S104 SuDS Guidance Document

Bio-retention

Version 1 (October 22)

(This document should be read in conjunction with S104 SuDS Technical appraisal form for Bio-retention Systems)

Comment no.	Technical Guidance
Types of bio-retention & adoptability	
1	We will adopt communal systems serving two or more properties located outside of domestic property curtilage. If the system is at the start or 'head' of the adopted network, domestic flows must enter via a point inlet so as to provide a point of demarcation for adoptable network. Property level rain gardens/raised planters should remain private but can drain to the adopted system provided there are arrangements for their ongoing maintenance. We may permit highway drainage only systems i.e. tree pits to drain to the adopted network but early discussion is recommended to secure agreement. The adoption of the following bio-retention systems will be considered on a case by case basis; ▪ Bioretention swale – see chapter 18.1.4 of CIRIA C753 for further information ▪ Anaerobic system – see chapters 18.1.5 & 18.3 of CIRIA C753 for further information ▪ Infiltration system – see chapter 13 of CIRIA C753 for further information If infiltration is the primary outlet the infiltration viability document must be completed prior to the full application. It's essential that it is made clear what type of bio-retention system is being utilised within the design at an early stage to enable an effective assessment to be completed and this must be referenced correctly on the S104 Agreement Plan.
High level considerations, location & layout	
2	**Topography:** The surface should be level to allow distribution of flows across it. **Shape, location & maintenance considerations:** The location and shape of the component should be agreed with the local planning authority but where the component is not located in a verge, other public open space or the boundary between the highway and a private garden, provision should be made for access including any specific features that are likely to pose maintenance difficulties and any associated mitigation measures that have been put in place – see chapter 32 of CIRIA C753 for guidance. Consideration should be given to planting of trees etc. which may hinder access for the maintenance particularly around ancillaries and access points
3	**Flood risk to existing features**: No surrounding properties or features should be at risk – see chapter 36 of CIRIA C753 for guidance
Design requirements	
4	**The sizing of Bio-retention sizing** will determine a number of characteristics including good water quality performance. Sizing calculation should be provided in accordance with equation shown in table EQ.18.1 within chapter 18.4.1 of CIRIA C753 The component cannot serve more than 0.8Ha or 2-4% of the overall site area to be drained. This must be represented on the impermeable area plan and/or S104 Agreement Plan in m^2. **Widths** are to be between 0.6-20m (to allow a 10m reach excavator access to both sides). If access is available from one side, the maximum width should be 10m. **Lengths** should be a maximum of 40m to avoid uneven distribution of water over the surface - see chapter 18.3 of CIRIA C753 for further information. **Depths** should not exceed 2m in order to facilitate effective cleansing and inspection of underdrain/perforated pipe system

