ACT Government

Environment, Planning and Sustainable Development

THE LEGISLATIVE ASSEMBLY FOR THE AUSTRALIAN CAPITAL TERRITORY

Variation to the Territory Plan No .354
Water Sensitive Urban Design

November 2019

Mr Mick Gentleman MLA
Minister for Planning and Land Management

Australian Capital Territory

Planning and Development (Plan Variation No 354) Approval 2019

Notifiable instrument NI2019-

made under the

Planning and Development Act 2007, s 76 (Minister's powers in relation to draft plan variations)

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1 Name of instrument

This instrument is the *Planning and Development (Plan Variation No 354) Approval 2019*.

2 Approval of draft plan variation

(1) I approve under section 76 (2) (a) of the *Planning and Development Act 2007* the draft plan variation No 354 to the Territory Plan.

(2) In this section:

draft plan variation No 354 to the Territory Plan means the draft plan variation in the schedule.

Mick Gentleman MLA
Minister for Planning and Land Management

13/4/2019

ACT Government

Environment, Planning and Sustainable Development

SCHEDULE

Planning and Development Act 2007

Variation to the Territory Plan No 354

Waterways: water sensitive urban design general code review and associated consequential amendments to Territory Plan codes

Final variation prepared under s76 of the
Planning and Development Act 2007

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1. EXPLANATORY STATEMENT

1.1 Background

The ACT Government's Water Sensitive Urban Design Review Report (WSUD) was released in 2014 (WSUD review). The WSUD review identified eight priority projects. The Priority Project 1 called for a revision of the WSUD provisions of the Territory Plan and for these provisions to be supported by a WSUD practice guideline. This Variation provides greater clarity and consistency in interpretation and implementation of the WSUD provisions. The new provisions promote innovation and increase flexibility in options for meeting the various WSUD targets.

Previously, the ACT Government released the Waterways WSUD Guidelines in 2007. This was given further effect when it was incorporated into the Territory Plan through the introduction of the Waterways: WSUD General Code in 2009. Prior to this Variation the format of the WSUD Code was not in keeping with the standard rules and criteria format of the other Territory Plan codes.

Before, this Variation, the WSUD provisions were contained in a number of the zone and development codes. These provisions were presented in rules and criteria format and the rules stipulate quantifiable requirements to meet targets. However, the criteria left proponents with discretion to demonstrate that a particular method achieves the target.

Lastly, some precinct codes also contained site-specific WSUD provisions and requirements.

The WSUD review concluded that:

- The WSUD Code and the related WSUD requirements in development codes in the Territory Plan may inhibit innovation by limiting the options available to meet the rules.
- The rules and criteria in development codes require revision to clarify WSUD requirements to reflect contemporary industry best practice.
- Other jurisdictions have developed comprehensive WSUD guidelines that are responsive to the changing environment and allow for innovation.
- WSUD requirements need to recognise changes in development form including a trend to smaller block sizes, and the need to adapt the urban form in terms of green streetscape, waterways, overland flow paths and drainage corridors.

1.2 Summary of the Proposal

This variation revises the Waterways: Water Sensitive Urban Design General Code (WSUD Code) and proposes a number of associated consequential amendments to Territory Plan codes. The WSUD Code has been reviewed in response to the ACT Government's WSUD Review Report which was released in 2014 (WSUD Review). The WSUD review called for a revision of the WSUD provisions in the Territory Plan and for these provisions to be supported by a WSUD practice guideline.

The key changes in the WSUD general code include:

- Mains water reduction target remains at 40% i.e. developments of a similar size must aim to reduce mains water consumption by 40% compared to 2003 levels. However, it now encourages the use of water efficient landscaping into this calculation and it outlines more reuse options.
- The Stormwater quantity provisions focus on retaining and reuse of stormwater on site. This brings the provision in line with other jurisdictions across Australia. Stormwater detention ensures that the stormwater infrastructure is not overloaded by encouraging stormwater to be detained and slowly released on site.
- Stormwater quality targets remain in place to ensure that total suspended solids, total phosphorous and total nitrogen (nutrients) are captured on block. A new gross pollutant target has been introduced that is achievable using gross pollutant traps.
- Rationalisation of the minimum block sizes to trigger the various provisions of the WSUD code from a mix of sizes between 2000m2, 3000m2- and 5000m2 to a standard 2000m2.
- Climate change adaptation is considered in the revised code. WSUD is an excellent mechanism to help alleviate the urban heat island effect in our city. The code recommends a permeable surface target of at least 20% and encourages developers to consider onsite irrigation of rainwater captured onsite, use of landscaping to allow for a natural cooling mechanism through evapotranspiration if this target cannot be met.
- The planning provisions also recommend development applicants address nuisance flooding and not build within overland flow paths.

The associated consequential Territory Plan amendments locate the water sensitive urban design provisions applying across all zones in one place, being the WSUD General Code. This excludes any site specific provisions which are contained in the relevant suburb precinct codes and the mains water reduction targets for single dwellings and secondary residences which will be retained in the single dwelling housing development code.

1.3 The National Capital Plan

The *Australian Capital Territory (Planning and Land Management) Act 1988* established the National Capital Authority (NCA) with two of its functions being to prepare and administer a National Capital Plan (NCP) and to keep the NCP under constant review and to propose amendments to it when necessary.

The NCP, which was published in the Commonwealth Gazette on 21 January 1990 is required to ensure that Canberra and the Territory are planned and developed in accordance with their national significance. The Planning and Land Management Act 1988 also requires that the Territory Plan is not inconsistent with the NCP.

In accordance with section 10 of the *Australian Capital Territory (Planning and Land Management*) *Act 1988*, the National Capital Plan defines the planning principles and policies for Canberra and the Territory, for giving effect to the object of the NCP and sets out the general policies to be implemented throughout the Territory, including the range and nature of permitted land uses.

It also sets out the detailed conditions of planning, design and development for areas that have special significance to the National Capital known as designated areas and identifies special requirements for the development of some other areas.

1.4 Current Territory Plan Provisions

The current Territory Plan provisions for water sensitive urban design are contained in the existing Waterways: Water Sensitive Urban Design General Code in addition to existing provisions in the following codes:

- Residential zones development code
- Multi unit housing development code
- Commercial zones development code
- Industrial zones development code
- Community facility zone development code
- Transport and services development code

- Parks and recreation zones development code
- Estate development code

The existing site specific water sensitive urban design provisions contained in various precinct codes are not intended to be amended by this variation. Additionally, the existing water reduction target provisions contained in the single dwelling housing development code will remain in place.

1.5 Changes to the Territory Plan

Detailed changes to the Territory Plan are noted in section 2 of this document.

This Variation will replace the existing Waterways: Water Sensitive Urban Design General Code with a revised general code. It will also consequentially amend a number of other zone and development codes to remove water sensitive urban design provisions. These provisions will be consolidated into the revised WSUD general code with the exception of any site specific provisions in the precinct codes and the existing provisions of the Single Dwelling Housing Development Code which will remain unamended.

1.6 Consultation on the Draft Variation

Draft Variation No 354 (DV354) was released for public comment between 21 September 2018 and 9 November 2018. A consultation notice under section 63 of the *Planning and Development Act 2007* (P&D Act) was published on the ACT Legislation Register on 21 September 2018. The date for public comments was further extended to 21 December 2018. A public notice was also placed on the ACT Government website and the EPSDD website.

A total of two written submissions were received. Comments related to the following:

- objection to the implementation and operation of an offset scheme for the code
- concern that increasing the number and range of options for water sensitive urban design outcomes may also provide increased opportunities for proponents to avoid compliance with the code requirements
- a perceived lack of capacity to respond to non-compliance with the code including through fines
- the meaning of a ‘suitably qualified person’ to prepare the various reports required by the code
- concerns about the cost of compliance with the code requirements.

1.7 Revisions to the Draft Variation Recommended to the Minister

No changes were made to the draft variation recommended to the Minister.

2. VARIATION

Variation to the waterways: water sensitive urban design general code

1. Waterways: water sensitive urban design general code

Substitute the existing waterways: water sensitive urban design general code with

Appendix A – waterways: water sensitive urban design general code.

Variation to the residential zones development code

2. Element 14 Environment – 14.1 water sensitive urban design

Omit section 14.1 water sensitive urban design, including rules and criteria 57 – 60.

Variation to the multi-unit housing development code

3. Element 4: Site design – 4.1 site design

Omit from rule 37 - item d) water sensitive urban design.

4. Element 8: Environment – 8.1 water sensitive urban design

Omit section 8.1 water sensitive urban design, including rules and criteria 86 – 89.

Variation to the commercial zones development code

5. Element 7: Environment – 7.1 water sensitive urban design

Omit section 7.1 water sensitive urban design, including rules and criteria 24 – 28.

Variation to the industrial zones development code

6. Element 6: Environment – 6.1 water sensitive urban design - mains water consumption – 6.3 water sensitive urban design – stormwater quantity

Omit sections 6.1 – 6.3 water sensitive urban design, including rules and criteria 38 – 41.

Variation to the community facility zone development code

7. Element 5: Environment – 5.1 water sensitive urban design

Omit section 5.1 water sensitive urban design, including rules and criteria 15 – 18.

Variation to the parks and recreation zones development code

8. Element 6: Environment – 6.2 water sensitive urban design – mains water consumption – 6.4 water sensitive urban design – stormwater quantity

Omit sections 6.2 – 6.4 water sensitive urban design, including rules and criteria 32 – 35.

Variation to the transport and services development code

9. Element 6: Environment – 6.2 water sensitive urban design – mains water consumption – 6.4 water sensitive urban design – stormwater quantity

Omit sections 6.2 – 6.4 water sensitive urban design, including rules and criteria 23 – 26.

Variation to the estate development code

10. Element 5: Environment – 5.1 water sensitive urban design

Omit section 5.1 water sensitive urban design, including rules and criteria 30 – 33.

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Appendix A

Waterways: Water Sensitive Urban Design General Code

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Contents

1. Introduction

Name

The name of this code is **Waterways: Water Sensitive Urban Design General Code**

Application of the code

This code applies to development and redevelopment on sites across all zones of the Territory Plan that:

- are currently connected or intended to be connected to the mains water supply; or
- are likely to alter the stormwater regime of the site.

This code does not apply to any of the following:

- single dwellings and secondary residences subject to the single dwelling housing development code; and
- as excepted within the provisions of this code.

This code stipulates the outcomes sought in relation to water sensitive urban design primarily through a series of targets for mains water reduction, water quality and stormwater quantity. The ACT Practice Guidelines for Water Sensitive Urban Design provides guidance and options for compliance with this code for both private and public developments.

While the ACT Practice Guidelines for Water Sensitive Urban Design is external to the Territory Plan, it is called up in the various rules and criteria of this code. In this way a key element of the Guidelines is to provide information on the 'online assessment tools' and other contemporary methods for proponents to demonstrate compliance with the relevant code requirements. The ACT Government also has design standards for municipal infrastructure which is external to the Territory Plan.

Purpose

Water sensitive urban design (WSUD) is an approach to urban planning and design that aims to integrate the management of the water cycle including stormwater into the urban development process which considers integrated water cycle management. The importance of WSUD is acknowledged in the statement of strategic directions of the Territory Plan, which states that "land and water resources will be planned in accordance with the principles of integrated catchment management and water sensitive urban design".

In conjunction with other relevant codes, the ACT Practice Guidelines for Water Sensitive Urban Design will be used to assess development applications and outline the relevant requirements to intending applicants in designing development proposals and preparing development applications.

The WSUD general code aims to provide the necessary WSUD targets and strategies to be implemented to ensure improved environmental sustainability.

Structure

The code requirements contain a number of elements. Each element has one or more rules and, unless the rule is mandatory, an associated criterion is provided. Rules provide quantitative, or definitive, controls. In contrast, criteria are chiefly qualitative in nature.

In some instances rules are mandatory. Such rules are accompanied by the words "This is a mandatory requirement. There is no applicable criterion." Non-compliance with a mandatory rule will result in the refusal of the development application. Conversely, the words "There is no applicable rule" is found where a criterion only is applicable.

Assessment tracks

Assessment tracks for particular developments are specified in the relevant zone development table.

Proposals in the **code track** must comply with all rules relevant to the development.

Proposals in the **merit track** or **impact track** must comply with a rule or its associated criterion, unless the rule is mandatory (ie. it has no related criterion). Where a rule is fully met, no reference to the related criterion needs to be made. Where there is a departure from a rule, or where a criterion only applies, the onus is on the applicant to demonstrate **compliance with the criterion**.

Code Hierarchy

Where more than one type of code applies to a development, the order of precedence when there is inconsistency of provisions between codes as defined in the *Planning and Development Act 2007* is

1. precinct code

2. development code

3. general code.

Definitions

Defined terms and references to legislation and other documents are italicized throughout this code. Definitions of terms used in this code are either listed in part 13 of the Territory Plan or, for terms that are only applicable to this code, the meaning of the terms are spelt out within the respective rule or referred to in the ACT Practice Guidelines for Water Sensitive Urban Design.

2. Development codes and general codes

Development must comply with all relevant codes (including precinct codes and other general codes), subject to the code hierarchy outlined in the introduction to this code. General codes are found in part 11 of the Territory Plan.

3. Code requirements

This part applies to all assessable development subject to this code, except where stated in the relevant provisions.

Element 1: Mains water use reduction

Rules	Criteria
1.1 Mains Water Use Reduction Target	
R1 This rule applies to all development currently connected or intended to be connected to mains water supply except any of the following: a) development subject to the estate development code b) development for minor alterations or extensions involving 50% or less of the existing floor area. Development achieves a minimum 40% reduction in mains water consumption compared to an equivalent development constructed in 2003. **Note:** Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.	This is a mandatory requirement. There is no applicable criterion.

