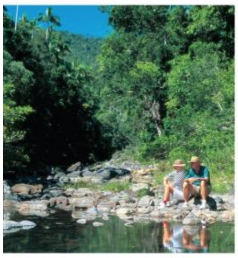
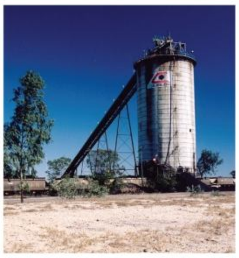
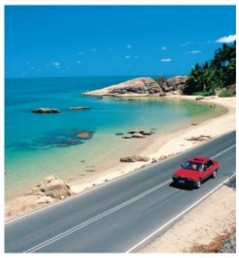
Whitsunday Regional Council

Stormwater Quality Guideline







Acknowledgements

This document was co-authored by Healthy Waterways, Ideanthro and Whitsunday Regional Council under the guidance of the Whitsunday Region Urban Water Management Reference Group. Membership of the reference group is comprised of urban planning, engineering and stormwater professionals from the private sector and from Whitsunday Regional Council. Council would like to acknowledge and thank everyone for their contribution to the production of this document.

Contents

1 Introduction

The Whitsunday Regional Council area encompasses a total land area of 23,862km² and includes the major centres of Airlie Beach, Bowen, Collinsville and Proserpine. The region is located in central Queensland adjacent to the World Heritage Listed Great Barrier Reef. The region is diverse in nature and each of our communities has its own individual character that helps to make this region so renowned and such a wonderful place to live and work.

Urban development places pressure on waterway assets such as the Great Barrier Reef, significant rivers and local streams. Stormwater carries pollutants such as nitrogen, phosphorous, sediment, litter, heavy metal and hydrocarbons. These impact upon local waterways, rivers and the Great Barrier Reef. Changes in hydrology associated with new urban development cause stream erosion and change flow regimes. These deliver greater loads of polluting sediment downstream and change ecological communities.

In recent years advances in urban development approaches and stormwater treatment technologies have made it possible to minimise the impact that new urban development has on waterways. Whitsunday Regional Council requires that new development appropriately manages its stormwater in order to protect the regions many and varied natural assets.

1.1 Purpose of this guideline

The purpose of this guideline is to clearly articulate Whitsunday Regional Council's requirements for new development and redevelopment with respect to how it manages the environmental impacts of its stormwater.

1.2 Whitsunday Regional Council documents

Managing the environmental impacts of stormwater does not occur in isolation. Catchment type, landform, urban design and the management for stormwater to prevent flooding all inter-relate with managing the environmental impacts of stormwater. In managing the environmental impacts of its stormwater, new development shall be cognisant of the wider requirements of the Whitsunday Regional Council Planning Scheme, Development Manual and Standard Drawings.

1.3 External documents

A range of regional guidelines have been published to support the design, construction, establishment and operation of sustainable stormwater treatment in Queensland. New development shall manage the environmental impacts of its stormwater in accordance with the following documents, except where modified by this guideline. Where a specific document is of particular relevance to a section of this guideline it may be mentioned again at the beginning of that section.

- Queensland Urban Drainage Manual (Department of Energy and Water Supply, 2013)
- Concept Design Guidelines for Water Sensitive Urban Design (Water by Design, 2009)
- MUSIC Modelling Guideline (Water by Design, 2010)
- Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (Healthy Waterways, 2006) – Chapter Two only
- Bioretention Technical Design Guideline (Water by Design, 2014)
- Constructed Wetland Technical Design Guideline (Water by Design, 2016)
- Stormwater Harvesting Guideline
- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010)
- Transferring Ownership of Vegetated Stormwater Assets (Water by Design, 2012)
- Maintaining Vegetated Stormwater Assets (Water by Design, 2012)
- Rectifying Vegetated Stormwater Assets (Water by Design, 2012)
- IPWEAQ Standard Drawings DS-070, DS-071, DS-076, DS-077, DS-078, DS-079 and DS-080

1.4 Suitably qualified persons

A suitably qualified person shall design and certify all stormwater management measures. A suitably qualified person is a person who:

- is a Registered Professional Engineer of Queensland (RPEQ) (civil engineering or environmental engineering)
- has at least five years demonstrated experience in the design and delivery of successful stormwater management strategies.

2 Objectives

This section describes the stormwater management design objectives that applicable development within the Whitsunday Regional Council local government area must comply with. Applicable development is that which is triggered by the water quality component of the State Planning Policy.

2.1 Stormwater quality

Table 1: Stormwater quality objective

Intent	Protect receiving water quality by limiting the quantity of stormwater pollutants discharged into receiving waters
Standard/ objective	A percentage reduction in mean annual loads of the following pollutants compared to unmitigated development as follows: • Gross pollutants >5mm – 90% reduction • Total suspended solids – 75% reduction • Total phosphorous – 60% reduction • Total nitrogen – 40% reduction
Application	All development from which the water quality component of the State Planning Policy requires the environmental impacts of stormwater to be managed

Note – While the design objective explicitly lists four pollutants of interest, this should not be taken to diminish the importance of other pollutants present in urban catchments including heavy metals and hydrocarbons. Nor should it be taken to diminish the relative importance of speciation of pollutants. Contemporary modelling software such as the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) can only model total suspended solids, total nitrogen, total phosphorous and total gross pollutants. Hence the objectives are specified for those pollutants only until such a time as a more complete modelling tool is available.

2.2 Waterway stability

Table 2: Waterway stability objective

Intent	Prevent in-stream erosion downstream of urban development by controlling sediment transporting flows.
Standard/ objective	Limit the peak 1-year ARI event discharge within the receiving waterway to the pre-development peak 1-year ARI event discharge.
Application	All development from which the water quality component of the State Planning Policy requires the environmental impacts of stormwater to be managed and that • Drains to an unlined channel or non-tidal waterways within the site or downstream of the site which is not significantly degraded; or • Drains to a tidal waterway within or downstream of the site which is not significantly degraded and is at risk of erosion due to changes in hydrology.

2.3 Integrated design

Table 3: Integrated design objective

Intent	To ensure that stormwater management infrastructure integrates into the surrounding landscape and is environmentally, socially and economically sustainable
Standard/ objective	Stormwater treatment infrastructure shall: • be considered early in the site planning and design process to ensure a suitable location can be met and space assigned • be integrated with the development layout to increase visual amenity • achieve a shape that complements the surrounding landform • be designed to minimise long term maintenance requirements while preserving functionality • be acceptably safe • be constructed from materials, and in a manner which minimises waste and embodied energy
Application	All development from which the water quality component of the State Planning Policy requires the environmental impacts of stormwater to be managed

3 Information to be provided

3.1 Alongside applications

Sufficient information shall be provided with material change of use (MCU), reconfiguration of a lot (RoL) and operational works (OW) applications to allow Council to understand and assess the efficacy of the proposed stormwater management approach.

MCU/ RoL applications shall provide:

- a stormwater quality management plan (SQMP) containing the information outlined in Table 4 in Section 3.1.1; and
- all stormwater models and calculations used in the creation of the SQMP and development application (see Section 3.1.5).

In some instances, additional information may be required in order to be confident that the proposed stormwater management approach is achievable on-site. This is to be assessed on a case by case basis but will typically occur on sites where the physical features of the site are out of the ordinary. For example, a very steep site proposing a bioretention system would likely need to provide additional information to ensure that the system, including its batter slopes can fit within the area allowed for it. In these instances, an MCU/ RoL application shall also provide conceptual earthworks drawings (see Section 3.1.3) to demonstrate that the proposed treatment measures can fit (vertically and horizontally) within the space provided.

OW applications shall provide:

- a stormwater quality management plan (SQMP) containing the information outlined in Table 5 in Section 3.1.2; and
- detailed engineering and landscape drawings (see Section 3.1.4); and
- working copies of all stormwater models and calculations used in the creation of the SQMP and development application (see Section 3.1.5); and
- suitably qualified person certification (see Section 1.4).

3.1.1 Stormwater quality management plan – MCU/RoL

Table 4: Details to be included in a stormwater quality management plan for a MCU/RoL application

Section	Contents
Cover page	Development name and reference
Document information page	Table outlining information relevant to the development of the SQMP, including document title (reference number, date and version), document authors and reviewers, suitably qualified persons details (qualifications and experience), names of the project team and signature and name of the client.
Table of contents	Structure of the SQMP.
Introduction	Description of the proposed development (works, address and RP) and purpose of the SQMP.
Previous reports	Summary of other reports which deal with stormwater management that are superseded by this report
Related reports	Summary of reports (such as waterway assessments and soil investigations) that should be read in conjunction with the SQMP.
Previous approvals or requests for information (if relevant)	Details of any previous approvals or requests for information for the development site.
Site description	Description of the development site including details of topography, geology, relevant hydrological/ drainage features, existing natural features, imperviousness etc. Site survey details including spot levels, contours, boundaries, waterways, vegetation (including regional ecosystem mapping), easements and other relevant site features. Description of site constraints.
Development description	Description of the proposed development including land use, scale, densities, site coverage (percent impervious), lawful point of discharge and general urban design.
Stormwater management objectives	List of all the stormwater management objectives (see Section 2) which apply to the development. Justification for any objectives not adopted.
Stormwater management strategy	Description of the selected stormwater management initiatives required to comply with each objective applicable to the development. This should include figures providing conceptual catchments, location and scale of the stormwater management initiatives. It must demonstrate that sufficient space is available for the stormwater management initiatives. This includes both horizontal and vertical space. The proposed system must be able to drain. If the proponent is proposing a bioretention system for the site to comply with the stormwater quality design objectives, they may, if they wish, adopt a filter media sized at 1.5% of the catchment, and allow a total of 3 times this area for the total footprint of the system. If the proponent is proposing a vegetated stormwater asset other than a bioretention system (typically a wetland or swale) they may, if they wish, adopt a size of that system's treatment area using MUSIC and allow a total of 3 times this area for the total footprint of the system. Note that the above does not negate the need to demonstrate that sufficient vertical space has been allowed and that the system can freely drain.
Assessment, modelling	Detailed description, calculations and models used to determine the

and calculations	stormwater management strategy and compliance with the relevant objectives.
Lifecycle costs (if relevant)	Where the stormwater management strategy involved proprietary devices, lifecycle costs shall be provided.
Conclusion	Relevant concluding information.
References	List of reference documents.
Appendix 2	Where MUSIC modelling has been completed, completed versions of the relevant reporting forms contained in Appendix B of the MUSIC Modelling Guidelines (Water by Design, 2016) shall be provided.
Other appendices (if relevant)	Other appendices as relevant.

3.1.2 Stormwater quality management plan – OW

Table 5: Details to be included in a stormwater quality management plan for an OW application

Section	Contents
Cover page	Development name and reference
Document information page	Table outlining information relevant to the development of the SQMP, including document title (reference number, date and version), document authors and reviewers, suitably qualified persons details (qualifications and experience), names of the project team and signature and name of the client.
Table of contents	Structure of the SQMP.
Introduction	Description of the proposed development (works, address and RP) and purpose of the SQMP.
Previous reports	Summary of other reports which deal with stormwater management that are superseded by this report
Related reports	Summary of reports (such as waterway assessments and soil investigations) that should be read in conjunction with the SQMP.
Previous approvals or requests for information (if relevant)	Details of any previous approvals or requests for information for the development site.
Site description	Description of the development site including details of topography, geology, relevant hydrological/ drainage features, existing natural features, imperviousness etc. Site survey details including spot levels, contours, boundaries, waterways, vegetation (including regional ecosystem mapping), easements and other relevant site features. Description of site constraints.
Development description	Description of the proposed development including land use, scale, densities, site coverage (percent impervious), lawful point of discharge and general urban design.
Stormwater management objectives	List of all the stormwater management objectives (see Section 2) which apply to the development. Justification for any objectives not adopted.
Stormwater management strategy	Description of the selected stormwater management initiatives required to comply with each objective applicable to the development. This should include a scale figures providing conceptual catchments, location and scale of the stormwater management initiatives.
Assessment, modelling and calculations	Detailed description, calculations and models used to determine the stormwater management strategy and compliance with the relevant objectives.
Lifecycle costs (if relevant)	Where the stormwater management strategy involved proprietary devices, lifecycle costs shall be provided.
Construction, establishment, bonding and handover	Detailed description of the construction, establishment, bonding and handover processes to be used (see Section 7)
Conclusion	Relevant concluding information.
References	List of reference documents.
Appendix 1	Detailed engineering and landscape design drawings shall be shown.
Appendix 2	Where MUSIC modelling has been completed, completed versions of the relevant reporting forms contained in Appendix B of the MUSIC Modelling Guidelines (Water by Design, 2016) shall be provided.
Other appendices (if relevant)	Other appendices as relevant.

3.1.3 Conceptual earthworks drawings

Conceptual earthworks drawings shall be scaled and based on a level of design development which gives confidence in the functional aspects of the design and the corresponding spatial requirements. Drawings shall be based on preliminary earthworks modelling which includes works to construct all relevant aspects of the stormwater management strategy in the context of the broader development. This includes the total footprint of the stormwater management initiatives, taking into account all aspects of the systems (treatment area, batters, maintenance access etc.) and both vertical and horizontal space. The earthworks plans should contain a plan view and section of the stormwater management systems.

3.1.4 Detailed design drawings

Detailed design drawings of stormwater management initiatives may form part of a larger set of drawings but must be clearly identified in the drawing set. The drawings must be of sufficient detail and resolution to support the detailed appraisal of the stormwater management approach adopted.

Engineering drawings will include annotated drawings for all stormwater management initiatives including plan views, cross sections and long sections.

Landscape drawings will document the landscape of the stormwater management initiatives and include topsoil requirements, planting and mulching details and hardscape details. Planting details shall be provided for all planted surfaces and include species, zones and densities.

Engineering and landscape drawings will be entirely consistent with each other.

Refer to the Bioretention Technical Design Guidelines (Water by Design, 2014) for requirements of detailed design drawings and an example of the level of detail to be provided.

