Acknowledgements

These guidelines are based on the Healthy Waterways Partnership's *Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (2006)*. Additional material has been kindly provided by the *Water Sensitive Urban Design Guidelines: Stormwater* (Brisbane City Council guidelines based on a similar document from Melbourne Water) and the *Water Sensitive Urban Design in the Sydney Region* project (from their *Technical Guidelines for Western Sydney*).

The guidelines have been produced by AECOM (Australia) for Townsville City Council with the approval of the Healthy Waterways Partnership. This publication was funded by the former Townsville and Thuringowa City Councils, the Queensland Environmental Protection Agency and the Australian Government's Coastal Catchment Initiative through the Department of Environment, Water, Heritage and the Arts

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Introduction

Chapter 1

1.1 Introducing Water Sensitive Urban Design

Scientific studies of urban catchments have shown treated sewage and urban stormwater to be key contributors to reduced water quality and reduced waterway health in local waterways and the Great Barrier Reef. The objective of traditional urban development practices was to move these discharge streams to receiving waters as efficiently as possible, providing minimal opportunity for treatment and reuse. With ongoing population growth in the region, a continuation of this traditional approach will result in further, and perhaps irreversible, degradation of the region's waterways.

Water Sensitive Urban Design (WSUD) is an internationally recognised concept that offers an alternative to traditional development practices. WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems. It promotes the integration of stormwater, water supply and sewage management at the development scale.

WSUD represents a fundamental change in the way urban development is conceived, planned, designed and built. Rather than using traditional approaches to impose a single form of urban development across all locations, WSUD considers ways in which urban infrastructure and the built form can be integrated with a site's natural features. In addition, WSUD seeks to optimise the use of water as a resource.

The key principles of WSUD are to:

- Protect existing natural features and ecological processes.
- Maintain the natural hydrologic behaviour of catchments.
- Protect water quality of surface and ground waters.
- Minimise demand on the reticulated water supply system.
- Minimise sewage discharges to the natural environment.
- Integrate water into the landscape to enhance visual, social, cultural and ecological values.

The former Townsville and Thuringowa City Councils identified the need for technical design guidelines for Water Sensitive Urban Design for Stormwater Management for the Coastal Dry Tropics region in recognition of increasing urban development pressure and consequential increases in pollutant delivery to urban waterways. Other project partners/funders include the Australian Government (through CCI funding for the Black Ross WQIP) and the Environmental Protection Agency.

1.2 Scope of These Guidelines

Various tools and guidelines are available to assist in the planning, design and construction of WSUD elements. Figure 1.1 shows different information needs associated with planning and design of WSUD (vertical axis) and stages of the development assessment process (horizontal axis). These guidelines are intended as a detailed design tool, applicable in the mid to latter stages of the urban development process.

These guidelines describe appropriate methods for the detailed design of some common structural stormwater management measures in the Coastal Dry Tropics. It is not the intention of the guidelines either to advocate or to discourage particular approaches. Hence, exclusion of a particular type of device from the Guidelines does not imply that it can not be used in the Coastal Dry Tropics.

Management approaches for other elements of the urban water cycle, whilst essential for effective WSUD, are not presently covered in these guidelines. In the future, the Guidelines may be expanded to address a wider suite of management techniques across the full water cycle. However, some of these, particularly demand management measures for water conservation, as well as greywater and blackwater management measures, are currently controlled by state or local government regulation, which provides limited design flexibility.

Knowledge of best practices for the design and construction of stormwater treatment measures is constantly increasing. These guidelines are not intended to limit innovation in design or construction of WSUD elements by restricting alternative approaches to those presented here. Alternative designs should be considered where potential improvements in performance, constructability or maintenance requirements can be

demonstrated. However, the design procedures and recommendations given in these guidelines are based on contemporary best practice, incorporating lessons from local experience, and are regarded as appropriate for the Coastal Dry Tropics region.

