Government of Western Australia
Department of Water

Looking after all our water needs

Water sensitive urban design

Biofilters

Summary

Biofilters (also known as biofiltration systems, bioretention systems and rain gardens) are excavated basins or trenches that are filled with porous filter media and planted with vegetation to remove pollutants from stormwater runoff. They use natural and physical processes to treat stormwater.

This brochure is part of a series that explain various aspects of water sensitive urban design. Please see *Water sensitive urban design in Western Australia* for background information on water sensitive urban design.

Main benefits

- They will work in a variety of climate, soil and groundwater conditions.
- Their flexible design (linear, basins, tree pits, planter boxes) allows them to fit into many different locations.
- Soil and sand filters provide good removal of sediment and heavy metals.
- Specially selected soil filter media and appropriate vegetation selection improves nutrient removal rates.
- They require less space than other infiltration systems due to their higher infiltration rate.

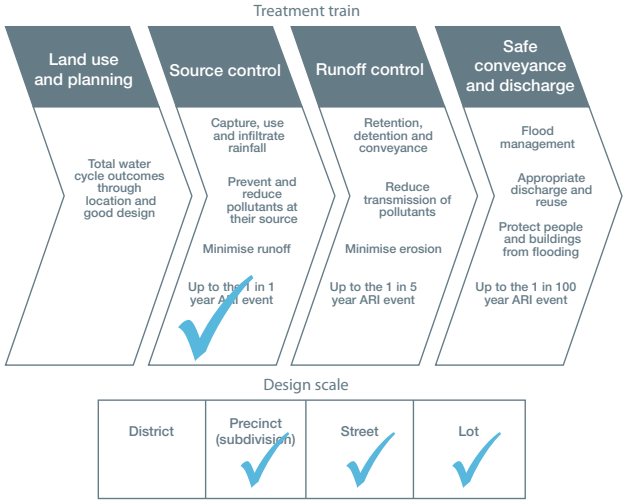
Design factors

- Ensure they are integrated into landscape design.
- Consider location as part of planning and design of roads and lots.
- Design to infiltrate or connect to the larger stormwater system where appropriate.
- Make the surface area at least 2% of the constructed, directly connected impervious catchment for water quality treatment.
- Size the storage volume to suit system hydraulics – ideally a 1-year critical average recurrence interval event.
- Use vegetation appropriate to the climate and desired pollutant removal.
- Incorporate a submerged zone and carbon source to promote vegetation health and resilience during dry periods and aid nitrogen removal.
- Consider the impact of potential acid sulfate soils on filter media and/or structures where relevant.

Target pollutants

- coarse sediment
- suspended solids
- phosphorus
- nitrogen
- heavy metals

Where they can be used in the water sensitive urban design process



Public open space biofilter, Meadow Springs, Mandurah

Roadside biofilter retrofit, Busselton CBD

On-lot biofilter, Evermore Heights, Baldivis

Water sensitive urban design

Biofilters

Design function

Note: Transition and drainage layers may not be required if direct infiltration of treated stormwater to surrounding soils is possible. See FAWB guidelines for diagrams demonstrating submerged zones, outlets, etc.

Aid aesthetics, assist in pollutant removal and maintain hydraulic conductivity of filter media

Sedimentation of primary sediments and metals

Suppress weeds and retain moisture in underlying filter media

Soil filters fine sediments and colloidal particles

Soil layer for plants to grow in

Sorption of metals and nutrients by filter particles

Side liner required if in clay sites to prevent contamination of filter, and in coarse sandy sites if the native soil has a higher hydraulic conductivity than the filter media

Include a carbon source to improve chemical processes in soil and promote vegetation health