Detailed design drawings shall be certified by a suitably qualified person (see Section 1.4) that they reflect the requirements of the SQMP and this guideline. Preferably this person shall also be the author of the SQMP.

3.1.5 Models and calculations

A working version of all models and calculations referred to in the SQMP shall be provided to Council. In this case of MUSIC modelling this entails providing a working copy of the .sqz file.

3.2 Requests for information

Notwithstanding the information outlined in Sections 3.1 and 3.2, Council reserves the right to request any further information necessary in order to understand and assess the efficacy and effectiveness of the stormwater management measures proposed.

3.3 Prior to plan commencement of use

For private developments containing proprietary nutrient removal devices, the developer shall provide to Council, prior to the commencement of use, plan documentation that a minimum 10-year maintenance contract has been entered into for the maintenance of the proprietary nutrient removal device.

3.4 During construction, establishment and handover

See Section 7 for a description of acceptable construction, establishment and handover processes, and the information to be provided at each stage.

4 Concept design

4.1 Reference documents

The conceptual design of stormwater management systems shall comply with the Concept Design Guidelines (Water by Design, 2009) except where modified by this guideline.

4.2 Considering stormwater management early

Stormwater management shall be considered up front in the design process of all sites. This means considering stormwater management before road layouts have been set. Considering stormwater management early in the design process enhances opportunities to integrate the stormwater management seamlessly into the site. This in turn reduces costs.

4.3 Selecting the right system

A range of stormwater treatment measures and technologies can be adopted within developments and streetscapes that will help achieve the stormwater management design objectives on-site. As part of a water sensitive urban design approach, good stormwater management practice may incorporate a number of stormwater treatment measures into a treatment train (utilising for example rainwater tanks, swales and raingardens) to meet stormwater management design objectives on-site (including on the lot and adjacent streetscape).

A range of different stormwater management measures are appropriate for use in the Whitsunday Regional Council area. The following sections describe the relative strengths and weaknesses of each stormwater management measure in meeting the given objectives. Section 4.3.3 lists treatment systems that are not accepted in the Whitsunday Regional Council area.

4.3.1 Stormwater quality

The stormwater quality design objective (see Section 2.1) requires given reductions in total suspended solids, total nitrogen, total phosphorous and total gross pollutants. The following stormwater management systems are appropriate for use in achieving the stormwater quality design objectives:

- Bioretention systems
- Stormwater treatment wetlands
- Proprietary nutrient removal devices
- Swales
- Self-watering street trees
- Rainwater tanks
- Gross pollutant traps
- Trash racks
- Gully baskets
- Flush kerbing

The following sections provide guidance on selecting the appropriate stormwater management systems based upon:

- Pollutants of interest
- Topography
- Size of development
- Ownership

Suggested use of this section

Having identified that the Stormwater Quality Objective applies to a site, the following sections provide guidance on how to select the appropriate treatment system types for further investigation. You may, as a starting point wish to:

1. select an array of treatment systems from those listed in Section 4.3.1.1
2. remove from the list any that are not appropriate for the sites topography (Section 4.3.1.2)
3. if the assets are to be publicly owned, remove any from the list that are not accepted as Council assets (see Section 4.3.1.3
4. use the remaining assets as the starting point to test scenarios and size treatment trains

4.3.1.1 Pollutants of interest

The level of pollutant reduction varies between the treatment system types listed. In broad terms, the given treatment systems can be divided into three groups:

- Group A - Those that are likely to be able to achieve the pollutant reduction targets on their own
    - Bioretention systems
    - Stormwater treatment wetlands
    - Proprietary nutrient removal devices
- Group B - Those that are likely to provide significant reductions in all pollutants of interest, but not meet the objectives on their own. Can improve integration and reduce overall costs if appropriately implemented in conjunction with treatment technologies from Group A:
    - Swales
    - Self-watering street trees
    - Rainwater tanks
- Group C – Those that provide reduction in some but not all pollutants of interest. Can improve integration and reduce overall costs if appropriately implemented in conjunction with treatment technologies from Group A:
    - Gross pollutant traps (gross pollutants)
    - Gully baskets (gross pollutants)
    - Sediment basins (gross pollutants)
    - Flush kerbing (total suspended solids, total nitrogen and total phosphorous)

In most cases development shall select at least one type of treatment system from Group A in order to be able to achieve the relevant stormwater quality objectives. Depending on site characteristics and desired outcomes it may then be desirable to select at least one treatment type from Group B or Group C in order to improve overall outcomes and reduce overall treatment costs.

4.3.1.2 Topography

Refer to Section 4 of the Concept Design Guidelines for Water Sensitive Urban Design (Water by Design, 2009) for guidance on the effect of topography of stormwater management approaches.

4.3.1.3 Ownership

All stormwater management measures identified in Section 4.3.1 may be implemented on developments where the asset will be privately managed.

Some of the stormwater management measures identified in Section 4.3.1 are not suitable for use where the asset will be publicly owned and managed. Only the following asset types may be implemented where the resulting asset will be publicly managed:

- Bioretention systems
- Stormwater treatment wetlands
- Swales
- Self-watering street trees
- Rainwater tanks (note – that the tank shall be implemented on the individual allotment and hence while the estate may contain publicly owned assets, the rainwater tank shall remain privately owned)
- Sediment basins (note – sediment basins may only be implemented as pre-treatment for large bioretention systems or stormwater treatment wetlands)
- Flush kerbing

4.3.2 Waterway stability

In order to achieve the waterways stability objective, storage will be required in most cases in order to attenuate flows. Storage may form part of the stormwater detention storage for the development (if required), or be co-located with a stormwater treatment system such as a bioretention system or stormwater treatment wetland.

4.3.3 Treatment systems that are not accepted

The following types of stormwater management system are not accepted in the Whitsunday Regional Council area. They are not accepted because of either polluting characteristics (e.g. leaching nutrients from wet sumps) or unnecessary maintenance costs (e.g. coarse sediment forebays):

- Treatment systems with wet sumps such as wet sump gross pollutant traps (note – saturated zone bioretention systems are acceptable)
- Urban lakes
- Sediment ponds (Note the following. Sediment ponds associated with wetlands and large bioretention systems are acceptable. This advice applies to post-construction phase sediment ponds and does not relate in any manner to sediment basins implemented for construction phase erosion and sediment control)

4.4 Integration with parkland

While vegetated stormwater management measures cannot currently receive credit as public open space in the Whitsunday Regional Council, the co-location of aesthetically pleasing stormwater management measures with public open space is strongly encouraged so as to increase the overall amount and continuity of green space available to the community. Useful reference documents for the integration of stormwater management with open space include the Framework for the Integration of Flood and Stormwater Management into Open Space (Water by Design, 2011)

5 Detailed design

5.1 Bioretention

Bioretention systems are shallow depressions in the urban landscape designed to collect and treat stormwater. Figure 1 depicts a typical bioretention system. Stormwater conveyed to a bioretention system is treated by filtering the stormwater though a densely vegetated, biologically active sand and loam filter media. As the water percolates through the filter media, pollutants are captured by fine filtration, adsorption, and biological processing by both soil microbes and plants. Treated water discharges to groundwater or is conveyed via slotted or perforated pipes to downstream drainage systems such as waterways, channels or pipes.

As well as removing pollutants, bioretention systems also help manage changes in hydrology that occur as a result of urbanisation. For example, runoff from small rainfall events is captured above the filter media surface, in the extended detention zone, and slowly percolates through the bioretention system's filter media. By delaying the release of stormwater, bioretention systems can mimic aspects of pre-development hydrology such as baseflow regimes and reduce pressures on urban streams. The volume of runoff is also reduced through evapotranspiration and infiltration into the surrounding soil.

Bioretention systems are flexible in size, shape and appearance. They can be readily integrated into a range of landscapes including individual development sites, allotments, streetscapes, civil spaces and forecourts, parklands and adjacent to riparian and bushland settings. Bioretention systems can be designed to seamlessly integrate with the local landscape or they can be a prominent landscape feature. Figures 2 to 5 provide examples of several different types of bioretention system.

Figure 1: Components of a typical bioretention system

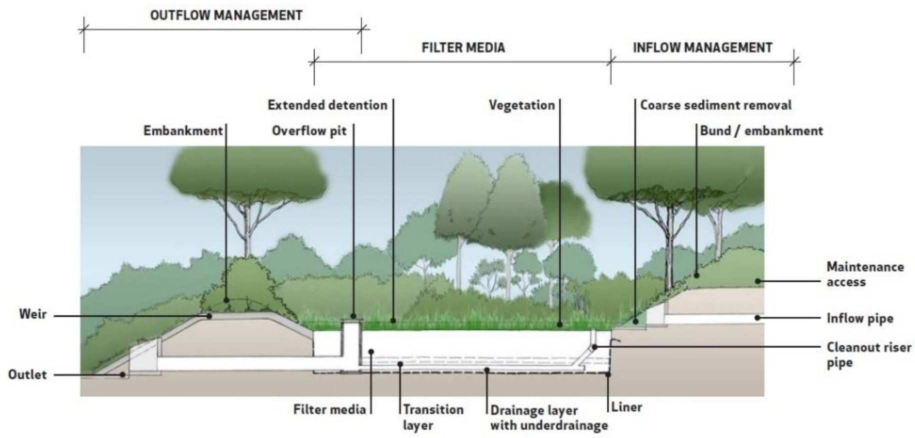


Figure 2: A high profile streetscape bioretention system

Figure 3: A bioretention street tree

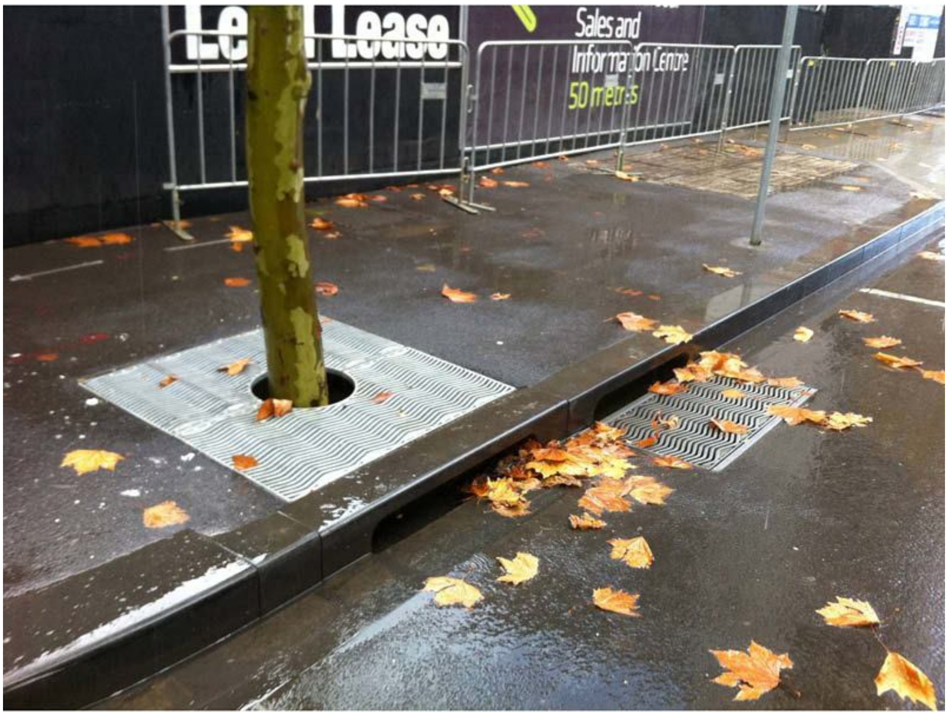


Figure 4: A bioretention system co-located with parkland

Figure 5: A bioretention system located next to bushland

5.1.1 Reference documents

The design of bioretention systems should be undertaken in accordance with the following documents (or subsequent ratified update) except as modified by the contents of this guideline:

- The Bioretention Technical Design Guidelines (Water by Design, 2014)
- IPWEAQ Standard Drawings:
    - DS-070 Bioretention Drainage Profile – Type 1 Saturated Zone – Unconstrained
    - DS-071 Bioretention Drainage Profile – Type 1 Saturated Zone – Constrained
    - DS-076 Bioretention Weir
    - DS-077 Bioretention Street Tree
    - DS-078 Bioretention Standard Notes
- Whitsunday Regional Council Standard Drawing Q-0003 Underdrain Flush Out – Grassed Streetscape Bioretention (see Appendix A)

5.1.2 Bioretention drainage profiles

Bioretention systems shall be designed with a saturated zone to facilitate plant health. Refer to Sections 2.4.1 and 3.2 of the Bioretention Technical Design Guidelines (Water by Design, 2014) for further information.

5.1.3 Coarse sediment management

Bioretention systems shall be designed to manage accumulation of coarse sediment in a manner which is congruent with their design and scale. In general terms, coarse sediment management is not required for bioretention systems whose catchment is less than 5ha in size. For bioretention systems with a catchment greater than 5ha in size, coarse sediment capture shall take the form of a sediment pond. Sediment ponds shall be designed in accordance with Section 3.4.3.3 of the Bioretention Technical Design Guidelines (Water by Design, 2014) and the relevant section of the Constructed Wetland Technical Design Guidelines.

5.1.4 Inlet energy dissipation and scour protection

Inlet energy dissipation and scour protection is critical to ensure that filter media around inlets is not eroded in either small regular rainfall events or larger infrequent events. Inlet energy dissipation and scour protection should be in accordance with Section 3.4.4 of the Bioretention Technical Design Guidelines (Water by Design, 2014).

It should be noted that Whitsunday Regional Council does not support the use of coarse sediment forebays. Therefore, energy dissipation and scour protection must be sufficient to protect the filter media from erosion without the added benefit that a coarse sediment forebay may provide. Particular attention should be paid to the guidance provided in the Bioretention Technical Design Guideline (Water by Design, 2014) as it relates to energy dissipation and scour protection where a coarse sediment forebay is not present.

5.1.5 Plant selection

Plant selection for bioretention systems is dependent on climate, the surrounding landscape, desired aesthetic outcomes and intended treatment performance. In general terms, plant selection for bioretention systems in the Whitsunday region should be in accordance with Tables 6 and 7 except as modified by Section 5.1.6 Typologies.

