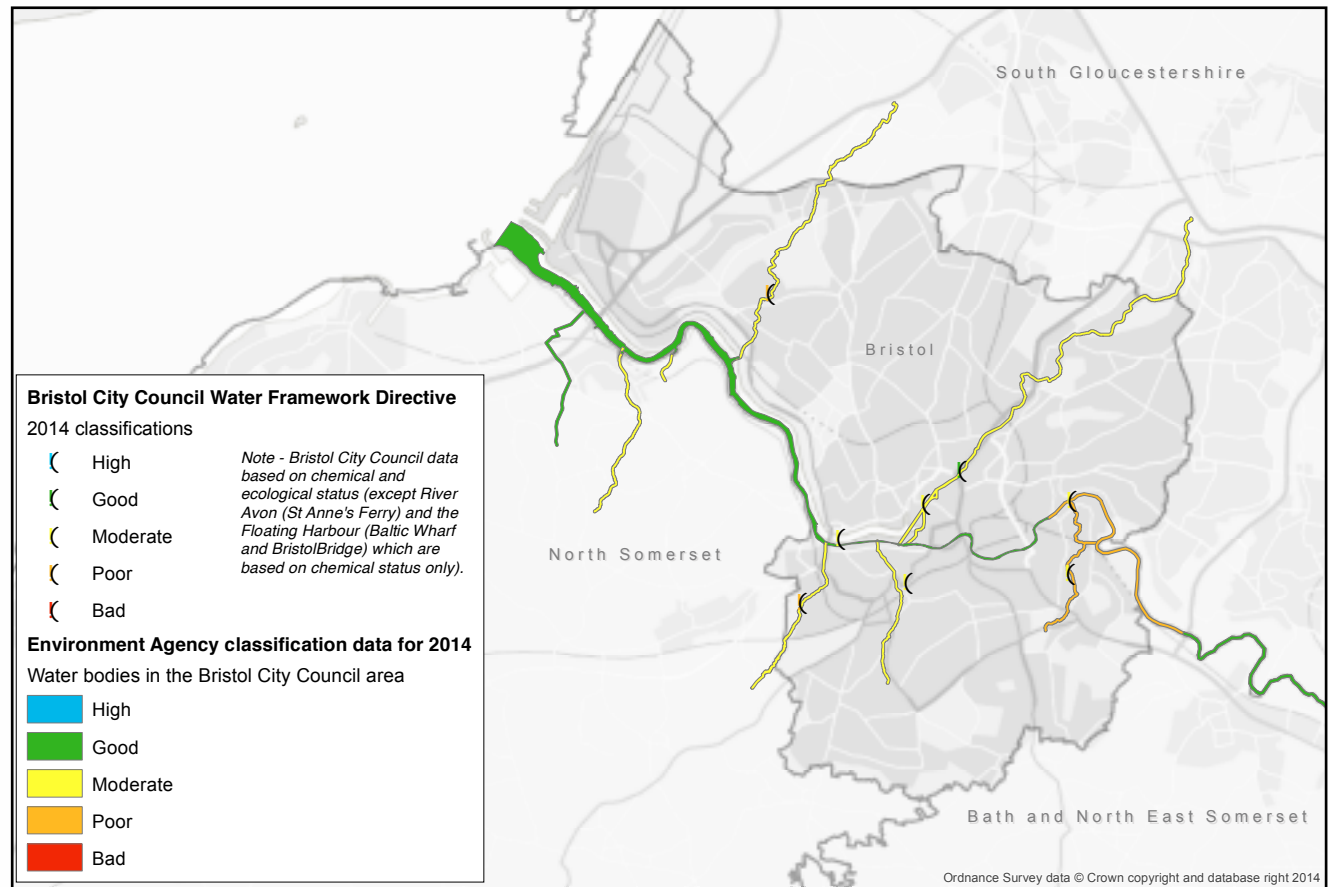


Figure 5: Waterbody classification data (Contains Environment Agency information © Environment Agency and database right). Note Bristol Avon downstream of Hanham Weir is an estuarine watercourse.

¹⁰ www.gov.uk/government/publications/river-basin-management-plan-severn-river-basin-district

Improving water quality in Bristol will improve the quality of habitats and biodiversity and the aesthetics of the water environment. The importance of mitigating and improving the water quality of discharges through SuDS from development is therefore of primary importance both in Bristol and vitally upstream where both flows and sediment loss can be slowed.

Policy DM33 of the Site Allocations and Development Management Policies document (adopted in July 2014) states that development adjacent to underground or surface water bodies covered by the WFD should contribute towards those water bodies maintaining or achieving Good Ecological Status. This may take the form of on-site measures or a financial contribution to off-site measures.

In terms of water quality the River Frome, Brislington Brook, Malago, River Trym and Colliter's Brook do not currently achieve Good Ecological Status due to quality of upstream and local flows which are affected by urbanisation, typically flood protection / land drainage works. To comply with the WFD water bodies should reach good ecological status or potential by 2027. Measures will therefore be sought from development adjacent to waterways covered by the

WFD, where feasible and viable, either through measures in the relevant WFD plans, local plans and initiatives and as a minimum recognised good practice such as naturalised river habitats, deculverting, buffers and appropriate vegetation management plans. A WFD compliance assessment may be required by the Environment Agency for such developments.

The River Avon is already at Good ecological status and this should not be allowed to deteriorate through development. As the FH is a primary amenity and economic asset to the city improving water quality is of major importance to the city and the focus on water quality improvement is required in the centre around the FH and further upstream to the north of the city.

Although the FH has not all yet been assessed and classified under the WFD, BCC is working with the EA to include it for designation in the second cycle and as such it will be BCC, as asset owners, responsibility to ensure the water body achieves Good Ecological Potential by 2027.

Since the FH is not a designated EU Bathing Water but has a significant amount of recreational use BCC undertakes routine bacteriological water quality monitoring for harbour users.

References:-

Bristol City Council FH water quality monitoring results - www.bristol.gov.uk/page/environment/harbour-and-rivers-water-quality

Relevant Local Plan Policies:

- Core Strategy Policy BCS23 (Pollution),
- DM33 (Pollution Control, Air Quality and Water Quality)



Bristol Drainage Strategy Drivers

The varied topography of the city, the presence of fluvial, impounded and tidal rivers passing through the urban area and the presence of intercepting tunnels to divert flood water away from the central area of the city results in a complex potential impact on the hydrology of the fluvial system close to the tidal limit.

As a result, an overarching drainage strategy has evolved over past years for different approaches to be applied to the discharge of surface water runoff in catchments close to the city centre and new development areas further upstream within the adjacent contributing catchments, supported by an increasing evidence base¹¹. This was used to inform our Local Flood Risk Management Strategy, adopted in November 2014.

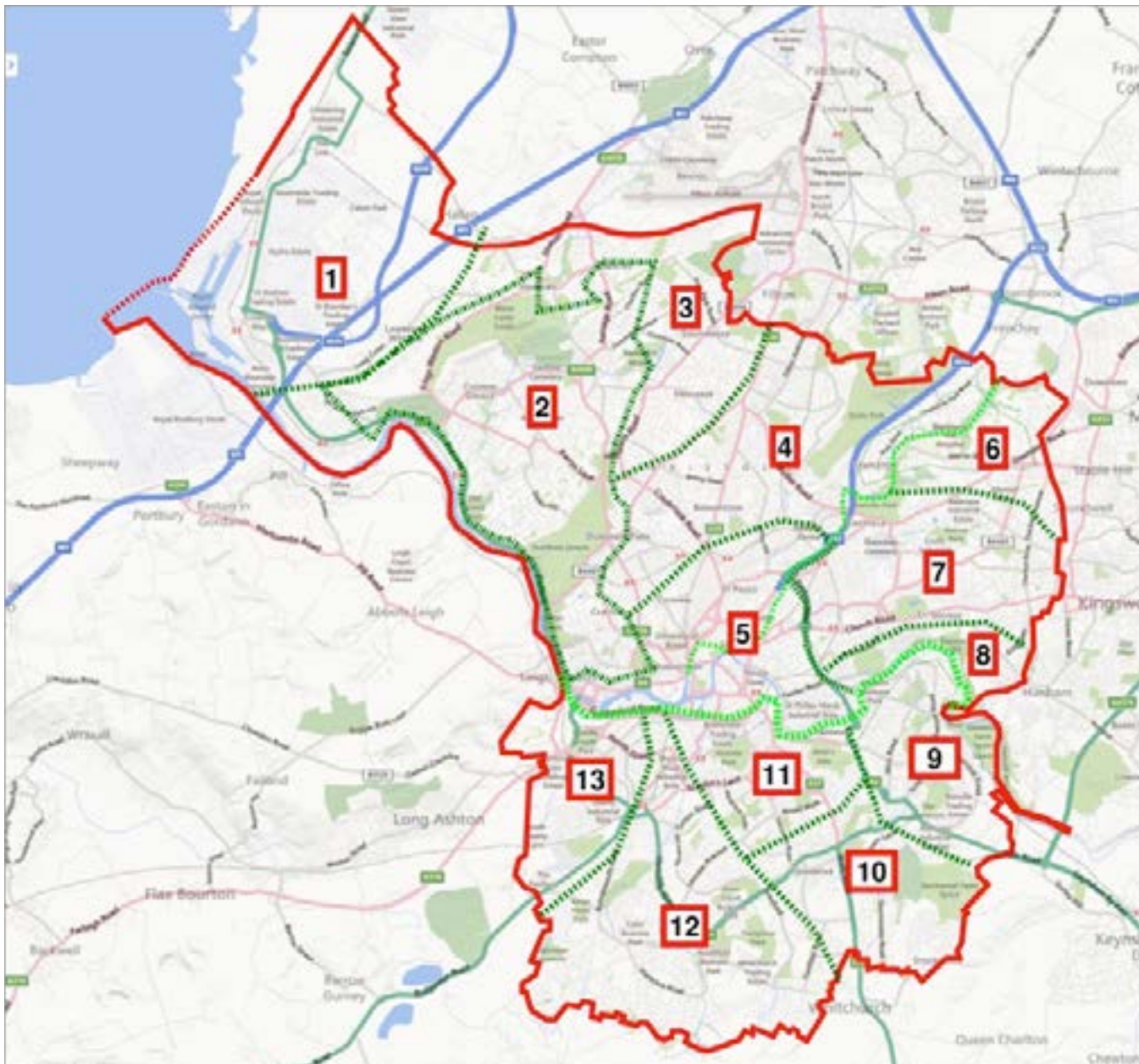
As Bristol is located low in the River Frome catchment and near the tidal limit, discharges from (re-)development within the urban area sited upstream of the NSWI are discharged as directly as reasonably possible within the capacity of the sewer system without introducing additional lag. This approach is applied to avoid the potential for interaction with

flood peaks from upstream catchments if significant lag was to be introduced through attenuation. A variety of objectives have developed in response to water quality goals and capacity constraints in downstream catchments. For surface water systems discharging to the FH for example, the enhancement of water quality is paramount in view of the amenity use of the FH and to satisfy Water Framework Directive requirements. In many catchments north of the NSWI however, subject to the capacity of the connecting sewerage system, it is desirable to discharge runoff as directly as feasible. A similar approach applies in catchments draining to the Malago tunnels.

The overarching drivers outlined in **Table 2** seek to indicate the likely spatially-variable drivers for surface water drainage of developments in Bristol. The boundaries between areas shown in **Figure 6** are indicative. We provides case-by-case advice on development above minimum risk thresholds. Developments should test the assumptions using site-specific characteristics as appropriate. Site-

specific information which should be sought and, if appropriate, the local sewer capacity through consultation with Wessex Water. The ‘natural’ water balance within a watercourse also is a factor. Reducing the peak flows is generally beneficial, but reducing the volumes can result in significant changes to overall flow characteristics. In some systems, reducing inflows at the top end of the system may detrimentally affect the watercourse base flow in summer months.