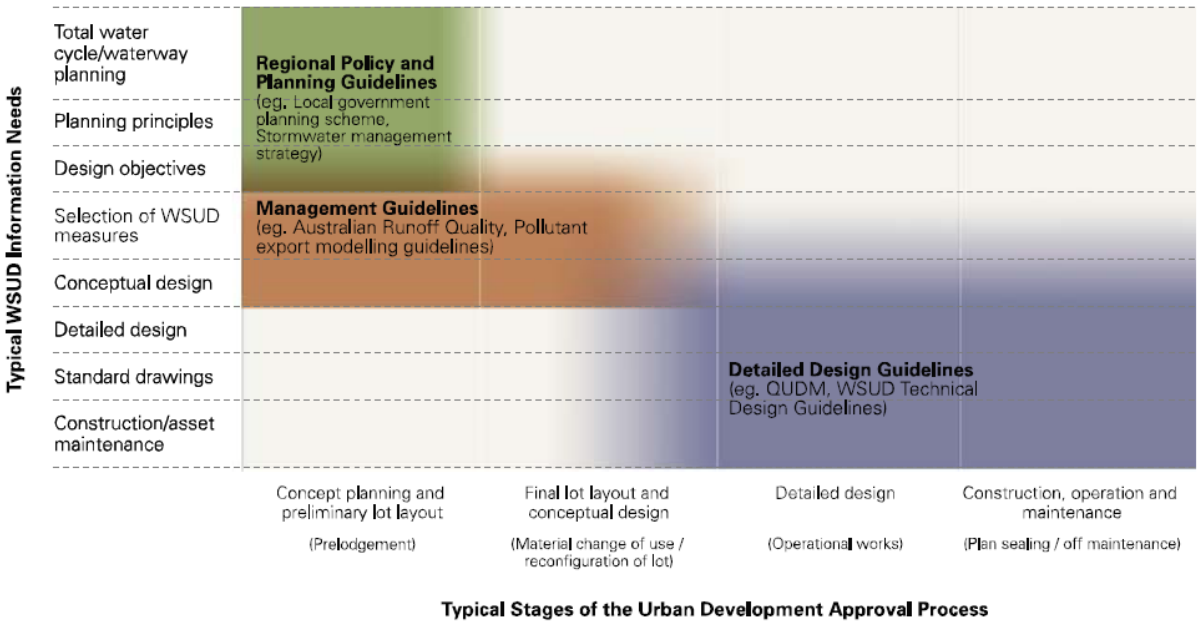

Figure 1.1 Applicable information tools and resources for different aspects of WSUD implementation

1.3 Structure of the Guidelines

The following eight chapters of these guidelines each detail the design methodology for a different type of stormwater management measure:

Chapter	Treatment Measure	Description
2	Swales and Buffer Strips	A swale is a shallow trapezoidal channel lined with vegetation. A buffer strip is a vegetated slope. Stormwater flows along a swale, but across a buffer strip. Treatment is provided by infiltration to the soil and by filtration of shallow flow through the vegetation.
3	Bioretention Swales	Bioretention swales include a vegetated infiltration trench within the invert of a swale. Incorporating the infiltration trench enhances removal of both particles and nutrients.
4	Sedimentation Basins	A sedimentation basin is a small pond, about 1 m deep, designed to capture coarse to medium sediment from urban catchments. Treatment is provided primarily through settling of suspended particles.
5	Bioretention Basins	A bioretention basin is a vegetated bed of filter material, such as sand and gravel. The basin is designed to capture stormwater runoff which then drains through the filter media. Pollutants are removed by filtration and by biological uptake of nutrients.
6	Constructed Wetlands	Constructed wetland systems are shallow, vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater.
7	Infiltration Measures	Infiltration measures typically consist of a holding pond or tank designed to promote infiltration of appropriately treated to surrounding soils. The primary function of these devices is runoff volume control rather than pollutant removal.
8	Sand Filters	A sand filter is a sand layer designed to filter fine particulates from stormwater before discharging to a downstream drainage system.
9	Aquifer Storage and Recovery	Aquifer storage and recovery involves enhancing water recharge to underground aquifers through pumping or gravity feed of treated stormwater.

Appendix A, Plant Selection for WSUD systems, provides advice on the selection of plant species to perform different functional roles within stormwater treatment devices in the Coastal Dry Tropics.