Table 6: Planting for the Dry Tropics (Bowen, Collinsville and surrounds)

Species	Form	Height
Atriplex muelleri	Prostrate	100
Bacopa monnieri	Prostrate	100
Bothriochloa pertusa	Turf	
Paspalum vaginatum cv 'Saltene'	Turf	to 500
Sporobolus virginicus	Turf	to 400
Fimbristylis ferruginea	Tufted	650-800
Fimbristylis tristachya	Tufted	600
Imperata cylindrica	Tufted	500
Juncus usitatus	Tufted	500
Lomandra hystrix	Tufted	1000
Lomandra longifolia	Tufted	500-1000
Lepidosperma laterale	Tufted	300-1000
Lomandra leucocephala	Tufted	200-800
Juncus polyanthemus	Tufted	700-1000
Rhynochospora corymbosa	Tufted	600-1200
Scleria polycarpa	Tufted	to 1200
Platyzoma microphyllum	Fern	150-500
Atractocarpus fitzalanii	Shrub	3 to 10
Hibiscus heterophyllus	Shrub	1.5 to 6
Leptospermum polygalifolium	Shrub	1 to 4
Melaleuca thymifolia	Shrub	to 1.5
Myoporum acuminatum	Shrub	0.5 to 6

Albizia canescens	Tree	
Alphitonia excelsa	Tree	to 21
Buckinghamia celsissima	Tree	20-30
Casuarina equisetifolia	Tree	8 to 16
Casuarina glauca	Tree	8 to 20
Chionanthus ramiflorus	Tree	6 to 8
Colubrina asiatica	Tree	
Cupaniopsis anacaroides	Tree	8 to 15
Callistemon (Melaleuca) viminalis	Tree	5 to 10
Eugenia reinwardtiana	Tree	2 to 6
Livistona decora	Tree	to 18
Melaleuca bracteata	Tree	5 to 10
Melaleuca leucadendra	Tree	10 to 30
Melaleuca quinquenervia	Tree	to 25
Melaleuca viridiflora	Tree	5 to 7

Table 7: Planting for the Wet Tropics (Proserpine, Airlie Beach and surrounds)

Species	Form	Height	Notes
Baumea articulata	Macrophyte	1000-2000	
Paspalum vaginatum cv. 'Saltene'	Turf	to 500	
Zoysia micrantha	Turf	to 200	
Chrysopogon filipes	Tufted	800-1000	
Crinum angustifolium	Tufted	to 500	
Crinium pedunculatum	Tufted	1000-1500	
Cyperus difformis	Tufted	300-5000	
Cyperus distans	Tufted	1000	
Cyperus javanicus	Tufted	60-1000	
Cyperus lucidus	Tufted	1000-2000	
Cyperus polystachyos	Tufted	600	
Cyperus scariosus	Tufted	900	
Dianella caerulea	Tufted	500-600	
Dianella longifolia	Tufted	500-600	
Gahnia aspera	Tufted	1000	
Gahnia sieberiana	Tufted	1000-1500	
Imperata cylindrica	Tufted	500	
Juncus usitatus	Tufted	500	
Juncus polyanthemus	Tufted	700-1000	
Lepidosperma laterale	Tufted	300-1000	
Lomandra hystrix	Tufted	1000-1500	
Lomandra longifolia	Tufted	1000	
Persicaria attenuata	Groundcover	1000-1500	Not suitable in the streetscape.
Persicaria strigosa	Groundcover	200	Not suitable in the streetscape.

Phyla nodiflora	Groundcover	to 100	Not suitable in the streetscape.
Aidia racemosa	Shrub	to 6	
Atractocarpus fitzalanii	Shrub	3 to 10	
Colubrina asiatica	Shrub	2	
Ficus congesta	Shrub	3 to 6	
Hibiscus heterophyllus	Shrub	1.5 to 6	
Leptospermum polygalifolium	Shrub	0.5 to 3	
Melastoma malabathricum subsp. malabathricum	Shrub	2 to 4	
Albizia canescens	Tree	3 to 10	
Alphitonia excelsa	Tree	to 21	
Buckinghamia celsissima	Tree	to 30	
Casuarina equisetifolia	Tree	8 to 16	
Casuarina cunninghamiana	Tree	10	
Cupaniopsis anacardioides	Tree	5 to 10	
Eugenia reinwardtiana	Tree	2 to 6	
Ganophyllum falcatum	Tree	10 to 20	
Hibiscus tiliaceus	Tree	5 to 7	Not suitable in the streetscape.
Livistona decora	Tree	7 to 15	
Lophostemon grandiflorus	Tree	8 to 12	
Melaleuca bracteata	Tree	5 to 10	
Melaleuca (Callistemon) viminalis	Tree	5 to 10	
Melaleuca viridiflora var. attenuata	Tree	5 to 7	
Melaleuca viridiflora var. viridiflora	Tree	5 to 7	
Melaleuca fluviatilis	Tree	to 30	
Melaleuca quinquenervia	Tree	to 25	
Planchonia careya	Tree	5 to 7	
Syzygium australe	Tree	7 to 10	
Thespesia populnea	Tree	5 to 7	

5.1.6 Typologies

Bioretention systems are immensely flexible treatment systems. They can be implemented on sites that are flat through to sites that are undulating. Sites that are very small through to sites that are large. Sites that are high profile with high visual amenity through to sites to are low key. The key to the long term operation of a bioretention systems is to ensure that it:

- Is designed in a functional manner
- blends in with its surrounding landscape
- is as low maintenance as possible.

Four bioretention typologies have been identified for use in the Whitsunday Regional Council area:

- precinct scale, low profile, bushland aesthetic
- streetscape, low profile, grass and trees
- streetscape, high profile, garden
- streetscape, high profile, trees

These four typologies are considered the most likely to result in a system that is functional, aesthetically pleasing and easy to maintain. Design guidance for each is provided in the following sections.

5.1.6.1 Precinct scale – low profile – bushland aesthetic

Precinct scale bioretention systems are those systems located within parkland, drainage reserves or adjacent to bushland (see Figures 6 to 8). They typically contain anywhere from 100m2 to 800m2 of filter media and are set back from the street. They are not located in the road reserve. They may be co-located within detention basins (see Figures 9 and 10).

Figure 6: Precinct scale bioretention system with trees and an understory

Figure 7: Precinct scale bioretention system adjacent to parkland

Figure 8: Large bioretention system adjacent to parkland (bushland aesthetic not shown)

Figure 9: Precinct scale bioretention system co-located with a stormwater detention basin (bushland aesthetic not shown)

Figure 10: Precinct scale bioretention system with a canopy and understory co-located with a flood detention basin

In the Whitsunday Regional Council area, precinct scale bioretention systems are most likely to occur in residential communities on moderately sloping land. The Bioretention Technical Design Guidelines refer to precinct scale bioretention systems more generally as bioretention basins and allow for many types of planting approaches including:

- groundcovers and sedges only

- bushland inspired planting approaches with understory, mid-storey and canopy species

Precinct scale bioretention systems in the Whitsunday Regional Council area however shall follow a bushland inspired planting approach as outlined below. The purpose for this is to reduce long term maintenance costs. Research has shown that precinct scale bioretention systems that contain a canopy and understory are significantly less costly to maintain that those with only understory plants. The canopy provides shade and leaf drop which suppresses weeds, reduces surface temperature and continually replenishes soil organic matter; all of which make the system far more hospitable to desirable bioretention plant species. For more information, see the Guide to the Cost of Maintaining Bioretention Systems (Water by Design, 2015).

5.1.6.1.1 Plant selection

Bioretention systems constructed within the Precinct Scale – Low Profile – Bushland Aesthetic typology shall contain canopy, mid-storey and understorey species. In most situations, all three planting levels shall be present within the filter media and on all surrounding batters.

While the treatment performance of bioretention systems occurs primarily within the filter media area, from a maintenance and ecological perspective, bioretention systems function as a single unit with their surrounding landscape, including batters. It is for this reason that plant selection for batters and the filter media must be treated as a single task.

Plant selection shall be in accordance with the following sections, Section 5.1.5 of this guideline and the Bioretention Technical Design Guidelines (Water by Design, 2014)

5.1.6.1.1.1 Canopy plant selection

The canopy within the Precinct Scale – Low Profile – Bushland Aesthetic typology shall be designed to provide continuous cover at plant maturity so as to shade out weeds, and cool the filter media. The canopy within a bioretention system does not need to consist of exceptionally tall trees. A canopy comprised of trees 5 to 10 meters tall is acceptable so long as appropriate planting densities are achieved.

The canopy species used shall be a mix of pioneer species and slower growing longer lived species. Pioneer species shall make up between 30% and 60% of the canopy species planted (see Figures 11 and 12), however the quantity of longer lived species applied must be sufficient to ultimately form a canopy in its own right after succeeding the pioneer species.

The Bioretention Technical Design Guidelines (Water by Design, 2014) recommend that trees are planted in bioretention systems are a density of between one tree every 20m2 and one tree every 100m2. While the planting density used shall depend upon the planting density chosen, in general achieving a canopy as outlined in this section will require greater planting densities than specified by the Bioretention Technical Design Guidelines.

Figure 11: A very large flood detention basin showing newly planted pioneer and longer lived canopy species

Figure 12: The same flood detention basin 18 months later showing exceptional growth of planted pioneer species and regeneration from seed

5.1.6.1.1.2 Mid-storey plant selection

Bioretention systems within the Precinct Scale – Low Profile – Bushland Aesthetic typology shall contain a mid-storey with selected shrubs on 1 to 2 meters in height scattered throughout the system. Care shall be taken in installing mid-storey plants to ensure that they do not impede sight lines.

5.1.6.1.1.3 Understorey plant selection

Understorey plants selected shall be adaptable to varying light conditions. Until the canopy is established, understorey plants must be capable of surviving in exposed conditions. As a canopy develops the understorey will receive more shade, ultimately producing a shading environment.

Understorey plants selected shall have a variety of growth habits. For example, some species chosen may be clumping (e.g. Lomandra species), while others may species may spread horizontally via rhizome (e.g. Imperata cylindrica) to fill in gaps between clumping species (see Figures 13 and 14).

Figure 13: A bioretention system with bare space between Lomandras (bushland aesthetic not shown)

Figure 14: Imperata cylindrica in a bioretention system filling the gaps between Lomandras in a nearby bioretention system (bushland aesthetic not shown)

5.1.6.1.2 Adapting for special circumstances

In some instances, it may be necessary to design a bioretention system that varies slightly from the above advice on plant selection. The following sections outline acceptable reason for doing this and approaches for doing so.

5.1.6.1.2.1 Shallow filter media

The Bioretention Technical Design Guidelines specifiy that trees shall only be planted in filter media 700mm or deeper. This is to ensure that trees have sufficient growing media to secure themselves too in order to prevent them falling over in high winds.

In some instances, a Precinct Scale – Low Profile – Bushland Aesthetic typology bioretention system will be desirable on a site without sufficient grade to permit 700mm of filter media without costly filling of the upstream site. In these instances, the height of canopy species shall be reduced to 2m (shrubs) to 5m (small tree) at maturity. This will permit a canopy to form while reducing the likelihood of trees collapsing in high winds.

In addition, plants at the taller end of this range (4m to 5m) shall be selected from a species that coppices when cut (e.g. Melaleuca). This will allow the height of such taller species to be managed over time without the tree dying.

5.1.6.1.2.2 Grassed batters

Where a Precinct Scale – Low Profile – Bushland Aesthetic typology bioretention system is located adjacent to parkland or other grassed open space, it may be desirable to omit planting of trees, shrubs and groundcovers on the batter adjacent to this grass. Instead it may be desirable to lay turf on these batters (see Figure 15). Turf may be desirable because of its ability to effectively stabilise batters and its ease of maintenance. Batters upon which turf are used must however be sufficiently shallow in grade (1:4 or shallower) to permit mowing.

Figure 15: A bioretention system with a canopy and turf on the batters

Turf shall only be used on the batters of bioretention systems where a canopy is present within the filter media. Where a canopy is not present and turf is used on the batters, the turf invades the filter media, increasing maintenance costs and likely the use of herbicide within the system. Where a canopy is present, the shade it produces limits the turf's growth to the perimeter of the system (Figure 16).

Figure 16: A bioretention system with turf on the batters shows no sign of weeds or grass in its centre

5.1.6.1.2.3 Bunds

While planting of batters with canopy, mid-storey and understorey plants is highly encouraged, planting of bunds must be undertaken with additional care. A batter is defined as sloping land from the base of the bioretention system to a high point surrounding it (see Figure 17). A bund on the other hand is defined as sloping land from the base of the bioretention system to a high point surrounding it and back down to a low point on the other side (see Figure 17). A bund is akin to a dam wall.

Trees planted on bunds have some chance of destabilising the batter through root growth. As such, where a failure of a bund is likely to result in flooding threatening life or property, trees should not be used on that bund in favour of establishing shade using shrubs and understorey plants.

Figure 17: A newly planted bioretention system. A large batter exists to the rear right of the system. A small bund exists to the near front of the system.

5.1.6.1.2.4 Ratio of core plants to supplementary plants

The Bioretention Technical Design Guideline (Water by Design, 2014) specifies that at least 50% of the filter media area should be planted with 'core' plant species identified in the guideline. Core plant species are those whose performance in bioretention systems has been proven through research and on ground observations. While it is ultimately desirable to achieve this minimum coverage of core plants, priority is to be placed on establishing a diverse, well structured and functioning ecosystem within the bioretention system. Bioretention systems with less than 50% core plant species will be accepted if a diverse, well-structured and functioning ecosystem is achieved and all other planting criteria of the Bioretention Technical Design Guidelines (Water by Design, 2014) are satisfied.

5.1.6.1.3 Water supply for establishment

Establishing bioretention systems in climates with a prolonged dry period is likely to require an additional supply of water beyond either:

- the stormwater which is ordinarily received
- irrigation or broadcast watering supplied in the weeks immediately after planting

A tap shall be installed with all Precinct Scale – Low Profile – Bushland Aesthetic bioretention systems to allow additional water to be provided to the system by filling the saturated zone. This can be done by removing the cap from an underdrainage flush out point and filling the saturated zone until water begin to flow out of the system.