¹¹ Studies including the Bristol Tidal Strategy, the Bristol Frome Flood Management Study, the Level 1 and 2 Strategic Flood Risk Assessments and Central Area Flood Risk Assessment studies and the River Avon CFMP and Bristol Frome CFMP



1. Avonmouth and Lawrence Weston
2. Westbury Limestone and River Trym, Clifton
3. Southmead and Henleaze
4. North of Northern Storm Water Interceptor (NSWI)
5. Central area and Floating Harbour
6. Fishponds Brook
7. East Bristol
8. North of River Avon
9. Broom Hill and Brislington
10. Brislington Brook
11. Bedminster
12. Malago and Pigeonhouse tunnels
13. Ashton Gate

■■■■■■■	Boundary of zones
■■■■■■■	Main Rivers, boundaries of zones

Figure 6: Discharge Strategy Driver Areas (source Bristol City Council, Bing Maps)

	Discharge Zone	Overarching drivers	Reason
1	Avonmouth and Lawrence Weston	Surface water storage with consideration of tide locking.	A largely flat area with some ground levels below spring tides that requires storage during times of tide locking and consideration of existing rhyne system.
2	Westbury Limestone and River Trym, Clifton	Infiltration where possible, or reduction in discharge rate and water quality improvements.	Large areas of limestone with good infiltration potential (ref BGS Infiltration for SuDS Map). River Trym can respond rapidly and has “poor” water quality classification in places ¹² .
3	Southmead and Henleaze	Reduction from existing discharge rate, water quality improvements.	SWMP identified areas at high risk of surface water flooding. Water quality classification of Trym in Southmead “bad” ¹³ .
4	North of Northern Storm Water Interceptor (NSWI)	Limit discharge to capacity of existing sewer network or existing rate.	Majority of this area is drained to the NSWI, which diverts flow to the tidal Avon. Reducing discharge therefore considered to provide little benefit provided surface water sewer network has capacity. Reduction will be required where localised capacity issues are known; see the SWMP and WaSC.
5	Central area and Floating Harbour	Water quality mitigation and improvements. Reduction in existing discharge to combined sewers.	Testing of the Floating Harbour carried out weekly shows that water quality deteriorates after heavy rainfall ¹⁴ . Reduction in volume and rate of water discharged to the combined sewer network therefore required.
6	Fishponds Brook	Infiltration where possible, or reduction in existing discharge rate and water quality improvements.	Pockets of ground suitable for infiltration (ref BGS Infiltration for SuDS Map). Outside these areas, reductions in discharge rate are required because of the potential impact of the Fishponds Brook on the river Frome flows upstream of the NSWI. Water quality classification of Fishponds Brook “poor” ¹⁴ .

Table 2: Discharge Catchment Strategies for SuDS

¹² Studies including the Bristol Tidal Strategy, the Bristol Frome Flood Management Study, the Level 1 and 2 Strategic Flood Risk Assessments and Central Area Flood Risk Assessment studies and the River Avon CFMP and Bristol Frome CFMP

¹³ maps.bristol.gov.uk/pinpoint/?service=localinfo&mapttype=js&layer=River+water+quality+2013&sidebar=false&mapopts=legend&theme=none

¹⁴ www.bristol.gov.uk/page/environment/harbour-and-rivers-water-quality

	Discharge Zone	Overarching drivers	Reason
7	East Bristol	Reduction in existing discharge rate and water quality improvements.	Historically known to be at high risk of surface water flooding. Water quality classification of Coombe Brook “poor” ¹² .
8	North of River Avon	Infiltration where possible, or reduction in existing discharge rate in places.	Some areas with good infiltration potential (ref BGS Infiltration for SuDS Map). Where infiltration not appropriate, reduction in discharge may be required dependant on location; see the SWMP and WaSC.
9	Broom Hill and Brislington	Infiltration where possible, or reduction in existing discharge rate and water quality improvements.	Large areas with good infiltration potential (ref BGS Infiltration for SuDS Map). Brislington Brook is a rapid response catchment with history of flooding and has “poor” water quality classification ¹² .
10	Brislington Brook	Reduction in existing discharge rate and water quality improvements.	Brislington Brook is a rapid response catchment with history of flooding and has “poor” water quality classification ¹² .
11	Bedminster	Reduction in existing discharge rate.	History of flooding in this area with lower areas vulnerable to the effects of tide locking.
12	Malago and Pigeonhouse tunnels	Limit existing discharge to capacity of existing sewer network or existing rate.	Area benefits from the Malago and Pigeonhouse interceptor tunnels. Discharge at capacity of sewer network largely appropriate, though reduction will be required where it provides local benefits, particularly at the top of the catchment; see the SWMP and WaSC.
13	Ashton Gate	Reduction in existing discharge rate.	SWMP identified areas at high risk of surface water flooding, also vulnerable to the effects of tide locking.

Guidance for achieving discharge zone drivers

The following sections provide guidance on achieving the overarching drivers for each discharge zone. The zones are grouped in to similar overarching drivers to minimise repetition..

Group 1: Westbury Limestone and River Trym, Clifton, Fishponds Brook, North of River Avon, Broom Hill and Brislington

The overarching drivers in group 1 are to infiltrate where possible and safe, or provide a reduction in existing discharge rate and water quality improvements where infiltration is not possible. To achieve this, consider:

- Site specific ground investigation. Are infiltration rates appropriate for infiltrating SuDS techniques? Does contaminated land exist and does this restrict the potential for infiltration? What is the ground water level?
- Source control. Can surface water runoff be reduced by allowing it to infiltrate to the ground at source? Can infiltration features be integrated in to the landscape and development layout? Are green / blue roofs an option? Can downpipes be disconnected to reduce the area draining to the system?
- Discharge rates and attenuation. If infiltration is limited, what reduction in existing discharge needs to be accommodated? Speak to the LPA. Can partially infiltrating techniques be used? Can storage be provided above ground and can areas be designated to flood to reduce attenuation requirements? Can water re-use be included?
- Water quality. What sources of pollution are there to the receiving water body? How can these be mitigated? How can water concentration be minimised? Can water be passed over vegetated areas?



Group 2: Southmead and Henleaze, East Bristol, Brislington Brook, Bedminster, Ashton Gate

The overarching drivers in group 2 are to reduce existing discharge rate and provide water quality improvements. To achieve this, consider:

- Discharge rate and attenuation. Is the Greenfield rate reasonably practicable? If not then what is? Speak with the LPA. Can storage be provided above ground and can areas be designated to flood to reduce attenuation requirements?
- Site layout. If space is limited providing storage can be a challenge. Can a number of small drainage features be built up to avoid the need for large storage areas? Can impermeable area be reduced?
- Water quality. What sources of pollution are there to the receiving water body? How can these be mitigated? How can water concentration be minimised? Can water be passed over vegetated areas?



Group 3: North of Northern Storm Water Interceptor, Malago and Pigeonhouse tunnels

The overarching driver in group 3 is to limit discharge to the capacity of the sewer network. To achieve this, consider:

- What is the existing drainage regime? What is the existing runoff rate? Consider a CCTV drainage survey.
- Are there any known issues or benefits that mean a reduction in discharge is required? Speak with the LPA and WaSC. Check the SWMP.

Group 4: Avonmouth and Lawrence Weston

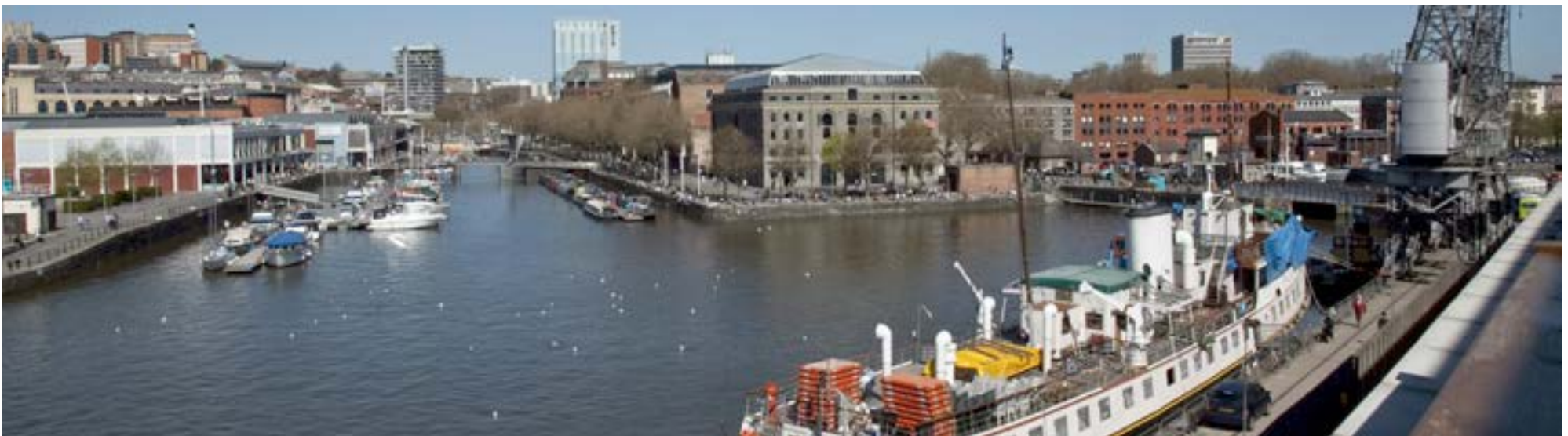
The overarching driver in group 4 is surface water storage with consideration of tide locking. To achieve this, consider:

- Existing features. A network of balancing ponds and rhynes exist in this area. Speak with the Lower Severn Internal Drainage Board.
- Tide levels. Can the site discharge during high tides? If not what mitigation is required? Consider ground levels and determine flood levels. Speak with the Environment Agency.

Group 5: Central area and Floating Harbour

The overarching driver in group 5 is for water quality mitigation and improvements, and a reduction in discharge to combined sewers. To achieve this, consider:

- Combined sewers. Does the existing site connect to the combined sewer system? How can discharge volume to the combined network be reduced or eliminated?
- Can source control measures be used to reduce the volume of surface water?
- Location. Is the site located near to the Floating Harbour? How will diffuse pollution be managed? Can discharge rate be unrestricted? Speak with the LPA.



Sustainable Drainage Design Principles and Good Practice

Common Considerations

We recognise that a large number of developments in Bristol will be on previously developed sites that present specific challenges.

Some considerations on previously developed sites are common to all regardless of location.

Concentration of flow – concentrating flow from a large area in to a single discharge point increases flood risk and causes significant pollution problems. Limit this by discharging flow to multiple areas across the site.

Existing infrastructure – previously developed sites may be constrained by existing infrastructure. Identify these constraints early and discuss with the LPA. Historic systems may not be suitable for present day requirements and therefore may need to be changed or replaced.

Limited space – inner city sites are often squeezed for space. Innovative solutions will be required to make space for water. This may include denser occupancy in some parts of the site to make other parts of the site available. Source control

and reduced impermeable areas are good ways of making the most of available space, and more efficient than traditional approaches.

Exceedance – any type of drainage system can be exceeded, it is therefore vital that exceedance is managed so that it does not become uncontrolled flooding. Because exceedance was not historically considered, buildings were occasionally sited in flow routes which resulted in flooding of property. This approach is not sustainable and site layout must be managed to

General SuDS Design Reference List

The list below outlines key and emerging legislation and guidance likely to be useful for the design and construction of Sustainable Drainage Systems (SuDS) elements.

This list must not be considered as an exhaustive list as design guidance and product development is continually evolving.

- The Water Performance Directive 2000/60/EC.
- National Planning Policy Framework and December 2014 Written Ministerial Statement
- Planning Practice Guidance and related Technical Standards for Sustainable Drainage
- Building Regulations Part H, Drainage and Waste Disposal.
- Biodiversity Action Plans.
- Environment Agency Pollution Prevention Guideline PPG 3.
- British Standard BS 7533-13:2009. CIRIA The SuDS Manual, C697.
- CIRIA Source control using constructed pervious surfaces, C582.
- CIRIA Designing for exceedance in urban drainage
- a good practice, V635.
- CIRIA Site handbook for constructing SuDS, C698.
- Environment Agency Drainage Details.
- Highway Agency Drainage and Construction Details.
- BRE 365 Soakaway design guide
- For outfalls, inlets, outlets and drainage details refer to Bristol City Council Standard Engineering Details¹⁵.

¹⁵ available at www.bristol.gov.uk/page/transport-and-streets/roads

Minor Development Design Considerations

Size thresholds

For residential developments, minor development is one where the number of dwellings to be constructed is between 1 and 9 inclusive. Where the number of dwellings to be constructed is not given in the application, a site area of less than 0.5 hectares should be used as the definition of a minor development. For all other uses, a minor development is one where the floor space to be built is less than 1,000 square metres or where the site area is less than 1 hectare.