Element 2: Stormwater Quantity

<table>
<tr><th>Rules</th><th>Criteria</th></tr>
<tr><td colspan="2">2.1 On-site stormwater retention</td></tr>
<tr><td>R2
This rule applies to development for at least one of the following:
a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code
b) development within existing urban areas which increases impervious area by 100m².
This rule does not apply to any of the following:
a) development of major roads
b) sites identified in a precinct code that stormwater retention requirements for the site have been fully dealt with through an estate development plan.
Development complies with at least one of the following:
a) stormwater retention management measures are provided and achieve all of the following:
i) Stormwater storage capacity of 1.4kL per 100m² of the total impervious area of the site is provided specifically to retain and reuse stormwater generated on site as a whole
ii) Retained stormwater is used on site
b) development captures, stores and uses the first 15mm of rainfall falling on the site.
For this rule, on-site stormwater retention is defined as the storage and use of stormwater on site.
Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: ACT Practice Guidelines for Water Sensitive Urban Design defines acceptable uses of stormwater on site.
Note: Any site specific stormwater retention requirements for new estates must be nominated on planning control plans submitted with the estate development plan.</td><td>C2
Development complies with all of the following:
a) It is demonstrated that stormwater retention measures can be more successfully met offsite
b) development complies with at least one of the following stormwater retention management measures:
i) An equivalent volume of stormwater is stored and used at an offsite location within the same catchment or a catchment in proximity to the site as part of a stormwater offset agreement
ii) If it is demonstrated that the above stormwater retention measures are unable to be provided, then a contribution to the construction of offsite measures within the same catchment or a catchment in proximity to the site as a means of offset may be approved by the Planning and Land Authority.
For this criterion, the meaning of a stormwater offset agreement as defined and detailed in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</td></tr>
</table>

<table>
<tr><th>Rules</th><th>Criteria</th></tr>
<tr><td colspan="2">2.2 On-site stormwater detention</td></tr>
<tr><td>R3
This rule applies to development for at least one of the following:
a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code
b) development within existing urban areas which increases impervious area by 100m²
This rule does not apply to any of the following:
a) development of major roads
b) sites identified in a precinct code indicating that stormwater detention requirements have been fully met.
Stormwater detention measures are provided and achieve all of the following:
a) capture and direct runoff from the entire site
b) Stormwater storage capacity of 1kL per 100m² of impervious area is provided to specifically detain stormwater generated on site
c) The detained stormwater is designed to be released over a period of 6 hours after the storm event.
For this rule on-site stormwater detention is defined as the short term storage and release downstream of stormwater runoff.
Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: Calculating on-site detention can include 50% of the volume of rainwater tanks where stormwater is used on-site.
Note: For new estates any stormwater detention must be nominated on planning control plans submitted with the estate development plan. In particular, where an estate development plan has partially achieved the stormwater detention measures, this can be taken into account for the detention measures on individual sites.</td><td>C3
Stormwater detention measures are provided and achieve all of the following:
a) ensure that the peak rate of stormwater runoff from the site does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for the 1 Exceedance per Year (1EY)
b) A maximum of 30% of the runoff from the site may bypass the onsite stormwater detention system where it can be demonstrated that at least one of the following circumstances applies:
i) Difficult ground levels
ii) The nature of the receiving drainage system cannot receive runoff from the entire site
iii) The need to retain significant trees or vegetation
iv) other demonstrated circumstances.
Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: where an estate development plan has partially achieved the stormwater detention measures, this can be taken into account for the detention measures on individual sites.</td></tr>
</table>

Rules	Criteria
2.3 Stormwater quantity for major road on sites over 2000m^2	
R4 This rules applies to development of major roads involving sites greater than 2000m^2. Development complies will all of the following: a) The capacity of existing pipe (minor) stormwater connection to the site is not exceeded in the 1 in 10 year storm event b) The capacity of the existing overland (major) stormwater system to the site is not exceeded in the 1 in 100 year storm event.	C4 Development for major roads on sites greater than 2000m^2 complies with at least one of the following: a) A reduction of the 1 in 5 year and 1 in 100 year stormwater peak run off flow to pre-development levels b) The capacity of the downstream piped stormwater system to its outlet with an open channel is not exceeded in the 1 in 10 year storm event. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
2.4 On-site stormwater detention for estate development plans	
There is no applicable rule.	C5 This criterion applies to estate development plans. Stormwater detention measures are provided and the peak rate of stormwater runoff from the estate does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for minor and major storms. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** The Major (1% Annual Exceedance Probability (AEP)) and Minor storms are as defined by Transport Canberra and City Services Directorate (TCCS) or the agency responsible for stormwater management. **Note:** Stormwater detention measures required for each individual block may contribute toward meeting the overall detention requirements for the estate as demonstrated in an estate development plan. **Note:** Any site specific stormwater detention must be nominated on planning control plans submitted with the estate development plan.

Element 3 – Stormwater Quality

Rules	Criteria
3.1 Stormwater Quality Target – sites greater than 2000m^2	
R6 This rule applies to development for all of the following: a) where the development site is greater than 2,000m^2 b) where development involves works that have potential to alter the stormwater regime for the site. This rule does not apply to development of major roads. The average annual stormwater pollutant export is reduced when compared with an urban catchment of the same area with no water quality management controls for all of the following: a) gross pollutants by at least 90% b) suspended solids by at least 60% c) total phosphorous by at least 45% d) total nitrogen by at least 40%. **Note:** Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.	C6 It is demonstrated that at least one of the following applies: a) stormwater quality measures can be more successfully met offsite b) a sensitive downstream environment will be negatively impacted. Development complies with at least one of the following: a) an equivalent load of pollutants is captured at an offsite location as part of a stormwater offset agreement b) if the above stormwater quality measures are unable to be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority. For this criterion a stormwater offset agreement is defined as detailed in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.

Rules	Criteria
3.2 Stormwater quality target – major roads	
R7 This rule applies to development of major roads, including the duplication of an existing major road in full or in part. The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following: a) gross pollutants by at least 90% b) suspended solids by at least 60% c) total phosphorous by at least 45% d) total nitrogen by at least 40%. **Note:** Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.	C7 If it can be demonstrated that the stormwater quality measures specified in the rule are unable to be provided, then a contribution to the construction of offsite measures as a means of offset may be approved by the Planning and Land Authority. **Note:** Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.

Element 4 – Climate change adaptation

Rules	Criteria
4.1 Nuisance flooding – sites greater than 2000m^2	
There is no applicable rule.	C8 This criterion applies to development on sites greater than 2,000m^2 involving works that have potential to alter the existing drainage and overland flow regime for the site. Overland flow paths are provided and achieve all of the following: a) accommodate overland stormwater flows up to the 1%AEP b) reduce nuisance flooding. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

Rules	Criteria
4.2 Green/living infrastructure	
R9 This rule applies to at least one of the following developments: a) Development on sites greater than 2000m^2 involving works that have potential to alter the stormwater regime for the site b) Development within existing urban areas that increase the impervious area of the site by 100m^2 or more. Development achieves a minimum of 20% of the site area to be permeable. **Note:** Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.	C9 It is demonstrated that the development achieves all of the following: a) Increases permeable surfaces and living infrastructure through green spaces b) Plants that require irrigation are supported by sustainable water systems such as onsite stormwater harvesting to achieve microclimate benefits c) Promotes evapotranspiration to mitigate extreme temperatures, improve air humidity and overall human comfort. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

Element 5 – Entity (Government agency) Endorsement

Rules	Criteria
5.1 Water infrastructure	
There is no applicable rule.	C10 This criterion applies to development that will result in municipal water sensitive urban design infrastructure being handed to the ACT Government. An operation and maintenance plan is to be endorsed by the ACT Government for the water sensitive urban design assets that are to be handed to the ACT Government. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

LEGISLATIVE ASSEMBLY
FOR THE AUSTRALIAN CAPITAL TERRITORY

STANDING COMMITTEE ON PLANNING AND URBAN RENEWAL
Caroline Le Couteur MLA (Chair), Mark Parton MLA (Deputy Chair), Michael Pettersson MLA

Mr Mick Gentleman MLA
Minister for the Environment and Heritage
Minister for Planning and Land Management

Dear Minister

Referral of *Draft Variation 354 – Waterways: Water Sensitive Urban Design General Code*

The Standing Committee on Planning and Urban Renewal (the Committee) wishes to inform you that following your referral, received 17 September 2019, the Committee will not be undertaking an inquiry into *Draft Variation 354 – Waterways: Water Sensitive Urban Design General Code*

Yours sincerely

Caroline Le Couteur

Caroline Le Couteur MLA
Chair
20 September 2019

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REPORT ON CONSULTATION

Draft Variation
to the Territory Plan
354

Waterways: water sensitive urban design general code review and associated consequential amendments to Territory Plan codes

July 2019

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1. INTRODUCTION

This consultation report was prepared in accordance with s 69 of the *Planning and Development Act 2007* (the P&D Act).

The report describes the consultation undertaken on the draft variation with the public, the National Capital Authority (NCA), the Conservator of Flora and Fauna, the Environment Protection Authority (EPA), and ACT Heritage Council, and responds to the issues raised.

2. COMMENTS FROM THE PUBLIC

2.1 Details

Draft variation 354 (DV354) was released for public comment on 21 September 2018. The closing date for comments was 9 November 2018. This date was further extended to 21 December 2018. DV354 released for public comments is at ***Appendix 1***.

A total of two written submissions were received including one submission from the Conservation Council ACT region. Comments related to the following:

- objection to the implementation and operation of an offset scheme for the code
- concern that increasing the number and range of options for water sensitive urban design outcomes may also provide increased opportunities for proponents to avoid compliance with the code requirements
- a perceived lack of capacity to respond to non-compliance with the code including through fines
- the meaning of a 'suitably qualified person' to prepare the various reports required by the code
- concerns about the cost of compliance with the code requirements.

The comments from the NCA the Conservator of Flora and Fauna, EPA and the ACT Heritage Council were received and assessed prior to release of the DV354 for public comment. The comments from these agencies are detailed in full, along with responses in the public consultation version of DV354 at ***Appendix 1.***

Copies of submissions received from the public are provided in ***Appendix 2***.

2.2 Issues and responses

The key issues raised are summarised below, and responses provided.

2.2.1 **Offset scheme**

Two submissions indicated that successful offset schemes are difficult to establish. One submission recommended that no offset scheme should be allowed in DV354 until the details of the scheme have been finalised.

Response

The offset scheme is yet to be established for the Water Sensitive Urban Design (WSUD) General Code. DV354 makes provision for this to occur at a later stage. The scheme would sit outside the Territory Plan and as such would be readily reviewed and updated in line with best practice. The key attribute of the offset scheme is that it allows sites to be considered in the context of the catchment in which the development is located.

2.2.2 **Flexibility and compliance**

Both submissions indicated that the new flexibility for compliance with the WSUD provisions of the code may present proponents with increased opportunities to avoid compliance with the provisions.

Response

The increased options for compliance with the WSUD general code requirements makes it easier for proponents to comply with the code and as such should reduce instances of proponents trying to avoid compliance. The various options are clearly outlined in the WSUD guidelines. They reflect best practice and allow for innovation. Regardless of the chosen options, all development subject of the WSUD general code is required to comply with the code.

2.2.3 **Fines for non-compliance**

Two submissions indicated that fines should be introduced for non-compliance with the WSUD general code. It was recommended that the enforcement approach moves away from the ‘inform and educate’ approach to one which captures non-compliance and the ACT Government should make further efforts to ensure that there is compliance with the codes.

Response

The Territory Plan does not deal with enforcement. The comments have been forwarded to the relevant ACT Government enforcement authorities for consideration.

2.2.4 **Suitable qualifications for WSUD reports and compliance**

Both submissions raised concerns about what constitutes suitably qualified persons to conduct the WSUD compliance reports.

Response

Suitably qualified persons can include people with a wide range of water related qualifications. This would include persons with qualifications using the MUSIC model, water science, engineering qualifications and the like. This can be detailed in the WSUD Guidelines.

2.2.5 **Cost impost and compliance**

Two submissions indicated that the cost impost of WSUD in development increases costs to proponents, who may seek to minimise the costs and this can then create difficulties with compliance.

Response

The amendments to the WSUD general code introduce a greater range of options to comply with the code. These are intended to allow proponents to design WSUD infrastructure suited to the nature and scale of development and to respond to site constraints. It also allows sites to be considered in the context of the catchment in which the development is located. The options presented in the guidelines reflect best practice and allow for innovation. Regardless of the options chosen, all development subject to the WSUD general code is required to comply with the code.

3. COMPLIANCE WITH THE PLANNING AND DEVELOPMENT ACT 2007

3.1 Release for Public Comment (section 63)

Draft variation 354 (DV354) was released for public comment on 21 September 2018. The closing date for comments was 9 November 2018. This date was further extended to 21 December 2018. DV354 released for public comments is at ***Appendix 1***.

3.2 Mandatory agencies (section 61 (b))

The comments from the NCA, the Conservator of Flora and Fauna, EPA and the ACT Heritage Council were received and assessed prior to release of the DV354 for public comment. The comments from these agencies are detailed in full, along with responses in the public consultation version of DV354 at ***Appendix 1.***

3.3 Notice of Submission to the Minister (section 70)

In accordance with s 70 of the P&D Act, a public availability notice will be placed in the ACT Legislation Register stating that DV354 has been submitted to the Minister and that the documents are available for public inspection. A public notice will also be placed on the ACT Government website.

4. APPENDICES

Appendix 1 – the public notification version of DV354

Appendix 2 – copies of the public submissions received about DV354

APPENDIX 1
Draft variation 354 public release version

APPENDIX 2
Copies of public comments received on draft variation 354

Australian Capital Territory

Planning and Development (Draft Variation No 354) Consultation Notice 2018

Notifiable instrument NI2018—

made under the

Planning and Development Act 2007, s 63 (Public consultation—notification) and s 64 (Public consultation—notice of interim effect etc)

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1 Name of instrument

This instrument is the *Planning and Development (Draft Variation No 354) Consultation Extension Notice 2018*.

2 Draft variation to the Territory Plan

The planning and land authority (the **Authority**) has prepared a draft plan variation No 354 – Waterways: water sensitive urban design general code review and associated consequential amendments (the **Draft Variation**) to vary the Territory Plan. The Draft Variation seeks to implement the planning outcomes of the ACT Government's Water Sensitive Urban Design Review Report which was released in 2014 (WSUD Review). The WSUD review called for a revision of the WSUD provisions in the Territory Plan and for these provisions to be supported by a WSUD practice guideline.

3 Documents available for public inspection

(1) The Authority gives notice that the following documents are available for public inspection and purchase:

(a) the Draft Variation; and

(b) the background papers relating to the Draft Variation.

(2) Copies of the documents mentioned in section 3(1) are available for inspection and purchase at Access Canberra, Environment, Planning and Sustainable Development Directorate Shopfront, Ground Floor South, Dame Pattie Menzies House, 16 Challis Street, Dickson, Monday to Friday (except public holidays) between 8:30am and 4:30pm for the period commencing on the day this notice commences and ending on Friday 9 November 2018 (the **Consultation Period**).

(3) Copies of the documents mentioned in section 3(1) are also available for inspection during the Consultation Period online at http://www.planning.act.gov.au/tools_resources/legislation_plans_registers/plans/territory_plan/draft_variations_to_the_territory_plan

4 Invitation to give written comments

(1) The Authority invites written comments about the Draft Variation during the Consultation Period. Comments should include reference to the Draft Variation and be addressed to the Territory Plan Section of the Environment, Planning and Sustainable Development

Directorate (**EPSDD**). Please also provide your name and contact details to assist in the assessment of the comments provided and to enable the Authority to contact you in relation to your comments, if required.

(2) Written comments should be provided to the Authority by:

(a) email to terrplan@act.gov.au; or

(b) mail to Territory Plan Section, EPSDD, GPO Box 158, Canberra, ACT 2601; or

(c) hand delivery to Access Canberra, EPSDD Shopfront, Ground Floor South, Dame Pattie Menzies House, 16 Challis Street, Dickson.

5 Public inspection of written comments

(1) Copies of written comments about the Draft Variation given in response to the invitation in section 4, or otherwise, or received from the National Capital Authority will be available (unless exempted) for public inspection for a period of at least 15 working days starting 10 working days after the day the consultation period ends, at Access Canberra, EPSDD Shopfront, Ground Floor South, Dame Pattie Menzies House, 16 Challis Street, Dickson, Monday to Friday (except public holidays) between 8:30am and 4:30pm and may be published on the EPSDD website at www.planning.act.gov.au.

(2) You may apply under section 411 of the *Planning and Development Act 2007* (the **Act**) for part of your consultation comments to be excluded from being made available to the public. A request for exclusion under this section must be in writing, clearly identifying what you are seeking to exclude and how the request satisfies the exclusion criteria. Please note that your name and contact details and other personal information will not be made public unless you request otherwise.

6 Effect of the Draft Variation

Section 65 of the Act does not apply in relation to the Draft Variation and therefore it does not have interim effect. The current Territory Plan will continue to apply while the Draft Variation remains in draft form.

7 Obtaining further information

Further information about the Draft Variation can be obtained through email correspondence with the Territory Plan Section, EPSDD, at Terrplan@act.gov.au, a reference to the Draft Variation should be included in any email.

8 Meaning of *draft plan variation No 354* – Waterways: water sensitive urban design general code review and associated consequential amendments

In this instrument:

***Draft plan variation No 354* – Waterways: water sensitive urban design general code review and associated consequential amendments** means the draft plan variation in the schedule.

Note 1: Your personal information will be managed in accordance with the *Information Privacy Act 2014* and the EPSDD *Information Privacy Policy* which are available through the EPSDD website.

Kathy Cusack
Delegate of the planning and land authority
September 2018

ACT Government
Environment, Planning and Sustainable Development

Schedule 1

Planning and Development Act 2007

Draft
Variation to the Territory Plan
No 354

Waterways: water sensitive urban design general code review and associated consequential amendments to Territory Plan codes

September 2018

Draft variation for public consultation prepared under s63 of the *Planning and Development Act 2007*

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Contents

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1. INTRODUCTION

1.1 Summary of the Proposal

This draft variation revises the waterways: water sensitive urban design general code (WSUD code) and proposes a number of associated consequential amendments to Territory Plan codes. The WSUD code has been reviewed in response to the ACT Government's WSUD Review Report which was released in 2014 (WSUD Review). The WSUD review called for a revision of the WSUD provisions in the Territory Plan and for these provisions to be supported by a WSUD practice guideline.