The tap shall be implemented in accordance with the Whitsunday Regional Council Development Manual.

5.1.6.2 Streetscape scale typologies

Streetscape scale bioretention systems are, as the name suggests, those systems located within the road reserve. They are typically smaller systems ranging from only 1 or 2 square meters of filter media up to 50m2 of filter media and occasionally larger. The planting in streetscape bioretention systems can take a number of forms:

- Low growing understorey plants (Figure 18)
- Low growing understorey plants with trees or shrubs (Figure 19)
- Bioretention street trees (Figure 20)
- Street trees surrounded by turf (Figure 21)
- Turf only (Figure 22)

The location of streetscape bioretention systems is also highly adaptable. They can be located in the verge (Figures 18 to 22), kerb buildouts or within the centre median.

Figure 18: Low growing understorey plants in a streetscape bioretention system in the verge

Figure 19: Low growing understorey plants with trees and/ or shrubs in a streetscape bioretention system in the centre median

Figure 20: Bioretention street trees

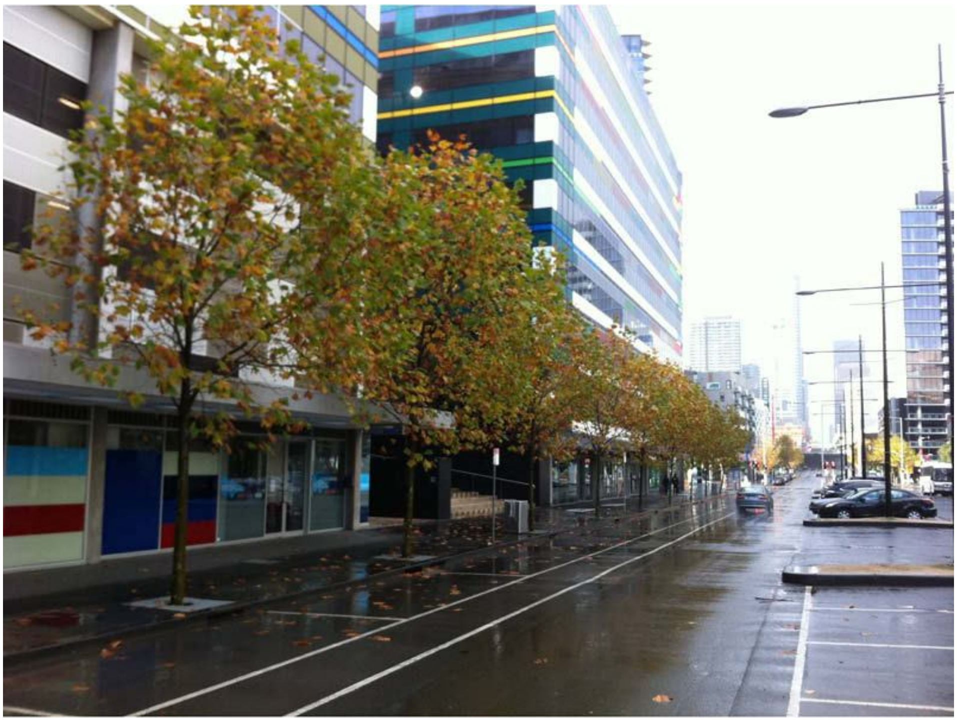


Figure 21: Street trees surrounded by turf in a streetscape bioretention system in the verge

Figure 22: A turfed streetscape bioretention system in the verge

This section describes three streetscape bioretention typologies for use in the Whitsunday Regional Council area:

- streetscape, low profile, grass and trees
- streetscape, high profile, garden
- streetscape, high profile, trees

5.1.6.2.1 Streetscape – low profile – grass and trees

Streetscape – Low Profile – Grass and Trees typology bioretention systems (Figure 23) are low key systems which accept stormwater directly from the road surface. They are typically located in residential areas that would have grassed verges regardless of the presence of the stormwater treatment system. They consist of a shallow depression on the verge, grass, a street tree and a kerb cut-out to allow water to enter the system. The intent of such systems is to:

- achieve good treatment performance facilitated by the mix of vegetation types (trees and turf)
- obtain the benefits of a street tree
- co-locate infrastructure by locating the street tree and the stormwater treatment together
- provide additional moisture for the tree
- reduce the maintenance cost of the bioretention by replacing groundcovers which require weed control (likely by Council) with turf which can be managed through mowing (by either Council or an adjacent resident as would occur on any normal verge

Streetscape – Low Profile – Grass and Trees typology bioretention systems are in essence a combination of a low tech, grassed bioretention system (Figure 24) and a street tree (Figure 25)

Figure 23: Sketch of a Streetscape – Low Profile – Grass and Trees typology bioretention systems

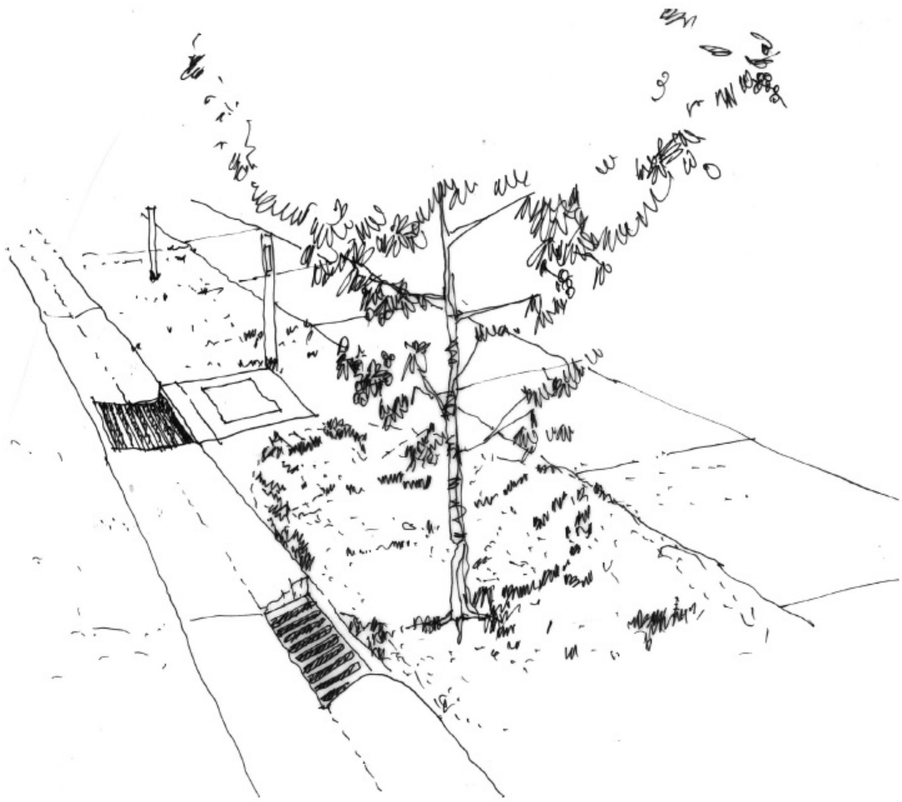


Figure 24: Example of a low tech grass bioretention system

Figure 25: Example of a street tree

5.1.6.2.1.1 Underdrainage flush out points

The Bioretention Technical Design Guidelines typically require the underdrainage flush out points in bioretention systems to have a finished top level above the filter media surface. This allows them to be easily located and accessed.

Streetscape – Low Profile – Grass and Trees typology bioretention systems will be mowed. This places the underdrainage flush out points at significant risk of being damaged if left prow of the surface. Therefore, in this typology bioretention system, the flush out points must have a finished top level 50mm below the surface of the filter media. A mark in the form of a metal plaque or similar shall be attached to the kerb in line with the flush out points to mark their location should they need to be unearthed in the future.

5.1.6.2.1.2 Plant selection and specifications

Trees in Streetscape – Low Profile – Grass and Trees typology bioretention systems shall be selected from Section D9.07 Street Tree Planting of Council's Land Development Guidelines and satisfy either the:

- planting guidance in Section 5.1.5 of this guideline; or
- key plant attributes described in Section 3.6 of the Bioretention Technical Design Guidelines (Water by Design, 2014)

Turf applied in Streetscape – Low Profile – Grass and Trees typology bioretention systems shall have bare roots at the time of planting to prevent sediment clogging the surface of the filter media.

The size of street tree applied in Streetscape – Low Profile – Grass and Trees typology bioretention systems shall be consistent with the requirements of Section D8.06 Plant Stock of Council's Land Development Guidelines.

5.1.6.2.2 Streetscape – high profile – garden

Streetscape – High Profile – Garden typology bioretention systems (Figure 26) are higher profile, high amenity systems best applied in areas where there is a desire and means to beautify the streetscape. Areas in and around Airlie Beach are a prime example of this.

These types of systems accept stormwater directly off the road's surface. They consist of a shallow depression, high amenity landscape plantings and a kerb cut-out. They interface with surrounding seating or walls as shown in Figures 27 and 28. The intent of these systems is to achieve good treatment performance while facilitated by the mix of vegetation types (trees and turf)

Figure 26: High profile streetscape bioretention system

Figure 27: Bioretention system adjacent the road and seating in an inner city multi-storey residential development

Figure 28: Bioretention system adjacent seating in a high profile parkland

5.1.6.2.2.1 Plant selection and specifications

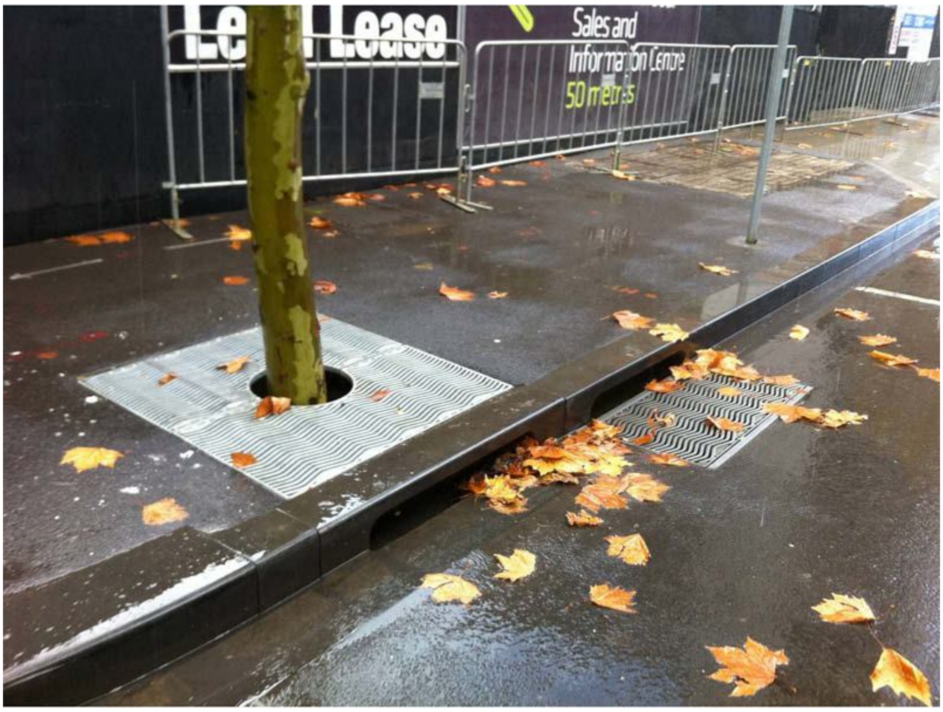
In Streetscape – High Profile – Garden typology bioretention systems a high priority is placed on using aesthetically pleasing plants that fit with the landscaping of the surrounding areas. Systems that do not do this generally standout and detract from the overall amenity of the area. As a result, in this typology of bioretention system, the Bioretention Technical Design Guideline's (Water by Design,

2014) requirement for at least 50% of plants in the filter media to be selected from the core plant species list may be waived. However, this should only occur if no species exists on the core list that will fit with the visual amenity of the site. When it does occur, all species that are used must still meet the functional requirements for plants in bioretention systems outlined in Section 3.6 of the Bioretention Technical Design Guidelines (Water by Design, 2014).

5.1.6.2.3 Streetscape – high profile – trees

Streetscape – High Profile – Trees typology bioretention systems (Figure 29) are an opportunity to co-locate standard street trees with stormwater treatment in dense urban environments. They accept stormwater directly off the road surface and are covered by a tree grate just as a standard street tree would be. This maximises the usable space in dense urban areas where land is typically at a premium.

Figure 29: Example of a bioretention street tree



5.1.6.2.3.1 Plant selection and specifications

Trees in Streetscape – High Profile – Trees typology bioretention systems shall be selected from Council's Section D9.07 Street Tree Planting of Council's Land Development Guidelines and satisfy either the:

- planting guidance in Section 5.1.6 of this guideline; or
- key plant attributes described in Section 3.6 of the Bioretention Technical Design Guidelines (Water by Design, 2014)

The size of street tree applied in Streetscape – High Profile – Trees typology bioretention systems shall be consistent with the requirements of Section D9.07 Street Tree Planting of Council's Land Development Guidelines.

5.1.7 Sourcing filter media

Bioretention filter media shall meet the specifications and requirements described in Section 4.3.1 of the Bioretention Technical Design Guidelines (Water by Design, 2014). Where a pre-made bioretention filter media is available from a local supplier it shall be used. A supplier is considered local when they are located within the region bounded by:

- North – Townsville
- East - the Queensland coast
- South – Mackay
- West – Collinsville

Pre-made bioretention filter media from outside these regions may be used at the developer or contractor's discretion, provided that it meets the requirements of Section 4.3.1 of the Bioretention Technical Design Guidelines.

In some instances, relatively low demand for Bioretention Filter Media may mean that a local supplier of pre-made filter media is not available. In these instances, filter media should be blended on-site using the following recipe as developed by SESL Australia (declaration of compliance included in Appendix B). The filter media shall be comprised of a well-mixed blend of:

- Loamy sand of sandy loam soil (20% v/v)
- Medium sand (50% v/v)
- Well Composted Bagasse (30% v/v)

D-Values are included in Appendix C.