Discharge and Storage Requirements

For small scale developments we recognise that it is not always practicable to undertake all of the relevant design considerations outlined in this guide. To help small scale developments, we have set the following discharge, storage and water quality requirements that will be deemed to satisfy the drainage requirements. However, it may be in the interest of the developer to undertake such preliminary design considerations so that storage (and hence cost) requirements may be minimised. The use of infiltration should always be explored and utilised, as the values shown in Table 1 are based on a system which does not allow for infiltration and therefore maximises storage requirements.

Total site area (ha)	Discharge (l/s)	Storage requirement
0 – 0.5	5	35 litres/m ² of impermeable area
0.5 < 1	5	30 litres/m ² of impermeable area

These figures have been estimated by restricting discharge from site to the average discharge rate from a typical greenfield site in Bristol¹⁶ with a consideration for a reasonably practicable minimum discharge rate. The storage requirement figures are based on the long term storage requirement resulting from a 1:100 year storm event with 6 hour duration, including an allowance for climate change.

Source Control SuDS

Source control SuDS will allow the attenuation volume to spread over different areas and keep water at or near the surface. Not utilising this will result in a significant attenuation volume in a single location and also make managing the peak discharge rate a potential problem.

Another benefit of source control SuDS is their ability to improve water quality and boost amenity and biodiversity. Rather than using a large attenuation tank, allowing runoff to discharge through a series of source control SuDS such as permeable paving, green roofs, rain gardens, etc. will reduce capital costs and the maintenance liability associated with a tank and flow control device.

¹⁶ This has been calculated using the ICP SuDS method based on data from the Bristol area

By utilising a series of source control SuDS there is the potential to have zero discharge from site; this will result in a reduced annual water bill for the occupier, reduction in downstream flood risk and improvement in overall water quality.

Source control measures also provide a treatment stage, for example: using a section of permeable paving will constitute a treatment stage, which cannot be achieved when using conventional gullies and asphalt. As gullies are not considered a treatment stage, utilising these will require the addition of a treatment stage, such as filter strip or swale, prior to discharging to the receiving water body/sewer.

Worked Examples

The following worked example shows how the above storage requirement and discharge rate is satisfied for a typical 7 house urban development.

Site Size (m ²)	872
Impermeable Area (m ²)	540 (450 for roof space, 90 for parking)
Max. Discharge Rate (l/s)	5
Storage Requirement (m ³)	25l * 540m ² = 13.5m³

Potential Solution - Permeable Paving

By connecting the roof areas into the permeable paved parking area for each individual house, the total volume is broken down to 1.9m³ per house. A typical parking space is 12.5m², therefore assuming a voids ratio in the sub-base of 0.3, the total depth of sub-base would be 0.5m. A flow control would be required to satisfy the maximum allowable discharge rate.

This solution would satisfy both water quality and attenuation requirements whilst also minimising excavation costs. This is therefore a very cost effective solution when compared to constructing a single 13.5m³ storage structure and associated water quality mitigation device.



SuDS Features Design Principles and Good Practice

The below section collates good practice design principles for each SuDS feature.

Swales

Description

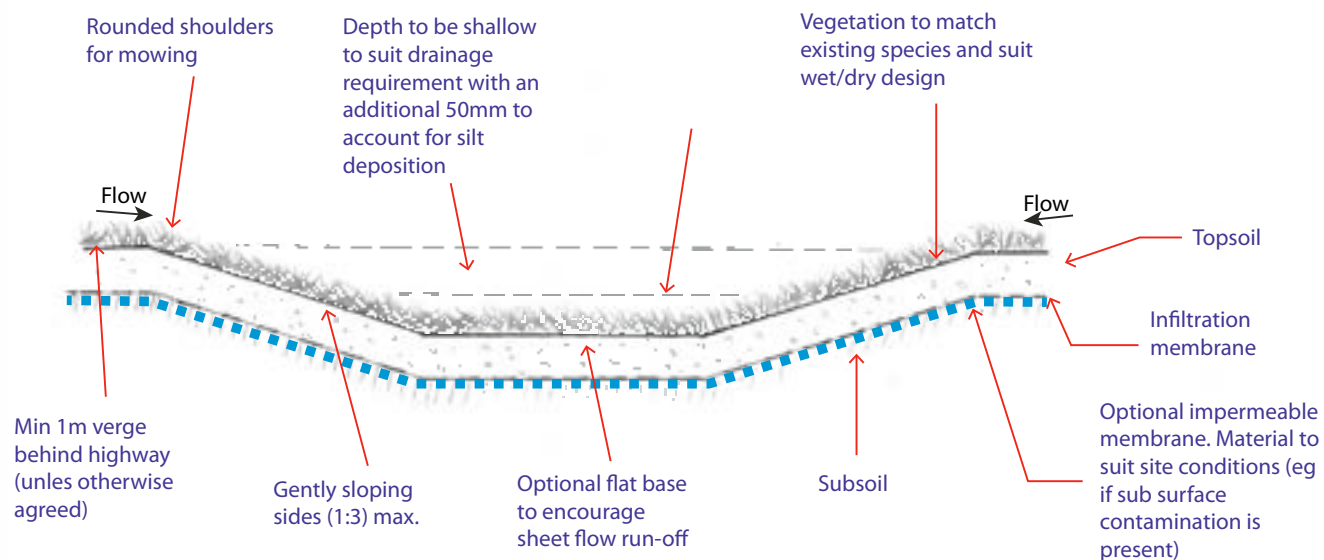
Swales are shallow channels that are used to collect and/or convey water and also remove pollution. They can be covered in grass or other vegetation and have shallow side slopes and a flat base, which means that for most of the time the water flows in a thin layer throughout the grass or other vegetation.

Swales are source control element of SuDS. The grass or vegetation slows the water down and traps some allowing it to soak into the ground. In addition, the plants help evaporate some water and filter out pollutants.

Swales can have a wet base, in which case they will behave like a wetland. In areas where a wet base is not desirable a perforated pipe, sand or gravel, can be installed below the bottom. This can promote water to ground.

Specific Design Considerations

The exact profile of swales will depend on specific ground levels, topography, ground and site conditions present at the site, as well as orientation, aspect and proximity to other landscape features and buildings. Bed width could be reduced to zero to maintain suitable bank gradient.



Where ground conditions do not allow for infiltration swales can be used as conveyance structures to pass the runoff to the next stage of the treatment train. Incorporating an impermeable membrane beneath the topsoil can help maintain some evaporation and infiltration.

The design should contribute to the amenity of the local communities. There should be an assumption to retain all existing native trees and vegetation.

Key Design Considerations and best practise

Maximum/minimum velocities should be considered to determine maintenance points within the swale (e.g. areas with lower velocity will have higher siltation).

- Infiltration rate to be confirmed by Developer and referenced to current site investigation. The impact of introducing water to ground shall be assessed and the risk of mobilising potential contaminants both within the site and on adjacent sites shall be assessed and provided to BCC for review and agreement.
- For infiltration swales, the permeability of the topsoil must be greater than the permeability of the underlying soils.
- Design to demonstrate no introduction of water to the lower sections of BCC adoptable footways and carriageways
- Primary pollution control might be required to suit site conditions.
- Pre-treatment is recommended to remove sediment and fine silts prior to infiltration (e.g. filter strips).
- Drop from adjacent surface onto swale to be 50-100mm for direct lateral flows.
- Design calculations shall be provided by the Developer to BCC and include an allowance for evaporation.
- Small piped outlets to swales shall have a minimum 150mm wide concrete surround laid flush to the ground profile (refer to BCC standard detail SD-05-010).
- Larger pipes shall have specific headwalls and scour protection (refer to details BCC standard detail SD-05-009)
- Check dams to be used where longitudinal slopes are steep to maximize storage and minimize land use where not appropriate. Locations to be proposed by the developer and a narrative provided to cover maintenance and silt removal.
- Check dams to be designed, placed and modelled to demonstrate conveyance velocity and storage by developer.
- Overland flood routing and swale capacity exceedance shall be considered and safe water routing identified as part of the design process.
- The lower section of a 2 part kerb drain unit can be used to discharge from highway to swale/pond and keep depths minimised. A plate will be required over the lower unit (refer to detail on Page 43).
- Where swales are adjacent to highways, refer to the Manual for Contract Documents for Highway Works (MCHW), edge of pavement drainage details that will provide good practice suggested details.
www.dft.gov.uk/ha/standards/mchw/vol3/section1.htm
- Where swales are adjacent to buildings, refer to the Building Regulations Approved Document H to ensure compatibility.

Items to Consider / Practical Issues and Solutions

Maintenance of the swale will be required as part of the overall site open space maintenance. If it is incorporated into the general maintenance regime there will only be some additional costs where swale related work needs to be undertaken above and beyond the cost of the general landscaping.

Frequency of maintenance to be reviewed and proposed by the Developer.

Item	Comment
Litter removal	Frequency will be site specific. This may be part of general landscaping maintenance.
Inspect control structures to swale	Control structures should be clear from debris and litter to reduce blockage risk and erosion to the structure.
Grass cutting	Swale design should aim to have rounded shoulders to assist cutting activities. Grass seed specification shall be confirmed by Developer including frequency of growth/cutting regime and suitability for location (e.g. north facing land/wet/dry/etc.).
Scrub/shrub clearance from bankside	The developer shall consider planting design, specification and rate of maintenance. (Consideration for future overhanging branches and encroaching growth undertaken).
Remove planting and silt from 25% to 30% of base and place in side piles.	The Developer shall consider areas in the design to accommodate this natural arising from maintenance. Carry out maintenance activities between Septembers – November if possible to minimise disruption to wildlife.
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.

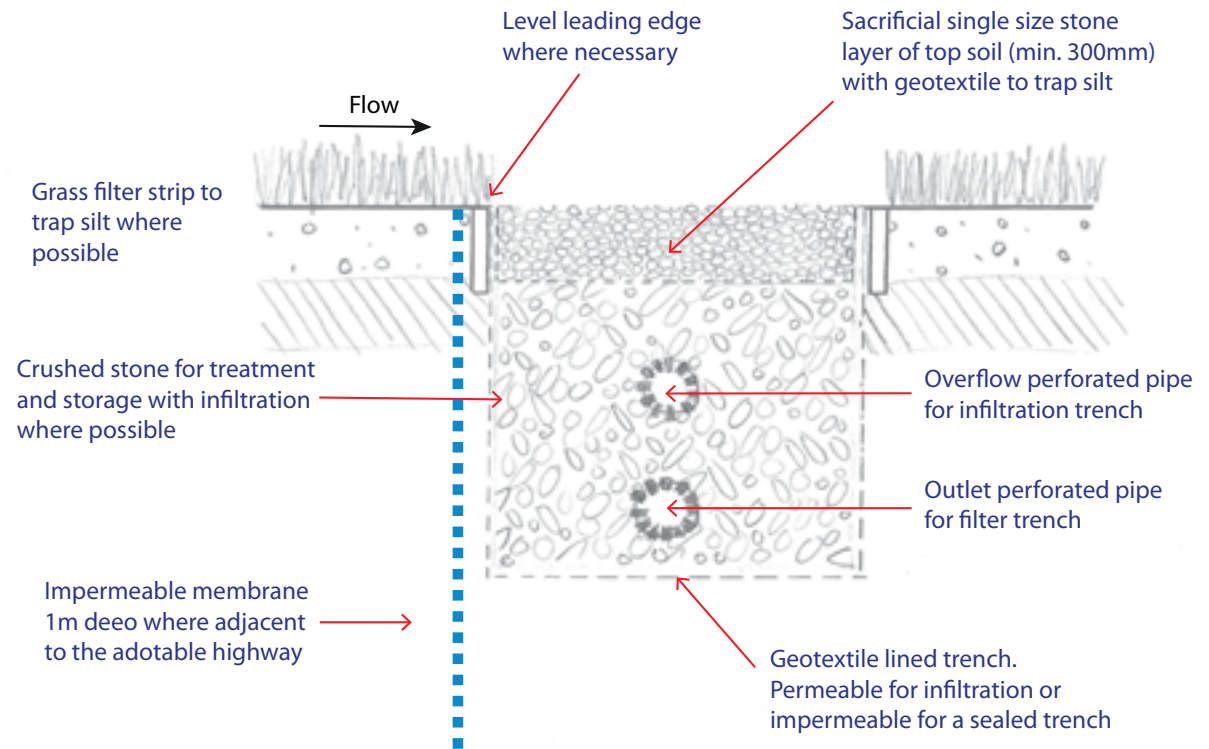
Issues	Solutions
Block movement	Laying to be undertaken in accordance with manufacturer requirements.
Block joint opening	Cleaning and sweeping to manufacture requirements. Re-grit where necessary after sweeping.
Clogging	Construction debris to be controlled and appropriate design levels of adjacent landscapes to prevent dirt entering the system.