The associated consequential Territory Plan amendments ensure that the water sensitive urban design provisions applying across all zones will now be located in the one place, being the WSUD general code. This excludes any site specific provisions which are contained in the relevant suburb precinct codes and the mains water reduction targets for single dwellings and secondary residences which will be retained in the single dwelling housing development code.

1.2 Outline of the process

The Commonwealth's *Australian Capital Territory (Planning and Land Management) Act 1988* allows for the Legislative Assembly to make laws to establish a Territory Planning Authority and for that Authority to prepare and administer a Territory Plan. The *Planning and Development Act 2007* (the Act) establishes the planning and land authority as the Authority which prepares and administers the Territory Plan, including continually reviewing and proposing amendments as necessary. The functions of the planning and land authority are administered by the Environment Planning and Sustainable Development Directorate (EPSDD).

The Territory Plan is comprised of a written statement and a map. The written statement contains a number of parts, namely governance; strategic directions; zones (including objectives and development tables and zone or centre development codes); precinct codes; general codes; overlays; definitions; structure plans, concept plans and development codes for future urban areas.

The Territory Plan Map graphically represents the applicable land use zones (under the categories of residential, commercial, industrial, community facility, urban parks and recreation, transport and services and non urban), precincts and overlays. The zone, precinct and overlay requirements are detailed in the volumes of the Territory Plan.

Draft variations to the Territory Plan are prepared in accordance with the Act. Following the release of the draft variation under section 63 of the Act, submissions from the public are invited. At the conclusion of the consultation period the EPSDD submits a report on consultation and a recommended final variation to the Minister responsible for planning for approval. The Minister has the discretion to determine if referral to the Legislative Assembly standing committee responsible for planning is warranted prior to approval, depending on the nature and significance of the proposal. If the draft variation is referred to the committee by the Minister or otherwise, the Minister must consider the findings of the committee before deciding whether to approve the draft variation. If the Minister approves the variation, the variation and associated documents will be tabled in the Legislative Assembly. Unless disallowed by the Legislative Assembly within five sitting days, the variation commences on a day nominated by the Minister.

1.3 Public Consultation

Written comments about the draft variation are invited from the public by **Friday 9 November 2018**

Comments should include reference to the draft variation and be addressed to the Territory Plan Section. Please also provide your name and contact details to assist in the assessment of the comments provided, and to enable Environment, Planning and Sustainable Development Directorate (EPSDD) to contact you in relation to your comments, if required. Personal information will be managed in accordance with the *Information Privacy Act 2014* and the EPSDD Information Privacy Policy, which is available for viewing on EPSDD's website.

Comments can be:

- emailed to terrplan@act.gov.au
- mailed to Territory Plan Section, GPO Box 158, Canberra, ACT 2601
- delivered to EPSDD's Customer Service Centre at 16 Challis Street, Dickson
- made on the 'Have Your Say' website: http://haveyoursay.planning.act.gov.au

Copies of written comments will be made available for public inspection for no less than 15 working days starting 10 working days after the closing date for comment. The comments will be available at EPSDD's customer service centre in Dickson and may be published on EPSDD's website. Comments made available will not include personal contact details unless you request otherwise.

A request may be made for parts of a submission to be excluded under section 411 or 412 of the *Planning and Development Act 2007*. A request for exclusion under these sections must be in writing, clearly identifying what parts of your submission you are seeking to exclude and how the request satisfies the exclusion criteria.

Further Information

The draft variation and the draft water sensitive urban design guideline (WSUD guideline) are available online at **www.act.gov.au/draftvariations** until the closing date for written comments.

Printed copies of the draft variation (this document) and background documents are available for inspection and purchase at the Access Canberra and the EPSDD Customer Service Centre, 16 Challis Street, Dickson, Monday to Friday (except public holidays) between 8:30am and 4:30pm. Please call 6207 1923 to arrange a copy for purchase.

2. EXPLANATORY STATEMENT

2.1 Background

The ACT Government's WSUD Review Report was released in 2014 (WSUD Review). It is available on the EPSDD website at:

> http://www.environment.act.gov.au/water/water-strategies-and-plans/water_sensitive_urban_design

The WSUD review identified eight priority projects. The Priority Project 1 called for a revision of the WSUD provisions of the Territory Plan and for these provisions to be supported by a WSUD practice guideline. The intent is to provide greater clarity and consistency in interpretation and implementation of the WSUD provisions. It is also intended to promote innovation and to increase flexibility in options for meeting the various WSUD targets.

Previously, the ACT Government released the Waterways WSUD Guidelines in 2007. This was given further effect when it was incorporated into the Territory Plan through the introduction of the Waterways: WSUD general code in 2009. However, the format of the WSUD code is not in keeping with the standard rules and criteria format of the other Territory Plan codes.

Additionally, there are WSUD provisions contained in a number of the zone and development codes. These provisions are presented in rules and criteria format and the rules stipulate quantifiable requirements to meet targets. However, the criteria leave the discretion to proponents to demonstrate that a particular method achieves the target.

Lastly, some precinct codes also contain site specific WSUD provisions and requirements.

The WSUD review concluded that:

- The WSUD Code and the related WSUD requirements in development codes in the Territory Plan may inhibit innovation by limiting the options available to meet the rules.
- The rules and criteria in development codes require revision to clarify WSUD requirements to reflect contemporary industry best practice.
- Other jurisdictions have developed comprehensive WSUD guidelines that are responsive to the changing environment and allow for innovation.
- WSUD requirements need to recognise changes in development form including a trend to smaller block sizes, and the need to adapt the urban form in terms of green streetscape, waterways, overland flow paths and drainage corridors.

2.2 Current Territory Plan Provisions

The current Territory Plan provisions for water sensitive urban design are contained in the existing waterways: water sensitive urban design general code in addition to existing provisions in the following codes:

- Residential zones development code
- Multi-unit housing development code
- Commercial zones development code
- Industrial zones development code
- Community facility zone development code
- Transport and services development code
- Parks and recreation zones development code
- Estate development code

The existing site specific water sensitive urban design provisions contained in various precinct codes are not intended to be amended by this draft variation. Additionally the existing water reduction target provisions contained in the single dwelling housing development code will remain in place.

2.3 Proposed Changes to the Territory Plan

It is proposed to replace the existing waterways: water sensitive urban design general code with a revised general code. It is also proposed to consequentially amend the various other zone and development codes to remove water sensitive urban design provisions. These provisions will now be consolidated into the revised WSUD general code with the exception of any site specific provisions in the precinct codes and the existing provisions of the Single Dwelling Housing Development Code which will remain unamended.

2.4 Reasons for the Proposed Draft Variation

The reasons for the draft variation are as follows:

- The ACT Government WSUD Review Report 2014 called for a revision of the WSUD provisions in the Territory Plan and for the development of a WSUD Practice Guideline.
- The structure of the current WSUD general code and the related WSUD requirements in various zone development codes in the Territory Plan present a limited range of options and solutions to meet the code requirements.
- The rules and criteria in development codes require revision to clarify WSUD requirements to reflect contemporary industry best practice.
- Other jurisdictions have developed comprehensive WSUD guidelines that are responsive to the changing environment and which promote innovation.

2.5 Planning Context

2.5.1 National Capital Plan

The *Australian Capital Territory (Planning and Land Management) Act 1988* established the National Capital Authority (NCA) with two of its functions being to prepare and administer a National Capital Plan (NCP) and to keep the NCP under constant review and to propose amendments to it when necessary.

The NCP, which was published in the Commonwealth Gazette on 21 January 1990, is required to ensure that Canberra and the Territory are planned and developed in accordance with their national significance. The *Planning and Land Management Act 1988* also required that the Territory Plan is not inconsistent with the NCP.

2.5.2 Territory Plan

Statement of Strategic Directions

The proposal is consistent with the Territory Plan's statement of strategic directions in terms of environmental, economic and social sustainability and spatial planning and urban design principles particularly in relation to principle no. 1.7 stipulating that land and water resources are to be planned in accordance with the principles of integrated catchment management and water sensitive urban design.

2.6 Interim Effect

Section 65 of the Planning and Development Act 2007 does not apply in relation to the draft variation so it does not have interim effect. The current Territory Plan will continue to apply while the variation remains in draft form.

2.7 Consultation with Government Agencies

EPSDD is required to, in preparing a draft variation under section 61(b) consult with each of the following in relation to the proposed draft variation:

- the National Capital Authority
- the Conservator of Flora and Fauna
- the Environment Protection Authority
- the Heritage Council
- the Land Custodian, if the draft variation would, if made, be likely to affect unleased land or leased public land – each custodian for the land likely to be affected

National Capital Authority

The National Capital Authority provided the following comments on 10 November 2016:

"*Please note that the National Capital Authority supports the WSUD Code draft variation*."

Response

The comments are noted.

Conservator of Flora and Fauna

The Conservator of Flora and Fauna made the following comments on 14 November 2016:

"In accordance with Section 61 (b) of the Planning and Development Act 2007 I advise that I have examined Draft Variation No 354, Waterways: water sensitive urban design general code review and associated consequential amendments to the Territory Plan and I have no comments to provide other than to note my support."

Response

The comments are noted.

Environment Protection Authority

The Environment Protection Authority provided the following comments on 27 February 2017:

"The Environment Protection Authority (EPA) supports the Territory Plan variation in its current form"

Response

The comments are noted.

Heritage Council

The Heritage Council provided the following comments on 10 November 2016:

"The Council does not object to the changes proposed by DV354, as Heritage Act 2004 provisions will continue to guide the management of heritage places and objects that may be affected by any water sensitive urban design code changes."

Response

The comments are noted.

3. DRAFT VARIATION

3.1 Variation to the Territory Plan

The Territory Plan is varied in all of the following ways:

Variation to the waterways: water sensitive urban design general code

1. Waterways: water sensitive urban design general code

Substitute the existing waterways: water sensitive urban design general code with

Appendix A – waterways: water sensitive urban design general code.

Variation to the residential zones development code

2. Element 14 Environment – 14.1 water sensitive urban design

Omit section 14.1 water sensitive urban design, including rules and criteria 57 – 60.

Variation to the multi unit housing development code

3. Element 4: Site design – 4.1 site design

Omit from rule 37 - item d) water sensitive urban design.

4. Element 8: Environment – 8.1 water sensitive urban design

Omit section 8.1 water sensitive urban design, including rules and criteria 86 – 89.

Variation to the commercial zones development code

5. Element 7: Environment – 7.1 water sensitive urban design

Omit section 7.1 water sensitive urban design, including rules and criteria 24 – 28.

Variation to the industrial zones development code

6. Element 6: Environment – 6.1 water sensitive urban design - mains water consumption – 6.3 water sensitive urban design – stormwater quantity

Omit sections 6.1 – 6.3 water sensitive urban design, including rules and criteria 38 – 41.

Variation to the community facility zone development code

7. Element 5: Environment – 5.1 water sensitive urban design

Omit section 5.1 water sensitive urban design, including rules and criteria 15 – 18.

Variation to the parks and recreation zones development code

8. Element 6: Environment – 6.2 water sensitive urban design – mains water consumption – 6.4 water sensitive urban design – stormwater quantity

Omit sections 6.2 – 6.4 water sensitive urban design, including rules and criteria 32 – 35.

Variation to the transport and services development code

9. Element 6: Environment – 6.2 water sensitive urban design – mains water consumption – 6.4 water sensitive urban design – stormwater quantity

Omit sections 6.2 – 6.4 water sensitive urban design, including rules and criteria 23 – 26.

Variation to the estate development code

10. Element 5: Environment – 5.1 water sensitive urban design

Omit section 5.1 water sensitive urban design, including rules and criteria 30 – 33.

Interpretation service

ENGLISH	If you need interpreting help, telephone:
ARABIC	إذا احتجت لمساعدة في الترجمة الشفوية ، إتصل برقم الهاتف :
CHINESE	如果你需要传译员的帮助，请打电话：
CROATIAN	Ako trebate pomoć tumača telefonirajte:
GREEK	Αν χρειάζεστε διερμηνέα τηλεφωνήσετε στο
ITALIAN	Se avete bisogno di un interprete, telefonate al numero:
MALTESE	Jekk għandek bżonn l-għajnuna t'interpretu, ċempel:
PERSIAN	اگر به ترجمه شفاهی احتیاج دارید به این شماره تلفن کنید:
PORTUGUESE	Se você precisar da ajuda de um intérprete, telefone:
SERBIAN	Ако вам је потребна помоћ преводиоца телефонирајте:
SPANISH	Si necesita la asistencia de un intérprete, llame al:
TURKISH	Tercümana ihtiyacınız varsa lütfen telefon ediniz:
VIETNAMESE	Nếu bạn cần một người thông-ngôn hãy gọi điện-thoại:

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ACT Government
Environment, Planning and Sustainable Development

Appendix A

DV354 - Draft Waterways: Water Sensitive Urban Design General Code

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Contents

1. Introduction

Name

The name of this code is **Waterways: Water Sensitive Urban Design General Code**

Application of the code

This code applies to development and redevelopment on sites across all zones of the Territory Plan that:

- are currently connected or intended to be connected to the mains water supply; or
- are likely to alter the stormwater regime of the site.

This code does not apply to any of the following:

- single dwellings and secondary residences subject to the single dwelling housing development code; and
- as excepted within the provisions of this code.

This code stipulates the outcomes sought in relation to water sensitive urban design primarily through a series of targets for mains water reduction, water quality and stormwater quantity. The ACT Practice Guidelines for Water Sensitive Urban Design provides guidance and options for compliance with this code for both private and public developments.

While the ACT Practice Guidelines for Water Sensitive Urban Design is external to the Territory Plan, it is called up in the various rules and criteria of this code. In this way a key element of the Guidelines is to provide information on the 'online assessment tools' and other contemporary methods for proponents to demonstrate compliance with the relevant code requirements. The ACT Government also has design standards for municipal infrastructure which is external to the Territory Plan.

Purpose

Water sensitive urban design (WSUD) is an approach to urban planning and design that aims to integrate the management of the water cycle including stormwater into the urban development process which considers integrated water cycle management. The importance of WSUD is acknowledged in the statement of strategic directions of the Territory Plan, which states that "land and water resources will be planned in accordance with the principles of integrated catchment management and water sensitive urban design".

In conjunction with other relevant codes, the ACT Practice Guidelines for Water Sensitive Urban Design will be used to assess development applications and outline the relevant requirements to intending applicants in designing development proposals and preparing development applications.

The WSUD general code aims to provide the necessary WSUD targets and strategies to be implemented to ensure improved environmental sustainability.

Structure

The code requirements contain a number of elements. Each element has one or more rules and, unless the rule is mandatory, an associated criterion is provided. Rules provide quantitative, or definitive, controls. In contrast, criteria are chiefly qualitative in nature.

In some instances rules are mandatory. Such rules are accompanied by the words "This is a mandatory requirement. There is no applicable criterion." Non-compliance with a mandatory rule will result in the refusal of the development application. Conversely, the words "There is no applicable rule" is found where a criterion only is applicable.

Assessment tracks

Assessment tracks for particular developments are specified in the relevant zone development table.

Proposals in the **code track** must comply with all rules relevant to the development.

Proposals in the **merit track** or **impact track** must comply with a rule or its associated criterion, unless the rule is mandatory (ie. it has no related criterion). Where a rule is fully met, no reference to the related criterion needs to be made. Where there is a departure from a rule, or where a criterion only applies, the onus is on the applicant to demonstrate **compliance with the criterion**.

Code Hierarchy

Where more than one type of code applies to a development, the order of precedence when there is inconsistency of provisions between codes as defined in the *Planning and Development Act 2007* is

1. precinct code

2. development code

3. general code.

Definitions

Defined terms and references to legislation and other documents are italicized throughout this code. Definitions of terms used in this code are either listed in part 13 of the Territory Plan or, for terms that are only applicable to this code, the meaning of the terms are spelt out within the respective rule or referred to in the ACT Practice Guidelines for Water Sensitive Urban Design.