Note that at least 95% of the mineral components of the media shall be comprised of material that is silica based or equivalently hard. This shall enhance the durability of the filter media and reduce the likelihood of structural collapse due to weathering of soft materials.

The top 100mm of blended filter media shall be ameliorated at the rates described in Table 8.

Table 8: Fertiliser to be applied to the top 100mm of blended filter medias

Type of fertiliser	Rate
Organic fertiliser (e.g. composted poultry manure)	5kg/m3 or 500g/m2
Compound fertiliser (NPK 16:4:14)	0.4kg/m3 or 40g/m2
Trace element mix	0.1g/m3 or 10g/m2
Superphosphate	0.2g/m3 of 20g/m2
Magnesium sulphate	0.3g/m3 or 30g/m2
Potassium sulphate	0.2g/m3 or 20g/m2

5.2 Wetlands

Constructed wetland (Figure 30) systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events and outlets are configured to slowly release flows (Figure 31), typically over two to three days, back to dry weather water levels. In addition to treating stormwater, constructed wetlands can also provide habitat, passive recreation, improved landscape amenity (Figure 32) and temporary storage of treated water for reuse schemes.

Figure 30: Example of a stormwater treatment wetland

Figure 31: The outlet from a stormwater treatment wetland the day after rain

Figure 32: A shelter adjacent to a stormwater treatment wetland

5.2.1 Reference documents

The design of swales should be undertaken in accordance with the following documents (or subsequent ratified update) except as modified by the contents of this guideline:

- The Constructed Wetland Technical Design Guidelines (Water by Design, 2016)
- Whitsunday Regional Council Standard Drawings
  - Q-0005 Constructed Wetland Inlet Zone Weir Details (see Appendix A)
  - Q-0006 Constructed Wetland Riser Pit (see Appendix A)

5.3 Proprietary nutrient removal devices

Proprietary nutrient removal devices include cartridge filters (Figure 33), proprietary floating wetlands (Figure 34) and any other proprietary product which removes or claims to remove nutrients from stormwater in meaningful quantities.

Proprietary nutrient removal devices shall be installed in accordance with manufacturer's instructions and in a manner that is consistent with the conditions under which their stormwater treatment performance was established.

Proprietary nutrient removal devices may be implemented on private developments but shall not be installed where they shall become a public asset.

For guidance on demonstrating the pollutant removal abilities of proprietary nutrient removal devices see Section 6.1.4.

Figure 33: Example of a proprietary cartridge filter stormwater treatment system

Figure 34: Example of a proprietary stormwater treatment wetland

5.4 Swales

Swales are vegetated open channels designed to convey stormwater in lieu of underground drainage and to remove pollutants such as sediment and nutrients from stormwater (Figures 35 and 36). Swales may be planted with either turf or understorey plants such as grasses and sedges. On some occasions swales will contain shrubs and trees along their batters.

Figure 35: Example of a vegetated swale

Figure 36: Example of a grass swale

5.4.1 Reference documents

The design of swales should be undertaken in accordance with the following documents (or subsequent ratified update) except as modified by the contents of this guideline:

- Chapter 2 of the Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (Healthy Waterways, 2006)
- IPWEAQ Standard Drawings:
  - DS-079 Streetscape Swale - Typical Section Sheet 1 of 2
  - DS-080 Streetscape Swale - Typical Section Sheet 2 of 2

5.4.2 Plant selection

The selection of plants for swales shall be in accordance with Section 5.1.5 Plant Selection (for bioretention systems) within this guideline.

5.5 Self-Watering Street Trees

Self-watering street trees (Figure 37) harness stormwater to provide supplementary water to standard street trees. In the process they reduce the amount of stormwater reaching waterways and remove pollution.

Self-watering street trees use a small hole in the kerb (Figure 38) to direct stormwater into a slotted pipe beneath the tree. Here it is stored and slowly percolated into the soil to water the tree.

Figure 37 A self-watering street tree

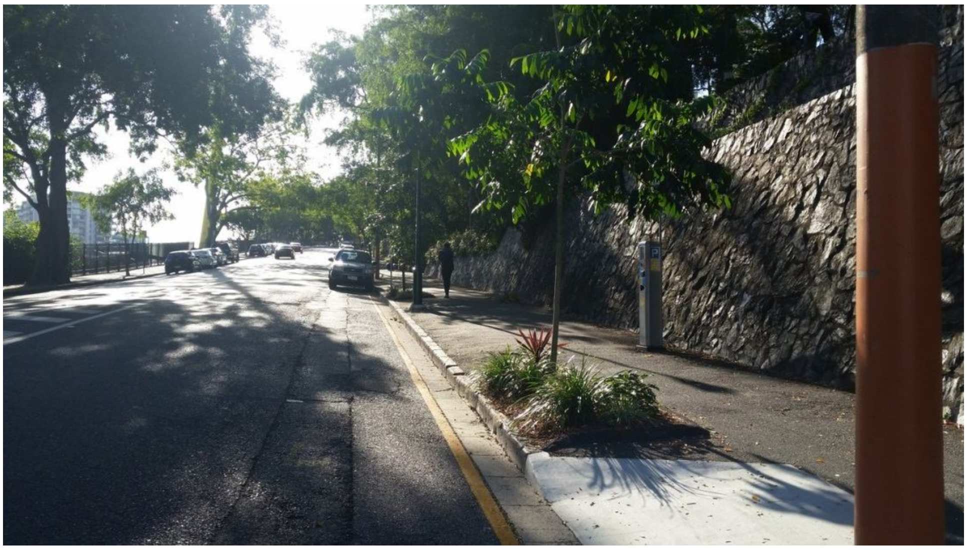


Figure 38: Pipe connection for a self-watering street tree

5.5.1 Reference documents
The design of self-watering street trees should be undertaken in accordance with the following documents (or subsequent ratified update) except as modified by the contents of this guideline:

- the Self-Watering Street Tree Technical Design Guideline (Water by Design, 2016)
- Whitsunday Regional Council Standard Drawing Q-0004 Self Watering Street Tree (see Appendix A)

5.5.2 Species selection
The species used in self-watering street trees shall be in accordance with Section D9.07 Street Tree Planting of Council's Land Development Guidelines. Care shall be taken to avoid species that absolutely require free draining soil or are sensitive to temporary saturated sub-soil conditions.

5.6 Buffer strips
Buffer strips are areas of vegetation through which runoff passes while travelling to a discharge point (Figure 39). They reduce pollutant loads by passing a shallow depth of flow through vegetation. They rely on well distributed sheet flow. Vegetation tends to slow velocities. They also help to disconnect impervious surfaces from waterways. With their requirement for uniformly distributed flow, buffer strips are suited to treatment of runoff from impervious surfaces where the stormwater is discharged from those impervious surfaces via flush kerbs (Figure 40).

Figure 39: A buffer strip treating road runoff

Figure 40: A buffer strip treating road runoff before it sheets over a footpath and into a swale

5.6.1 Reference documents

The design of buffer strips should be undertaken in accordance with the following documents (or subsequent ratified update) except as modified by the contents of this guideline:

- Chapter 2 of the Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (Healthy Waterways, 2006)
- Chapter 10 of Australian Runoff Quality (Engineers Australia, 2006)
- Whitsunday Regional Council Standard Drawing Q-0002 Flush kerbing and buffer strip detail (see Appendix A)

5.7 Rainwater tanks

Rainwater tanks (Figure 41) capture stormwater for later external (e.g. watering gardens) or internal (e.g. flushing of toilets) re-use. Stormwater is typically collected from roofs and gutters. The re-use of stormwater via rainwater tanks makes them an effective treatment system. Re-using stormwater reduces reliance upon centralised water supplies and removes pollution.

Figure 41: Example of a rainwater tank

5.7.1 Reference documents

Rainwater tanks shall be designed in accordance with manufacturer's instructions and all relevant standards.

5.7.2 Ensuring rainwater tanks are implemented

Section MP 4.2 – Rainwater Tanks and Other Supplementary Water Supply Systems of the Queensland Development Code requires local governments to apply to the Minister for Housing and Public Works for permission to opt in to the requirements of Section MP 4.2 and make it mandatory for new development to implement alternative water supplies such as rainwater tanks.

Whitsunday Regional Council has not made a submission to the minister and hence it is not currently mandatory for new development to implement mandatory water savings in accordance with MP 4.2.

This however does not prevent development from applying rainwater tanks, so long as an appropriate mechanism is in place to ensure that they are delivered during house construction or building works.

Where rainwater tanks are specified, the developer shall demonstrate that appropriate mechanisms are in place to ensure that all proposed rainwater tanks shall be delivered during house construction or other relevant building works.

5.8 Gross pollutant traps

Gross pollutant traps (Figure 42) are stormwater treatment systems that capture litter, organic matter and coarse sediments. They are most often located underground. Gross pollutant traps are typically proprietary systems. Gross pollutant traps may be implemented on private developments but they shall not be used where they will become a public asset. Gross pollutant traps shall be designed and installed in accordance with manufacturer's instructions.

Figure 42: Example of a gross pollutant trap

5.9 Gully baskets

Gully baskets (Figure 43) are stormwater treatment systems placed in stormwater inlets to capture litter. They also capture organic matter in the process. As the name suggests, they take the form of a removable basket. Gully baskets are normally proprietary systems. Gully baskets may be implemented on private developments but they shall not be used where they will become a public asset. Gully baskets shall be designed and installed in accordance with manufacturer's instructions.

Figure 43: A stormwater inlet with a gully basket

5.10 Sediment basins

The term sediment basin can be used to describe both temporary basins applied during construction to control sediment discharge during construction, and permanent features integrated into the urban landscape to manage stormwater quality. This section refers to the later.

Sediment basins are open bodies of water with fringing vegetation (Figure 44). They serve to slow stormwater flows, allowing sediment to settle out. They are typically sized such that they settle all sediment above a given particle size, with smaller sediment remaining entrained in the stormwater.

While it is possible to install sediment basins in their own right, sediment basins in the Whitsunday Regional Council area shall only be installed as pre-treatment and flow diversion systems within a wetland system or large bioretention system. As such, this section should be read in conjunction with Section 5.2 Wetlands and Section 5.1 Bioretention Systems.

Figure 44: A sediment basin upstream of a bioretention system

5.10.1 Reference documents

The design of sediment basins shall be undertaken in accordance with the Constructed Wetland Technical Design Guidelines (Water by Design, 2016) in the relevant wetland or bioretention chapters of this guideline.

5.11 Integration with flood detention basins

Where a development is required to implement a flood detention basin, the manner in which this is integrated with stormwater treatment systems on-site has a significant impact on the visual amenity of the site. Done well, the resulting asset can be visually appealing (Figure 45). Done poorly and the outcome is unacceptable (Figure 46). Typically, where poor amenity is the outcome from combined detention and stormwater treatment systems, it is the depth of the detention component, and the associated fencing and safety features that cause the poor amenity, not the stormwater treatment component.

Figure 45: A bioretention system and a detention system co-located and planted to appear like a pocket of bushland

Figure 46: A combined bioretention and flood detention basin that is poorly integrated into the landscape and showcases a number of other aspects of inappropriate design.

Whitsunday Regional Council will accept the following stormwater management technologies being implemented within flood detention systems:

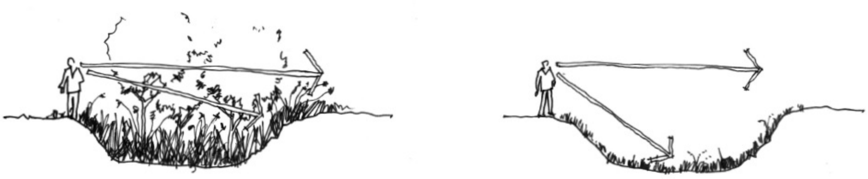
- Bioretention systems
- Wetlands
- Sediment basins

Take the following steps to improve the aesthetic outcome when flood detention is implemented in conjunction with stormwater treatment:

1. Only implement detention where it is necessary
2. Implement batters in accordance with Section 3.3.5.3 of the Bioretention Technical Design Guidelines (Water by Design, 2014)
3. Avoid fencing, and if fencing is used, ensure it is entire screened through plantings (see Figure 47)
4. Implement moderately tall to tall plants in the base of deep systems to reduce the visual effect of their depth (see Figure 48)

Figure 47: Vegetation effectively screening a fence beside an access gate.

Figure 48: Moderately tall and tall plantings in the base of systems reduces the angle with which an observer must lower their eye to view what they perceive as the base of the system



For further advice, see:

- Section 3.3.9 of the Bioretention Technical Design Guidelines (Water by Design, 2014)
- The Constructed Wetland Technical Design Guidelines (Water by Design, 2016)

5.12 Flood immunity of stormwater treatment infrastructure and integration with riparian areas

Stormwater treatment infrastructure must be protected from flood damage from regional rivers and local waterways. Doing so requires providing them with a suitable level of immunity to ensure their function, while taking advantage of opportunities to integrate them with riparian buffer zones. Table 9 outlines the flood immunity requirements for treatment systems likely to be used as end of line systems, and therefore likely to be integrated with riparian areas.

Table 9: Flood immunity requirements for bioretention systems and wetlands

Treatment type	Regional flooding (backwater flood with flow velocity <1m/s)	Local flooding (flooding within waterways and drainage lines)	Flow velocities in adjacent waterways
Bioretention systems	Top of embankment >2yr ARI flood level (allow 200mm freeboard) Inundation period <24hrs for>2year ARI	Top of embankment >2yr ARI flood level (allow 200mm freeboard) Inundation period <12hrs for >2yr ARI Velocity over surface <1m/s	Embankments (external and internal) designed to withstand flood velocities for all events up to the 100yr ARI.
Wetlands	Top of embankment >3month ARI flood level (allow 200mm freeboard) Inundation period <5 days for >1yr ARI	Top of embankment >2yr ARI flood level (allow 200mm freeboard) Inundation period <5days for >2yr ARI Velocity over surface <0.5m/s	Embankments (external and internal) designed to withstand flood velocities for all events up to the 100yr ARI.