Filter Drains / French Drains

Description

Filter drains – traditionally French drains are shallow excavations filled with gravel or stone, and often have a perforated pipe in the bottom. They collect, temporarily store water and convey it further to downstream

SuDS components. Filter drains are widely used to drain roads and are often seen along the edge of the main roads. Ideally, filter drains are expected to drain adjacent impermeable areas via lateral inflows, but point flows may be acceptable (to be confirmed with BCC).



Specific Design Considerations

Key Design Considerations and best practise

- Gently sloping grass verges (filter strips) a minimum of 1m in width to be incorporated in the design as means of pre-treatment. This is essential to remove silt and pollutants.
- For industrial areas, upstream treatment must be used before discharge to the filter drains. Refer to the Pollution Prevention Guidelines PPG3.
- In general to be used where no other SuDS feature will work. Developers shall confirm in the design submission why other SuDS features are not suitable.
- Effective upstream pre-treatment to remove sediment and fine silts.
- Filter drains can be used in conjunction with swales to create enhanced swales and act as a pre-treatment system.
- Size to suit catchment area, infiltration rate and groundwater levels to be provided by the Developer to confirm the design.
- Size of perforated pipe to suit storm events and infiltration rates.
- A minimum void ratio of 0.3 to be used for the fill material.
- Filter drains to be incorporated into site landscaping wherever possible.
- Filter drains are not suitable for use in trafficked areas.
- Design to ensure ground water is not transferred to the public sewers.
- Low level outlets to be used when designed for conveyance, high level overflows to be used when designed for infiltration.
- Where filter drains are adjacent to highways it is recommended that a verge is utilised between the road and the filter drain. Refer to the Manual for Contract Documents for Highway Works (MCHW), edge of pavement drainage details that will provide good practice suggested details. www.dft.gov.uk/ha/standards/mchw/vol3/section1.htm
- Filter drains to be used an adequate distance away from any building or septic tank. Refer to Building Regulations Approved Document H.

Items to Consider / Practical Issues and Solutions

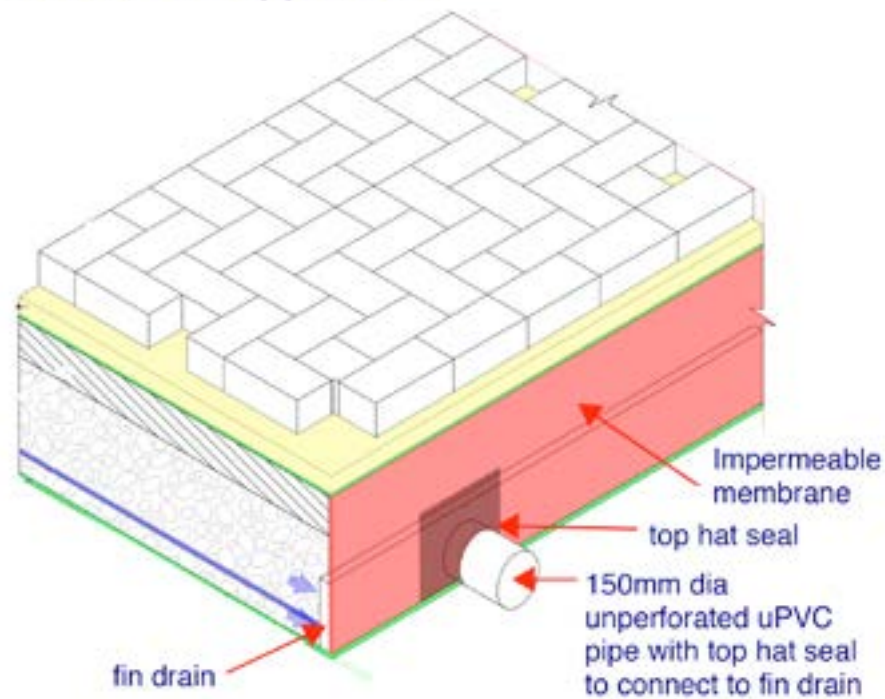
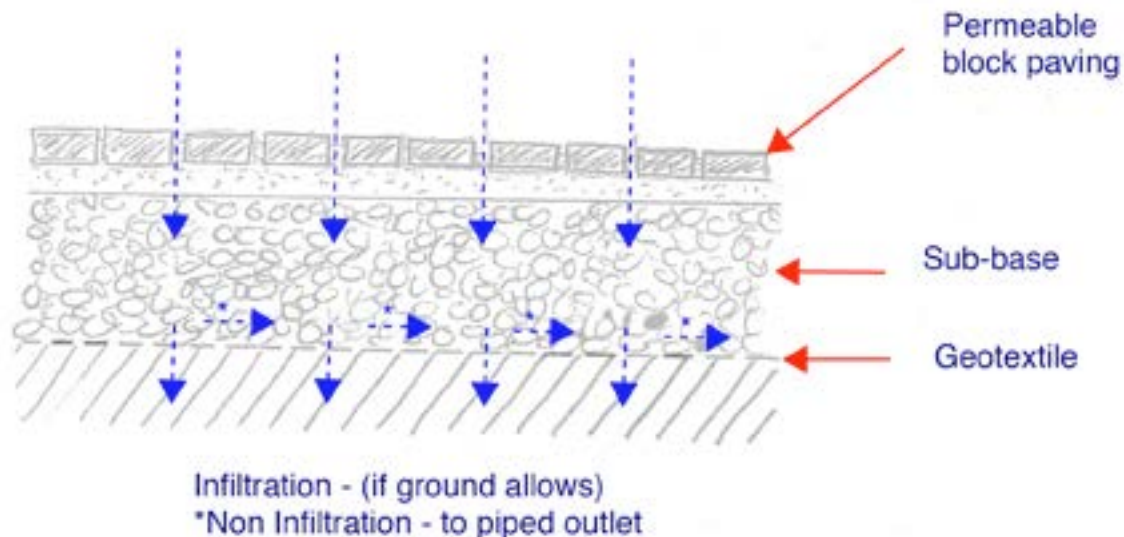
Item	Comment	Issues	Solutions
Sediment removal from pretreatment system	Special care must be taken for sites with high debris input.	Using impermeable membrane instead of permeable as pipe lining	Good communication between parties during design and construction. Pipe lining should be permeable and trench membrane can be either permeable or impermeable.
Vegetation clearance from sides to promote lateral runoff inflow	Vegetation closer to the filling material must be cut back regularly for best results.	Overgrowing of surrounding grass that causes the stone to be invisible at edges	Regular cutting of grass to keep a clear surface and reduce problems associated with mowing and stone.
Clogging inspection	Clogging is closely related to pre-treatment measures; the more effective the pre-treatment, the less clogging. Access to filter system is key for efficient use.	High siltation during construction	Construction runoff to be managed by other means of drainage and filter drains to be protected using geotextile traps.
Litter removal	Quantity and frequency will be site specific. This could form part of general landscaping maintenance.	Scattering of fill material when drains are adjacent to roads	Crushed rock can be used on top of fill material to reduce scatter. Rumble strips can also be used. Consideration of a grass verge or a filter strip to separate the adjacent drained hard surface and the filter drain.
Removal and cleaning or replacing the fill material	Cleaning and replacing the fill materials is more sustainable than disposing. Strip to be inspected regularly.		
Debris in perforated pipe	Pipe to be lined with geotextile material to prevent soil and other matter from entering pipe.		
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.		

Permeable Paving

Description

Permeable paving consist of blocks or porous asphalt that act as a source control measure. Water can be discharged to another system or temporarily attenuated before infiltrating into the ground. The paving itself can be of porous material that allows for infiltration across the entire surface area or impervious with voids in between to allow for water infiltration.

This is not the preferred option for BCC to adopt. Developers shall fully explore other SuDS techniques. If BCC were to consider adopting permeable paving systems, this will need to be at the head of any drainage system and will require agreeing commuted sums with BCC. As well as ongoing maintenance costs the full replacement value will also be added to any commuted sum.



Specific Design Considerations

Type of permeable paving for infiltration, attenuation or conveyance will depend on specific site requirements and infiltration rates. These will need to be confirmed by the developer and referenced to current site investigation. Information to be provided to BCC prior to construction. Commuted sums will be required by BCC to cover the maintenance costs for the life of the pavement use and development.

Key Design Considerations and best practise

- Developer must ensure that the design levels are appropriate. This is particularly important when discharging at certain levels downstream, considering overland flood routing in higher storm events and blockage of the pavement surface scenarios.
- Base of the paving system to be laid flat to maximise storage, or if installed on a sloping site, baffles should be considered to slow flows and promote maximum infiltration.
- Infiltration systems must not be used in contaminated site. Sealed systems may be considered subject to suitable material specification for the ground conditions.
- Appropriate geotextile membrane to be used to prevent sub-base clogging.
- Adequate distance between base of infiltration device and ground water table should be considered. Normally at least 1m clearance should be demonstrated between base of system and the seasonal variation ground water level. Information to be provided to BCC.
- The maximum designed water depth must not exceed the top of the sub-base.
- Where infiltration is not suitable (vulnerable groundwater or draining of pollution hotspots), sealed systems can be used.
- Storage capacity should satisfy the storm requirements, especially for steep sites.
- Sub-base storage must be an adequate distance from building foundations. Refer to guidance in the design reference list above.
- A preferable void ratio of 0.3 to be used for the sub-base.
- Depth of sub-base to be designed in accordance with BS7533-13 or TRL Report PPR 482.
- Sub-base specification and laying course to meet the requirements set in BS7533-13. Refer to the manufacturer's requirements for the blocks.
- Permeability of the surface layer must be greater than 5000mm/h.
- Avoid point inflows and consider inflows in the sub-bases.
- To be used in areas where traffic speed will not be more than 20mph. Not in public highways by possible in parking areas.
- Permeable pavements must be designed to satisfy the required traffic loads (axle loads) and frequency.
- Refer to Building Regulations Approved Document H for further information.

Items to Consider

Item	Comment
Organic matter and silt removal	For blocks and bituminous systems, regular vacuum brushing and jet-washing must be considered at the surface. Following cleaning, joints to be filled with small stone to maintain their interlocking design.
Weed growth	Weed removal and weed killer to be applied when needed.
Replacement of blocks	Relaying of blocks and impermeable membranes when in poor condition.
Outfalls	For sealed systems, inspection of outfalls should be undertaken regularly.
Warranty Terms & Conditions	Manufacturer’s warranty to be obtained by developer and provided to BCC.
Stockpiling	No stockpiling of materials to be held by BCC. The developer shall agree the modular block dimensions with BCC.
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.

Issues	Solutions
Block movement	Laying to be undertaken in accordance with manufacturer requirements.
Block joint opening	Cleaning and sweeping to manufacture requirements. Re-grit where necessary after sweeping.
Clogging	Construction debris to be controlled and appropriate design levels of adjacent landscapes to prevent dirt entering the system.

Soakaways

Description

Soakaways are underground excavations used to store surface water and allow it to infiltrate when conditions permit. The soakaway structure can either be lined with perforated brickwork or precast concrete rings.

Depending on how much storage is needed and land space available, either can be used.