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5	**Hydraulic assessment information criteria;** **Representing component for hydraulic calculations**: Components must be labelled correctly in the model as part of the online piped network. If labelled as a storage component then it must be explained how this is linked in the model as part of the online network. Any impermeable areas around the component need to be included within the design. **Inflow velocities** in full flow conditions should be below 0.5m/s and not exceed a maximum of 1.5m/s in the 1:100yr event. Any erosion protection must be reflected in the hydraulic model by applying a headloss of 0.5 at the point of outfall. The same headloss value of 0.5 needs to be applied for catch pits and check dams where applicable. **Underdrain / perforated pipes** should be sufficient to deal with design storm event (2yr event). Pipe roughness of 0.35 should be used to accommodate for the perforations to the pipework, this will confirm the complex network is adequate providing a factor of safety. **Depth of temporary storage** is the storage of water on the surface (above the filter medium) to capture the volume that requires treatment and (if required) provides attenuation. Normally this will be at a maximum depth of 150-300mm but should be confirmed by the designer as part of the overall site design- see chapter 18.1 (figure 18.1) of CIRIA C753 for further guidance **Flow control diameter should** usually be a minimum of 100mm, however if the flow control has robust upstream protection which prevents debris this could be reduced to a minimum of 50mm **Component drain down time** must be within 24hrs and will need to be supported with calculation. For infiltration systems, this is 48hrs (or half drain down within 24hrs) **Designing for exceedance & considering overland flow** Overland flows from surrounding land must be considered particularly if adoptable components are designed to accept surface inflow. Flow routes for significant offsite flow paths must be provided as part of the overall site design and should be separated from any new adoptable network design See chapter 36 (table 36.1) of CIRIA C753 for guidance on acceptable velocities for exceedance.
6	**Side slopes** need to be within a gradient of 1:3 and 1:5 for the perimeter of the component, 1:5 is preferred around any access to ancillaries (i.e. inlets & outlets) **UU will not adopt a feature with the minimum slope around the entire perimeter of the surface SuDS feature.**
7	Inflow into an adoptable SuDS feature must have appropriate **pre- treatment**. United Utilities will only adopt pre-treatment associated with domestic run-off as part of the in-line system. If United Utilities allow highway drainage run off to enter the adopted network upstream pre-treatment measures for the highway runoff such as filter strips, sediment forebays will need to be adopted by the highway authority as part of the section 38 adoption agreement. For systems with multiple inlets distanced apart, pre-treatment should be provided at or upstream of each inlet. Adoptable pre-treatment can be provided in the form of forebays and catch-pit details, or in the case of infiltration systems proprietary treatment systems such as vortex separators. A forebay area must be at least 10% of the total component. If the area is <10m2 then the depth of the forebay should be 200mm deep, if the area is >10m2 it should be 300mm deep – see CIRIA C753 chapter 18.8.1 (EQ.18.2). Each forebay should be accessible and easily maintained. A fixed sediment depth marker is recommended to monitor silt levels over time. Consideration can be given to a concrete lined forebay as this would also protect from erosion and can facilitate desilting (without damage to a liner for example). If using catch pit manholes, they must be sufficiently sized and representative of the upstream catchment with sump depths between 300-500mm. Maintenance access should be provided and the maintenance document must consider potential increase for desilt activities. Ideally sediment should be managed by an upstream component management train – see chapters 18.8.1, 26 & 28.4.8 of CIRIA C753 for further guidance.

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8	**Erosion protection** will be required for any outfall to a SuDS component and needs to be in keeping with the pipe size outfall details. Inlets need to be designed to allow water to run onto the surface of the filter medium without causing scour or damage to vegetation, inflows should be uniformly distributed to maximise treatment potential. Protection will also need to be considered opposite lateral connections where flow may hit to prevent damage. **Energy dissipation** measures can comprise of check dams, gravel flow spreader or flow dividers – see CIRIA C753 chapters 17.9.2, 17.9.3, 17.9.4, 28.4.6 & 28.4.7 for further guidance, specifications and visual images (figure 17.13 below provides an example of a check dam design).
9	**Inlet and outlet connections** Inflow for these components could enter laterally at surface along its length or via a point inlet. Lateral surface inflow details are usually relevant to highway flows, pre-treatment details are provided in the SuDS manual in the relevant sections. There are various point inlet details within the DCG and CIRIA SuDS manual which can differ based on pipe size, component type and application, if discharging via piped network inlets up to 350mm diameter, are to be constructed as per the standards set out in the Design & Construction Guidance (DCG) or our inlet headwall details drawing located within our SuDS technical library on our website Inlets greater than 350mm diameter, are to be constructed as per our inlet headwall details drawing or our standard detail drawings which can be found within our S104 technical library on our website. For **lateral flow connections** into the component, considerations need to be made to ensure there's minimal risk of deterioration in performance or failure of the component - See chapter 28.4.3 of CIRIA C753 along with some images of lateral connections on figures 28.3 & 28.4 for further guidance.
10	**Overflow / underdrain** The overflow outlet should be as close as possible to the inlet so that the flow path across the surface of the filter medium is minimised for larger flows and should be provided to safely pass flows in excess of the temporary storage capacity to the downstream drainage system, this should be sized to convey the overflow event. Inspection access is usually combined with the overflow, therefore inspection for maintenance must be considered (i.e. a T junction at the base of the overflow/perforated pipe would not be appropriate). The overflow should be set at the required height above the surface (150-300mm) to operate when the overflow event occurs and should be sized appropriately (i.e. Type E chamber with a vented cover) - see figures 18.16 & 18.17 of CIRIA C753 for further information **Perforated pipes/underdrains** collect water from the system and convey it downstream, they may not be required if the system is designed to infiltrate. If the design objective is to convey flows to a discharge point, the bottom of the system can be shaped to define a flow path towards the underdrain - see CIRIA C753 section 18.8.2 (figure 18.14) for examples. Perforated pipes should use PVC (min. 100mm dia) with 150mm clean gravel above the pipe. The gravel and pipe should be enclosed by geotextile fabric. The underdrain should infiltrate into the subsoils or drain freely to an acceptable discharge point. Perforated pipe should start and end in line with the component, non-perforated pipework to be utilised as rocker pipes into and out of the traditional/catch pit manholes or connection to an upstream or downstream sewers. A chamber would be required at any intermediate point linking a chain of systems together and this would be located in a raised culverted section. Connections from sewers should not be made into a perforated underdrain.

