How To Guide

Hydro International®

How to Design a Hydro Biofilter™ for Urban Stormwater Treatment

hydro-int.com

Contents

The Hydro Biofilter™ Stormwater Treatment System

What is the Hydro Biofilter™?

The Hydro Biofilter™ is an innovative biofiltration system that harnesses the natural treatment action of vegetation and the filtration power of specially engineered soils.

What pollutants can it remove from surface water runoff?

The Hydro Biofilter™ is proven to remove:

- Up to 85% of very fine particles (mean particle size of 20 microns);
- Gross pollutants and street litter;
- Up to 90% of liquid and sediment bound hydrocarbons;
- Up to 90% of sediment bound and dissolved heavy metals;
- Up to 70% of sediment bound nutrients, such as nitrogen and phosphorus reducing the likelihood of adverse effects to local watercourses; and
- Dissolved pollutants within the flow.

Targeted Pollutants

- Very fine particles
- Liquid and sediment bound hydrocarbons
- Gross pollutants
- Nutrients — Sediment bound
- Heavy Metals — Sediment bound
- Dissolved pollutants

Where can I use it?

The Hydro Biofilter™ is applicable for urban and rural catchments for the immediate collection, treatment and discharge of surface water runoff back to the local environment. Specific example applications are:

- Urban streets
- Commercial high streets
- Car parks
- School playgrounds

How it Works

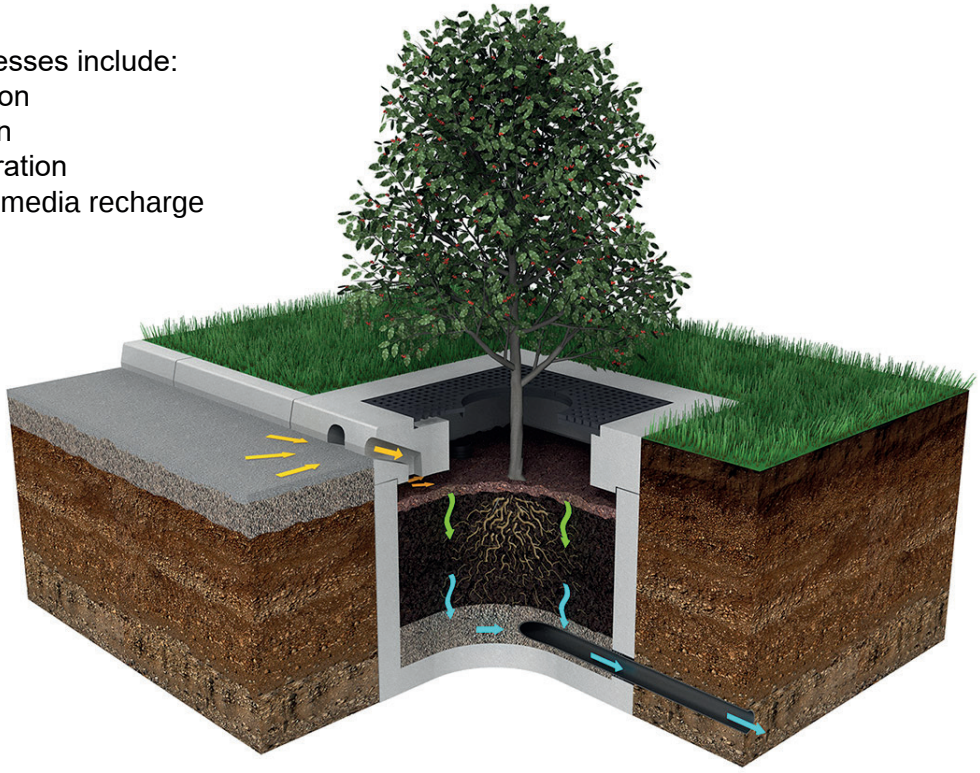
Contaminated surface water runoff drains from the impermeable surface through the kerb inlet slots incorporated into the Hydro Biofilter™ cover slab, direct inlet through the tree grate, or through an inlet pipe on to the mulch layer, where energy dissipater stones are applied to prevent erosion of the mulch and engineered media.

The runoff then flows through the mulch and engineered media layers where pollutants are captured and immobilised.

Treated water is collected in an underdrain carrier pipe, which exits the chamber via a standard pipe coupler cast in to the wall of the chamber.

Treatment processes include:

- Sedimentation
- Inert filtration
- Reactive filtration
- Engineered media recharge



Design considerations we've made for you

The following design considerations have already been made for you as part of the product design:

- Calculation of the water flow rate into the Hydro Biofilter™;
- Calculation of water velocity into the Hydro Biofilter™;
- Determined infiltration rate;
- Calculated Hydro Biofilter™ chamber dimensions;
- Likely maximum depth of water in the Hydro Biofilter™.