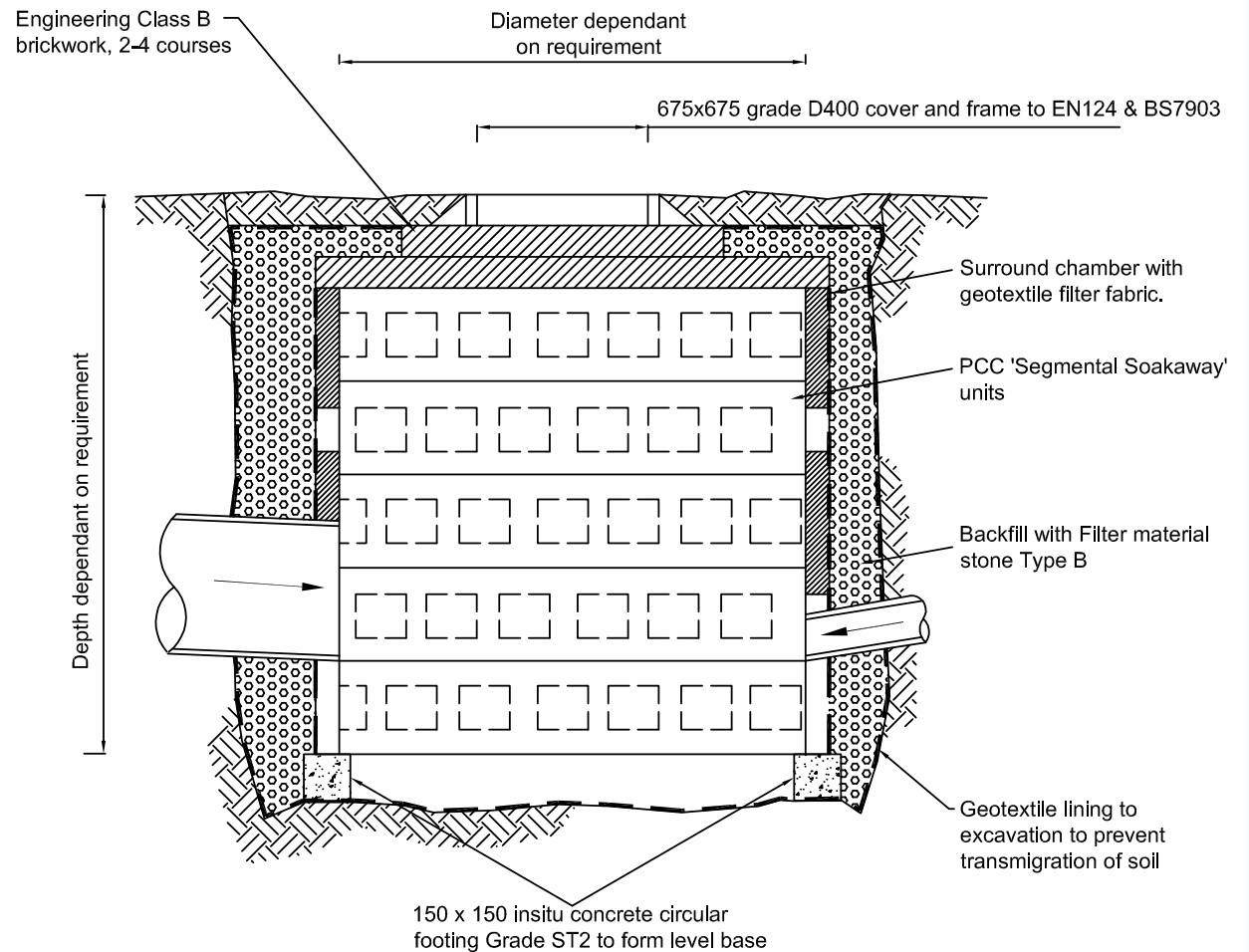
The type of soil is an important factor for the soakaways to work as they are highly dependant on infiltration. A series of soakaways can be used to increase the storage capacity.

Specific Design Considerations

Soakaways can be used wherever conditions are suitable for infiltration. Developers should provide ground investigation data before they can proceed with the soakaway design.

Key Design Considerations and best practise

- Soakaway design must allow for half capacity infiltration within 24 hours.
- Developers to provide infiltration rates and groundwater table information.
- Size to accommodate expected runoff in accordance with BRE guidelines.
- Soakaways not to be used in contaminated sites.



Source: Bristol City Council , Drawing SD05-006 (detail subject ot change)

- Outfalls from soakaways not be connected to public sewers, unless agreed with BCC. However, discharge can be released to another SuDS element downstream.
- Sediment control measures to be considered when discharging to other systems downstream.
- Filter strips and/or swales and /or downstream propriety silt removal units to be used as means pre-treatment to reduce velocities and catch coarser sediments.
- External wall of chambers to be lined with geotextile layer to prevent silt from entering the system. Observation wells/ inspection tubes must be provided for considerably large soakaways.
- Soakaways must not be constructed to influence vulnerable ground groundwater, drinking water wells, septic tanks, buildings or highways.
- Areas upstream of the trench should be stabilised for health and safety reasons and to prevent collapsing of soil
- Refer to Building Regulations Approved Document H and BRE Digest 365.

Items to Consider

Item	Comment
Sedimentation	Debris to be removed from the pre-treatment device to prevent clogging. Catchment areas to be cleaned regularly.
System failure	Soakaways to be inspected in accordance with BCC drainage requirements for the area and on regular intervals throughout the design life.
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.

Issues	Solutions
Finding soakaway locations for maintenance	Inspection access to be provided. This will help locate the soakaways.
Polluted run-off	Pre-treatment may be required for polluted sites (e.g. petrol interceptors for car parks and car wash-down areas).
Failure of structure	Soakaway design must ensure that the structure is stable and has sufficient strength. Soil stabilisation around the soakaway chamber must be certified.

Detention/Infiltration Basins

Description

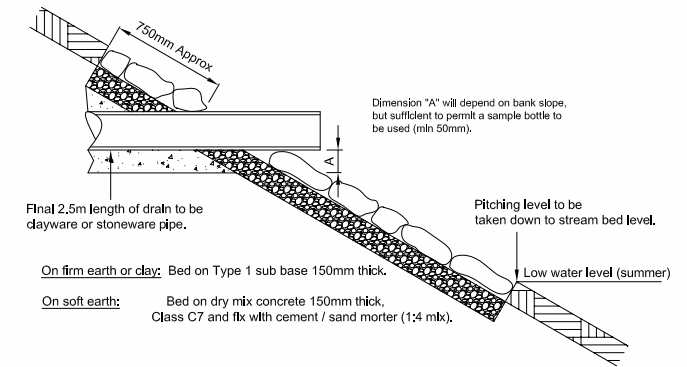
Detention and infiltration basins are two types of vegetated depressions in the ground designed to store surface water runoff on the surface. Both types can be dry most of the time except in periods of heavy rain.

Infiltration basins allow for water to gradually soak into the ground, while detention basins store water and can be permanently wet, hence are usually at the end of the treatment train as they allow for extra treatment.

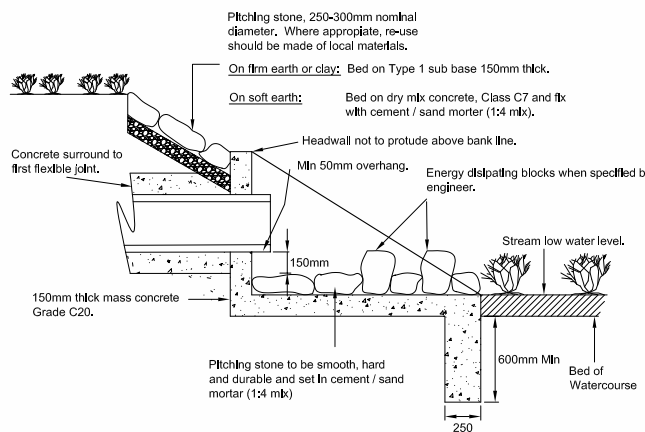
Specific Design Considerations

Basins should be designed as landscape features that act as visual enhancement and habitat creation. When dry, they can be used for social space, and habitat creation. Therefore, source control measure are advisable to control pollution and siltation.

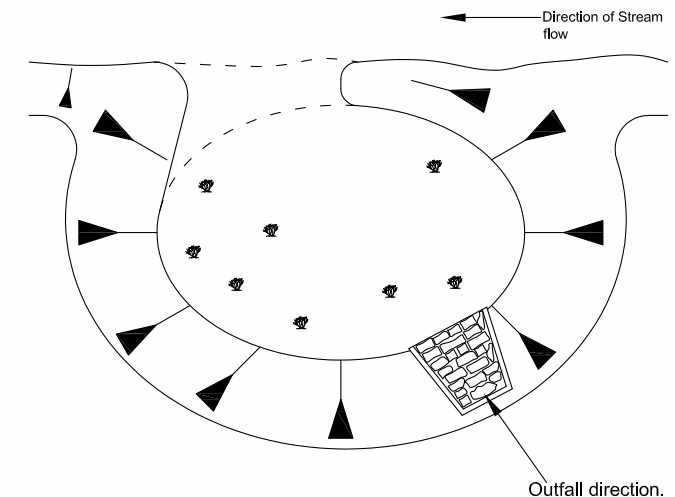
In Bristol, detention basins may be more appropriate due to the clay nature of the soil, and hence the lower infiltration rates. However, either of the basins should be used where ever the ground conditions allow.



Extract from SD-005-010 – general requirements for outfalls through a bank for pipes up to 150mm in diameter (detail subject to change)



Extract from SD-005-009 – general requirements for outfalls through a bank for pipes 200mm to 1750mm (detail subject to change)



Extract from SD-005-012 – alternative arrangement for outfalls through a bank for pipes 200mm to 1750mm diameter where space is not restricted.

Basins to be incorporated into large areas or open space. Where next to housing, they should be designed to overlook the basins rather than hiding them away.

Key Design Considerations and best practise

General

- Basins must have pre-treatment and be part of a cascading SuDS. They should not just be connected to the end of a piped system.
- Erosion control measures to be installed at inflows to the pond. Inlet flow spreaders can be used to reduce the water velocity.
- A gentle fall (1 in 100 to 1 in 300) should be used to encourage surface sheet flow by gravity.
- Pre outfall forebays (over deepened areas) can be used prior to outfalls to enhance treatment and provide extra sediment control.
- Side slopes should be 1 in 3 maximum, with clear access for maintenance.
- An overflow should be included in the design to account for extreme events and prevent water from over topping and eroding the embankment.
- Treatment height (grass length) to be 75-100mm minimum.

- Within permanently wet basin design, consideration must be provided to BCC assessing the safety risk especially to children. Child safety must be considered in pond and wetland design.
- Side slopes to include densely vegetated areas with native species to provide slope stability and assist in sediment removal.
- Where there is potential for seepage of pollutants to groundwater, impermeable liners should be incorporated.
- Gradual sediment accumulation should be accounted for when specifying the size.
- Lower parts of the basins can be installed at different levels to allow for some recreation.
- All existing vegetation and tree species are expected to be retained. Tree roots must not be compromised.

Infiltration Basins

- Geotechnical tests must be carried out to confirm suitability for infiltration.
- Ground stability must be confirmed and risks to surrounding features must be eliminated.
- Depth of water table to be confirmed by developer and suitability for

infiltration to be provided to BCC.

- Vehicle access to be limited for structures and areas for maintenance only.