Vegetated stormwater treatment systems may be located within mapped waterway buffer zones where the area affected by the treatment system (including all batters) is degraded prior to work, and the construction of the treatment system rehabilitates that portion of waterway buffer. Where the buffer is not degraded prior to work, a treatment system shall not be located within the portion of the buffer that is not degraded.

6 Demonstrating compliance

This section describes how to demonstrate compliance (for example through modelling) with the stormwater objectives described in Section 2. See Section 3 for a description of the information to be provided at various stages of the development process.

6.1 Stormwater quality objectives

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) shall be used to conceptually design and size stormwater treatment systems, and demonstrate compliance with the stormwater quality objectives. MUSIC Modelling shall be undertaken in accordance with the MUSIC Modelling Guidelines (Water by Design, 2016) and the following provisions of this guideline:

- Section 6.1.1 Rainfall Data and Modelling Periods
- Section 6.1.2 Rainfall runoff parameters
- Section 6.1.3 Pollutant export parameters
- Section 6.1.4 Modelling Self-Watering Street Trees in MUSIC
- Section 6.1.5 Proprietary Products

6.1.1 Meteorological data

Table 10 shows the rainfall stations and modelling periods to be used in the Whitsunday Regional Council area. The rainfall stations and modelling periods have been selected as they most closely characterise the mean annual rainfall for the surrounding region and have a minimal amount of missing and/ or accumulated data. Table 10 also provides potential evapotranspiration data to be used for each location.

Figure 49 shows the geographic locations for which each rainfall station should be used. If modelling a location not shown in Figure 49, consult with Council for further guidance on the appropriate rainfall station to use.

Meteorological templates for each of the rainfall stations described in Table 10 have been developed and are available from Council at https://www.whitsunday.qld.gov.au/.

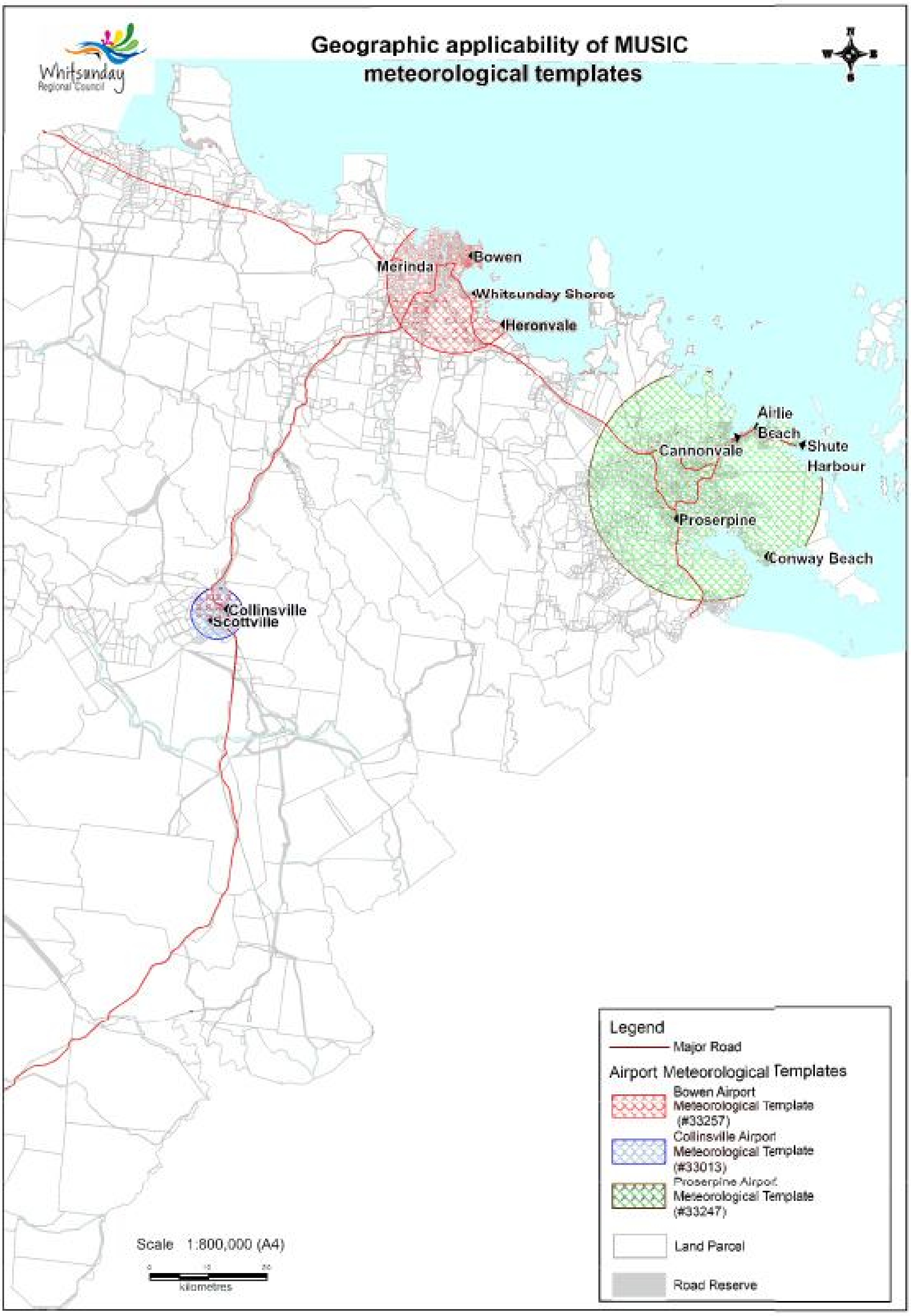
Should the user wish to obtain the rainfall data independently of the meteorological templates, this can be done using the eWater Pluviograph Rainfall Data Tool at http://ewater.org.au/products/music/related-tools/pluviograph-rainfall-data-tool/

Modelling shall be undertaken using a 6 minute timestep.

Table 10: Rainfall data and modelling periods along with evapotranspiration data to be used in the Whitsunday Regional Council area.

Station ID	Station Name	Climate Period for MUSIC	Mean Annual Rainfall Over Period (mm)	Mean PET (mm) (Climate Atlas of Australia											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
33247	Proserpine Airport	1992 – 2001	1388	191	164	187	139	113	97	99	116	139	184	200	192
33257	Bowen Airport	1990 – 1999	893	196	170	193	142	115	100	101	119	144	188	206	198
33013	Collinsville Airport	1986 – 1995	702	184	158	178	132	107	93	94	111	134	177	193	187

Figure 49: Geographic applicability of MUSIC meteorological templates



6.1.2 Rainfall runoff parameters

The rainfall runoff parameters presented in Table 11 shall be used for modelling development applications in the Whitsunday Regional Council area.

Table 11: Rainfall runoff parameters for the Whitsunday Regional Council area

Parameter	Location	
	Proserpine, Airlie Beach and surrounds	**Bowen, Collinsville and surrounds**
Rainfall threshold (mm)	1	1
Soil storage capacity (mm)	100	250
Initial storage (% capacity)	30	5
Field capacity (mm)	100	100
Infiltration capacity coefficient a	200	200
Infiltration capacity exponent b	1	1
Initial depth (mm)	10	0
Daily recharge rate (%)	4	25
Daily baseflow rate (%)	2	0
Daily deep seepage rate (%)	0.4	0

A note on how the rainfall runoff parameters were developed

Ideally, rainfall runoff parameters in MUSIC are developed by calibrating to a local waterways gauging station with both rainfall and flow data. MUSIC has an inbuilt maximum catchment size that it can model. Only one gauging station with the appropriate data, and a sufficiently small catchment size to allow calibration to occur, was available in the Whitsunday Regional Council area. This gauging station was used to develop the parameters for Proserpine, Airlie Beach and the surrounds. In recognition that soil types vary significantly across the Whitsunday Regional Council area, alternate values were sought for Bowen, Collinsville and the surrounding. The values for Sandy Soils from the Mackay Regional Council MUSIC Guidelines (Mackay Regional Council, 2008) have been adopted for these regions in recognition that their soil type varies greatly from that in Proserpine, Airlie Beach and the surrounds.

6.1.3 Pollutant export parameters

Pollutant export parameters for split catchment urban landuse modelling shall be in accordance with Table 3.8 of the MUSIC Modelling Guidelines (Water by Design, 2010).

Pollutant export parameters for lumped catchment modelling shall be in accordance with a combination of Table 3.9 of the MUSIC Modelling Guidelines (Water by Design, 2010) and the provisions of Tables 12 and 13 as follows. When using a lumped catchment approach for modelling urban residential, industrial, commercial or rural residential development, the relevant parameters in the MUSIC Modelling Guideline shall be used. When using a lumped catchment approach for modelling non-urban landuses, the parameters shown in Table 12 (low rainfall areas) and Table 13 (high rainfall areas) shall be used.

Table 12: Pollutant export parameters for rural catchment modelling using a lumped catchment approach – low rainfall areas

Land Use Type	Baseflow	Stormflow

	TSS (log mg/L)	TP (mg/L)	TN (log mg/L)	TSS (log mg/L)	TP (log mg/L)	TN (log mg/L)
Horticulture (food crops only)	1	-1.155	-0.155	2.477	-0.495	0.290
Irrigated Cropping (sugar cane)	0.978	-1.237	-0.293	2.043	-0.454	0.375
Native Vegetation	0.017	-1.770	-0.754	0.954	-1.272	-0.485
Grazing	0.602	-1.113	-0.620	2.14	-0.770	-0.113

Table 13: Pollutant export parameters for rural catchment modelling using a lumped catchment approach – high rainfall areas

Land Use Type	Baseflow			Stormflow		
	TSS (log mg/L)	TP (mg/L)	TN (log mg/L)	TSS (log mg/L)	TP (log mg/L)	TN (log mg/L)
Horticulture (food crops only)	1	-1.155	-0.155	2.477	-0.495	0.290
Irrigated Cropping (sugar cane)	0.978	-1.237	-0.293	2.043	-0.454	0.375
Native Vegetation	0.017	-1.770	-0.754	1.837	-1.171	-0.485
Grazing	0.114	-1.553	-0.656	2.015	-0.733	-0.113

Source: Modelling Rural Catchments using MUSIC (Qld Gov)

6.1.4 Proprietary products

Any pollutant removal performance claimed by proprietary products shall be justified. At the time of writing, a number of testing protocols are in development. Until such a time as Council endorses the use of such a protocol, Whitsunday Regional Council will either:

a) accept the nominated pollutant removal performances of devices as they are accepted by Mackay Regional Council
b) accept the nominated pollutant removal performance of devices tested to local conditions in accordance with the MUSIC Modelling Guidelines (Water by Design, 2016)

6.2 Waterway stability objective

Compliance with the waterway stability objective shall be assessed and demonstrated using the methods outlined in Table 2.3 and Appendix C of Water Sensitive Urban Design: Developing Design Objectives for Urban Development in South East Queensland (Water by Design, 2007).

6.3 Integrated design objective

The Living Waterways Framework (Water by Design, 2014) shall be used to assess and demonstrate compliance with the integrated design objective. Developments shall achieve a minimum 1 drop rating (minimum 36 credits) in the Living Waterways Scoring System. It should be noted that compliance with the stormwater design objectives (see Section 2.1) is mandatory in the Whitsunday Regional Council area, and hence a minimum of 8 credits must be achieved on item LW1.2 of the Living Waterways Scoring System.

7 Construction, Establishment and Handover

Construction, establishment and handover refers to the time period from when works begin on site, until an asset is transferred to its long term asset owner. As such it covers civil and landscape works as well as on and off maintenance. Contemporary stormwater treatment systems are designed to function in a post construction environment. As such they are susceptible to damage from the exceptionally high sediment loads encountered during construction. Appropriate construction, establishment and handover approaches seek to ensure the assets are protected from damage by sediment during and shortly after construction, and to ensure that the handover process runs as smoothly as possible.

7.1 Construction and Establishment

7.1.1 Bioretention systems, wetlands and swales

Bioretention systems, wetlands and swales shall be constructed in accordance with the Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010). The signoff forms contained within the guideline shall be used during all relevant steps of the construction and establishment process.

7.1.1.1 Additional requirements

At the time the Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010) was written, turf was used regularly in conjunction with geofabric to protect bioretention systems from sediment damage, but rarely as a final planting option. Contemporary bioretention system allows the use of turf as a bioretention plant species.

For bioretention systems where turf is specified as one of the final plant species specified, it shall be installed without any dirt attached to its roots.

Note that the presence of turf in the final planting list does not negate the need to install protective turf and geofabric to prevent sediment damage. This protective layer must still be installed for the duration of time that building is occurring on site, and removed prior to the final planting being installed.

7.1.2 Self-watering street trees

Self-watering street trees are susceptible to sediment damage as much as bioretention systems, swales and constructed wetlands are. In the case of self-watering street trees, damage can occur if sediment is allowed to enter and block the subsoil drainage. As such they must be protected from sediment damage during building and construction works. Two construction and establishment options exist for self-watering street trees.

Option 1 – Normal installation and protection

- Install the self-watering street tree at the completion of civil works
- Use a temporary, water tight and secure method to block both the inlet and the outlet to the subsoil drains. The seal must be water tight to prevent water carrying fine sediment in suspension from entering the sub-soil drain.
- When building works are complete on site, remove the seal from both the inlet and outlet

Option 2 – Late installation

- Install the self-watering street tree after building works are complete on site

7.1.3 Proprietary products

Proprietary stormwater treatment systems are generally, but not always, less susceptible to sediment damage during building works than vegetated treatment systems. In most instances sediment will still inhibit their function, but rectification will be much simpler, often only entailing a clean.

Two construction and establishment options exist for proprietary stormwater treatment systems for which sediment will inhibit function but not damage the asset itself.