2. Relevant development codes and general codes

Development codes that may be relevant to water sensitive urban design are:

- Residential Zones Development Code
- Multi Unit Housing Development Code
- Commercial Zones Development Code
- Industrial Zones Development Code
- Community Facility Zone Development Code
- Parks and Recreation Zone Development Code
- Transport and Services Zone Development Code
- Non-Urban Zones Development Code

Development must comply with all relevant codes (including precinct codes and other general codes), subject to the code hierarchy outlined in the introduction to this code. General codes are found in part 11 of the Territory Plan.

3. Code requirements

This part applies to all assessable development subject to this code, except where stated in the relevant provisions.

Element 1: Mains water use reduction

Rules	Criteria
1.1 Mains Water Use Reduction Target	
R1 This rule applies to all development currently connected or intended to be connected to mains water supply except: a) development subject to the estate development code; b) development for minor alterations or extensions involving 50% or less of the existing floor area. Development achieves a minimum 40% reduction in mains water consumption compared to an equivalent development constructed in 2003. **Note:** Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.	This is a mandatory rule there is not applicable criterion.

Element 2: Stormwater Quantity

<table>
<tr><th>Rules</th><th>Criteria</th></tr>
<tr><td colspan="2">2.1 On-site stormwater retention</td></tr>
<tr><td>R2
This rule applies to development for at least one of the following:
a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code.
b) development within existing urban areas which increases impervious area by 100m².
This rule does not apply to any of the following:
a) development of major roads
b) sites identified in a precinct code that stormwater retention requirements for the site have been fully dealt with through an estate development plan.
Development complies with one of the following:
a) stormwater retention management measures are provided and achieve all of the following:
i) Stormwater storage capacity of 1.4kL per 100m² of the total impervious area of the site is provided specifically to retain and reuse stormwater generated on site as a whole;
ii) Retained stormwater is used on site;
b) development captures, stores and uses the first 15mm of rainfall falling on the site.
For this rule, on-site stormwater retention is defined as the storage and use of stormwater on site.
Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: ACT Practice Guidelines for Water Sensitive Urban Design defines acceptable uses of stormwater on site.
Note: Any site specific stormwater retention requirements for new estates must be nominated on planning control plans submitted with the estate development plan.</td><td>C2
Development complies with all of the following:
a) It is demonstrated that stormwater retention measures can be more successfully met offsite;
b) development complies with at least one of the following stormwater retention management measures:
i) An equivalent volume of stormwater is stored and used at an off-site location within the same catchment or a catchment in proximity to the site as part of a stormwater offset agreement.
ii) If it is demonstrated that the above stormwater retention measures are unable to be provided, then a contribution to the construction of off-site measures within the same catchment or a catchment in proximity to the site as a means of offset may be approved by the Planning and Land Authority.
For this criterion, a stormwater offset agreement is defined as detailed in the ACT Practice Guidelines for Water Sensitive Urban Design.
Note: Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.</td></tr>
</table>

Rules	Criteria
2.2 On-site stormwater detention	
R3 This rule applies to development for at least one of the following: a) development on sites greater than 2,000m² involving works that have the potential to alter the stormwater regime of the site, including sites subject to the estate development code. b) development within existing urban areas which increases impervious area by 100m². This rule does not apply to any of the following: a) development of major roads b) sites identified in a precinct code indicating that stormwater detention requirements have been fully met. Stormwater detention measures are provided and achieve all of the following: a) capture and direct runoff from the entire site; b) Stormwater storage capacity of 1kL per 100m² of impervious area is provided to specifically detain stormwater generated on site; c) The detained stormwater is designed to be released over a period of 6 hours after the storm event. For this rule on-site stormwater detention is defined as the short term storage and release downstream of stormwater runoff. **Note:** Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** Calculating on-site detention can include 50% of the volume of rainwater tanks where stormwater is used on-site. **Note:** For new estates any stormwater detention must be nominated on planning control plans submitted with the estate development plan. In particular, where an estate development plan has partially achieved the stormwater detention measures, this can be taken into account for the detention measures on individual sites.	C3 Stormwater detention measures are provided and achieve all of the following: a) ensure that the peak rate of stormwater runoff from the site does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for the 1 Exceedance per Year (1EY). b) A maximum of 30% of the runoff from the site may bypass the onsite stormwater detention system where it can be demonstrated that at least one of the following circumstances applies: i) Difficult ground levels; ii) The nature of the receiving drainage system cannot receive runoff from the entire site; iii) The need to retain significant trees or vegetation; or iv) other demonstrated circumstances. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** where an estate development plan has partially achieved the stormwater detention measures, this can be taken into account for the detention measures on individual sites.

Rules	Criteria
2.3 Stormwater quantity for major road on sites over 2000m^2	
R4 This rules applies to development of major roads involving sites greater than 2000m^2. Development complies will all of the following: a) The capacity of existing pipe (minor) stormwater connection to the site is not exceeded in the 1 in 10 year storm event b) The capacity of the existing overland (major) stormwater system to the site is not exceeded in the 1 in 100 year storm event.	C4 Development for major roads on sites greater than 2000m^2 complies with at least one of the following: a) A reduction of the 1 in 5 year and 1 in 100 year stormwater peak run off flow to pre-development levels b) The capacity of the downstream piped stormwater system to its outlet with an open channel is not exceeded in the 1 in 10 year storm event. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.
2.4 On-site stormwater detention for estate development plans	
There is no applicable rule.	C5 This criterion applies to estate development plans. Stormwater detention measures are provided and the peak rate of stormwater runoff from the estate does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for minor and major storms. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** The Major (1% Annual Exceedance Probability (AEP)) and Minor storms are as defined by TCCS. **Note:** Stormwater detention measures required for each individual block may contribute toward meeting the overall detention requirements for the estate as demonstrated in an estate development plan. **Note:** Any site specific stormwater detention must be nominated on planning control plans submitted with the estate development plan.

Element 3 – Stormwater Quality

Rules	Criteria
3.1 Stormwater Quality Target – sites greater than 2000m^2	
R6 This rule applies to development for all of the following: a) where the development site is greater than 2,000m^2 b) where development involves works that have potential to alter the stormwater regime for the site. This rule does not apply to development of major roads. The average annual stormwater pollutant export is reduced when compared with an urban catchment of the same area with no water quality management controls for all of the following: a) gross pollutants by at least 90%; b) suspended solids by at least 60%; c) total phosphorous by at least 45%; d) total nitrogen by at least 40%. **Note:** Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.	C6 It is demonstrated that at least one of the following applies: a) stormwater quality measures can be more successfully met offsite b) a sensitive downstream environment will be negatively impacted. Development complies with one of the following: a) An equivalent load of pollutants is captured at an off-site location as part of a stormwater offset agreement; b) if the above stormwater quality measures are unable to be provided, then a contribution to the construction of off-site measures as a means of offset may be approved by the Planning and Land Authority. For this criterion a stormwater offset agreement is defined as detailed in the ACT Practice Guidelines for Water Sensitive Urban Design. **Note:** Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.

Rules	Criteria
3.2 Stormwater quality target – major roads	
R7 This rule applies to development of major roads, including the duplication of an existing major road in full or in part. The average annual stormwater pollutant export is reduced when compared with a road catchment of the same area with no water quality management controls for all of the following: a) gross pollutants by at least 90%; b) suspended solids by at least 60%; c) total phosphorous by at least 45%; d) total nitrogen by at least 40%. **Note:** Compliance with this rule is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the rule. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.	C7 If it can be demonstrated that the stormwater quality measures specified in the rule are unable to be provided, then a contribution to the construction of off-site measures as a means of offset may be approved by the Planning and Land Authority. **Note:** Compliance with this criterion is consistent with the ACT Practice Guidelines for Water Sensitive Urban Design and is demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the criterion. If parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.

Element 4 – Climate change adaptation

Rules	Criteria
4.1 Nuisance flooding – sites greater than 2000m²	
There is no applicable rule.	C8 This criterion applies to development on sites greater than 2,000m² involving works that have potential to alter the existing drainage and overland flow regime for the site. Overland flow paths are provided and achieve all of the following: a) accommodate overland stormwater flows up to the 1%AEP; b) reduce nuisance flooding. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

Rules	Criteria
4.2 Green/living infrastructure	
R9 This rule applies to at least one of the following developments: a) Development on sites greater than 2000m^2 involving works that have potential to alter the stormwater regime for the site; b) Development within existing urban areas that increase the impervious area of the site by 100m^2 or more. Development achieves a minimum of 20% of the site area to be permeable. **Note:** Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.	C9 It is demonstrated that the development achieves all of the following: a) Increases permeable surfaces and living infrastructure through green spaces; b) Plants that require irrigation are supported by sustainable water systems such as onsite stormwater harvesting to achieve microclimate benefits; c) Promotes evapotranspiration to mitigate extreme temperatures, improve air humidity and overall human comfort. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

Element 5 – Entity (Government agency) Endorsement

Rules	Criteria
5.1 Water infrastructure	
There is no applicable rule.	C10 This criterion applies to development that will result in municipal water sensitive urban design infrastructure being handed to the ACT Government. An operation and maintenance plan is to be endorsed by the ACT Government for the water sensitive urban design assets that are to be handed to the ACT Government. **Note:** Compliance with this criterion is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

Draft Variation to the Territory Plan 354

Comment from Prof. Ian Falconer, Water Quality Consultant.

[redacted]

Water saving urban design is a positive benefit to the society through conserving water, and improving the quality of stormwater runoff. The ACT has extensive design regulations on developers to enhance water saving urban design. Draft variation 354 provides, to quote, 'A key feature of DV354 is the flexibility offered to developers to meet these important targets'.

Hence the flexibility requires attention, as the current guidelines are apparently not necessarily strictly observed at present and increasing flexibility will obviously allow less adherence to the present guidelines.

In particular the clause 3.2.5 'Offsetting WSUD requirements' is set up to allow developers to avoid 'on-site WSUD solutions'.

The alternative options to avoid WSUD guidelines for their developments are

'A contribution is paid and used to implement regional WSUD solutions'

Or

'a mechanisms whereby the developer can offset an equivalent volume of stormwater (for stormwater quantity management) or 'equivalent load of pollutants at an off-site location'

However 'No WSUD offset scheme is currently available in the ACT'

'in the interim the ACT Government must be consulted about any offset scheme proposal'

Offsets of any type are notoriously difficult to set up and to achieve actual results. NSW now has a land offset scheme that allows developers to pay a fee to the Government in lieu of an offset, and this new ACT proposal appears similar. Unless the utmost rigor is employed to implement a WSUD offset, the outcome is likely to be overall negative. The ACT policy for dealing with infringements in many cases is 'to inform and educate', whereas the application of a substantial fine would be far more effective.

Code Compliance

To quote

Note: Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.

This provision, which regulates the compliance with the WSUD Code, allows unspecified employees of developers who can be argued to be (unspecified) 'suitably qualified' to sign off on the development meeting the WSDUD Code.

In other rules it specifies an 'independent suitably qualified person'.

How is suitability described? Appropriate degree? Industry qualification? Consulting practice?

Since the strength of the whole process is only a strong as ‘suitability’ the definitions need to be described and enforced, and ‘suitably qualified persons’ authorised by the authority to carry out the work.

There are significant costs associated with employing WSUD into new developments, and there will be an attraction to minimise them, which will make compliance more important to ensure that the Codes are followed.

05/11/2018

Comments on
Draft Variation to the Territory Plan 354

November 2018

The Conservation Council ACT region is the peak non-government environment organisation for the Canberra Region. We have been the community's voice for the environment in the Canberra region since 1979.

Our mission is to influence government, business and community through effective public policy and engagement to protect nature.

We represent more than 45 member groups who in turn represent over 15,000 supporters. We harness the collective expertise and experience of our member groups and networks. We work collaboratively with Government, business and the community to achieve the highest quality environment for Canberra and its region.

The Conservation Council is active in a number of campaign areas. Our current focus includes:

- **Biodiversity Conservation** – protecting our unique ecological communities and the Bush Capital
- **Climate Change** – a regional, national and global challenge
- **Planning** – the right things in the right places
- **Transport** – connecting people and places
- **Waste** – being efficient through closed-loop systems
- **Water** – smart use of a scarce resource
- **Governance** – for a Smarter, Sustainable Canberra

If you have any queries regarding this submission please contact: Larry O'Loughlin Executive Director on 6229 3202 or director@conservationcouncil.org.au.

1. Overview

The Conservation Council welcomes the opportunity to comment on the Draft Variation to the Territory Plan 354.

The Conservation Council regards water as a major environmental issue and has maintained interest and involvement in the ACT's water activities for some decades.

The Conservation Council Board has a water sub-committee and the Board includes as a member Professor Ian Falconer, Water Quality Consultant.

Conservation Council comments and input over recent years on water and water issues including runoff and the need for water sensitive urban design include the following[1]:

- 23 March 2018 – **Comments on Molonglo River Reserve Draft Reserve Management Plan 2018** (*submission*)
- 23 February 2018 – **Comments on ICRC Draft report Regulated water and sewerage services prices 2018–23** (*submission*)
- 3 October 2017 – **Icon Water proposals for water and sewerage tariffs 2018-2023**(*submission*)
- 25 July 2016 – **A 2016 ACT Election Agenda – Our Future, Our Environment** (*policy*)
- 23 March 2016 – **Briefing paper: Suburb concept "Thompson" west Tuggeranong**(*submission*)
- 18 January 2016 – **DA 2015-28681 Watson Section 64, Block 9 Watson Estate Development Plan**
- 26 August 2015 – **Dargues Reef Mine – Modification 3** (*submission*)
- 19 June 2015 – **ACT Budget 2015-16 Weeds Briefing Paper**
- 20 December 2013 – **Managing the Urban Edge Discussion Paper December 2013**
- 30 August 2013 – **Draft Water Strategy** (*submission*)
- 30 September 2012 – **Jerrabomberra Wetlands Draft Master Plan** (*submission*)
- 16 April 2012 – **Murray Darling Basin Draft Plan** (*submission*)
- 9 March 2012 – **Weathering the Change Draft Action Plan#2** (*submission*)

2. Water saving urban design offsets

Water saving urban design is a positive benefit to the society through conserving water, and improving the quality of stormwater runoff. The ACT has extensive design regulations on developers to enhance water saving urban design. Draft variation 354 provides, to quote, 'A key feature of DV354 is the flexibility offered to developers to meet these important targets'.

Hence the flexibility requires attention, as the current guidelines are apparently not necessarily strictly observed at present and increasing flexibility will obviously allow less adherence to the present guidelines.

In particular the clause 3.2.5 'Offsetting WSUD requirements' is set up to allow developers to avoid 'on-site WSUD solutions'.

The alternative options to avoid WSUD guidelines for their developments are:

'A contribution is paid and used to implement regional WSUD solutions'

[1] See https://conservationcouncil.org.au/publications/submissions/

Or

'a mechanism whereby the developer can offset an equivalent volume of stormwater (for stormwater quantity management) or 'equivalent load of pollutants at an off-site location'

However 'No WSUD offset scheme is currently available in the ACT':

> *'in the interim the ACT Government must be consulted about any offset scheme proposal'*

Offsets of any type are notoriously difficult to set up and to achieve actual results. NSW now has a land offset scheme that allows developers to pay a fee to the Government in lieu of an offset, and this new ACT proposal appears similar. Unless the utmost rigor is employed to implement a WSUD offset, the outcome is likely to be overall negative. The ACT policy for dealing with infringements in many cases is 'to inform and educate', whereas the application of a substantial fine would be far more effective.

> ***Recommendation 1.***
> ***The ACT Government should not allow any offset arrangements for water sensitive urban design until such time as clear and transparent policies and arrangements for offsets have been consulted and established.***

> ***Recommendation 2.***
> ***There should be consideration to changing the ACT policy for dealing with infringements from 'to inform and educate' to application of a substantial fine.***

3. Code Compliance

To quote:

> ***Note:*** *Compliance with this rule is demonstrated through a report from a suitably qualified person consistent with the methods specified in the ACT Practice Guidelines for Water Sensitive Urban Design.*

This provision, which regulates the compliance with the WSUD Code, allows unspecified employees of developers who can be argued to be (unspecified) 'suitably qualified' to sign off on the development meeting the WSDUD Code.