So all you need to do is calculate your drained area then pick the number / size of Hydro Biofilter™ required. Go to design steps to find out what you need to consider...

Useful Reference Documents

The SuDS Manual (C753)

The SuDS Manual is a comprehensive document covering the optioneering, design, operation and maintenance of SuDS systems for both the urban and rural catchments. The SuDS Manual is built upon four pillars for consideration when designing a SuDS system:

- Water quantity – the management of flood risk across the site, mitigation of damage caused by water flowing through the site and retention of water for surface water features.
- Water quality – the treatment of surface water runoff to remove grit, pollutants and debris from the flow to mitigate pollution and damage to watercourses and groundwaters.
- Amenity – making the SuDS system multi-functional and a positive addition to the environment, catchment and lives of the local residents.
- Biodiversity – increased benefits to flora and fauna for an improvement in the local ecology.

As part of helping SuDS designers select the most appropriate features for meeting water quality targets, the Simple Index Approach has been developed. This approach ranks the pollution hazard for certain site uses and tasks the designer with selecting SuDS structures to equal or better that mitigation score.

Target Aims:	Met by Hydro Biofilter™
Water quantity	Limited benefit
Water quality	Yes
Amenity	Yes
Biodiversity	Yes - contingent on plant selection

Download a free copy of The SuDS Manual.

The Simple Index Approach

The SuDS Manual (C753) Simple Index Approach (Table 26.7.1) follows three design steps. These are:

Step 1	Allocate a suitable pollution hazard level based on site use.
Step 2	Select SuDS and/or proprietary systems with a total pollution mitigation equal to or greater than the pollution hazard index.
Step 3	Where discharge is to protected[1] surface waters or groundwater, consider the need for a more precautionary approach.

Note: 1 Designated as those protected for the supply of drinking water (see SuDS Manual Table 4.3).

To find out more about The Simple Index Approach and where to apply it, please contact our design team on +44 (0)1275 337977.

Useful Reference Documents

Manual for Streets

The Manual for Streets is a DCLG and DfT produced document aiming to provide a “fundamental culture change” in the design and adoption of residential streets to make them high-quality living places. The document focuses primarily on the combined stakeholder approach to make the spaces usable and enjoyable to everyone. The document is predominantly applied to new streets intended for construction, however the principles are applicable to streets requiring rejuvenation. Chapter 11 discusses the drainage elements required in street design.

Target Aims:	Met by Hydro Biofilter™
Reduce vehicle speed	Yes
Soften the street scene	Yes
Improve microclimate and habitats	Yes

Download the Manual for streets.

Transport for London: SuDS in London - a guide

“SuDS in London – A guide’, produced by Transport for London, is an advice document for those who wish to “design, build, operate and maintain London’s streets”, of which SuDS plays a part in managing the water runoff and adding amenity and biodiversity benefits. The document is intended to be used in conjunction with The SuDS Manual but emphasises the issues, challenges and plans for London with regard to managing flood risk. Section 3.8 focuses on Bioretention Systems, such as the Hydro Biofilter™, and outlines the benefits and design considerations for applying these features in London’s streets.

Target Aims:	Met by Hydro Biofilter™
Retrofit SuDS	Yes
Reduce issues with existing contaminated soil	Yes
Make the most of constrained space	Yes
Reflect local character	Yes

Download SuDS in London - a guide.

Useful Reference Documents

Designing Streets: A Policy for Scotland

Designing Streets is the first Scottish policy statement addressing street design. The policy aims to take the design procedure for streets away from a rigid standards-based methodology but rather allow designs to be area, location and community led. The document also advocates the value in good street design and how it can influence our own daily lives and tackle the wider climate issues. Pages 46 and 49 of the document discuss the use of SuDS and planting within the design.

Target Aims:	Met by Hydro Biofilter™
Appropriate SuDS techniques as relevant to the context in order to minimise environmental impacts	Yes
Integrate natural landscape features and foster positive biodiversity	Yes

Download Designing Streets: A Policy for Scotland.

SUDS for Roads

SUDS for Roads was published in 2009 by the Scottish SUDS Working Party. Together with the accompanying whole life costing and carbon tool, it allows designers, developers and Local Authorities to cost and compare the construction and maintenance costs and carbon emissions of various SUDS and particularly of those most suited to drainage of the road network. Section 2.8.9 talks specifically about 'Prefabricated Bioretention systems', such as the Hydro Biofilter. Chapter 5 looks at the challenges around retrofit of SUDS components, highlighting a number of opportunity spaces for which 'prefabricated bioretention systems' could be a viable and effective option.

Target Aims:	Met by Hydro Biofilter™
Retrofit SUDS	Yes
Enabling effective infiltration	Yes - where suitable
Ensuring effective drainage of road surface	Yes
Pollutant removal	Yes - 2 levels of treatment provided

Download SUDS for Roads.