Option 1 – Early installation and clean

- Install the asset during civil works
- At the completion of building and construction within the upstream catchment, clean the asset

Option 2 – Late installation

- Install the asset during civil works without treatment media (e.g. without filter cartridges) if applicable
- At the completion of building and construction works within the upstream catchment, clean the asset and install the treatment media

If the proprietary stormwater treatment system is susceptible to sediment damage then it shall be installed using a method conceptually similar to the one outlined in the Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2016). It shall be protected from sediment damage during building and functionally completed once the threat of sediment damage has abated.

7.2 Handover and bonding

7.2.1 Swales, bioretention systems, wetlands, self-watering street trees and proprietary devices susceptible to sediment damage

7.2.1.1 Approach 1

Handover and bonding of swales, bioretention systems, wetlands, self-watering street trees and proprietary devices shall occur in accordance with the following (and the construction and establishment provisions of Section 7.1):

- The developer shall install and protect the asset from sediment in accordance with Section 7.1 of this guideline
- The developer shall lodge with Council a maintenance security bond to the value of the greater of:
    - 5% of the total value of the asset
    - 150% of the likely cost to reconstruct the asset if it were to be damaged by sediment
- The developer shall maintain the asset in its protected state until at least 90% of upstream building works are complete and associated lands stabilised
- The developer shall remove the sediment protection, repair any damage to the asset and finish its construction in accordance with Section 7.1 of this guideline
- The developer and Council shall attend an on-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be placed on-maintenance for a period of 24 months. The maintenance security bond may be reduced to 5% of the value of the asset. Should the asset not be in acceptable condition the defects shall be rectified and another on-maintenance inspection arranged.
- The developer shall undertake maintenance and ensure that the vegetation establishes appropriately.
- The developer and Council shall attend an off-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be accepted off maintenance and the remainder of the maintenance security deposit returned. Should the asset not be in acceptable condition the defects will be rectified. If the defects were minor in

nature, the asset shall be accepted off maintenance and the security deposit returned. If the defects were major in nature, the 24-month maintenance period shall be served in full again.

The signoff forms contained within the Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010) shall be used at all relevant stages of the handover process.

7.2.1.2 Approach 2

Should the handover and bond approach outlined in Section 7.2.1.1 not be considered desirable by the developer, they may choose to apply to Council prior to approval of the operational works application to undertake the following alternative handover process:

- The developer shall install and protect the asset from sediment in accordance with Section 7.1 of this guideline
- The developer shall lodge with Council a maintenance security bond to the value of 5% of the total value of the asset
- The developer shall prior to plan sealing lodge with Council a monetary contribution for Council to complete construction of the asset and establish all vegetation after building works are complete. The value of the monetary contribution shall be 150% of the cost of such works (see note below).
- The developer and Council shall attend an on-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be placed on-maintenance for a period of 12 months. Should the asset not be in acceptable condition the defects shall be rectified and another on-maintenance inspection arranged.
- The developer shall maintain the asset in its protected state
- The developer and Council shall attend an off-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be accepted off maintenance and the maintenance security deposit returned. Should the asset not be in acceptable condition the defects will be rectified. If the defects were minor in nature, the asset shall be accepted off maintenance and the security deposit returned. If the defects were major in nature, the 12-month maintenance period shall be served in full again.
- Once the asset is accepted off-maintenance, Council shall maintain the asset in its protected state until at least 90% of upstream building works are complete and associated lands stabilised
- Council shall use the monetary contribution to remove the sediment protection, repair any damage to the asset and finish its construction in accordance with Section 7.1 of this guideline

The signoff forms contained within the Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands (Water by Design, 2010) shall be used at all relevant stages of the handover process.

Pricing of contribution

Council recognises that bioretention systems are likely to be the asset that is most commonly handed over to Council from developers. To assist with pricing the contribution for Council to complete the construction of the asset as described above, Council has determined indicative prices to complete the works:

- in precinct scale bioretention systems, \$56 per square meter of bioretention filter media
- in streetscape bioretention systems, \$219 per square meter of bioretention filter media

These figure are calculated prior to application of the 150% loading, bringing the total figures to \$84 and \$328.50 per square meter of bioretention filter media respectively.

Note that:

- the figures above are provided in 2016 dollars and may be scaled to account for inflation

- the streetscape bioretention rate above was calculated based on the cost for a standalone system. It is likely that some developments will include multiple streetscape systems in close proximity. This economy of scale will reduce costs. Developments with multiple streetscape systems in close proximity are encouraged to contact Council to discuss a lower rate.

For assets other than bioretention systems the developer shall lodge a bill of quantities with Council as a basis from which to determine the value of the contribution.

7.2.2 Proprietary devices not susceptible to sediment damage

Handover and bonding of proprietary devices that are not susceptible to sediment damage shall occur in accordance with the following (and the construction and establishment provisions of Section 7.1):

- The developer shall install the asset in accordance with Section 7.1 of this guideline
- The developer shall lodge with Council a maintenance security bond to the value of the great of:
    - 5% of the total value of the asset; or
    - the cost to clean and/or reinstate the asset after sediment damage
- The developer and Council shall attend an on-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be placed on-maintenance for a period of 12 months, or until 90% of upstream building works are complete and lands stabilised. Should the asset not be in acceptable condition the defects shall be rectified and another on-maintenance inspection arranged.
- The developer shall maintain the asset for the 12-month maintenance period and until 90% of upstream building works are complete. The developer shall then arrange for the asset to be cleaned.
- The developer and Council shall attend an off-maintenance inspection. Should the asset be in acceptable condition (see Section 7.1 and associated documents), it shall be accepted off maintenance and the maintenance security deposit returned. Should the asset not be in acceptable condition the defects will be rectified. If the defects were minor in nature, the asset shall be accepted off maintenance and the security deposit returned. If the defects were major in nature, the 12-month maintenance period shall be served in full again.

Appendix A

Std. Dwg. No.	Descriptions	Std. Dwg. No.	Descriptions
	STORMWATER QUALITY		
Q-0002	FLUSH KERBING AND GRASS BUFFER STRIP DETAIL		
Q-0003	UNDERDRAIN FLUSH OUT-GRASSED STREETSCAPE BIORETENTION		
Q-0004	SELF WATERING STREET TREE		
Q-0005	CONSTRUCTED WETLAND INLET ZONE WEIR DETAILS		
Q-0006	CONSTRUCTED WETLAND RISER PIT		
	BIORETENTION		
	IPWEAQ STANDARD DRAWINGS		
DS-070	BIORETENTION DRAINAGE PROFILE-TYPE 1 SATURATED ZONE-UNCONSTRAINED		
DS-071	BIORETENTION DRAINAGE PROFILE-TYPE 1 SATURATED ZONE-CONSTRAINED		
DS-076	BIORETENTION WEIR		
DS-077	BIORETENTION STREET TREE		
DS-078	BIORETENTION STANDARD NOTES		
	SWALES		
	IPWEAQ STANDARD DRAWINGS		
DS-079	STREETSCAPE SWALE-TYPICAL SECTION SHEET 1 OF 2		
DS-080	STREETSCAPE SWALE-TYPICAL SECTION SHEET 2 OF 2		

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INDEX

STANDARD DRAWINGS

STORMWATER QUALITY

SW QUALITY

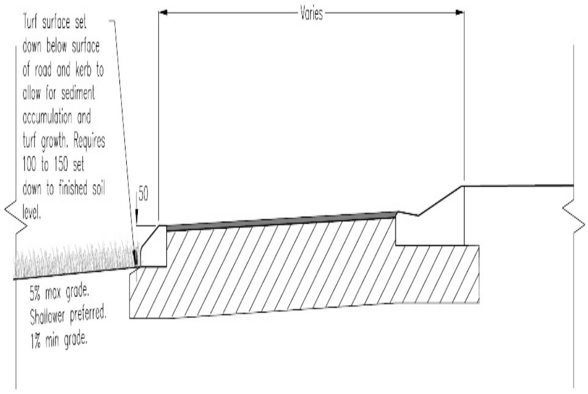
Standard Drawing

Q-0001

A

NOTES:

1. Engineering works to be in accordance with councils engineering guidelines, standards and specifications.
2. All dimensions in millimetres unless specified otherwise.
3. Ensure appropriate drainage downstream of buffer. Design to suit context (eg. open space, swale).



TYPICAL SECTION

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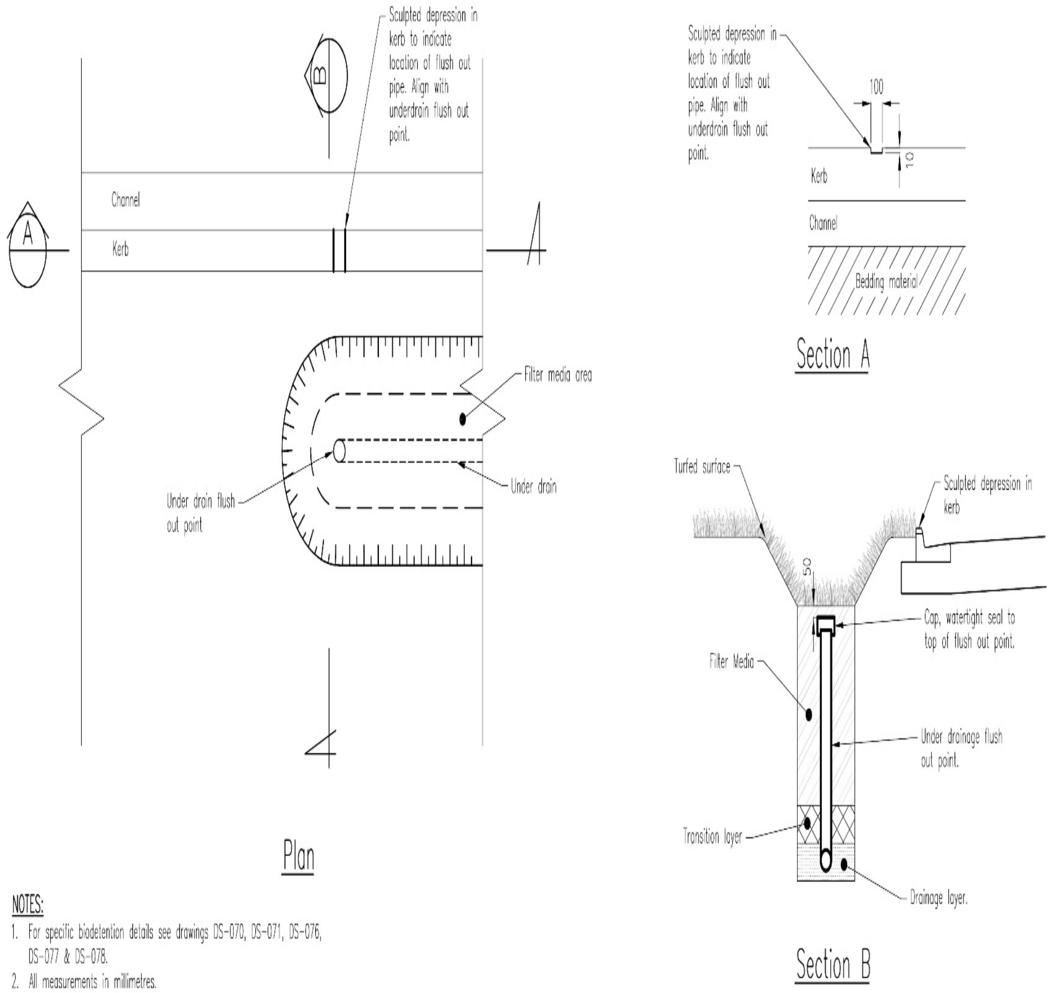
Ph 07 4785 5366

PROSERPINE
83-85 Main St
Proserpine 4800 Q
Ph 07 4945 0200

FLUSH KERBING AND GRASS BUFFER STRIP

SW QUALITY Standard Drawing Q-0002

A



NOTES:

1. For specific biodetention details see drawings DS-070, DS-071, DS-076, DS-077 & DS-078.
2. All measurements in millimetres.

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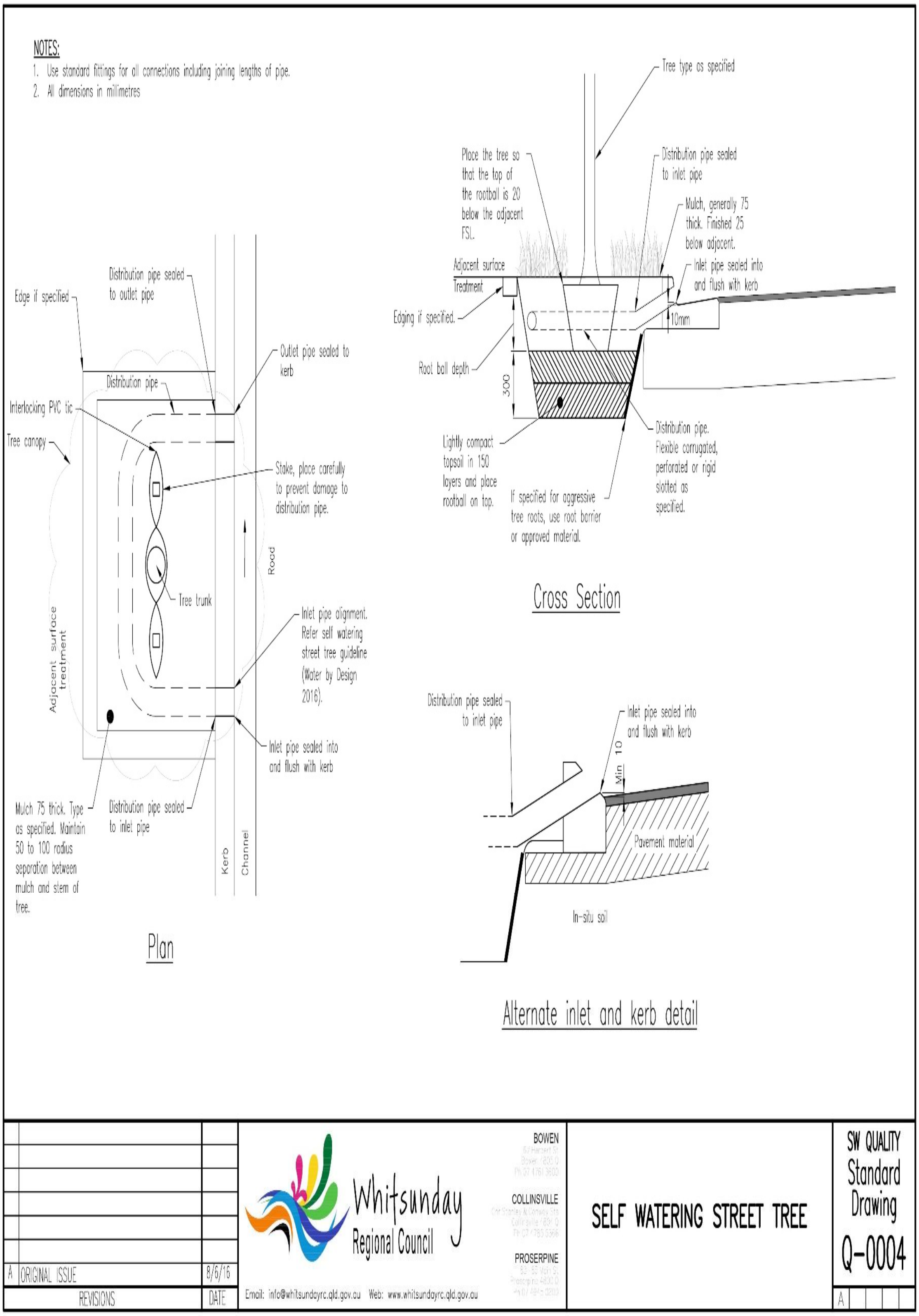
UNDERDRAINAGE FLUSH OUT GRASSED STREETSCAPE BIORETENTION