In other rules it specifies an 'independent suitably qualified person'.

How is suitability described? Appropriate degree? Industry qualification? Consulting practice?

Since the strength of the whole process is only a strong as 'suitability' the definitions need to be described and enforced, and 'suitably qualified persons' authorised by the authority to carry out the work.

Recommendation 3.
The definitions of suitably qualified persons need to be described and enforced, and 'suitably qualified persons' should require authorisation by the authority to carry out the work.

There are significant costs associated with employing WSUD into new developments, and there will be an attraction to minimise them, which will make compliance more important to ensure that the Codes are followed.

Recommendation 4.
The ACT Government should make further efforts to ensure that there is compliance with codes.

ACT Government

ACT PRACTICE GUIDELINES FOR WATER SENSITIVE URBAN DESIGN

MODULE 1: INTRODUCTION TO WSUD IN THE ACT

Director-General,
Environment, Planning and Sustainable Development Directorate,
ACT Government,
GPO Box 158, Canberra ACT 2601.

Telephone: 02 6207 1923
Website: www.environment.act.gov.au
Printed on recycled paper

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CONTENTS

1. INTRODUCTION

Water sensitive urban design (WSUD) is an approach to urban planning and design that aims to integrate the management of the urban water cycle into the urban development process. This includes the management of stormwater to minimise water run-off and ensure that any run-off causes the least amount of damage from a water quality and quantity perspective. It includes the wise use of potable water (i.e. drinking water supplies) and reduction in the generation of wastewater (i.e. water that has been adversely affected in quality by anthropogenic influence. Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities and is expressed as surface runoff or stormwater) to improve our urban environments.

The ACT Practice Guidelines for WSUD (WSUD Guidelines) continue the ACT Government's commitment to WSUD as part of a broader strategy of responsible water resources management. For example, the ACT Water Strategy 2014–44: Striking the Balance (ACT Water Strategy) sets the strategy for water management in the ACT over the next 30 years. The vision of the ACT Water Strategy is: *"A community working together, managing water wisely to support a vibrant, sustainable and thriving region."* WSUD is intrinsic to the implementation of the ACT Water Strategy as it encourages reduced mains water use, improved stormwater quality and managed stormwater flows and promotes greywater reuse.

Implementing WSUD is important to the Canberra and region environment because it mitigates the urban impacts on our waterways. WSUD requirements are given effect under the Territory Plan, the key statutory planning document in the ACT, and must therefore be considered at some level in developments. WSUD also provides many benefits to the community.

As Australia's largest inland city, and the largest urban area in the Murray–Darling Basin, Canberra has a proud heritage in high quality water management, which has been refined in the decades since the National Capital Development Commission was responsible for the construction of the city. The 1980s, in particular, saw a change from highly engineered urban waterways to a naturalisation of water management and an increasing appreciation of the merits of natural processes in water quality management. The 1990s saw an increasing emphasis on placing water management responsibility as close to the source as possible (i.e. on block) instead of on the broader catchment or sub-catchment. In the early 2000s, Canberra experienced a severe drought that placed a focus on potable water (drinking water) security.

The Waterways: WSUD General Code (the WSUD Code) is a general code under the Territory Plan, which provides the policy framework for the administration of planning in the ACT and manages land use change and development. The WSUD Guidelines support the WSUD Code by helping to explain the planning provisions set out in the WSUD Code. The WSUD Guidelines provide developers, residents and ACT Government officers with support on introducing WSUD into their urban patch, streetscape, neighbourhood and estate.

The ACT Government previously released a WSUD guideline through the now superseded Waterways 2007 guideline, which was previously codified following the introduction to the new Territory Plan in March 2008. The WSUD Guidelines (2017) are now released for comment following a comprehensive review process involving ACT Government agencies and directorates as well as a technical review panel of industry experts.

The new ACT WSUD Guidelines were revised to support the updated Territory WSUD General Code (2017), which now provides clearer compliance criteria and increased options for complying with the provisions.

The guideline commentary that is currently contained in the Territory Plan WSUD code is proposed to be removed from the Territory Plan and sit as a standalone guideline. This will mean future updates to the guideline would not need Territory Plan variations.

The ACT WSUD Guidelines is presented as two modules:

» Module 1—an introduction to WSUD in the ACT— is a newly created ACT WSUD framework document offering a high level review of the ACT regulatory and policy frameworks, and establishing planning principles for the promotion and adoption of WSUD to support ACT Government policies and the Territory Plan.

» Module 2—designing successful WSUD solutions in the ACT—is a technical practice guideline for WSUD with guidance on how to plan, design and maintain WSUD assets in Canberra, and design checklists and technical references specific to the ACT context.

This set of guidelines and reference documents will support a more cost-effective and efficient adoption of WSUD in the ACT and implementation of the ACT Water Strategy. These documents will also help the ACT Government and urban development industry to work with communities to ensure the planning, design, construction, retrofitting and renewal of urbanised landscapes are more sensitive to the natural water cycle.

Figure 1: An overview of the two WSUD Guidelines documents, outlining the different content provided within each document

Module 1: Introduction to WSUD in the ACT

1. **Introduction**
2. **The need for WSUD in the ACT**
3. **Solutions for a water sensitive Canberra**
4. **ACT Water Sensitive Urban Design policy environment**
5. **Key objectives of Water Sensitive Urban Design in the ACT**
6. **Water Sensitive Urban Design adoption framework in the ACT**

Module 2: Designing successful WSUD solution in the ACT

1. **Introduction**
2. **Overview of the WSUD planning, design and delivery process**
3. **Critical steps to WSUD planning**
4. **Critical steps to WSUD design**
5. **WSUD treatment assets construction and establishment**
6. **WSUD treatment asset operation and maintenance**
7. **Handover of WSUD treatment assets to the ACT Government**
8. **Monitoring water quality**
9. **Asset renewal and decommissioning**

Rubble drain in Forde

GPT in Weston

1.1 PURPOSE OF MODULE 1

The ACT Practice Guidelines for WSUD comprises two main documents as outlined in the following figure. The first module provides an introduction to WSUD in the ACT (this document), summarising the need for it and the policy and regulatory framework supporting its adoption.

In Module 1 you will find information relating to the policy context and intent for the application of the WSUD principles in the ACT in relation to the Waterways: Water Sensitive Urban Design General Code. This preamble is primarily intended for policy makers, analysts and town planners. It is also intended for this document to help with the interpretation of policy intent that may be required as part of development approvals by ACT Government officers.

Information contained in this document outlines:

- » the value of WSUD principles in mitigating the impact of urbanisation on the environment and Canberra's lakes, ponds and waterways in particular
- » the importance of WSUD as part of the wider policy framework in sustainable water resources management, land use planning and climate change adaptation
- » how the WSUD policy and practice relate to other initiatives from the ACT Government on climate change adaptation, living infrastructure policy and water quality improvement
- » the expectations from the ACT Government for the application of WSUD to greenfield developments, urban renewal projects and transport infrastructure
- » the relative importance and specific targets and objectives that future developments will be expected to comply with across a range of water management issues and pollutant types.

Figure 1 represents the chapters and content.

Scientists, engineers and WSUD practitioners will find more details and specific information in Module 2 of the ACT Practice Guideline for WSUD.

Civic raingarden

2. THE NEED FOR WSUD IN THE ACT

WSUD has been trialled and adopted in the ACT since 2005 to better protect our urban waterways, lakes and ponds and ultimately contribute to a more sustainable urban community. The historical approach to urban water management of relying on conventional 'pits and pipes' drainage solutions and typical provisioning of water and sewerage services is recognised for creating a number of challenges and issues for the long-term health and integrity of our waterways.

The typical negative impacts of urbanisation on the urban water cycle and waterways are presented in Figure 2 and discussed in more detail in following sections.

2.1 IMPACT OF URBANISATION

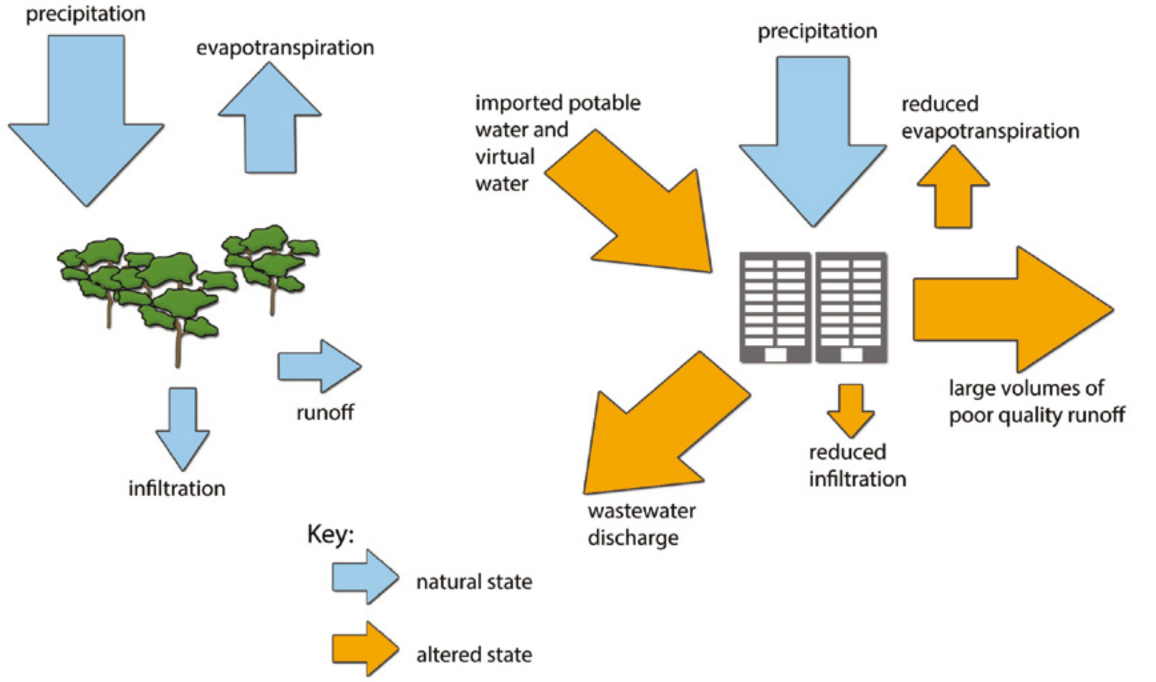
As our city grows, more urban areas need to be developed to supply the demand for housing from a growing population. This urbanisation of the ACT natural catchments has been identified as having significant impacts.

2.1.1 Urban catchment hydrology

In well vegetated, undeveloped catchments, the majority of the small, frequent rainfall events are absorbed by catchment soils and vegetation and do not produce surface run-off. When these catchments are urbanised, the water cycle changes dramatically (Figure 2).

The increased impervious areas in urban environments (such as roofs, roads, parking lots, driveways) reduces evapotranspiration and infiltration, which results in higher volumes of surface run-off being generated and transported directly to receiving waters in a pipe network. Additional impacts to the receiving environments also result from the discharge of treated wastewater from treatment plants into waterways.

Figure 2: The water cycle comparison for natural areas (left) and urban areas (right) showing key changes in imported flows, evapotranspiration, infiltration and run-off/discharges (Hoban and Wong, 2006)



The resulting changes in stormwater flow events (both in magnitude and frequency) deliver urban pollutants and disturb in-stream ecosystems (e.g. Walsh 2000). These changes have been shown to have a strong correlation with the degradation of receiving waters, such as streams and lakes.

Two factors driving this increase in stormwater flow events are: the increase in imperviousness and the hydraulic efficiency of our conventional drainage infrastructure.

Imperviousness is the source of most problems

With increasing impervious areas (such as roofs, roads, parking lots, driveways) in urban areas, the natural processes of infiltration and evapotranspiration are substantially reduced. During storms, rain that previously would have infiltrated the soils now runs off impervious surfaces into the stormwater system. This in turn reduces the recharge of groundwater systems and base flows in creeks.

Conventional drainage does not meet modern expectations

To manage the increased surface run-off, conventional drainage solutions have relied on increasing the hydraulic capacity and effectiveness of drainage infrastructure with smooth concrete or plastic pipes, concrete floodways and other drains that can efficiently, rapidly and cost effectively convey flows away from assets and people. Until the 1990s, this approach met the expectations of our community by reducing nuisance flooding, protecting lives and properties. Since the 1990s the growing public awareness of environmental issues has highlighted the effect on receiving waters, the degradation of urban waterways, the gradual worsening of flash flooding downstream and loss of ecosystem function and values.

2.1.2 Water quality

Compared to natural catchments such as forests or rural areas, urban areas typically generate pollutants at a greater rate, from both stormwater and wastewater discharges.

The range and quantum of pollutants associated with human activities, economic activity, cars and other vehicles are significantly greater.

Three factors explain these observations:

» a higher generation rate of pollutants (from metal roof areas, vehicle wear, littering in urban areas and general corrosion of urban infrastructure)

» a greater mobilisation of the pollutants via the efficient drainage infrastructure that prevents the natural trapping of these pollutants by the plants and soil of undeveloped catchments

» Stormwater quality is a fairly complex and well documented matter (Engineers Australia, ANZECC Guidelines), but it can be simplified in a range of:
  - physical parameters: turbidity, preventing the penetration of light that sustains ecosystems in water bodies and smothering aquatic habitats; temperature; acidity/pH; electrical conductivity and salinity
  - biochemical parameters: increased concentration of nutrients, oxygen demanding material
  - micro-organisms and toxic pollutants including heavy metals, pesticides, hydrocarbons, microbes, bacteria.

These pollutants may impact immediately due to their presence in the water column, but also have the potentially to settle and accumulate in sediments creating a long-term threat to ecosystems and food chains.

2.1.3 Impact on receiving water ecology and geomorphology

In addition to the pollution challenges, ACT waterways are also directly affected by the increase in stormflow events. Erosion and changes to the morphology of creek beds and banks commonly lead to loss of ecosystem function and habitat values. The material eroded from streams typically settles and accumulates in lakes and ponds, where habitats become degraded.

In Canberra, as elsewhere, the impacts and challenges for waterways and creek systems are different from those for urban ponds and lakes.

Waterways and creeks

For waterways and creeks in natural catchments, the buffering capacity of the catchment through infiltration and evapotranspiration means less water enters the creeks as surface flows and the frequency of creek flooding is less than in urban catchments for a storm event of a given size. Less frequent disturbances means the waterways and creek ecosystems have time to re-establish and recover.

In urban catchments, the intensity and frequency of storm flows are high enough for systems to be impacted in many ways, including:

- erosion and scour of banks (widening of channels)
- loss of habitat by scouring away of cobbles, woody debris and other habitat supporting elements
- increased algal growth due to the more prevalent availability of light because of lost vegetation
- loss of aquatic fauna and organisms, except for a select few species that resist higher flows
- decreasing levels of dissolved oxygen concentration.

Management of healthy waterways and creeks requires the protection of the geomorphic and ecosystem integrity, primarily by focusing on frequency of disturbance, intensity of disturbance and frequency of stormflows. Rehabilitation work in streams may only succeed if catchment-scale impacts have been addressed.

Lakes and ponds

These water systems are quite different from waterways and creeks because of their large buffering capacity. They are less subject to the frequent disturbance that impacts waterways and creeks. The most concerning issue for lakes and ponds is the accumulation of pollutants, nutrients and sediments in the water body. Degrading water quality and loss of amenity and ecosystem integrity is commonly noticed after many years of accumulation. This means that restoring lakes and ponds can be quite complex and expensive. Management of lakes and ponds needs to focus on nutrient and sediment loads and have long-term objectives.