Detention Basins

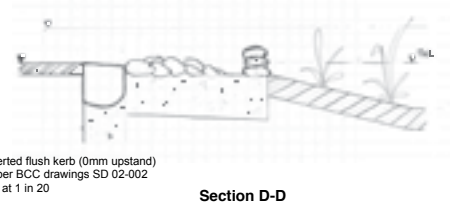
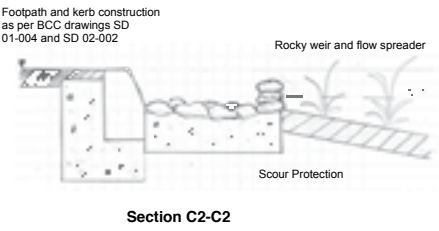
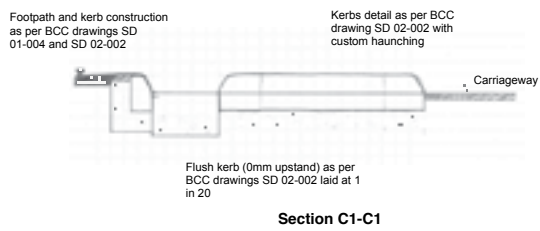
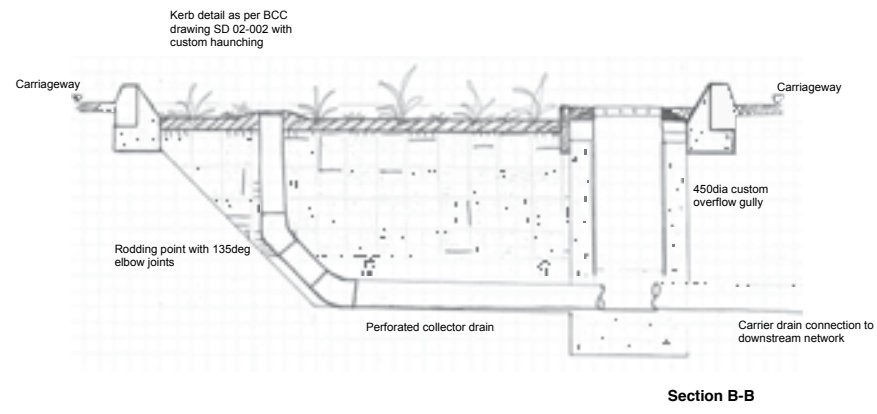
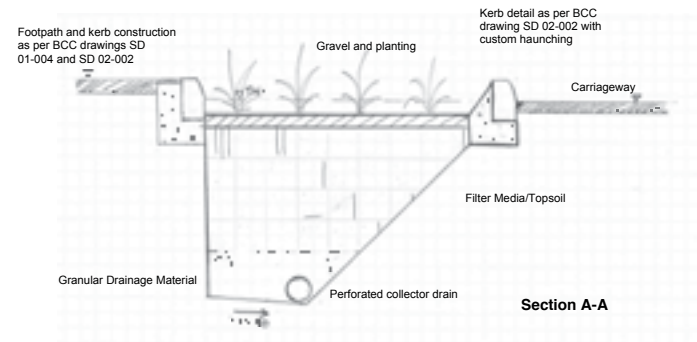
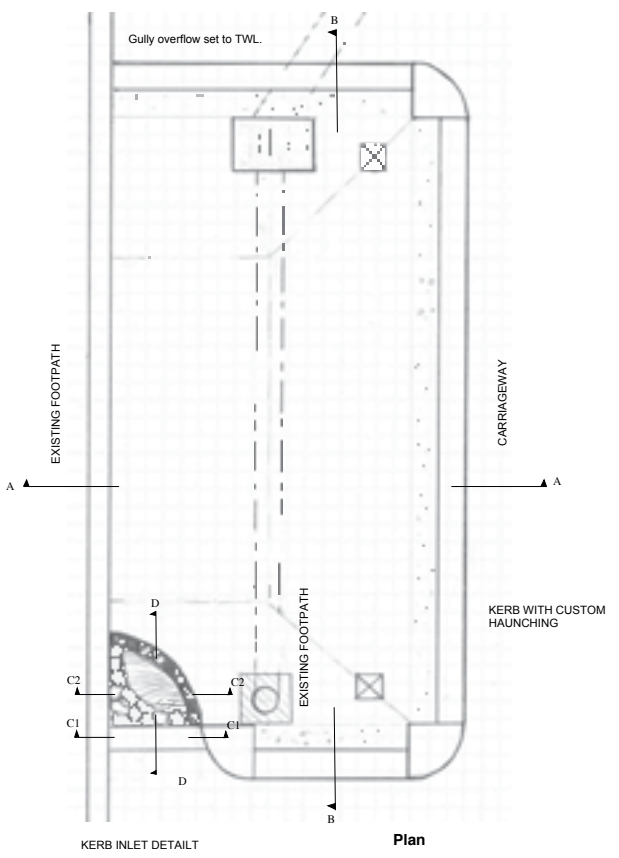
- Basins to have a 2:1 to 5:1 length to width ratio to further encourage settlement and filtration of run-off.
- When detention basins are off-line, flow diverters will be required to store larger volumes of water.
- Retained water should not cause clogging to trees.

Items to Consider / Practical Issues and Solutions

Item	Comment
Litter and debris removal	Can be part of the general landscaping maintenance. Frequency will be site specific and after large storms.
Grass cutting	Basins to have rounded shoulders to assist cutting activities. Grass seed specification shall be confirmed by Developer including frequency of growth/cutting regime and suitability for location.
Inlets and outlets inspection	Inlets and outlets to be positioned to be visible for ease of access and maintenance. Regular inspections are required to prevent blockages.
Sediment removal	Source controls and pre-treatment to be used to reduce silt accumulation.
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.

Issues	Solutions
Reduced infiltration rate	Ground conditions to be tested after a period of time. Occasional silt removal is also recommended. Hollow tine and scarifying of ground will increase infiltration.
Silt build up during construction	Construction runoff prevention and management systems to be utilised. Geotextile traps or straw bales can be used to control construction runoff and avoid silt from running into the feature.
Erosion before planting is established	Allow existing vegetation to be established quickly by reusing the topsoil without application of weed killer. Alternatively, biodegradable erosion control mats or turfs to be used.
Erosion after planting is established	Correct design and construction levels to manage flow velocity. High water velocities to be controlled and vegetation to be checked after larger storm events.
Poor maintenance	Retention basins to be located in visible spaces and less remote areas. Visible features receive better maintenance. Encourage community engagement.
Debris accumulation in forebays and pretreatment structures.	Forebays to be inspected and cleaned regularly. This will enhance the pre-treatment of water before entering the pond.

Example highway bio-retention planter



Geocellular Storage Systems

Description

Geocellular systems are modular plastic structures with high void ration used to store storm water, to be gradually conveyed or infiltrated into the ground. Geocellular systems are often used in conjunction with other SuDS features. Underground storage systems attenuate agreed volume with control structures to limit the discharge rate. Treatment is limited with these type of storage structures. Structural design is key for the longevity of these structures, especially that they are used under all types of traffic loadings.

Specific Design Considerations

It is not permitted to install these under a BCC adoptable highway or area subject to full highway loading. It is unlikely that BCC will adopt these systems in other areas but with early consultation with BCC to agree use, type and location, there may be opportunity to develop an adoptable system. There are many different types of proprietary geo cellular storage systems on the market. They should be selected to suit the specific site requirements. Information on systems proposed shall be provided to BCC. Silt traps must be used upstream of the storage structures so that there is a manageable and minimised maintenance requirement in long term.

Key Design Considerations and best practise

- Correct design levels must be achieved, especially in conveyance systems, to achieve adequate drainage.
- Adequate protection measures must be used for trafficked areas.
- Ground conditions should be confirmed by developer prior to installing infiltration systems.
- Pipework in the system should be designed in accordance with the current guidance and legislation.
- Vertical loading to be confirmed by developer and provided to BCC.
- Lateral loading must be confirmed by developer for systems prone to high lateral loading from the sides.
- Developers to obtain creep test data and results before installing any geocellular systems.
- Installation to manufacturer's requirements.
- Sealed systems to be used in contaminated land.
- Inspection chambers must be provided for regular checks.
- When storage is used as part of an online storage, flow channels must be wholly accessible for maintenance.

Items to Consider / Practical Issues and Solutions

Item	Comment
Inspection of treatment train (silt traps, manholes and pipe work)	Regular inspections to ensure that any blockages and silts are cleared and the system is functioning.
Removal of sediment and debris	Systems must be inspected and cleaned as prescribed by the supplier.
Warranty Terms & Conditions	Developer to obtain products warranty.

Issues	Solutions
Access difficulties	Access chambers to be located adjacent to areas a vehicle can gain access
Silt accumulation in geocellular systems	High pressure water jetting. Vortex flow control upstream. Silt traps upstream.
Management Plan for SuDS.	The developer shall develop a detailed management plan on how the SuDS were designed, any spare capacity and the maintenance regime to be adopted to maintain their design intent.

Other SuDS Components

There are numerous drainage and SuDS components that can be used in conjunction the main features outlined above. This section will identify each component and identify the key guidance for their design and construction. These component should be designed in accordance with the relevant legislation in the design reference list above.

SuDS Component	Comments	Items to Consider
Planters and Tree Pits	<p>Tree pits are very useful pre-treatments and features that can sit within or on the margins of basins, ponds and swales.</p> <p>These are promoted for use by BCC</p>	<p>Tree pit design is critical to ensure the root ball has free draining material. Refer to BCC SD-04-019</p> <p>The tree species fits with the condition it will endure.</p> <p>The design location allows for the tree to grow without detriment to conveyance of other features such as paved areas.</p>
Linear Drain (Channel)	<p>Linear drains are trenches filled with permeable material with a perforated pipe at the bottom to assist in drainage. This form of sustainable drainage can be used in conjunction with the above systems (e.g. base of swale or pond) or independently, where space is prohibitive for a surface conveyance feature.</p>	<p>Maintenance regime should be considered by the developer to ensure longevity of the system.</p> <p>Where linear drains are used independently as a form of SuDS, design has to be justified and agreed with BCC.</p>
Manholes and Catchpits	<p>Design, placing, and spacing of manholes and catchpits must be approved by BCC.</p>	<p>Refer to current guidance and legislation and BCC standard details</p>
Gullies	<p>Gullies must be trapped to provide one level of treatment by trapping silt. Where in highways, gullies must be designed to BCC and Highway Agency (HA) adoption standards.</p>	<p>Where gullies are used as outlets in landscaped areas (e.g. swales/ponds), consideration to their location for maintenance should be given by the developer.</p> <p>Gullies in these locations must have a minimum of a 150mm wide concrete (or similar) mowing strip/surround.</p>

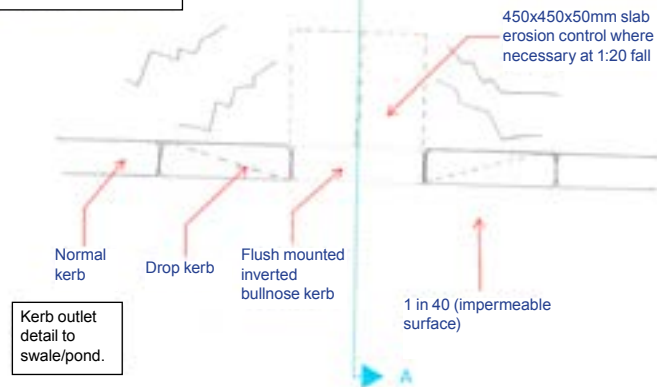
SuDS Component	Comments	Items to Consider
Kerb Drains	Kerbs can be used as inlets to swales and other systems. Design should be in accordance with BCC and HA adoption standards.	<p>It is recommended that a concrete bed/slab to be used adjacent to the dropped kerbs before discharge to the vegetated surfaces to protect against erosion.</p> <p>Consideration to loads, location and maintenance regime should be given by the developer.</p> <p>Where kerbs are adjacent to roads and pavements, refer to the HA Construction Details.</p>
Flow Controls	Flow controls are key elements of a well-designed SuDS. They must be designed to ensure longevity of the system.	<p>Flow controls should be integrated with the urban surroundings wherever possible.</p> <p>Flow controls to be designed with silt management in mind.</p> <p>Ensure these units are accessible for maintenance.</p>
Inlets and Outlets	Inlets and outlets should be designed to allow for erosion protection and maximum infiltration in the relevant systems.	<p>It is preferable the inlets and outlets are placed above ground to allow for ease of maintenance. A typical single dropped kerb details is shown below.</p> <p>If draining from a highway 2 part kerb drain unit the lower section of the unit</p> <p>can be used to convey surface water flows to the pond basin of swale, keeping connections shallow. A typical detail is shown below.</p> <p>Silt control measurements to be considered to allow for maximum use of SuDS features.</p>