Design Steps

1) Determine the required project area

This is the total drained area from site for which the runoff will enter the Hydro Biofilter™.

For assistance calculating the required project area, please contact our design team on +44 (0)1275 337977.

2) Initial unit sizing and characteristics

Using the table below, determine the number of each Hydro Biofilter™ unit required.

The kerb inlet slots and underdrain pipe have been designed to allow more water to pass through the system than the infiltration rate of the engineered media. Therefore, the engineered media becomes the limiting factor on the pass forward flow rate from the chamber. The table below shows the anticipated outlet flow rate from the Hydro Biofilter™ units.

Hydro Biofilter ™ Sizes			Drained Area (m^2)	
Width (m)	Length (m)	Filter Area (m^2)	Minimum	Maximum
1.2	1.2	1.44	480	720
1.2	1.8	2.16	720	1080
1.2	2.4	2.88	960	1440

3) Bypass and inlet options

Options for directing flow into the Hydro Biofilter™ are listed in the table below. These inlet options can also be used in combination (ie. a Hydro Biofilter™ can accept surface flows via kerb and pipe inlet and direct into the grate simultaneously).

Kerb Inlet	Pipe / Channel Inlet	Tree Grate Inlet
An integrated half-battered kerb profile, complete with high capacity inlet slots.	A piped inlet into the side of the unit from the surface water network or collection channels.	Surface water enters the unit via the tree grate over the chamber.

Bypass Options

The unit should not be installed as a terminal inlet – as the unit is designed to treat 90% of the annual runoff volume, an effective bypass is required to accept higher intensity rainfall events. The bypass can be internal (if piped) or external (kerb or direct feed). Where surface ponding is a concern, the bypass inlet design should be checked to ensure that it is able to accept the higher intensity or duration storm events. See also Section 8) on free drainage.

Kerb Inlet Arrangement

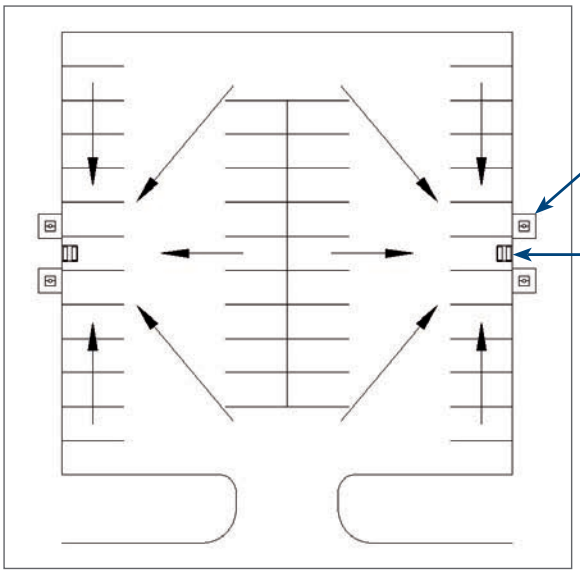
Piped Inlet Arrangement

Typical Bypass Arrangement.