2.2 EVIDENCE OF THE PROBLEM

2.2.1 Increasing concern for water quality in Canberra's lakes and ponds

In recent years, work carried out by the ACT Government through water quality monitoring and predictive modelling of water quality in Canberra's lakes and ponds has revealed an accumulation of common nutrients (nitrogen and phosphorus).

In addition, the community engagement informing the review of the WSUD General Code revealed a growing concern amongst catchment groups, scientists, practitioners and Canberrans for the decreasing quality of water in our ponds, lakes and waterways. The Social Expectations Survey of the ACT and Region Waterways conducted by the University of Canberra in 2015 also found that understanding of the threats to water quality is relatively low. Therefore it is important to convey a clear message of the benefits of WSUD.

2.2.2 Community expectations and government action to remediate the problems

In responding to the community expectations regarding the preservation of high amenity values associated with Canberra's lakes and ponds, the ACT Government is also reacting to the conclusion of the CSE report: 'unless there is effective action, threats are expected more severe into the future'.

In aligning the policies, including these WSUD Guidelines, with the ACT Water Strategy 2014–2044: Striking the Balance, and progressing with the ACT Healthy Waterways Project, the ACT Government is demonstrating its commitment to improve the long-term health of ACT waterways.

Detention basin in Harrison

3. SOLUTIONS FOR A WATER SENSITIVE CANBERRA

3.1 WSUD IN THE ACT

In response to the many challenges associated with conventional drainage solutions, the concept of water sensitive urban design emerged in the 1990s. WSUD placed a focus on the interconnection between land-use planning, urban planning and design and the impact on urban streams at the centre of a new approach.

It marked the latest evolution of modern water management in cities that first emerged as municipal sanitation programs in the late 19th century, when cities constructed extensive sewer systems to help control outbreaks of disease such as typhoid and cholera. This evolution over the last 130 years revealed the gradually increasing scope for water management in cities, now including sewerage and sanitation, potable water supply, stormwater drainage and flood mitigation, non-potable water supply and stormwater quality control.

The application of the WSUD principles in the ACT can reduce the common impacts of urbanisation on the water cycle (Figure 4). One key impact of urbanisation is that excess water (run off) is generated, leading to more water, rather than less, being delivered to urban streams. WSUD helps to manage urban stream environmental flows through a range of strategies such as stormwater harvesting.

WSUD strategies should aim to mimic the natural water cycle in urban environments by:

» reducing the amount of stormwater run-off generated (reducing impervious areas)

» reducing the amount of imported water (using local water sources such as harvested and treated rainwater, stormwater and wastewater)

» reducing the amount of wastewater generated (water conservation)

» reducing the amount of polluted water entering the waterways (treatment and re-use of wastewater and stormwater).

Figure 3: Water sensitive city journey (Brown et al, 2009)

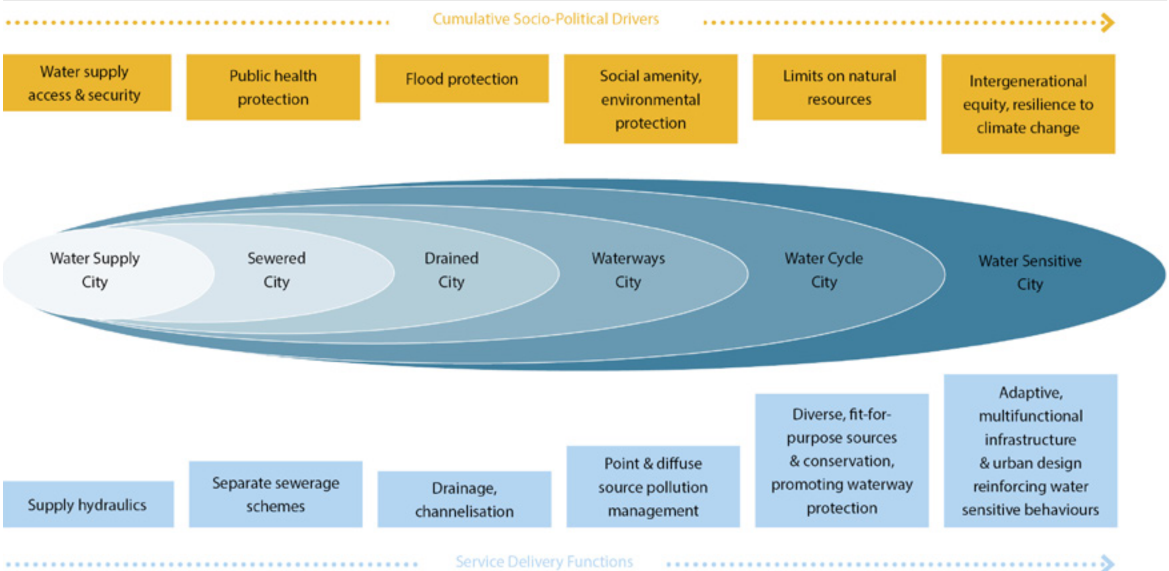
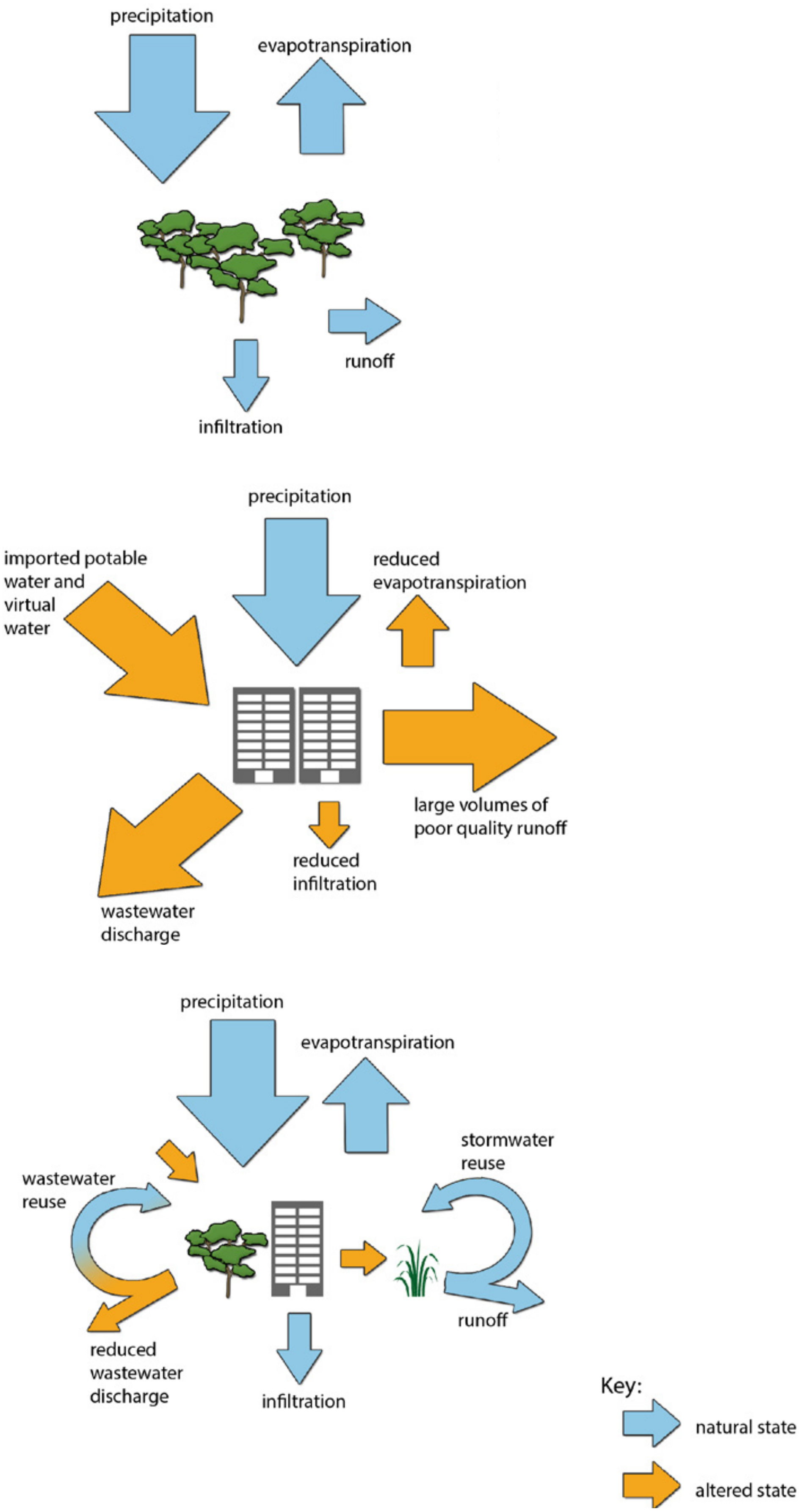


Figure 4: The water cycle comparison for natural areas (top), urban areas (middle) and urban areas incorporating WSUD (bottom) shows key changes in imported flows, evapotranspiration, infiltration and run-off/discharges (Hoban and Wong, 2006)



To ensure WSUD is effectively and efficiently delivered in the ACT, the following principles should be considered:

1. Identify and consider the type and condition of the receiving waters.
2. Focus on addressing the causes of the hydrological imbalance first.
3. Preserve existing public and private assets such as potable water and stormwater networks.
4. Promote the integration of WSUD as part of the broader green infrastructure and environmentally sustainable design principles.
5. Identify fit-for-purpose use of all urban water sources.
6. Create stormwater treatment trains and match solutions to pollutant types.
7. Keep stormwater assets simple and cost effective wherever possible.

These principles are described in more detail in the following sections.

3.1.1 Consider the receiving waters

Located two hours from the nearest coast, water bodies in the ACT have a particular value. Preserving the water quality and the associated amenity values in Canberra is about more than good environment management. Many families rely on the creeks, waterways and urban lakes and ponds for recreational purposes and relief during summer in particular.

The potential impacts of urbanisation on flowing and still receiving waters differs. It is therefore important to develop a WSUD strategy that reflects this.

Flowing water systems

Flowing water systems (i.e. waterways or creeks) can be either ephemeral (occasionally dry) or perennial (permanent water).

Table 1: WSUD strategy requirements for Flowing (creeks and waterways) systems identifying the difference between ephemeral and perennial waterways

Waterways	WSUD strategy requirements
Ephemeral	These headwater streams will become much wetter when the catchment is urbanised. It is therefore important to try and reduce frequent flow events and ensure constant wastewater discharges do not occur.
Perennial	Increasing the volume and frequency of stormwater run-off events increases the risk of bed and bank erosion in freshwater streams. Channel forming flows (1.5–2 year Average Recurrence Interval (ARI) flows) should be managed to reduce waterway stability impacts.

Still water systems

Designing and managing lakes and ponds needs to focus on reducing pollutant loads entering the water column and the time it takes for water to pass through the water body (i.e. residence time). Specific design considerations include:

» water quality of the inflows (poor water quality will result in a build-up of nutrients in the system, which can result in algal blooms)

» carbon loads (high volumes of floating plants can provide a continuous supply of carbon, which can deplete the oxygen in the water and release nutrients when it decomposes)

» mixing of the water profile (deep lakes can experience stratification, which leads to low oxygen levels and release of nutrients from the sediments)

» Residence times (large systems which are not flushed by catchment flows regularly have an increased risk of algal blooms).

3.1.2 Preserve existing public and private assets

When WSUD is incorporated into new developments, it can protect the function of existing public and private assets including existing water and drainage networks. WSUD can preserve these existing assets by:

- reducing potable water requirements by using alternative water sources for appropriate demands
- slowing and detaining stormwater flows, which attenuates peak flows entering the stormwater network, reducing nuisance flash flooding
- providing resilience to urban areas given predicted climate change impacts of more intense storm events.

Strict consideration of the potential impact of a development's stormwater flows on conventional drainage and existing assets in compliance with MIS 08 Stormwater is required.

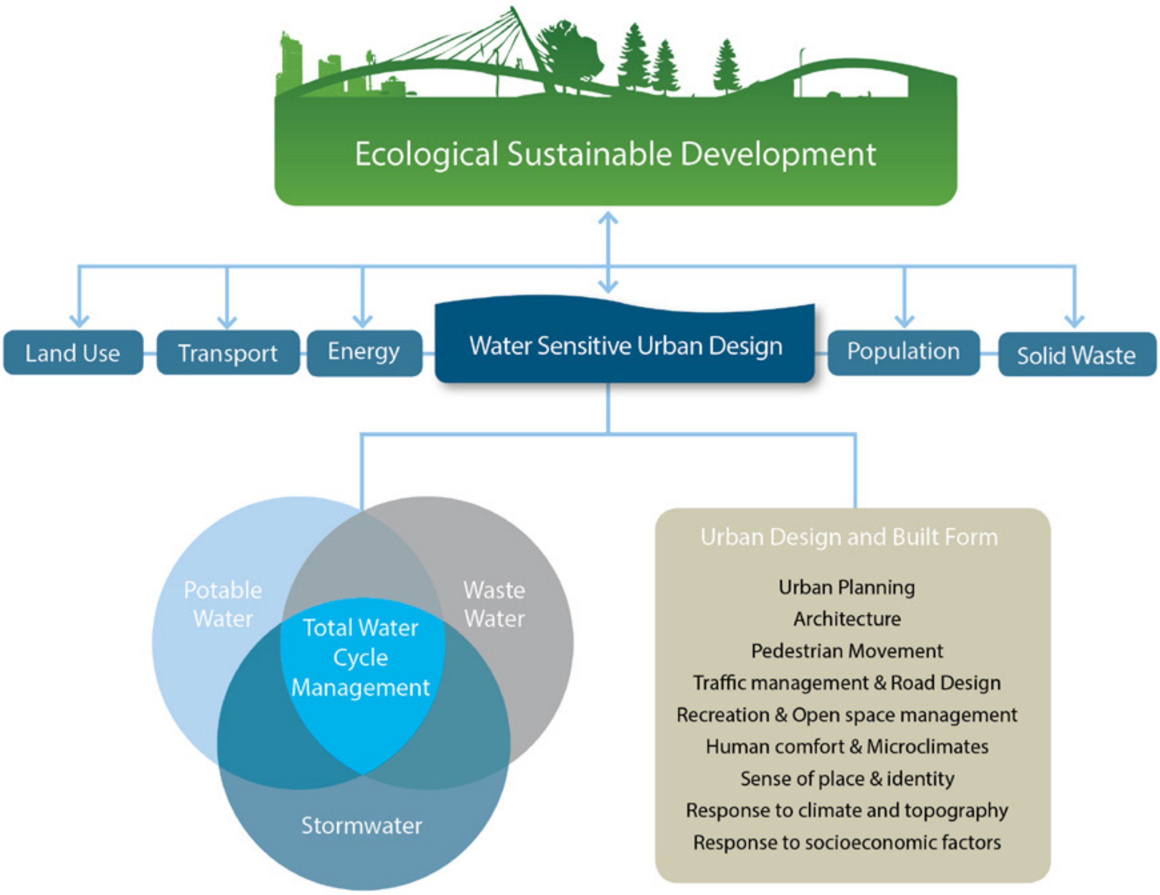
3.1.3 Promote the integration of WSUD as part of the broader living (green) infrastructure and environmentally sustainable design

WSUD brings together integrated water cycle planning and urban design and planning and should be considered early in projects as a layer in the delivery of environmentally sustainable development (refer Figure 5). This integration of sustainable water management and the urban landscape also supports the delivery of resilient green infrastructure which can help to deliver multiple benefits including sense of place, microclimate and human comfort, stormwater treatment and potable water reduction.

Integration with public realm and public open spaces planning

The successful planning and design of public realm and open spaces will manage competing outcomes in the most effective manner to achieve multiple functions in these important urban green spaces.

Figure 5: WSUD brings together total water cycle management and the design of the urban built form to contribute to environmentally sustainable development (Hoban and Wong, 20006)



The following design principles based on the Concept Design Guidelines for WSUD (Water by Design, 2009) should be used to guide the integration of stormwater management devices within public open spaces:

» Maximise the amenity and use of open space areas by ensuring that the footprint of stormwater management device should not take up more than 50% of the available open space area.
» Sit the stormwater management device seamlessly with the surrounding landscape setting and design it to maximise the visual interest and amenity.
» Locate stormwater management devices along waterway corridors away from flood flows and depths capable of impacting performance.
» Wherever possible, retain or revegetate areas with locally endemic plant species.
» Investigate opportunities to collect stormwater for re-use for irrigation or public water features.