SW QUALITY Standard Drawing Q-0003

A


NOTES:
1. Use standard fittings for all connections including joining lengths of pipe.
2. All dimensions in millimetres
Tree type as specified
Place the tree so that the top of the rootball is 20 below the adjacent FSL.
Distribution pipe sealed to inlet pipe
Mulch, generally 75 thick. Finished 25 below adjacent.
Adjacent surface Treatment
Inlet pipe sealed into and flush with kerb
Edging if specified.
10mm
Root ball depth
300
Lightly compact topsoil in 150 layers and place rootball on top.
If specified for aggressive tree roots, use root barrier or approved material.
Distribution pipe. Flexible corrugated, perforated or rigid slotted as specified.
Cross Section
Edge if specified
Distribution pipe sealed to outlet pipe
Distribution pipe
Interlocking PVC tie
Tree canopy
Outlet pipe sealed to kerb
Stake, place carefully to prevent damage to distribution pipe.
Road
Tree trunk
Adjacent surface treatment
Inlet pipe alignment. Refer self watering street tree guideline (Water by Design 2016).
Inlet pipe sealed into and flush with kerb
Mulch 75 thick. Type as specified. Maintain 50 to 100 radius separation between mulch and stem of tree.
Distribution pipe sealed to inlet pipe
Kerb
Channel
Plan
Distribution pipe sealed to inlet pipe
Inlet pipe sealed into and flush with kerb
Min 10
Pavement material
In-situ soil
Alternate inlet and kerb detail
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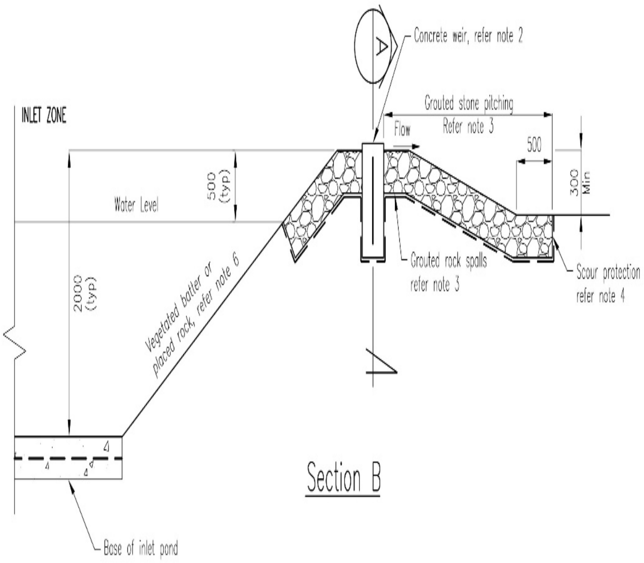
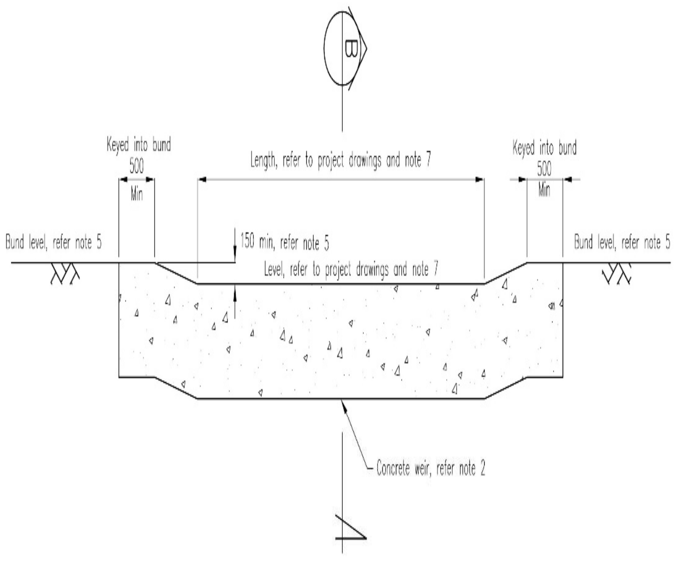
SELF WATERING STREET TREE
SW QUALITY
Standard Drawing
Q-0004
A



Section B



Section A

NOTES:

1. Insitu material to be tested and approved by geotechnical engineer prior to weir construction.
2. Concrete weir – 300 wide x 800 high concrete (N32) with SL81 mesh placed centrally.
3. Grouted stone pitching – stones 75–100, 300 thick on filter cloth, non–woven geotextile. Refer landscape drawings and project drawings for plant specification and details. Geotechnical engineer to confirm compaction requirements for bund subsoil. Option to drill 100 cores through to subsoil to provide voids for planting (Subject to flow velocities and local government requirements). Option to use placed rock with void plantings subject to approval by hydraulic engineer and local authority.
4. For extent and details of scour protection refer to project drawings. Bund levels must be noted on project drawings.
5. Bund level, refer to project drawings for minimum freeboard requirements.
6. Refer to project drawings for vegetated batter slope. Batters must be in accordance with local authority safety requirements.
7. Construction tolerances as documented in the "Water Sensitive Design Construction and Establishment Guidelines – Swales, Bioretention Systems and Wetlands " (Water by Design) must be achieved. Construction tolerances must be noted oN project plans. Invert levels of pits, pipes and base levels must be noted on project drawings.
8. All dimensions are in millimetres unless noted otherwise.

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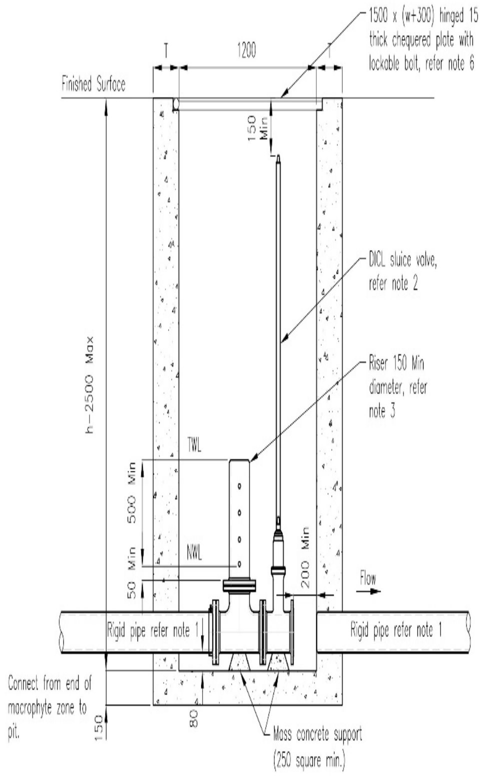
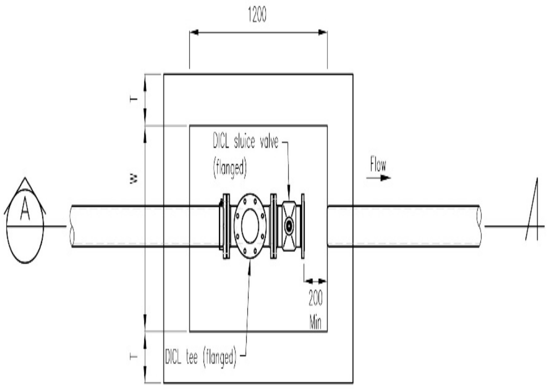
CONSTRUCTED WETLAND
INLET ZONE
WEIR DETAILS

SW QUALITY
Standard
Drawing
Q–0005

A



Section A



Plan

NOTES:

1. Refer to project drawings for rigid pipe diameter and invert level.
2. DICL sluice valve, refer project drawings for valve size. Valve to remain in closed position for normal operation. Valve to be opened to lower the water level for maintenance of the wetland.
3. Riser rigid pipe CL16, refer to project drawings for holes sizes and locations. Hole size and number as per relevant section of "The Constructed Wetland Technical Design Guidelines" (Water by Design).
4. For pits over 2500 in depth refer project drawings for pit dimensions and reinforcing details.
5. Concrete N25 in accordance with AS 1379:2007 AS 3600:2009
6. Lid and frame to be hot dip Galvanised after fabrication to AS 1650:1989.
7. Construction tolerances as documented in the "Water Sensitive Urban Design Construction and Establishment Guidelines - Swales, Bioretention Systems and Wetlands" (Water by Design) must be achieved. Construction tolerances must be noted on project plans. Invert levels of pits, pipes and base levels must be noted on project drawings.
8. All dimensions in millimetres unless noted otherwise.

Pit Dimensions

Height (h)	Width (w)	Wall thickness
0-1500	600	150
1500-2500	900	225

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Email: info@whitsundayrc.qld.gov.au Web: www.whitsundayrc.qld.gov.au

CONSTRUCTED WETLAND

OUTLET RISER PIT

SW QUALITY Standard Drawing

Q-0006

A

Appendix B Certificate of Compliance from SESL Australia

Independent consulting, laboratory, research and training services to:

- Agriculture
- Environment
- Horticulture
- Mining
- Sport & Leisure Turf
- Waste Industries

SESL AUSTRALIA
Environment & Soil Sciences

Declaration of Compliance

Certificate Nº: DOC40180A-1

To: Adam Folkers
Whitsunday Regional Council
83-85 Main Street
Proserpine QLD 4800

Ph: 07 4945 0242
Mob:
Email: info@whitsundayrc.qld.gov.au

Project name:	FAWB Blend	
Product name:	50 Sand:30 Soil: 20 Sugar	
Supplier:		
Suppliers batch		
Compliance Standard:	Guidelines for Soil Filter Media in Bioretention Systems (V3.01)	
Date sampled:	17/8/16	
Laboratory ID:	Batch Nº: 40180A	Sample Nº: 1

I, Declan McDonald, of SESL Australia Pty Limited

Hereby certify that:

1. I am a qualified Soil Scientist and a Professional Member of Soil Science Australia.
2. This sample has been submitted by *Adam Folkers* and has been analysed in accordance with *Guidelines for Soil Filter Media in Bioretention Systems (V3.01) June 2009*.
3. I am experienced in the interpretation of soil test results for the establishment and cultivation of plants in urban horticulture.
4. The extent of sampling and the results of all tests carried out on the subject soil mix conducted for the subject project are described in my report *DOC40180A-1* dated *31 August 2016* and are attached to this declaration for reference.
5. In my professional opinion, the soil mix described in the attached report complies with the nominated site specification and having given due consideration to the intended use and purpose, this soil mix is deemed fit for purpose.

Corrective Actions Required

No corrective actions required.

This FAWB Bioretention developed by SESL is fit for purpose for use as a Bioretention Mix.

This professional opinion is furnished to *Adam Folkers* as a representative of *Whitsunday Regional Council* for their purposes alone on the express condition this it will not be relied upon by any other person and does not remove the necessity for the normal inspection of site conditions, workmanship and product liability at the time of construction.

Signed: Declan McDonald **Date of Report:** 31 Aug 2016

Name: **Declan McDonald** **Certificate Nº:** DOC40180A-1

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Em: info@sesl.com.au
Web: www.sesl.com.au

Appendix C D-Values for filter media

SESL AUSTRALIA
Environment & Soil Sciences

Results Summary Profile

Sample Drop Off: 16 Chilvers Road, Thornleigh NSW 2120
Tel: 1300 30 40 80
Fax: 1300 64 46 89
Mailing Address: PO Box 357, Pennant Hills NSW 1715
Em: info@sesl.com.au
Web: www.sesl.com.au

Batch N°: 40180A **Sample N°: 2** **Date Instructions Received: 17/8/16** **Report Status:** ○ Draft ◉ Final

Client Name:	**Whitsunday Regional Council**	Project Name:	**FAWB Blend**
Client Contact:	**Adam Folkers**	SESL Quote N°:	**QR#5797**
Client Job N°:		Sample Name:	**50 Sand: 20 Soil: 30 Sugar**
Client Order N°:		Description:	**Mixes**
Address:	**83-85 Main Street Proserpine QLD 4800**	Test Type:	**SIEVE_US_Wet, pH_Sol, EC_Sol, TN_DC_S, PO4_Olsen**

Reported D-value

D-Values derived from sieve results.

D100	#N/A
D90	3.10
D85	2.48
D60	1.07
D50	0.82
D35	0.51
D30	0.44
D25	0.37
D15	0.22
D10	0.12
D5	0.04

Consultant
Chantal Milner

Authorised Signatory
Declan McDonald

Date Report Generated
31/08/2016