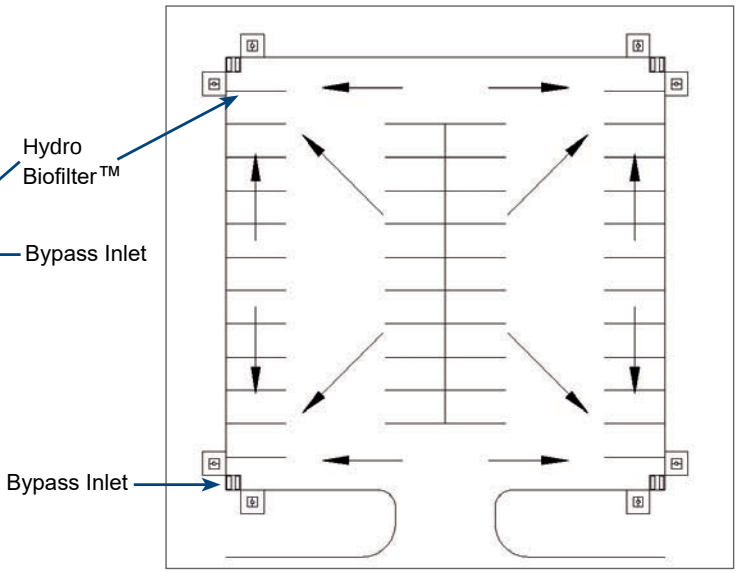
Bypass Inlet

4) Surface Gradation

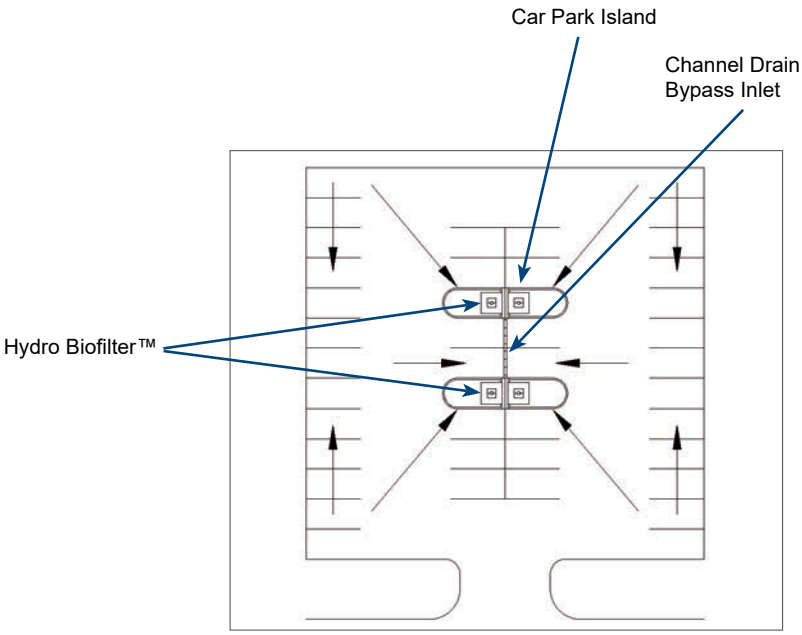
The slope and camber of the road / car park should be set to encourage flows into the Hydro Biofilter™. Where required, a diversion inlet may be incorporated into the system design to pass the water quality treatment volume into the Hydro Biofilter™ unit and divert extreme flows to a separate bypass inlet using conventional hydraulic design criteria for flow over paved surfaces. There are a number of techniques that can be employed to direct the majority of the surface water flows to Hydro Biofilter™ units as illustrated in the drawings below. If your site does not fit any of these typical layouts, please contact us for advice.



Low Points at 2 Sides.



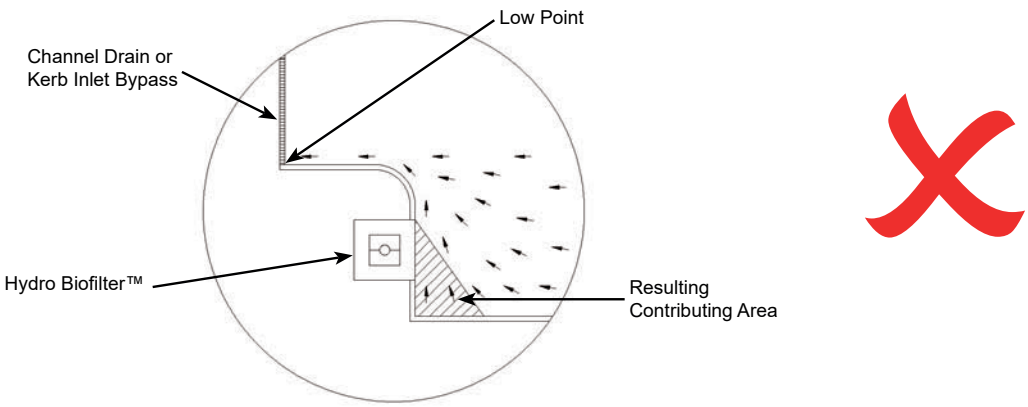
Low Points at 4 Corners.



Central Low Point.

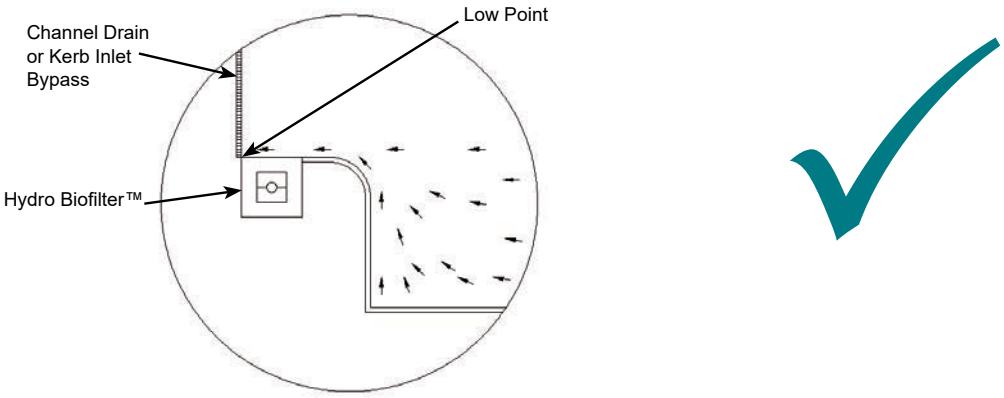
5) Avoid short circuiting

Care should be taken to ensure that the gradation does not direct surface flows away from the Hydro Biofilter™ unit. This could lead to the majority of flows short circuiting the Hydro Biofilter™ and draining directly via the bypass inlet. In the example below the arrows show the likely flow path. The resulting contributing area is reduced to the corner of the drained area.