Each chapter of the Guidelines has a similar generic structure which includes the following elements:

Introduction:	Introduction to the general features of the device, principles of operation and treatment processes.
Design Considerations:	A discussion of important issues that should be considered in the design of various elements of the device.
Design Process:	Step-by-step guide through the details of the recommended design process. Calculation summary sheets are provided to help ensure that key design issues have been addressed.
Landscape Design Notes:	Discussion of landscape design considerations, including illustrations showing possible landscape forms.
Construction and Establishment:	Advice on the construction and establishment of WSUD elements, based on recent industry experience around Australia.
Maintenance Requirements:	Discussion of maintenance requirements for WSUD elements. Maintenance inspection forms are provided for each element to highlight the components of a system that should be routinely checked. These can be used as templates to develop more site-specific maintenance inspection forms.
Checking Tools:	A series of checking tools, comprising design, construction, asset transfer and maintenance checklists, are provided in each chapter, to assist designers and local government officers in checking the integrity of designs, both before and after construction.
Example Engineering Drawings:	Working drawings that detail key elements of the system. These example drawings illustrate the typical level of detail required in the documentation to facilitate successful construction. However, these are not standard drawings and requirements may vary between different local authorities.
Worked Example:	A worked example of the design procedure. The worked example completes a detailed design based on an initial concept design layout and discusses design decisions that are required as well as performing the calculations outlined in the design procedure.
References:	A list of reference documents and information sources.

1.4 The Policy and Planning Context for WSUD in the Coastal Dry Tropics

There are numerous pieces of planning and environmental protection legislation that have a direct bearing on the regulatory aspects of WSUD in the Coastal Dry Tropics. Due to the wide range of issues encompassed by WSUD, such as environmental protection, stormwater management, water conservation and wastewater management, it does not fit neatly under one Act or regulatory authority.

The *Sustainable Planning Act 2009* (SPA) is the primary planning legislation in Queensland. The Act is focussed on achieving ecological sustainability by using natural resources prudently and minimising environmental impacts. Since these objectives are also fundamental to WSUD, the Act provides strong support for a water sensitive approach to urban development.

SPA is also the legislative basis upon which local governments prepare a planning scheme. The environmental objectives of SPA are reflected in the requirement for every planning scheme to specify strategic outcomes (similar to Desired Environmental Outcomes (DEOs)) which development must achieve. Measures within a planning scheme, such as zones, codes and strategies must work towards the strategic outcomes. WSUD provides an appropriate method for development to comply with some water-related strategic outcomes.

1.5 Design Objectives for Stormwater Management

Design objectives are specific and measurable water management targets, selected to meet desired outcomes, such as a reduction in water usage or protection of downstream environmental values. For stormwater management, regulation of design objectives is the responsibility of Townsville City Council. The typical form of stormwater design objectives is based on achieving target pollutant concentrations or target reductions in pollutant load.

Experience within Australia and overseas has identified some problematic issues with the application of concentration-based receiving water targets or water quality objectives as discharge criteria for urban stormwater. These issues include selection of a representative median concentration for stormwater flow, which is highly variable. In addition, the substantial increase in runoff volume that typically accompanies urban development can increase pollutant loads to receiving waters (even if concentrations are not increased) and also damage urban streams through increased erosion. For these reasons many authorities across Australia, are moving towards the use of load-based objectives.

The design approach presented in these guidelines is essentially independent of the design objectives that the device is required to meet. It is assumed that the size and general configuration of the device to meet design objectives has already been determined through a conceptual design process. For small developments, conceptual design may be undertaken by specifying deemed-to-comply solutions based on local government requirements. For larger developments, numerical modelling may be required to demonstrate compliance with design objectives.

The adopted design objectives for the Coastal Dry Tropics in mean annual pollutant load leaving a development site, compared to traditional urban design where stormwater is not treated:

- >= 80% reduction in total suspended solids load
- >= 65% reduction in total phosphorus load
- >= 40% reduction on total nitrogen load
- >= 90% reduction in gross pollutant load.

1.6 How to Use These Guidelines

Table 1.1 shows typical WSUD-related tasks undertaken during each stage of the urban development process, as well as the corresponding progress of the local government approval process. These Guidelines

are specifically for use during the detailed design and construction, operation and maintenance stages of the urban development process.