Integration with urban design and built form

There are many opportunities to incorporate WSUD solutions within the built form to provide multiple benefits. These opportunities include:

» reducing potable water requirements of buildings by using water-efficient fittings and appliances and fit-for-purpose re-use of alternative water supplies (such as rainwater, stormwater and wastewater)
» reducing water discharged from a site by:
  – reducing stormwater run-off by using permeable surfaces such as porous pavements and green roofs
  – treating and harvesting rainwater, stormwater or wastewater on-site for uses such as toilet flushing and garden and green wall irrigation
» improving local microclimates and reducing urban heat island impacts with the use of green infrastructure such as green walls and street trees, which retain water in the soil and support healthy plant growth.

Appropriate solutions will need to be developed in close partnership with project planners, architects and landscape architects, on a case by case basis.

3.1.4 Fit-for-purpose water use

Many alternative sources of water can be used in urban developments to reduce potable water use and reduce the volume of wastewater and stormwater discharged from the site. Any source of alternative water can be used for any purpose; the issue is the amount of treatment and the associated regulatory complexity. Based on minimising the amount of treatment required and considering regulatory complexity, a fit-for-purpose approach can be used to match potential supply to demands. This approach considers the risk profile of the water demand and ensures the water source is suitable for this end-use, reducing the risk to the end-user but also ensuring the water is not over-treated, which can be costly. Table 2 presents the fit-for-purpose framework which can be used to inform integrated water cycle solutions.

Table 2: Fit-for-purpose water use framework identifying the preferred uses for all urban water sources

Source	Demand							
	Irrigation	Kitchen		Laundry		Toilet	Bathroom	
		Cold	Hot	Cold	Hot		Cold	Hot
Mains water	3	1	2	1	2	3	1	2
Wastewater								
Treated effluent	2	4	4	4	4	2	4	4
Greywater	1	4	4	4	4	1	4	4
Stormwater								
Roofwater	2	2	1	1	1	2	2	1
Non-roof water	2	4	4	4	4	2	4	4

1 =preferred use, 2 = compatible use, 3 = non-preferred use, 4 = not compatible
Source: Landcom WSUD best planning and management practices (2004)

Create stormwater treatment train and match solutions to pollutant types

A stormwater treatment train is a combination of stormwater treatment devices that together address the range of pollutants found in stormwater by using a range of treatment processes. Rainwater tanks, while not strictly a stormwater treatment device, provide a mechanism to capture and reuse roof water to reduce the volume of stormwater that needs to be subsequently treated. Rainwater tanks can therefore be the first element in a stormwater treatment train. Similarly, stormwater harvesting (e.g. from a pond) can reduce the volume of stormwater entering the downstream receiving environment.

Where stormwater harvesting systems are incorporated, they are typically the last element of a stormwater treatment train, to ensure the quality of the stormwater is suitable for the connected end uses. The sections below focus on stormwater pollutant removal processes to inform the development of treatment trains after any initial roof water harvesting and prior to stormwater harvesting and reuse.

Mechanisms of pollutant removal

Different treatment processes are required to remove the wide range of pollutant types and sizes in stormwater. Processes include screening of solids, sedimentation of coarse to medium sediments, adhesion of very fine and colloidal matter, sorption and biological uptake of dissolved nutrients (Figure 6).

Figure 6: Stormwater pollutant sizes, associated management issues and treatment processes required to remove the pollutant and address the issues effectively (Ecological Engineering, 2003)

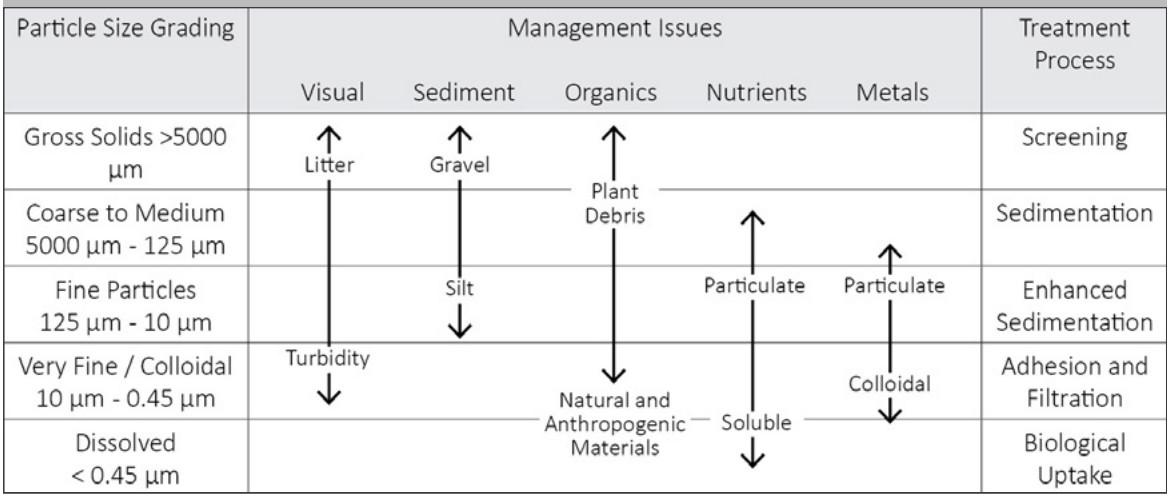
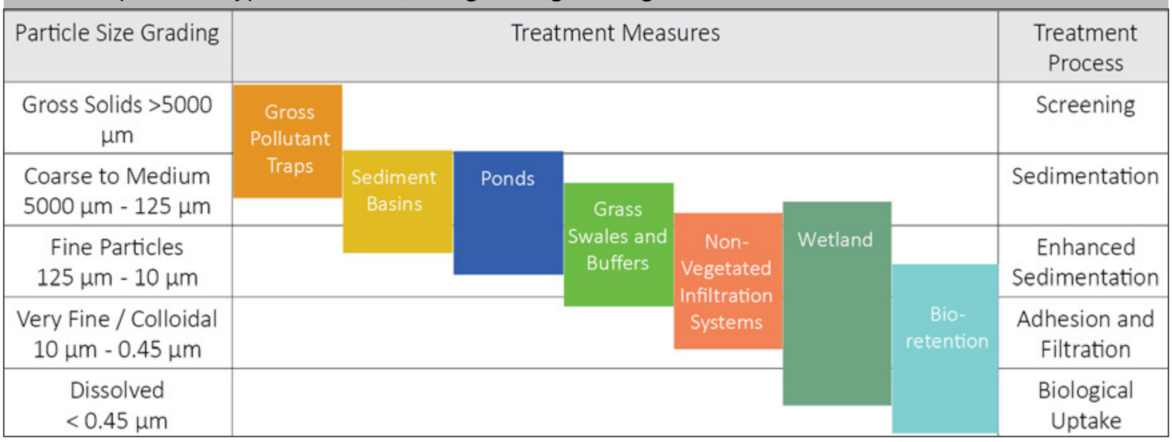


Figure 7: Stormwater treatment measures and the treatment processes they provide can remove different pollutant types and sizes (Ecological Engineering, 2003)



Stormwater treatment train

Different stormwater treatment devices are effective at removing different pollutants, from screening of gross pollutants through to biological uptake of dissolved nutrients (Figure 7).

The order of the treatment systems in a treatment train should target gross pollutants first so following treatment systems can target fine particles and dissolved pollutants more effectively. For example, a bioretention system will work more effectively if it is located after a coarse sediment removal system. Note, urban catchments typically transport more sediment (in stormwater) than natural forested catchments. The typical treatment train is therefore designed to trap the enhanced sediment transport resulting from urban catchments. The addition of high flow by-passes (e.g. the high flow by-pass on a constructed stormwater treatment wetland) allow the transport of medium sized particles (silts and sands) during high flow events. Coarse sediment transport to waterways during infrequent high flow events is a natural and important waterway process.

A typical stormwater treatment train often adopted in Canberra is shown in Figure 8. There is the potential to harvest the treated stormwater from the pond for reuse.

Figure 8: Typical stormwater treatment train adopted in Canberra

GROSS POLLUTANT TRAP
Removes
gross pollutants

SEDIMENT BASIN
Removes coarse
to medium particles

WETLAND
Removes fine
particulates and
nutrients

POND
Storage of good
quality water from
treatment train

3.1.5 Keep WSUD assets simple and cheap wherever possible

An important design principle to adopt is to eliminate complexity, reduce moving and mechanical parts and work with gravity in order to:

- reduce costs
- limit possibilities for structures to fail
- increase resilience to extreme events.

Three main focus areas to achieve this are:

1. using gravity
2. reducing complexity
3. addressing blockage risk.

These are described below in more detail.

Use gravity systems

There are circumstances where using pumps may offer significant advantages and may be appropriate but, in most instances, pumps should be avoided to:

- reduce capital costs
- reduce maintenance costs
- reduce operating costs
- reduce energy consumption
- lower carbon emissions.

Reduce hydraulic structure complexity

As much as possible, designs should rely on typical structures as outlined in MIS 08 Stormwater or previously accepted by Transport Canberra and City Services Directorate (TCCS) and proven to operate adequately. Where hydraulic constraints dictate, complex structures may be appropriate but should be discussed with TCCS.

Blockage/fail safe solutions

Given the variable nature of pollutant loads, there is a possibility for inlets, outlets and other hydraulic structures to fail. Part of the design process requires testing the impact of blockage to prove the adequate operation of structures in failsafe conditions.

The seven key design principles described in this section should be considered throughout the development of WSUD strategies to ensure the solutions are effectively and efficiently delivered in the ACT. The following sections provide an overview of how these strategies should be developed and delivered.

3.2 SCOPE OF APPLICATION

WSUD principles are to be applied consistently across the many different development types.

As the application of WSUD is required more broadly, it is important that the objectives be adjusted to reflect the constraints and opportunities associated with each major development type, as identified below.

3.2.1 Greenfield development

Greenfield developments transform relatively undeveloped land (e.g. natural areas or rural lands) into urban land uses. The key WSUD objective for greenfield development is to influence the urban fabric structure during planning and design. The strategic urban fabric in greenfield developments sets the trajectory for the long-term performance of the new urban communities.

Consequently, the priorities in such developments are:

» providing adequate public open space

» influencing the location and planning of road networks

» adjusting the WSUD infrastructure to reflect the specific conditions and constraints of each catchment

» influencing the connectivity between public land and private lease open spaces

» supporting the inclusion of considerations for urban heat island and climate change in the conception of urban infrastructure.

» developing solutions at neighbourhood scale.

Greenfield developments are the most typical application of the ACT WSUD Guidelines and WSUD Code. They also offer the most diverse range of solutions. The WSUD strategy can leverage the best possible flexibility and relative absence of infrastructure constraints compared to the other development types.

Accordingly, with the highest degree of flexibility and lowest constraints, greenfield developments are not intended to be eligible for exemptions or offset of the WSUD requirements (see section 3.2.5 below).

3.2.2 Redevelopment and urban infill projects

Urban renewal and redevelopment projects form a significantly increasing portion of urban development projects in the ACT. While the ACT Government always considered urban renewal projects would contribute to achieving the Territory's objectives for WSUD, the objectives and WSUD framework for urban renewal projects were poorly defined.

The importance of defining cost-effective and flexible WSUD solutions in urban infill projects is reflected in this section.

In urban infill projects, the adoption of WSUD principles is limited or constrained by the presence of existing infrastructure. The three key consequences are:

» All proposed WSUD infrastructure needs to take account of infrastructure constraints in terms of outlet points and infrastructure capacity.

» WSUD strategy and infrastructure may attract a higher cost than greenfield developments and any proposed infrastructure needs to be carefully considered in terms of benefit/cost.

» Frequently, the developments will be constrained by the legacy of historical planning. Opportunities for larger scale solutions may be limited.

Consequently, the priorities in most developments are:

- the adoption of identical targets as greenfield developments wherever possible to progressively improve water quality discharged from existing urban areas as part of the urban renewal process
- to achieve a net reduction in directly connected imperviousness compared to existing development conditions
- to maintain or improve the capacity of stormwater drainage networks (in terms of flooding)
- to manage wastewater in a manner which responds to local sewer and treatment plant capacities, such that infrastructure upgrades are avoided
- to achieve a net improvement in water quality outcomes.

In instances where achieving these priorities may prove technically impossible or represent prohibitive costs, there is the potential for projects to participate in a WSUD requirements offset scheme when developed and implemented in the ACT.

3.2.3 Transport infrastructure

The incorporation of WSUD into transport infrastructure can prove particularly challenging from a stormwater management perspective due to the linear and elongated nature of development.

The WSUD strategy for transport infrastructure projects should:

- apply the standard targets wherever possible
- maximise all opportunities for WSUD in verges and medians
- reduce impervious areas wherever possible, such as parking bays
- look for opportunities outside of the transport corridor
- offset residual impacts.

3.2.4 Low impact developments and developments downstream of natural catchments

The framework and targets in the WSUD General Code aim to mitigate the impact of common urban development types. Situations where the strict application of these targets may lead to expensive and unnecessary infrastructure include, in particular:

- low impact development
- low density development
- developments located downstream of natural hills and ridges.

For such situations, a framework for adjusting the applicable targets has been developed. The reduction in developer targets reflects the natural loads generated in natural catchments and is based on:

- proposed urban imperviousness (%)
- percentage of total catchment zoned 'urban'.

Refer to Appendix A of Module 2 for the Catchment-wide Reduction Targets Framework.

3.2.5 Offsetting WSUD requirements

The intent of a WSUD offset scheme is to provide:

- A mechanism whereby the ACT Government provide flexibility for developers in lieu of delivering on-site WSUD solutions. A contribution is paid and used to implement regional WSUD solutions that deliver an equivalent or greater benefit at lower cost. In principle, offsets are limited to developments where on-site stormwater management is highly constrained and where all other feasible and cost effective measures to avoid and mitigate on-site impacts of development have been exhausted.
- A mechanisms whereby the developer can offset an equivalent volume of stormwater (for stormwater quantity management) or equivalent load of pollutants at an off-site location as part of a stormwater offset agreement with the ACT Government.

No WSUD offset scheme is currently available in the ACT. The superseded version of the Waterways: WSUD General Code (2009) provided a clause to facilitate an offset, stating

> *"in such cases it may be possible, with the approval of the Authority, for the developer to consider a contribution to the construction of off-site measures as a means of offset."*
> However, no scheme was developed.

The introduction of an offset scheme requires careful planning to develop strategies for the collection and acquittal of offset funds including:

» the identification of catchments where offsets may apply, informed by total water cycle and catchment planning (including receiving water condition and rehabilitation potential)

» the identification and costing of offset projects

» determination of the offset scheme pricing (typically based on infrastructure total life cycle costs including land costs, CAPEX, OPEX, planning, design, construction, establishment and administration)

» a transparent method of reporting on the outcomes and benefits delivered through the offset scheme.

» The ACT Government will continue to work on developing an offset scheme; however, in the interim the ACT Government must be consulted about any offset scheme proposal prior to the development application being lodged. Each application will be assessed on its merits on a case-by-case basis.

3.3 HOW WILL THE ACT COMMUNITY BENEFIT FROM WATER SENSITIVE URBAN DESIGN?

Water sensitive urban design can provide multiple benefits to the ACT community including:

» healthy water environments, with less water pollution

» resilient green landscapes which are irrigated by non-potable sources

» cooler urban areas created by keeping water and vegetation in built up areas, reducing urban heat island effects

» improved urban habitat and biodiversity by retaining and using native vegetation

» improved urban amenity and social interaction

» reduced nuisance flooding by detaining and treating frequent flows within the catchments.