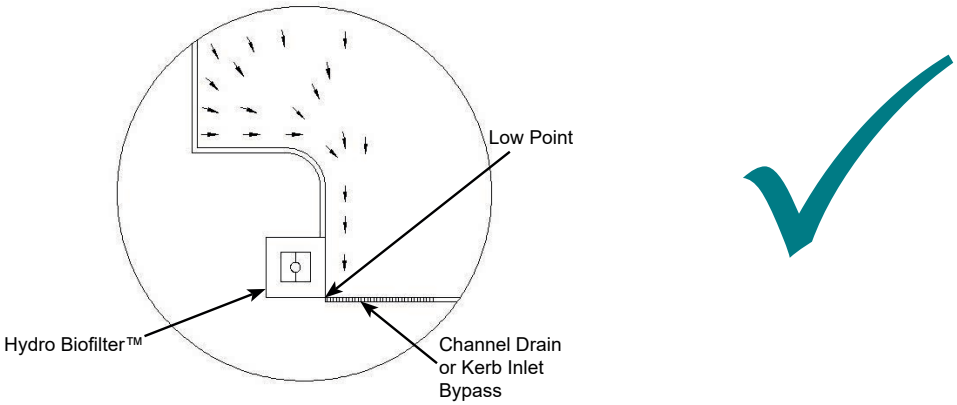


Short Circuiting Problem.

This problem can be alleviated by altering the position of the Hydro Biofilter™ unit or by re-grading the surface as shown in the diagrams below.



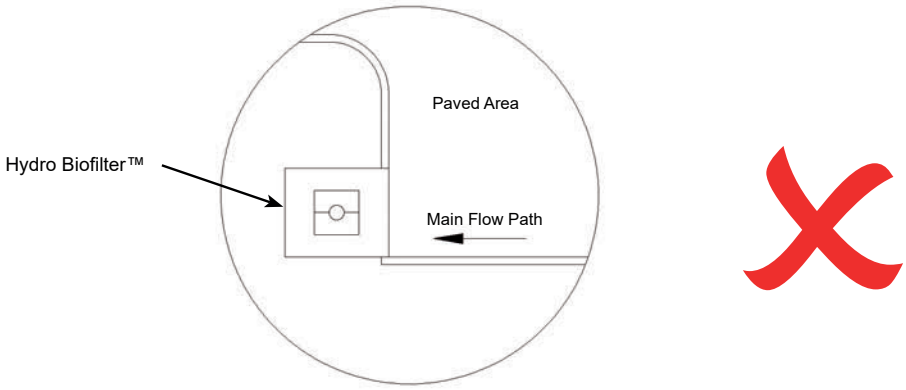
Alternative Unit Placement.



Re-Graded Surface.

6) Avoid head-on flow

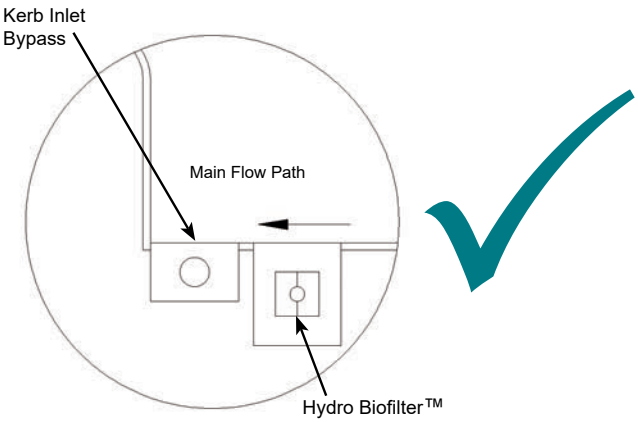
The surface flow path should be so designed as to encourage a cross linear flow along the kerb line in front of the Hydro Biofilter™ inlet.