SuDS Typical details

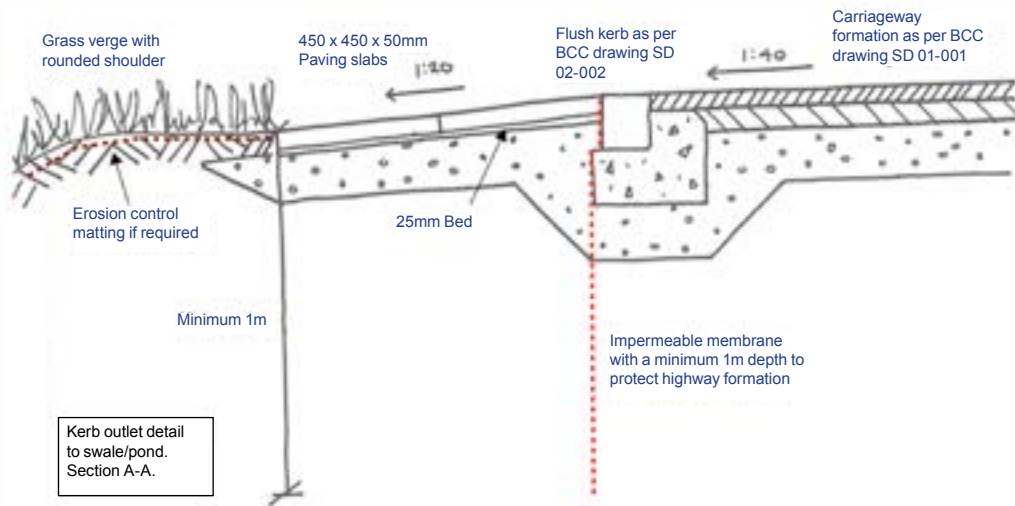
Linking sustainable drainage elements to one another can be challenging especially to keep depths shallow whilst delivering adoptable infrastructure. Below are possible details for draining from Highway to ponds or swales

Kerb outlet detail:

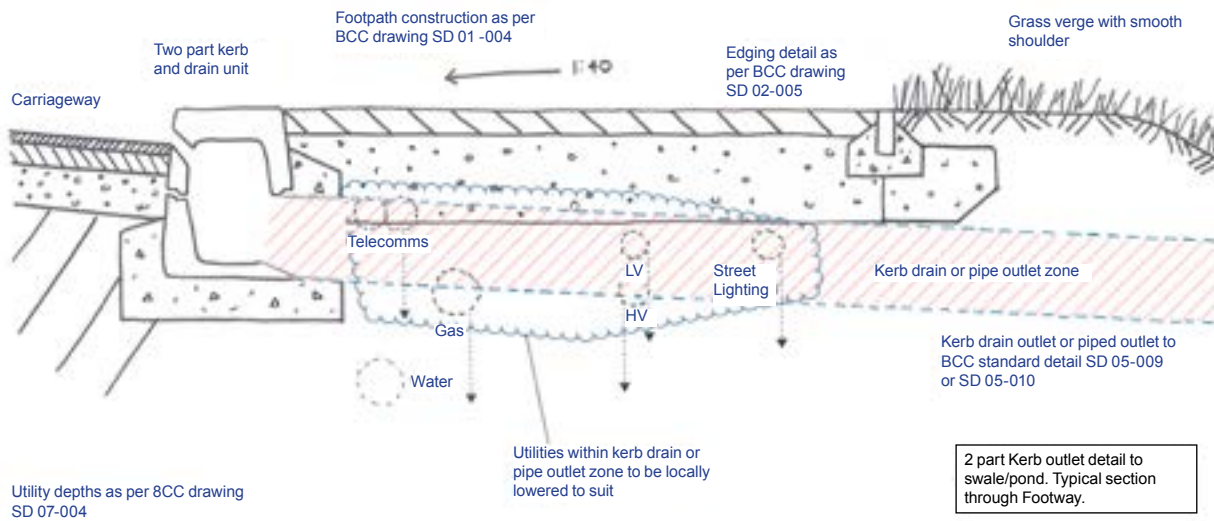
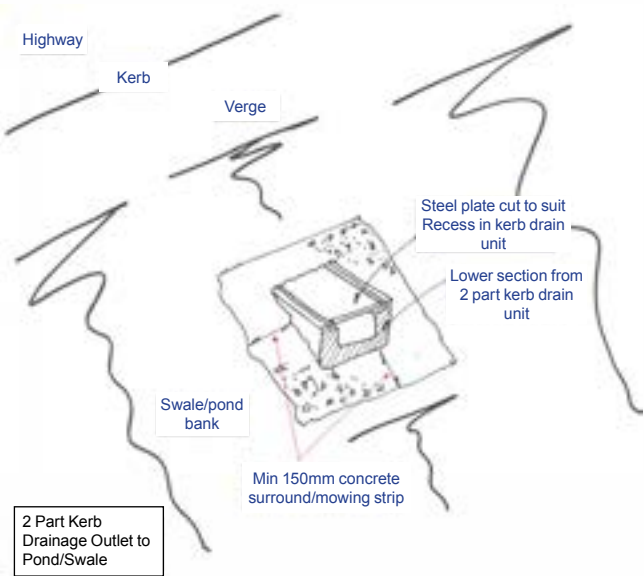
Kerbs to suit Bristol City Council specification and construction details

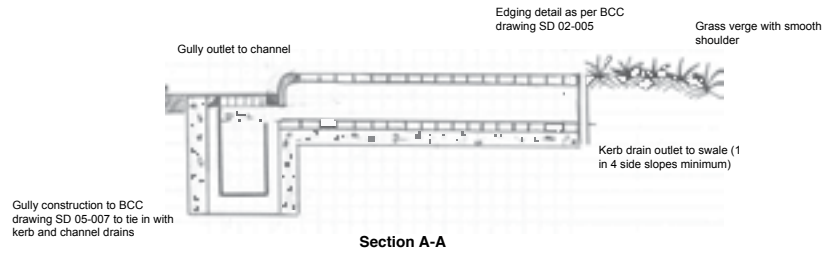
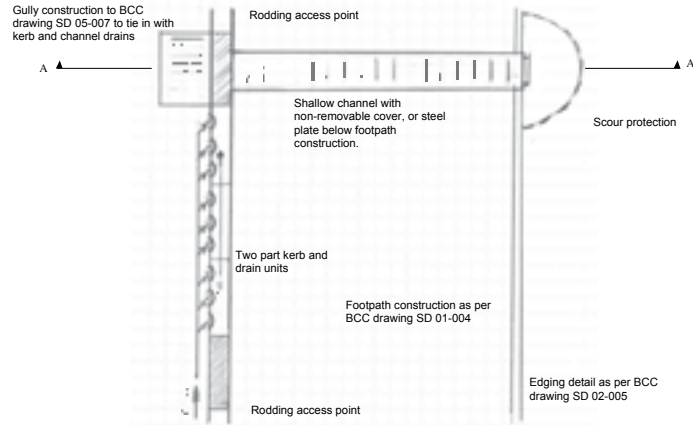


Kerb outlet detail to swale/pond.



Kerb outlet detail to swale:





SuDS Feature Inlet Through Footpath

SuDS ownership and maintenance

When planning a sustainable drainage system, developers need to ensure their design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any personnel, vehicle or machinery access required to undertake this work.

Management and Maintenance plans will need to allow the Local Planning Authority to satisfy themselves that the proposed minimum standards of operation area appropriate and that there are clear arrangements in plan for ongoing maintenance over the life time of the development.

It is critical that the most appropriate party own and maintain the feature. There are a number of factors to consider when determining the most appropriate party:

- Location of feature
- Complexity of system
- Level of operation and maintenance (see Section 1, 3.6 Maintenance)
- Primary function of feature
- Benefiting parties of SuDS features

Potential parties include those listed

in Section 1, 3.7 Adoption of SuDS and consideration should be on a site-specific basis. The list below is not exhaustive and is subject to change.

- Where a SuDS is within the private curtilage of a property it is reasonable to expect the owners/occupiers of properties drained by SuDS that do not also drain other properties to maintain their own SuDS. The developer should provide the owner(s) with clear instructions on the maintenance of the SuDS including repair and replacement requirements.
- In the Lower Severn Internal Drainage Board areas of Avonmouth and Severnside, subject to IDB consent, by agreement and following either payment of a commuted sum or ongoing infrastructure charge, a developer may build (or contribute to) SuDS that the IDB subsequently owns and/or maintains.
- Wessex Water supports the use of SuDS to manage surface water flood risk, sewer flooding and improve water quality. Wessex Water are, at the time of writing, reviewing their policy on the maintenance and adoption of SuDS.

They are anticipated to offer to adopt certain types of SuDS components serving more than one property, again subject to a number of safeguards.

- SuDS serving the public highway may also be adopted as part of a publicly maintainable highway constructed in line with guidelines, following agreement between developer and Bristol City Council using a model agreement and commuted sum, under a Section 38 Agreement of the Highways Act 1980.
- SuDS serving more than one property could be maintained by a maintenance company. Management company would be funded by annual payment by way of service charge in a sum to be agreed which may be reviewed each year. Collected by or on behalf of the management company from each occupier. Developers will need to ensure that any requirement to pay fees is binding. Service charge will need to be secured by a rent charge together with an obligation within a sale contract/transfer for new owner to pay the relevant charge.

For further information:

Bristol City Council

www.bristol.gov.uk/page/environment/flood-risk-drainage-and-development

Email:

development.drainage@bristol.gov.uk

Lower Severn Internal Drainage Board

www.lowersevernidb.org.uk

Wessex Water

www.wessexwater.co.uk/developers

Annex

Amenity

Bristol has a strong network of public parks and other green infrastructure elements which any future development should acknowledge and consider, strengthening and making more resilient the existing citywide Green Infrastructure (GI) network.

In general terms, development that harms the amenity of an area is not seen favourably. Therefore, any development proposals should be sited and designed in a way as to avoid adverse impacts on amenity by reason of smell, water pollution or others. The inclusion of well-designed SuDS, as important assets of the wider GI network, has the potential to increase the profile and profitability of new developments as well as to cater for amenity, recreation, well-being and other social and environmental benefits. Even if an area is deemed to be affected by temporary flooding, is still possible to make it multifunctional through conscious design solutions regarding access, materials, structures and planting. Other solutions should also be considered like tree and hedgerow planting and green roofs as means to improve the amenity value of an

area and at the same time complementing the proposed SuDS elements.

The amenity uses of the Floating Harbour and improvements in water quality standards being driven through the Water Framework Directive have resulted in a particular emphasis on drainage systems discharging directly to the Floating Harbour to include robust SuDS to improve quality.

Plans & GIS Layers: BCC Boundary, Roads, Rail, Water Courses, Local Sites (SINCs, SNCIs, County Wildlife Sites), World Heritage Sites, Country Parks, AONB, Ancient Woodland, Registered Parks and Gardens, National Trails, National Cycle Network, Local Cycle Network, Public Rights of Way, Conservation Areas, NE9 Parks and Gardens, Common Land and Village Greens, DM25 Greenways, Open Access Land, Woodland Trust Land, Tree Preservation Orders, Living Environment Deprivation Index.

References: Magic Map Application, Bristol Pinpoint map, Bristol Parks and Green Space Strategy, Bristol Central

Area Plan

Relevant Local Plan Policies:

DM15 (Green Infrastructure Policies), DM16 (Open Space for Recreation), DM17 (Important Open Space), DM19 (SNCIs) and DM31 (Local Historic Parks and Gardens)

Core Strategy Policies

BCS11 (Development Principles), BCS9 (Green Infrastructure), BCS13 (Climate Change), BCS15 (Sustainable Design and Construction), BCS20 (Effective and Efficient Use of Land), BCS21 (Quality Urban Design), BCS22 (Conservation and the Historic Environment), 1997 Saved Policies NE01 (Open Space), B05 (Layout and Form), B15 (Conservation Areas: Streets and Open Spaces), Core Strategy Policies BCS23 (Pollution), 1997 Saved Policies NE01 (Open Space), B05 (Layout and Form), B15 (Conservation Areas: Streets and Open Spaces)

Core Strategy Policy BCS9 contains the requirement ‘new Development should incorporate, or contribute towards an appropriate level and quality of open space’.



Policies DM15 and DM16 of the Site Allocations and Development Management Policies document (adopted in July 2014) set out the requirements for provision of new public open spaces; including a requirement that the spaces are provided to be as multifunctional as practicable.

The first policy provision of DM15 sets out that any green infrastructure assets provided should maximise multifunctional benefits and role, wherever practicable and viable. Open spaces, landscape features, or any wildlife habitats provided or enhanced (covered by DM19) that are designed to also serve a SuDS function will be considered to respond positively to this aspect of the policy.

Paragraph 2.16.8 of DM16 is explicit in its support for open space which is also designed to have a SuDS function. DM16 requires development to meet the need it creates for public open space. DM16 sets out standards for a quantity (per person), quality and distance to public open space for recreation. These standards are shown in Appendix 1 of the Site Allocations and Development Management Policies document. Supporting text of DM16, 2.16.5 and 2.16.6, provide further guidance as to how this policy requirement is practicably applied. In certain circumstances, where

development creates substantial need, new open space for recreation may need to be delivered as part of the development. This would be dependent on the size of the development, need for open space for recreation in the locality and practicability of provision. DM16 sets out the requirements for new open space provision.