The Guidelines are not intended to be used for determining the size (typically, plan area and/or volume) of a device to meet design objectives. Throughout the guidelines it is assumed that a conceptual design has been previously completed to determine the size and general arrangement of proposed stormwater treatment devices.

The guidelines contain many illustrations and photographs of stormwater treatment devices. These are intended as examples only and should not be regarded as acceptable solutions. Unless specifically indicated, all drawings are not to scale.

Table 1.1 Stages of the Urban Development and Local Government Approval Processes

The Urban Development Process	Typical Tasks	The Local Government Approval Process
Concept planning and preliminary lot layout	■ Site assessment ■ Establish design objectives ■ Device selection and indicative location	Pre-lodgement discussions
Final lot layout and conceptual design	■ Refine device selection and location ■ Size and general arrangement of devices ■ Catchment modelling to demonstrate compliance with design objectives	Material change of use and/or reconfiguration of a lot application
Detailed design	■ Internal configuration of device ■ Design inflow and outflow structures ■ Specify vegetation ■ Develop maintenance plan	Operational works application
Construction, operation and maintenance	■ Implement sediment and erosion control measures ■ Qualitative performance monitoring ■ Implement maintenance plan	Plan sealing, on and off maintenance

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1.7 Selection of Appropriate Stormwater Management Measures

Not all of the stormwater management measures presented in these Guidelines are suitable for any given site. Appropriate measures should be selected by matching device characteristics to target pollutants and the physical constraints of the site. Figure 1.2 shows the recommended process for planning and designing WSUD measures.

These guidelines are not intended to provide detailed advice on selection of stormwater treatment devices. However, the following tables provide an indication of:

- The scale at which various treatment measures are typically applied (Table 1.2),
- The effectiveness of these treatment measures in removing pollutants, attenuating peak flow rates and reducing runoff volume (Table 1.3), and
- Site conditions that may affect the suitability of different treatment measures (Table 1.4).