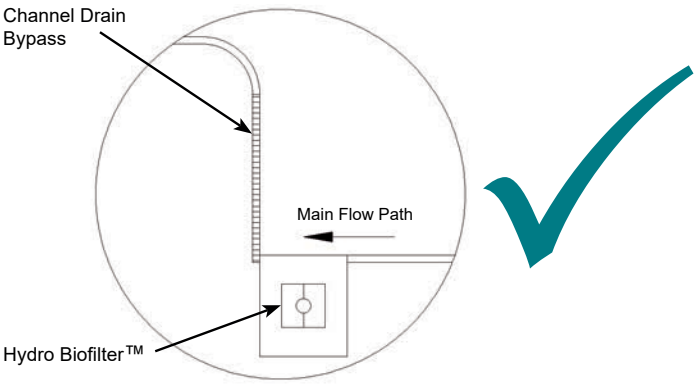


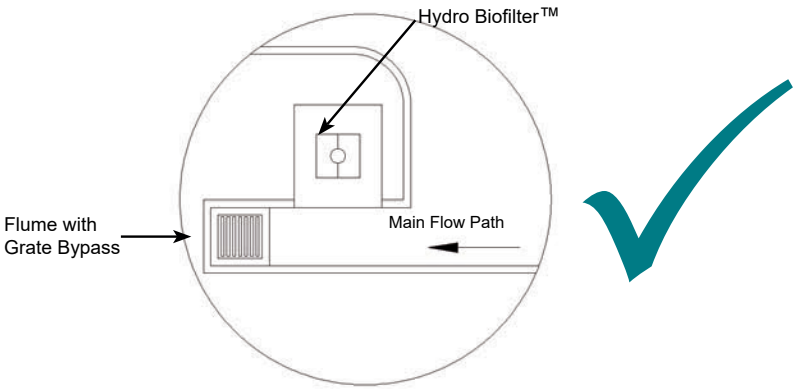
Head-on Flow Placement Problem.

In the above example, the main flow path directs the surface runoff head-on into the Hydro Biofilter™ unit. This could cause erosion or suspension of the engineered media. The diagrams below show alternative placement options that could help to reduce the head-on flow and the associated risk of system degradation.

Head-on Flow Placement Solutions

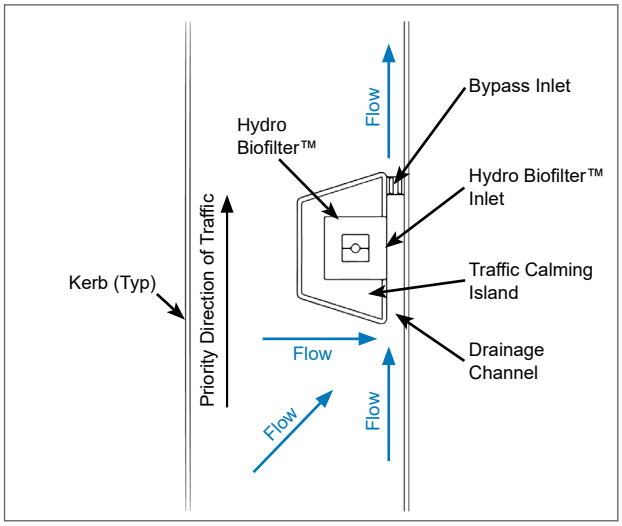


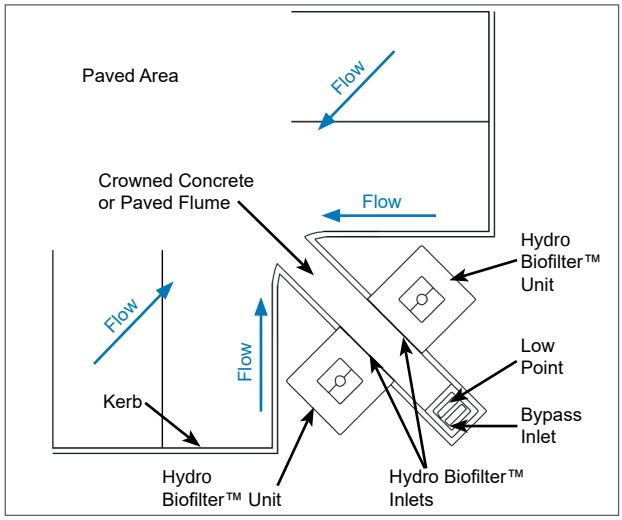




7) Channels, flumes and islands

Whilst having a kerb line is generally preferred, it's not essential as we can dish the surface and take flows in through the grate. Where there is no kerb or where the natural lie of the land directs the surface flow away from a logical placement of the Hydro Biofilter™ system along the kerb line, there are some techniques that can be employed to form a channel, flume or island for the Hydro Biofilter™. This can be used to create a short kerb line to direct the flows and / or to protect the Hydro Biofilter™ unit from receiving head-on flows. The pictures below show a few placement examples.



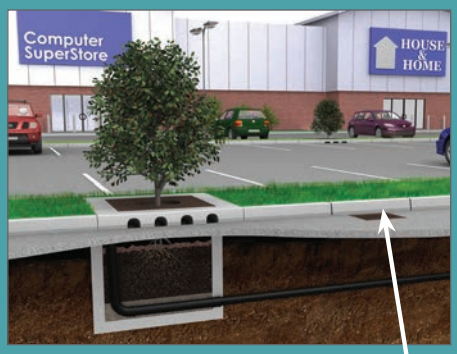


8) Free draining

The unit should drain freely and should not be placed under surcharge conditions; there must be no ponding or standing water in or outside of the chamber under dry weather conditions / after storm events have subsided. There may be ponding within the unit during a storm event. The treated surface water discharged from the Hydro Biofilter™ unit can be passed forward to a soakaway, attenuation structure, re-use system, receiving watercourse or sewer system depending on the site conditions.