Nutrient sorption and pollutant decomposition by soil and bacteria

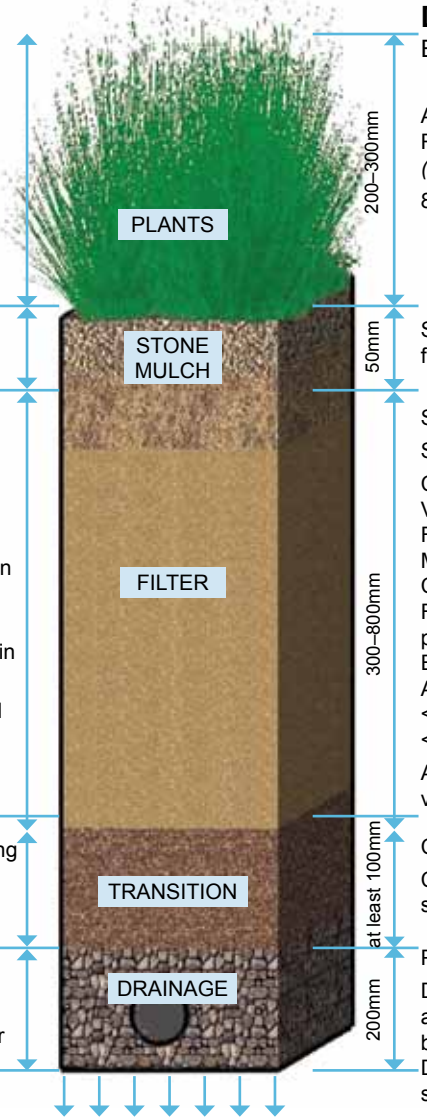
Separates filter layer from drainage layer to avoid clogging and stop transition of the filter media into the drainage layer

Free draining layer containing pipe (if required)

Subsoil pipe can aid in watertable control and is also required in impervious systems to collect and convey water

Infiltration from base if applicable

Biofilter elements



Design guidelines

Extended detention depth

At least 50% of the plants to be effective at nutrient removal. Remainder to be local, native, ephemeral plants e.g. *Ficinia nodosa (*formerly *Isolepis nodosa)*

8–12 plants per m^2, depending on species

Stone 100% 4–13mm in size. No fines. Note that wood mulch will float under flooded conditions

Sandy loam

Saturated hydraulic conductivity in range 100–300mm/hr

Clay and silt	<3%	(<0.05mm)
Very fine sand	5–30%	(0.05–0.15mm)
Fine sand	10–30%	(0.15–0.25mm)
Medium to coarse sand	40–60%	(0.25–1.0mm)
Coarse sand	7–10%	(1.0–2.0mm)
Fine gravel	<3%	(2.0–3.4mm)
pH	5.5–7.5	
Electrical conductivity	<1.2dS/m	

At least 3% low nutrient-content organic matter
<80mg/kg orthophosphate
<1000mg/kg total nitrogen content

Amend soil with 5% mulch and 5% hardwood chips (6mm) by volume

Clean, well-graded sand <2% fines

Clean, fine gravel or crushed rock 2–5mm and carbon source, if submerged

Perforated PVC subsoil pipe (if required)

Drainage layer (if there are no subsoil pipes) - should be at least as deep as the extended detention depth, however this should be based on individual site characteristics
Drainage layer (if subsoil pipes are used) - completely surround the subsoil pipe and at least 50mm over pipe

(Adapted from: Thompson McRobert Edgeloe Group 2008)

Required reading

Adoption guidelines for stormwater biofiltration systems, 2009, Facility for Advancing Water Biofiltration, Monash University, available at <www.monash.edu.au/fawb/products/index.html> for the most recent advice.

Australian runoff quality: a guide to water sensitive urban design, 2006, Engineers Australia, available at <www.arq.org.au>.

Construction and establishment guidelines: swales, bioretention systems and wetlands, 2009, Water by Design, South East Queensland Healthy Waterways Partnership, Brisbane, available at <www.waterbydesign.com.au/ceguide>.

Guideline specifications for soil media in bioretention systems, 2008, Monash University Facility for Advancing Water Biofiltration.

In situ monitoring of hydraulic conductivity, 2009, Monash University Facility for Advancing Water Biofiltration.

Stormwater management manual for Western Australia, 2004–07, Department of Water, available at <www.water.wa.gov.au>. See Section 4.2 of Chapter 9 – Structural controls. Suitable plant species for use in biofilters in Western Australia are being researched. Section 4.2 will be updated to reflect the findings from this research and the Monash University FAWB research.

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