CRC for Water Sensitive Cities

Fact Sheet: Vegetation selection for stormwater biofilters

Plants are an essential component of biofilters. Without plants, the performance of stormwater biofilters is much poorer. Both plants and microbes serve multiple roles in biofilter function (Figure 1). Importantly, plants and microbes are inseparable, as most microbes are supported in the zone around plant roots.

Plants also provide additional benefits within the urban environment, including improving amenity, creating green spaces, enhancing biodiversity and habitat, and providing microclimate benefits, which are associated with considerable human health and economic benefits.

However, not all plant species will perform the same in stormwater biofilters, particularly for nitrogen removal. Research has identified the characteristics of effective and poorer performing plant species (Table 1 and Figure 2). Species must be capable of survival in the biofilter environment (sandy substrate, prolonged drying and intermittent inundation). It is recommended that a mixture of plant species including various plant types are selected, including at least 50% of species with desirable traits for effective removal of the target pollutants (Table 1). Other considerations for plant selection also include aesthetics and amenity within the local environment, diversity and habitat objectives, microclimate benefits and safety requirements (Table 1).

Plants should be densely planted and carefully established to develop an effective and low-maintenance biofilters in the long-term.

Further guidance is provided in the full Biofilter Guidelines and 'Vegetation guidelines for stormwater biofilters in the South West of Western Australia' (Monash Water for Liveability, 2014).

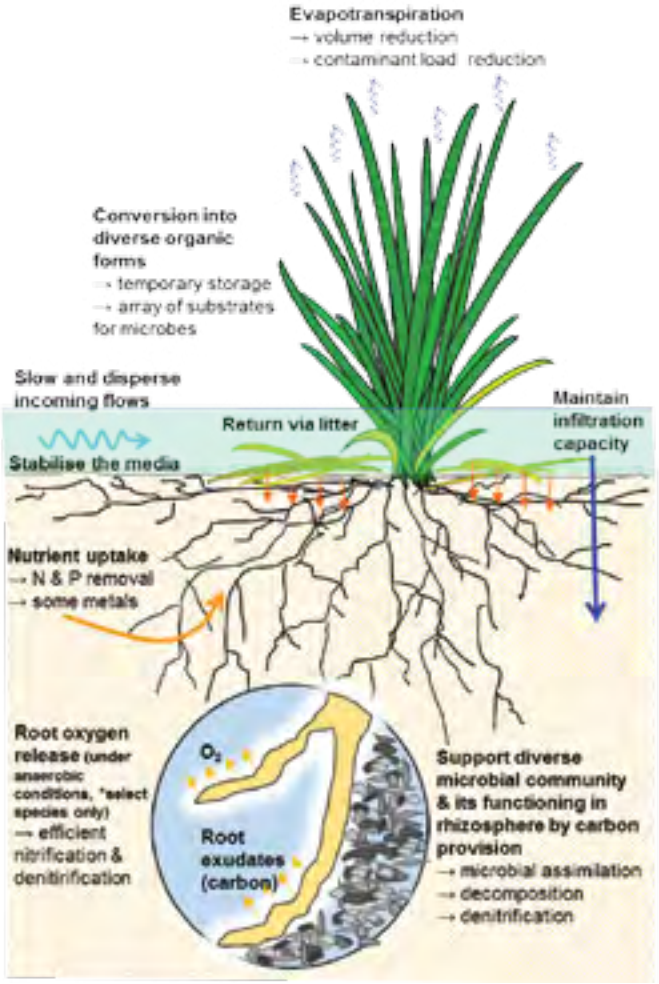

Figure 1. Traditional urban design with impervious surfaces brings challenges for water management, climate control, human wellbeing and waterway health

For full details please refer to the Adoption Guidelines for Stormwater Biofiltration (CRC for Water Sensitive Cities, 2015)