Hydro Biofilter™ connected to Stormbloc® soakaway.

Traffic Calming Arrangement.



Typical Bypass Arrangement.

9) Select Your Shrub

The shrubs and small trees listed in the table below are deemed suitable for the variable conditions and engineered filter media in the Hydro Biofilter™. This list was compiled in conjunction with Robert Bray Associates.

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height* (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade
Native Trees								
Sorbus aucuparia	Rowan	D	5 +	✓	✓	✓	✓	✓
Native Shrubs								
Buxus sempervirens	Box	E	2-5	-	-	-	✓	✓
Hippophae rhamnoides	Sea Buckthorn	D	2-5	-	✓	-	✓	-
Ilex aquifolium	Holly	E	2-5	-	✓	-	✓	✓
Viburnum lantana	Wayfaring Tree	D	1-3	✓	✓	-	✓	-
Viburnum opulus	Guelder Rose	D	1-3	✓	✓	✓	✓	-
Ornamental Trees								
Amelanchier lamarckii	Snowy Mesipilus	D	3 +	✓	✓	✓	✓	-
Cercis siliquastrum	Judas tree	D	5 +	✓	-	✓	✓	-
Corylus colurna	Turkish hazel	D	5 +	-	-	✓	✓	-
Koelreuteria paniculata	Golden Rain Tree	D	5 +	✓	✓	✓	✓	-
Malus 'Evereste' and others	Crab apples	D	5 +	✓	✓	-	✓	-
Pyrus nivalis	Pear	D	5 +	✓	✓	✓	-	✓
Sorbus commixta and other varieties	Rowan	D	5 +	✓	✓	✓	✓	-
Ornamental Shrubs								
Abelia x grandiflora	Abelia	E	1.2 x 1.2	✓	-	-	✓	-
Aralia elata	Angelica tree	D	3 x 2.5 +	✓	-	✓	✓	✓
Arbutus unedo	Strawberry tree	E	2.5 x 2 +	✓	✓	-	✓	✓
Aucuba japonica Rozannie +others	Aucuba	E	1.2 x 1.2	-	✓	-	✓	✓
Choisya 'Aztec Pearl' & C. ternata	Mexican orange blossom	E	1.5 x 1.5	✓	-	-	✓	✓
Cotinus coggygria + other varieties	Smoke bush	D	3 x 2 +	✓	-	✓	✓	-
Fatsia japonica	Castor oil plant	E	1.5 x 1.5	✓	✓	-	-	✓
Garrya elliptica	Garrya	E	3 x 2.5	✓	✓	-	✓	✓
Hypericum Hidcote	St Johns wort	D	1.5 x 1.5	✓	-	-	✓	✓
Juniperus X media 'Pfitzeriana' + others	Juniper	E	1.5 x 2	-	-	-	✓	-
Laurus nobilis	Sweet bay	E	3 x 2	✓	-	-	✓	-
Ligustrum lucidum + others	Privet	E	3 x 2	✓	-	-	✓	✓
Mahonia Charity + others	Mahonia	E	3 x 2	✓	✓	-	✓	✓
Nandina domestica Richmond	Sacred Bamboo	D	2 x 1.5	✓	✓	✓	✓	✓

Botanical Name	Common Name	Evergreen or Deciduous	Usual Height* (m)	Flowers	Berry	Autumn Leaf Colour	Sun	Shade
Osmanthus x burkwoodii + others	Osmanthus	E	2 x 1.5	✓	-	-	✓	✓
Phormium tenax-cookianum hybrids	New Zealand flax	E	1.5 x 1.5	✓	-	-	✓	-
Photinia Red Robin	Photinia	E	2.5 x 1.5	✓	-	✓	✓	✓
Prunus laurocerasus forms like P, Etna	Laurel	E	varies	✓	-	-	✓	✓
Pyracantha 'Teton' + others	Pyracantha	E	3 x 2	✓	✓	-	✓	-
Rhus typhina 'Laciniata'	Stags Horn Sumach	D	3 x 2	✓	✓	✓	✓	✓
Skimmia x Kew Green + others	Skimmia	E	0.9 x 0.9	✓	✓	-	-	✓
Trachycarpus fortunei	Chusan palm	E	3 x 2	✓	-	-	✓	✓
Viburnum varieties	Viburnum	E & D	varies	✓	✓	✓	✓	✓
Cotoneaster Erect								
Cotoneaster bullatus + others	Cotoneaster	E & D	1.5 +	✓	✓	✓	✓	✓
Euonymus Low								
Euonymus japonicus	Evergreen spindle	E	2 x 1.5	-	-	-	✓	✓
Escallonia 'Slieve Donard' and other varieties	Escallonia	E	1.5-1.5	✓	-	-	✓	-

* Due to the rootball containment within the small, pre-fabricated bioretention planters, the plants may not reach the usual height specified and will generally be restricted to 1.2 - 2 m mature height.