DM16 and Appendix 1 embed in planning policy the open space standards within the Parks and Green Spaces Strategy (PGSS). The PGSS is an evidence base document for the purposes of local plan preparation. It was adopted by the Council in 2008 and remains the Council's adopted strategy for Parks and Green Spaces.

The Planning Obligations SPD was adopted on September 2012 (and replaced SPD4). This details Landscaping Scheme and Tree obligations. Provision of, or improvements to, open space as identified in the PGSS will be covered via Community Infrastructure Levy contributions. The justification in respect of the provision of Landscaping Schemes is set out in Policies BCS9 and BCS11 of the Core Strategy.

Biodiversity

Bristol contains a wide range of important nature conservation sites that contribute to a varied stock of natural habitats and species.

The use of SuDS to contribute towards maintaining and enhancing the biodiversity of Bristol is encouraged.

Plans: SSSIs, SAC/SPA/Ramsar etc. designated areas from GIS data

References: Bristol Biodiversity Action Plan (BBAP) www.bristol.gov.uk/sites/default/files/assets/documents/BBAP.pdf

Relevant Local Plan Policies:

Core Strategy policy BCS9 provides details on the requirement to maintain the integrity of the wildlife network, along with development management policy DM19. This provides further detailed criteria for the consideration of proposals affecting nature conservation sites and features of value in Bristol. The use of SuDS can contribute towards complying with these requirements.



The city has two sites of international importance: The Severn Estuary, which is a Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar site, and; the Avon Gorge SAC. The findings of the Severnside & Avonmouth Wetland Habitat Project, October 2010 and December 2011 (the Cresswell Study Stages 1 and 2) should also be taken into account in determining any proposals which affect the international designations of the Severn Estuary. There are also currently five Sites of Special Scientific Interest (SSSI) in Bristol, which are of national importance for habitat conservation value. The SPA, SAC and Ramsar international sites receive the highest level of protection and no significant negative effects upon the habitats, species and special features of the sites will be permitted. Development on land within or outside SSSIs will be expected to meet the requirements for SSSIs set out in the National Planning Policy Framework.

As well as these statutory designated sites, Local nature conservation sites help to ensure the habitats, species and features of value are adequately protected and allow for appropriate public access to nature. Local nature conservation sites in Bristol include Sites of Nature Conservation Interest (SNCIs),



Regionally Important Geological Sites (RIGS) and Wildlife Corridors. These sites provide a refuge for flora and fauna; contribute to national biodiversity and geodiversity targets; add to the local character and distinctiveness of an area; contribute to quality of life; enhance the natural processes that support quality of life by maintaining air, soil and water quality; and can also reduce the effects of flooding and pollution. Together the SNCIs and connected sites in Wildlife Corridors form the Bristol Wildlife Network. This network strengthens the resilience of species and habitats to changes in the built and natural environment, including rising temperatures and flood risk associated with climate change. In order to maintain the integrity of the Wildlife Network, as required by Core Strategy policy BCS9, development proposals will be expected to understand the role and route of any Wildlife Corridors on a development site and any habitats and features which contribute to a Wildlife Corridors function, along with current and potential species which might utilise the wildlife corridor. The Bristol Nature Conservation Map displays the location of Wildlife Corridors within Bristol and also gives an overview of valuable habitats and species on each site. Statutory designated sites

and local nature conservation sites are shown on the Bristol Policies Map.

Policy DM19: Development and Nature Conservation of the Bristol Local Plan - Site Allocations and Development Management Policies (Adopted July 2014) builds on the adopted Core Strategy policy BCS9. This emerging policy provides further detailed criteria for the consideration of proposals affecting nature conservation sites and features of value in Bristol. This policy has been used to provide a summary of the ecological resource and value of Bristol and how that sits within any type of development, including changes and new drainage strategies. Within Policy DM19 it is stated 'Development which would be likely to have any impact upon habitat, species or features, which contribute to nature conservation in Bristol will be expected to:

- i.** Be informed by an appropriate survey and assessment of impacts; and
- ii.** Be designed and sited, in so far as practicably and viably possible, to avoid any harm to identified habitats, species and features of importance; and
- iii.** Take opportunities to connect any identified on-site habitats, species or features to nearby corridors in

the Wildlife Network. Where loss of nature conservation value would arise development will be expected to provide mitigation on-site and where this is not possible provide mitigation off-site.

Development on or adjacent to sites of nature conservation value will be expected to enhance the site's nature conservation value through the design and placement of any green infrastructure provided.

Development which would have a harmful impact on the nature conservation value of a Site of Nature Conservation Interest will not be permitted.

Development which would have a harmful impact on the connectivity and function of sites in Wildlife Corridors will only be permitted where the loss in connectivity, or function, of an existing Wildlife Corridor is mitigated in line with the following hierarchy:

- a.** Creation of a new wildlife corridor within the development site;
- a.** Enhancement of an existing corridor or creation of a new corridor off-site to maintain the connectivity of the Bristol Wildlife Network.'

Protected Species within Bristol are subject to separate legislation which determines appropriate development and approaches to mitigation. Protected Species legislation will need to be met before planning permission can be granted. To assist in determining the type of development and locations where Protected Species might be present, guidance is contained within a BCC report 'Bristol survey and assessment of impacts upon Nature Conservation' (In preparation and which may be discussed with BCC officers).

Species or Habitats of Principal Importance¹⁵ are determined under Section 41 of the Natural Environment and Rural Communities Act 2006. It sets out the habitats or species of Principal importance for the conservation of biodiversity in England. Principal Species of Importance in Bristol include otters, water voles, hedgehogs and house sparrows. Often Species or Habitats of Principal Importance will be contained with local nature conservation sites such as SNClS and Wildlife Corridors. The Bristol Nature Conservation Map (available through the Bristol Regional Environmental Records Centre¹⁶) sets out the known Species and Habitats of Principal Importance on sites in the Bristol Wildlife Network (SNClS

and Wildlife Corridors). This can be used to initially identify where these nature conservation assets exist on a development site.

An appropriate survey and assessment of impacts will also be needed to determine developments likely to impact upon Species, or Habitats of Principal Importance. To assist in determining the type of development and locations where Species or Habitats of Principal Importance might be present, guidance is contained within the 'Bristol survey and assessment of impacts upon Nature Conservation'. The guidance note assists with understanding the type of survey and assessment that should be undertaken to inform assessment of impact, potential harm, suitable development and potential need for mitigation or compensation.

¹⁵ www.naturalengland.org.uk

¹⁶ www.brerc.org.uk

Heritage

Approach to SuDS for designated heritage assets

Designated heritage assets are those that are afforded statutory protection by means of Scheduled Monument status for archaeological sites and monuments, or Listed Building status for buildings of national significance (an initial guide to relevant assets within Bristol is available¹⁷). When planning works in the vicinity of designated assets there are 2 primary concerns: direct impacts (changes to the fabric of the asset) and impacts upon setting (visual or noise effects that reduce the significance of the asset).

At the initial planning stage, English Heritage GIS datasets should be consulted to identify whether designated assets are present in the vicinity of the proposed works; for an urban environment the search radius should be 500m. This process would usually form part of an archaeological desk based assessment, required by NPPF as the most basic level of assessment required to consider the impacts of a development upon heritage assets.

Where the assessment identifies that direct impacts may occur, the design of the proposed development should be amended to remove these direct impacts; direct impact upon designated assets would likely be considered as substantial harm, which under NPPF should only be permitted under exceptional circumstances¹⁸. For such a development to proceed it would have to be demonstrated that there is an overwhelming need for the development and that the design selected is the only practical solution.

Consultees for developments affecting designated assets will be:

- Bristol City Archaeological Officer
- English Heritage (Scheduled Monuments)
- BCC Conservation Officer (Listed Buildings)



¹⁷ www.bristol.gov.uk/knowyourplace

¹⁸ planningguidance.planningportal.gov.uk/blog/policy/achieving-sustainable-development/delivering-sustainable-development/12-conserving-and-enhancing-the-historic-environment/

Approach to SuDS for non-designated heritage assets

The approach where non-designated heritage assets are concerned is similar to that for designated assets; however there is substantially greater leeway with regard to impacts than for designated assets. An archaeological desk based assessment would be required as the first stage of assessment, drawing on data held by the city Historic Environment Record. Where potential direct impacts are identified, discussions should be held with the City Archaeological Officer to determine whether archaeological surveys are required to investigate the nature of the archaeological remains present and to design mitigation proposals as appropriate.

For impacts upon locally listed buildings the BCC Conservation Officer should be consulted with regard to appropriate mitigation for the loss of the building, although there may be circumstances where a locally listed building is slightly below the threshold for full Listed Building status, where demolition would not be deemed acceptable.



Landscape & Townscape Character

We seek to preserve and enhance the character of neighbourhoods as set out in the adopted Core Strategy and Development Management Policies. Emerging highway protocols also seek to reinforce this aspiration by seeking to ensure that historic street materials are retained, whether in a conservation area or not, to enhance local character and distinctiveness.

Planning Policy requires developers to carefully consider the context and setting of future development and to make use of documentation which helps to inform the proposed layouts and detailed designs. Detailed assessments will be required whenever a development is proposed within or near a designated site or area.

The layout of the built environment makes a key contribution to creating quality urban design. Policy DM27: Layout and Form includes the expectation that the landscape design and planting of development will integrate SuDS.

BCC area sits within two National Character Areas; the Severn and Avon Vales, to the Northwest of the M5 and the Bristol, Avon Valleys and Ridges for the remaining area. It lacks a Townscape Character Assessment but

a Citywide Urban Context Analysis will be undertaken as set out under policy BCS21 and several Character Appraisals have been adopted for a large number of Conservation Areas. These appraisals also set a series of management proposals for each area. Bristol City character is predominately urban with Clifton Down, Blaise Castle Estate and Stoke Park being the main large scale areas of open green space. The River Avon limits the south western boundary of the urban area, which stretches from Avonmouth to the Floating Harbour, for then to cut through the urban fabric on a West-East direction. The Floating Harbour, the Feeder Canal and the Avon New Cut are central features which have been and will be shaping the development around this central area of Bristol.

Several smaller water courses run from the north and south towards the Avon originating numerous valleys and hills which give Bristol an undulating character and provide a series of green corridors. It comes natural that some of the aforementioned open green spaces are located within incised valleys, like Blaise Castle Estate and Stoke Park, which run along Hazel Brook and the River Frome respectively. The Avonmouth area is severed by the M5 and has a markedly industrial character due to the presence



of the Port, its supporting infrastructure and activities.

Future development should aim to protect and enhance the character, distinctiveness, diversity and quality of the landscape and townscape. The references below should be considered throughout the development process in order to create a landscape which integrates SuDS in the most sympathetic way into the existing landscape and townscape of the area.

Plans & GIS Layers: BCC Boundary, Roads, Rail, Water Courses, National

Character Areas, Local Sites (SINCs, SNCIs, County Wildlife Sites), World Heritage Sites, Country Parks, AONB, Agricultural Land Classification, Ancient Woodland, Registered Parks and Gardens, National Trails, National Cycle Network, Local Cycle Network, Public Rights of Way, Conservation Areas, NE9 Parks and Gardens, Common Land and Village Greens, DM25 (Greenways), DM27 (Layout and Form), Open Access Land, Woodland Trust Land.

References: National Character Area 106, National Character Area 118, Magic Map Application, Conservation Areas Character Appraisals, Bristol Pinpoint map, Bristol Central Area Plan Policies DM17 (Important Open Space), DM19 (SNCIs) and DM31 (Local Historic Parks and Gardens), Core Strategy Policies BCS11 (Development Principles), BCS9 (Green Infrastructure), BCS13 (Climate Change), BCS15 (Sustainable Design and Construction), BCS20 (Effective and Efficient Use of Land), BCS21 (Quality Urban Design), BCS22 (Conservation and the Historic Environment), 1997 Saved Policies NE01 (Open Space), B02 (Local Context), B05 (Layout and Form), B15 (Conservation Areas: Streets and Open Spaces),



Southmead Green Streets - concept visualisations © Ove Arup and Partners Ltd