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11	**Filter medium** is normally sand based with some source of organic matter and slow-release plant nutrients to maintain healthy plant growth, which filter out pollutants and controls the rate at which water filters through the system, which is a key influence of the effectiveness. It is normally 750-1000mm deep, although for very small catchments it can be less, but a minimum of 400mm is recommended. The filter medium should also be correctly installed with an appropriate level of compaction during installation to prevent migration of fine particles. An indicative specification is provided in 'Box 18.1' within chapter 18.9.2 of CIRIA C753. See also chapter 18.1 (figure 18.1) for further guidance A **transition layer** is required to prevent the washing of fines from the filter medium into the drainage layer. To achieve this it should be at least 100mm deep. Alternatively a geotextile layer can be used, both of which should be designed using standard filter criteria - see chapter 18.1 (figure 18.1), 18.9.3 & 30 of CIRIA C753 for further guidance A **drainage layer** is required to collect water from the filter medium and allow it to reach the perforated pipes easily. The drainage layer should provide adequate cover to the perforated pipes (typically at least 100mm) Materials such as crushed recycled concrete may be appropriate for the drainage layer, but should not contain any fine particles that could wash out of the drainage layer as this could contaminate runoff and cause blockage within underdrain pipework. Crushed concrete should also be tested to make sure that it will not leach contaminants into the water - see chapters 18.1 (figure 18.1) & 18.9.4 of CIRIA C753 for further guidance For **anaerobic bio-retention systems**, the standing water level needs to be contained within the drainage layer – see chapter 18.1.5 (figure 18.8) of CIRIA C753 **Infiltration systems** (with no overflow) will not require a transition or drainage layer but should also have a **mulch layer** which needs to be a maximum depth of 75mm, it can be spread over the bio-retention area to retain some soil moisture. Organic matting that degrades within 6 months, bonded fibre matric mulches or a layer of gravel can be used as an alternative to standard organic mulches – see chapter 18.9.1 of CIRIA C753 for further information
12	**Lining considerations:** Below is a list of information/considerations required when lining is proposed; Unlined components should not be used on brownfield sites unless it has been demonstrated that the risks posed by leaching of contaminants is managed to acceptable levels. Specification of chosen liner will be required. Geosynthetic barriers should be designed in accordance with BS EN 13361 or BS EN 13362 (see section E2.45 of Design & Construction Guidance), this includes tensile load, tear resistance and puncture resistance. These should have welded joints, taping would not be acceptable.
13	The **full design detail** should show all individual components which may include; inlet, lateral connections, forebay, underdrain, vegetation/planting, check dam, flow spreader/divider, outlet etc. as applicable. **Materials** should be shown on the **sectional drawing** i.e. mulch layer, filter media, transition layer, drainage layer, perforated pipe/underdrain, geotextile membranes, geosynthetic barrier etc. as applicable. See CIRIA C753 chapters 18.9 (Bio-retention), 30 (Materials including specification for liners – see 30.5.4) and 31 (Construction) along with CIRIA C768 chapters 21 (Soils) & 22 (Materials) for further guidance.

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Construction

Construction of Bio-retention systems should be in accordance with the guidance provided in the appropriate chapters of CIRIA C753 (18.11) and CIRIA C768 chapter 31 along with CIRIA C753 Appendix B: Construction assessment checklist.