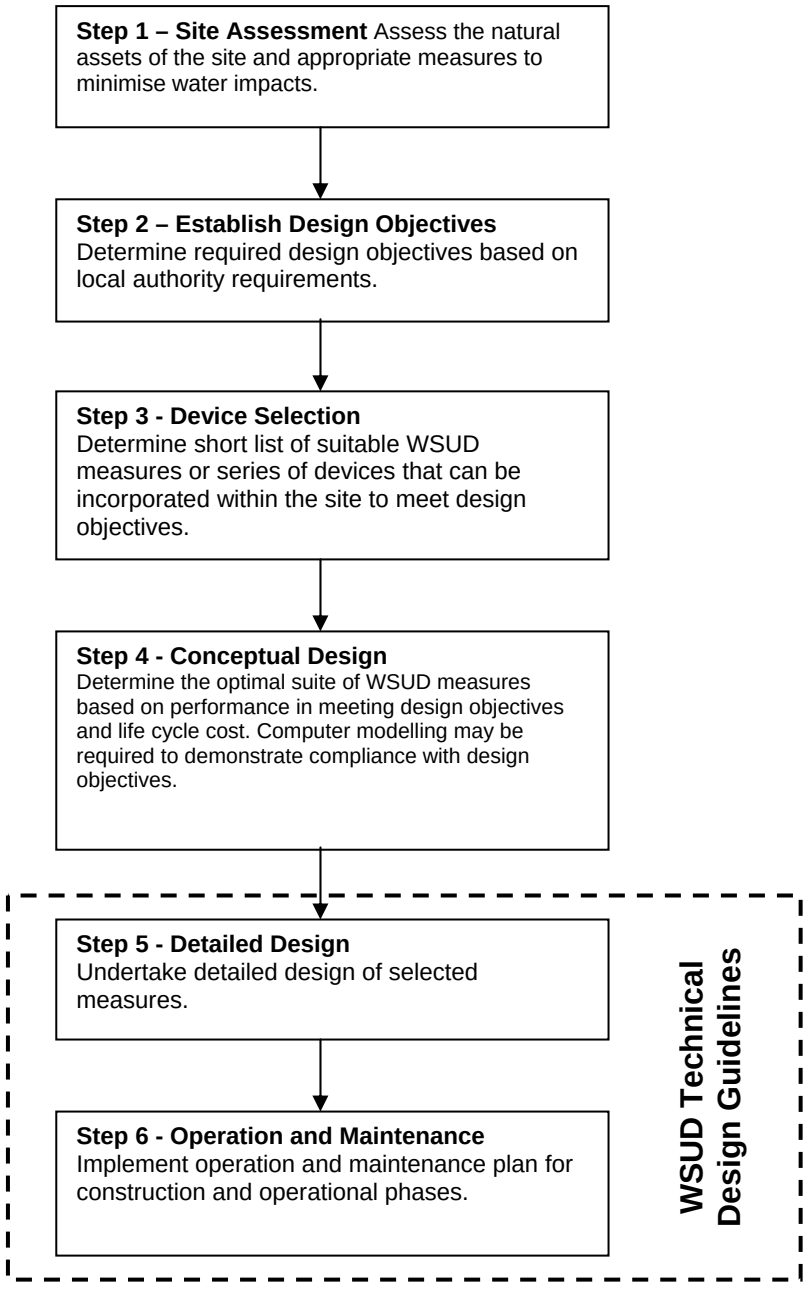

Figure 1.2 Example WSUD Planning Process

Table 1.2 Scale of WSUD Application in Urban Catchments

WSUD Measure	Allotment Scale	Street Scale	Precinct or Regional Scale
Swales and buffer strips		✓	
Bioretention Swales		✓	✓
Sedimentation basins			✓
Bioretention basins	✓	✓	✓
Constructed wetlands		✓	✓
Infiltration measures	✓	✓	
Sand filters	✓	✓	
Aquifer storage and recovery			✓

Table 1.3 Effectiveness of WSUD Measures for Runoff Quality and Quantity Management

WSUD Measure Water	Quality Treatment			Peak Flow Attenuation *	Reduction in Runoff Volume*
	TSS	TP	TN		
Swales and buffer strips	H	M	L	L	L
Bioretention Swales	H	H	H	M	L
Sedimentation basins	H	M	L	M	L
Bioretention basins	H	H	H	M	L
Constructed wetlands	H	H	H	H	L
Infiltration measures**	-	-	-	H	H
Sand filters	H	M	L	L	L
Aquifer storage and recovery**	-	-	-	H	H

H – High; M – Medium; L – Low * Frequent events only ** Water quality treatment is not a primary function of these devices

Table 1.4 Site Constraints for WSUD Measures

WSUD Measure	Steep site (>5%)	Shallow bedrock	Acid Sulfate Soils	Low permeability soil (eg. Clay)	High permeability soil (eg. sand)	High water table	High sediment input	Land availability
Swales and buffer strips	C	D	D	✓	✓	D	D	D
Bioretention Swales	C	C	C	✓	✓	C	D	D
Sedimentation basins	C	✓	✓	✓	✓	D	✓	D
Bioretention basins	D	D	D	✓	✓	C	C	D
Constructed wetlands	C	D	C	✓	D	D	D	D
Infiltration measures	C	C	C	C	✓	C	C	D
Sand filters	D	✓	✓	✓	✓	D	C	✓
Aquifer storage and recovery	C	C	C	C	✓	C	C	D

C – Constraint may preclude use; D – Constraint may be overcome through appropriate design;

✓ - Generally not a constraint

1.8 Safety and Risk Management

WSUD aims to protect the environmental assets of a site and enhance liveability through greater integration of built and natural features. This approach may introduce some risks to the urban environment that are greater than or different to those encountered in traditional land development practice. The more obvious of these risks relate to the presence of open water bodies and the introduction of street-scape elements that may alter lines of sight or other aspects of traffic safety.

Whilst these Guidelines make occasional comment on various aspects of safety, they are not intended to provide comprehensive advice on appropriate risk management strategies. Designers are responsible for providing an appropriate level of public safety in their designs and for ensuring that risk management procedures, in accordance with relevant standards and guidelines, are followed. Further information on risk management for water-related urban infrastructure is provided in the Queensland Urban Drainage Manual.