Australian Government
Department of Industry and Science
Business Cooperative Research Centres Programme

www.watersensitivecities.org.au | admin@crcwsc.org.au

Table 1. Desirable plant traits for stormwater biofilters

Objectives	Desirable species traits and plant selection tips
FUNCTIONAL OBJECTIVES (stormwater treatment)	• Include at least 50% plant species with effective traits that meet water treatment objectives • Distribute these across the biofilter area as much as possible
Nitrogen (N) removal	• Effective species have extensive and fine root systems which maximise uptake capacity, contact with the stormwater and supports a vast microbial community alongside the root: - High total root length - High root surface area - High root mass - High root shoot ratio - High proportion fine roots • Relatively rapid growth but ability to survive and conserve (or 'down regulate') water across dry periods • High total plant biomass often accompanies an extensive root system • Do not select species based on similarity in above-ground appearance or plant type – this is a poor indicator of performance for N • Exclude species with limited root systems (i.e. minimal total root length and mass) or dominated by thick roots which are less effective • In particular, avoid trees or shrubs with limited root systems as these tend to be consistently poor performers • Use a diversity of plant species and types, as species can vary in their relative performance between wet and dry conditions • Avoid nitrogen-fixing species which can input additional N to the system (e.g. wattles (Acacia species), clover and peas; all legumes from the Fabaceae family, and members of the Casuarinaceae family (e.g. Allocasurina). • Use a high planting density to maximise root and microbial contact with the media and stormwater • If feasible, consider harvesting the plant biomass to permanently remove N and possibly stimulate new growth and uptake
Phosphorus (P) removal	Although plant selection is less critical, select species with extensive root systems, similar to characteristics effective for N removal – these will also effectively take up P.
Heavy metal removal	Select effective species with extensive root systems (e.g. *Carex appressa*)
Pathogen removal	Select effective species with extensive root systems (e.g. *Leptospermum continentale, Melaleuca incana, Carex appressa*) Select species associated with lower infiltration rates
Hydrological treatment - Volume reduction	Select species with high transpiration (such as trees) but also able to conserve water in dry periods Use multiple layers of vegetation and various plant types to increase transpiration (i.e. trees and shrubs with understorey species)
Infiltration capacity	• It is recommended to: - Include species with a proportion of thick roots (e.g. Melaleuca ericifolia), - Include species with robust stems able to disturb the surface layer - Avoid species with predominantly fine roots (i.e. no thick roots) - Avoid species with shallow or minimal root systems (e.g. Microleana stipoides) - Plant relatively densely

Cont.

Australian Government Department of Industry and Science | Business Cooperative Research Centres Programme

Table 1 Cont.

Objectives	Desirable species traits and plant selection tips
Effective maintenance	• Plant densely across the entire biofilter • Select robust species for edges and plant densely to deter pedestrian access • Similarly, near inflow points carefully select robust species and offset planting rows to help widely distribute inflows • Include a diversity of species to provide resilience and allow plants to 'self-select' and expand if other species die out. • Do not select short-lived or annual species • Avoid species that require regular pruning or those that produce large volumes of litter at senescence • Avoid the use of deciduous trees in or near biofilters • If possible, include trees to shade understorey layers and the media surface. • Plant sedges or grasses along biofilter edges adjacent to lawn to provide shade and reduce the need for edge trimming
ADDITIONAL OBJECTIVES	• Plants with attributes that only suit these objectives (i.e. do not overlap with effective traits for functional objectives) should comprise ← 50% of biofilter vegetation
Biodiversity	• Select local indigenous species, compatible with nearby remnant vegetation • Include a diversity of species and plant types to provide structural diversity • Include flowering plant species, species used by local birds and insects • Never use invasive species in biofilters – not only known invasive species, but beware of species that can rapidly and easily spread by rhizomes or seeds
Aesthetics and Amenity	• Understand the site context - match species, layout and materials to surrounding landscape and neighbourhood character (conduct a site visit) • Consider land use, architecture, other landscaping and plantings in the area • Balance unity and variety in design • Include some complexity but the design should be orderly (i.e. avoid 'messy' and 'unkempt' appearance) • Consider long-term appearance and form as plants grow • Consider use of colours, textures, patterns, and use of light and shade • Include trees as features (if possible), consider use of colours and textures • Include seasonal variety with various flowering plants
Habitat	• Use a diversity of plant species and plant types • Incorporate woody plants and some woody debris if possible
Microclimate	• Include trees with a sizeable canopy and depth of shade (broad-leaved)
Safety	• Always consider plant species size at maturity and any tendency to collapse during senescence, drop limbs, fruit or significant volumes of leaf litter • Consider line-of-sight requirements for vehicles and pedestrians • Avoid planting species in border plantings that may protrude or collapse onto adjacent pathways

Australian Government
Department of Industry and Science
Business Cooperative Research Centres Programme

Carex appressa

Melaleuca incana

Juncus kraussii

Carex tereticaulis

Juncus pallidus

Figure 2. Examples of effective species for nitrogen removal in stormwater biofilters

Australian Government
Department of Industry and Science
Business Cooperative Research Centres Programme