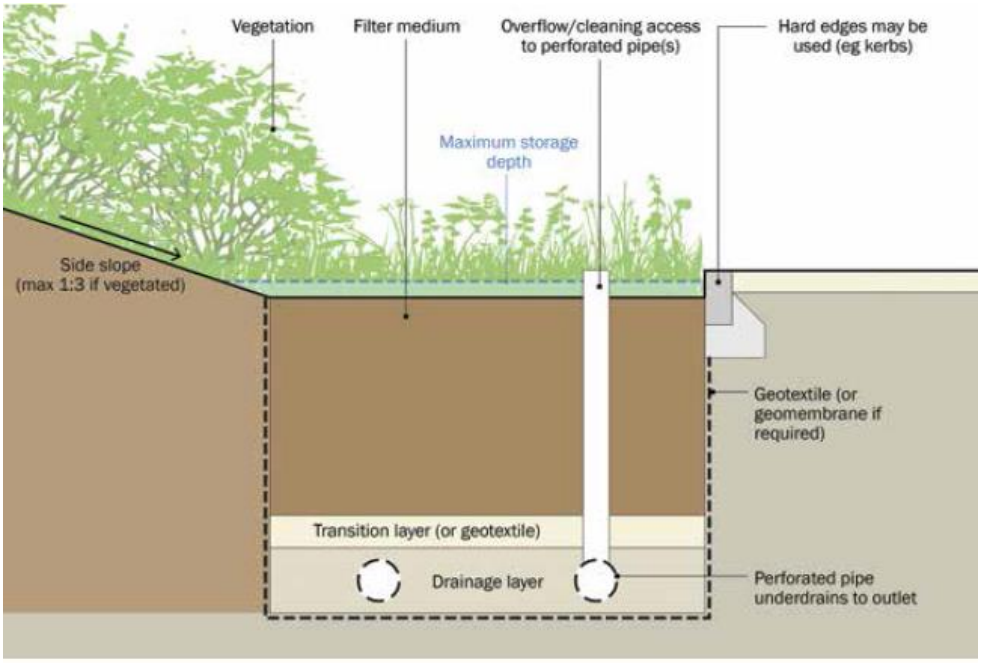

Figure 18.1 Components of a bioretention system

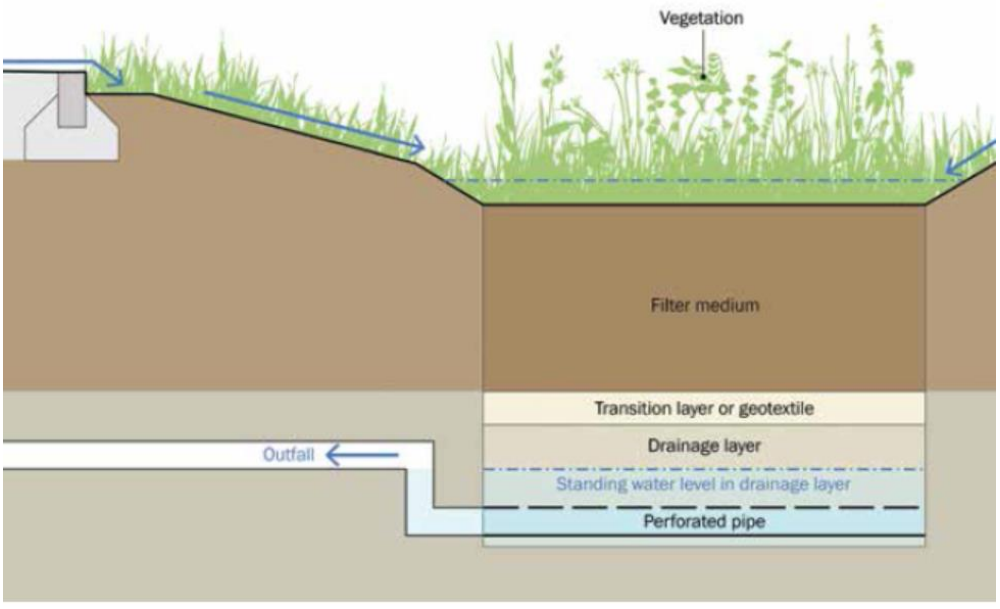

Figure 18.8 Anaerobic bioretention system