Case Study

Hydro Biofilter™ helped Vale of Glamorgan Council to provide urban planting and landscaping while meeting SuDS standards.

Objective

To meet Sustainable Drainage Systems (SuDS) standards and provide urban planting and landscaping as part of the construction of a new car park.

Solution

Three Hydro Biofilter units were sized and installed to ensure that the drainage and treatment requirements were met at each point, providing an attractive solution that was sympathetic to the need to improve the landscaping and amenity of the area.

One of the first UK installations of the innovative new Hydro Biofilter™ bioretention and biofiltration system has brought amenity and stringent stormwater quality control to a sensitive location in Barry, South Wales.

Vale of Glamorgan Council installed three Hydro Biofilter™ units at the Business Service Centre (BSC) car park to meet Sustainable Drainage Systems (SuDS) standards and provide urban planting and landscaping within construction of a new car park.

The Hydro Biofilter™ bioretention and biofiltration system is a self-contained unit with high retention rate for solids, heavy metals and oils and grease, thanks to the vegetation and special growing medium.

Its footprint is typically up to 50 times smaller than other standard bioretention systems, and requires little maintenance.

The system looks like a normal tree box from the surface, with suitable shrubs or a tree protruding through a decorative grating in a typical concrete slab at pavement level.

Underneath, a concrete container with a mulch layer and soil filter medium provide effective and consistent stormwater treatment and attenuation.

Each unit is connected to a surface water drain, infiltration or soakaway system via an underdrain system.

"Features like swales and reed beds were not feasible to introducing more biodiversity, as there was not enough room in this typical urban location which is surrounded by buildings and infrastructure.

The three Hydro Biofilter™ units enabled us to meet Environment Agency requirements for removing pollutants from stormwater runoff before discharge via the storm sewer into the adjacent docks.

Hydro Biofilter™ combined several different SuDS features within one system, which was not met by any other solution the council looked at."

- Keith Sulsh, Drainage Engineer, Vale of Glamorgan Council

The council decided to review surface water drainage at the BSC Car Park when a previous design using porous paving was proving unsatisfactory. The Hydro Biofilter™ units provided an attractive solution that was sympathetic to the need to improve the landscaping and amenity of the area.

As the overall parking is for 63 cars, Environment Agency requirements on pollution are strict, so water quality treatment must be very effective. The BSC car park is divided into three connected areas, which added complexity to the falls required for drainage.

Final discharge from the car park is via the surface water drainage system into Barry Dock. Requirements from the Association of British Ports, who are responsible for the marine environment of the docks, were that no additional pollution should be allowed to jeopardise the marine ecosystems.

The Business Service Centre was completed in the early 2000s, as part of a redevelopment and regeneration initiative for the whole Barry Waterfront Development and harbour areas after the demise of local industry.

Currently the Barry Waterfront Development drainage is being assessed by Welsh Water with a view to adoption. Hydro Biofilter™ units are being considered for other locations in Barry.

The Vale of Glamorgan Council is committed to explore SuDS solutions wherever drainage projects occur. Each location is assessed on its merits and requirements to enable the most effective options to be chosen from a range of SuDS techniques, against available budgets.

"We had several different elements to take into the equation, including the cost. Within this type of project, landscaping should not be treated as a separate budget; with Hydro Biofilter™ units, tree containment is integral. With a traditional landscape design cast iron grilles and the plastic root barriers for root growth containment to prevent future damage to surrounding construction would have added to the costs of the whole installation.

However, when we factored in these elements, even with additional hydrocarbon interceptors for 'belt and braces' pollution control for water discharged into the harbour, the difference in costs between a standard storage attenuation unit with high performance silt and hydrocarbon interceptors and the three Hydro Biofilter™ units was negligible.

What really swung the deal was the committed approach of the Hydro International design team. They sized the units to ensure that the drainage and treatment requirements were met at each point; it was effectively a bespoke installation."

Surface drainage had to be more efficient than it was previously, so we had to adjust the falls a little. The lowest unit was specially adapted so that it performed as an attenuation storage unit as well, by repositioning the outlet to slow down discharge. The modular units were quite simple to install and, although it was not the best season for starting tree growth, after a year they are fine."

- Keith Sulsh

To learn more about how our Hydro Biofilter™ can help you meet water quality objectives for urban street design visit **hydro-int.com/hydro-biofilter** or search **hydro urban design** online.

Contact us:

Talk to an expert today:

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