3.4 KEY RISKS AND UNCERTAINTIES ASSOCIATED WITH WATER SENSITIVE URBAN DESIGN

Water sensitive urban design can present a number of risks when the design and maintenance of stormwater assets are not undertaken adequately, including:

» nuisance weed growth

» poor plant establishment in vegetated stormwater assets

» poor amenity associated with litter, sediment and weeds in stormwater assets

» variable performance outcomes

» increased maintenance costs.

Module two of these guidelines provides the necessary information to mitigate these risks in the future.

4. ACT WSUD POLICY ENVIRONMENT

4.1 NATIONAL POLICY CONTEXT

4.1.1 Murray—Darling Basin Plan

The Murray–Darling Basin Plan 2012 (Basin Plan) is a major water resource plan that affects the ACT in water-related matters including WSUD. The Basin Plan provides a high level framework that sets standards for the Australian Government, Basin states (including the ACT) and the Murray–Darling Basin Authority to manage the Basin's water resources in a coordinated and sustainable way in collaboration with the community.

In 2012, the ACT and other Basin states accepted a limit on the maximum volume of surface water that can be diverted from each river system of the Murray–Darling Basin annually under the Murray–Darling Basin Agreement. This abstraction limit is fixed, regardless of the amount of water available in the river system or the capacity to store water (in dams, lakes etc.). This limit is referred to as the 'Cap'. Under the Basin Plan, from 2019 all Basin states are required to operate under a sustainable diversion limit (SDL), which will replace the Cap. The SDL will be 40.5 gigalitres (GL). The Basin Plan will be reviewed in 2022.

Unlike other states, the ACT uses 'net' abstractions to account for water use. That is, the ACT's SDL includes water abstracted and returned to the river, rather than just abstracted. For example, if the ACT abstracts 50 GL from its water resources but returns 30 GL to the Murrumbidgee River (following treatment at the Lower Molonglo Water Treatment Plant), its 'net' abstraction is 20 GL. The diversion cap has relevance for any large-scale harvesting.

The Basin Plan requires the ACT to have a water resource plan and a water quality plan. Through these plans, WSUD has an important role to play in our commitment to the Basin Plan in identifying alternative water sources to supplement river extractions and helping continue to protect water quality in the ACT and downstream, and help ensure there is no net decline on river health in the Basin.

4.1.2 ACT Healthy Waterways (Basin Project)

On 26 February 2014, the ACT Government signed a funding agreement, in the form of a Project Schedule to the Water Management Partnership Agreement (WMPA), for the ACT Healthy Waterways (Basin Project). The WMPA is between the Basin States and the Commonwealth to undertake water reforms in the Murray–Darling Basin.

The agreement provides for funding of up to $85 million and is aimed at 'improving the long term water quality in the ACT and the Murrumbidgee River System'.

ACT Healthy Waterways will contribute to achieving positive outcomes for the Canberra community through improvement in water quality in its lakes and waterways. It will also provide significant downstream benefits through improving water quality below the ACT in the Murray–Darling Basin. Improving water quality will have benefits not only for the environment, but also for the community through the social and economic contribution of lakes and waterways to the region.

Phase 1 of this project focused on implementing a comprehensive water quality monitoring program and assessing a range of potential options to improve water quality.

Based on the collected data, phase 2 involves the development and construction of infrastructure in six priority catchments that will help improve the water quality flowing from these catchments. ACT Healthy Waterways is expected to be completed by 30 June 2019.

The information gathered from ACT Healthy Waterways will assist in the understanding of WSUD assets and infrastructure and how they operate within our catchments.

4.1.3 National Capital Plan

Planning within the Territory is guided by the Australian Government through the National Capital Plan, administered by the National Capital Authority (NCA), and through the Territory Plan, administered through the ACT Government. The National Capital Plan provides a general policy framework for land use and planning in the Territory and, more specifically, guides the planning, design and development of areas of the Territory that have been identified as having national capital importance (Designated Areas). Any significant departure from the metropolitan structure for the Territory contained in the National Capital Plan requires the Australian Government's agreement to amend the National Capital Plan. Any such amendment would include consideration of matters of national significance. Included in these objectives is 'the development of a city which both respects environmental values and reflects concerns with the sustainability of Australia's urban areas'. The WSUD code addresses this and other objectives of the National Capital Plan.

4.1.4 Australian Rainfall and Run-off

Australian Rainfall and Run-off (ARR) is a national guideline document, data and software suite that can be used to estimate design flood characteristics in Australia. Published and supported by the Commonwealth, ARR is pivotal to the safety and sustainability of Australian infrastructure, communities and the environment. It provides reliable and robust estimates of flood risk and is the basis of most flood estimation undertaken in Australia. Consistent use of ARR ensures development does not occur in high risk areas and that infrastructure is appropriately designed.

The Australian Run-off Quality is a companion document to ARR and is considered to be the current industry standard for the management of urban stormwater quality. An initiative of the Institution of Engineers and Australia's National Committee on Water Engineering, it provides an overview of current best practice in Australia. It details procedures for estimating a range of urban stormwater contaminants, design guidelines for commonly applied stormwater quantity and quality management practices, procedures for the estimation of the performance of these practices, and advice with respect to the development/consideration of integrated urban water cycle management practices.

4.1.5 Australian and New Zealand Environment Conservation Council Guidelines

The Australian and New Zealand Environment Conservation Council (ANZECC) published the revised Australian and New Zealand Guidelines for Fresh and Marine Water Quality in 2000. These guidelines provide governments and the community—particularly regulators, industry, consultants, community groups and catchment and water managers—with a framework for conserving ambient water quality in our rivers, lakes, estuaries and marine waters. The guidelines form the central technical reference of the National Water Quality Management Strategy, which the Commonwealth and all state and territory governments have adopted for managing water quality. The ANZECC Guidelines assist in identifying environmental values and water quality objectives for a site's receiving waters.

The primary aim of the Guidelines for Managing Risks in Recreational Waters is to protect the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters. Threats may include natural hazards such as aquatic organisms and those with an artificial aspect, such as discharges of wastewater. These guidelines were developed by the National Health and Medical Research Council and are a tool to assist in the development of legislation and standards to ensure that recreational water environments are managed as safely as possible.

4.2 ACT POLICY CONTEXT

4.2.1 Territory Plan

The Territory Plan is the key statutory planning document in the ACT, providing the policy framework for the administration of planning in the ACT. The purpose of the Territory Plan is to manage land use change and development. The WSUD Guideline provides developers, residents and ACT Government officers with support on introducing WSUD into their urban residential lot, streetscape, neighbourhood and estate. The WSUD Guideline supports the Waterways: Water Sensitive Urban Design Code (the WSUD General Code). The WSUD General Code is a General Code under the Territory Plan.

There are three types of assessment codes in the Territory Plan:

- Precinct codes, which apply to geographical areas (e.g. the Inner North Precinct Code or Local Centres Precinct Code);
- Development codes, which apply to specific zones or development types (e.g Residential Zones—Development Code, Commercial Zones Development Code).
- General codes, which may apply to defined development types and/or planning and design issues (e.g. Parking and Vehicular Access General Code or Access and Mobility General Code).

The Territory Plan contains WSUD provisions as a set of rules and criteria in the three types of assessment codes. Rules provide definitive controls for development; some rules are mandatory while others may allow criteria to be met. Proposals that follow a 'code track' for development approval must comply with all rules relevant to the development. With the increase in development types that can now be considered exempt from development approval, few developments are considered in the code track.

Criteria provide the qualitative controls for development. Proposals that follow the 'merit track' can comply with the rules or the criteria unless the rule is mandatory. If meeting the criteria instead of a rule, the proponent must demonstrate, using supporting plans and/or written documentation, how the proposed development satisfies the criteria.

4.2.2 The Territory Plan and WSUD

The Waterways: Water Sensitive Urban Design Code (WSUD General Code) contains rules and criteria for:

- reduction in mains water use
- stormwater retention
- stormwater detention
- stormwater quality
- climate change adaptation
- entity (government agency) endorsement.

These apply to all development zones to support the objectives of the relevant zone. The WSUD General Code contains a consolidated suite of WSUD provisions that are applicable to all developments across all zones, unless another code has explicit WSUD provisions.

Under the *Planning and Development Act 2007*, where more than one type of code applies to a development and there is inconsistency between provisions, the order of precedence is: precinct code, development code and general code.

The WSUD Guideline guides stakeholders within the Territory who need to or would like to implement WSUD in their development or urban block. The guideline helps proponents meet requirements under the Territory Plan for their development or introduce ideas that can apply to the block.

This guideline is a support tool to the WSUD General Code. For most development applications, some form of WSUD provision will most likely apply, so the relevant code must be followed.

4.2.3 The ACT Municipal Infrastructure Standards

The ACT Municipal Infrastructure Standards supersede the Design Standards for Urban Infrastructure. Managed by the TCCS, they provide a broad scope and a series of standards of municipal infrastructure development and management in the ACT.

For the purposes of this series of standards, municipal infrastructure pertains to road works (except arterial and higher order roads), stormwater and landscaping required to service residential, commercial and industrial estates for both greenfield and brownfield/urban infill developments. They are works to be owned and maintained by TCCS and to be constructed either by a developer and gifted to the ACT Government or constructed as part of the ACT Government Capital Works program.

4.2.4 The ACT Municipal Infrastructure Technical Specifications

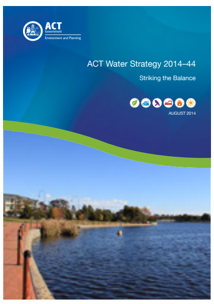
The ACT Municipal Infrastructure Technical Specifications provides a uniform specification for use in the construction of civil engineering and landscaping works within the ACT.

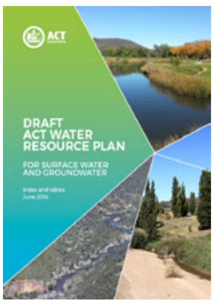
While based on the earlier ACT Public Works Basic Specifications, it has been significantly expanded and updated to include new technologies and Quality Assurance requirements and to bring it into line with Australian best practice.

The standard specification primarily applies to urban services capital works contracts and projects involving the construction of infrastructure destined for transfer to TCCS, superintended by experienced professional engineers/landscape architects. In the interests of uniform construction standards, its appropriate use on other contracts within the ACT is encouraged, but the ACT Government accepts no liability with regard to its use by others.

4.2.5 Relationship of WSUD policy context

The diagram below illustrates the relationship between the various policy instruments and resources governing development in the ACT and the role of this WSUD Practice Guideline in informing the process.





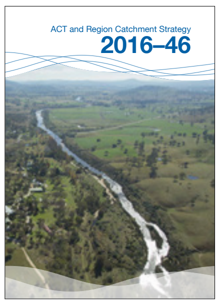
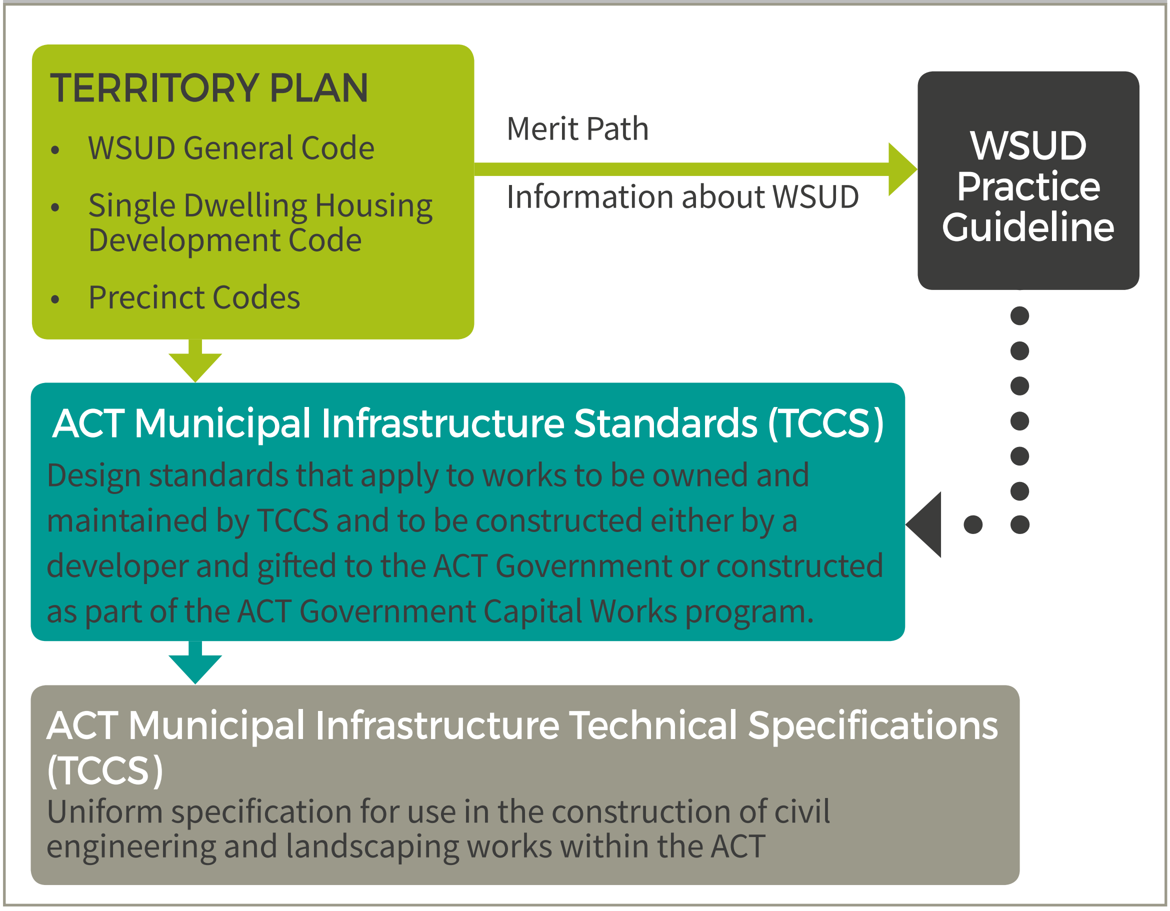


Figure 9: Overview of the relationship between the Territory Plan and TCCS Municipal documentation



4.3 RELATED ACT PLANS AND POLICIES

By adopting WSUD practices in the ACT, the ACT Government supports and delivers related environmental policies where water plays an important role.

» **ACT Water Strategy – Striking the Balance 2014–44 (Water Strategy)** sets a strategy for water management in the ACT over the next 30 years. The Water Strategy's vision is: 'A community working together, managing water wisely to support a vibrant, sustainable and thriving region'. WSUD is intrinsic to the implementation of the Water Strategy as it encourages reduced mains water use, improved stormwater quality and management of stormwater flows and promotes greywater reuse. WSUD is about working with communities to ensure the planning, design, construction and retrofitting of urbanised landscapes are more sensitive to the natural water cycle.

» **Water Resources Act 2007 (ACT)** is the governing legislation for managing water resources in the ACT, defining access rights to surface and ground water resources, environmental flow provisions, water licensing requirements, resource management and monitoring responsibilities and setting penalties for water-related offences.

» **ACT and Region Catchment Strategy 2016–2046 (Catchment Strategy)** aims to guide and deliver priority actions for the benefit of the region as a whole. The ACT and Region, located within the Upper Murrumbidgee Catchment, is unique in having multi-jurisdictional influences of federal, state and territory governments and local councils, making it a complex catchment to manage.

  The ACT and Region Catchment Strategy has a 30-year vision, recognising that the region is the economic hub and current and future growth centre for south-east NSW. It details the key factors predicted to affect the catchment and includes 19 actions to promote a healthy catchment region. Key issues include climate change, an increasing population, and the challenges of multi-jurisdictional governance. The strategy aims to bring governments, community and industry together to produce a healthy, productive, resilient and liveable catchment region.

- **Environment Protection Act 1997 (ACT)** provides for the protection of the environment. The Water Quality Standards detailed in the Act and the Environment Protection Regulation 2005 list the necessary water quality to support the water uses referred to in the Territory Plan. The Water use and Catchment General Code, within the Territory Plan sets the permitted uses for waters in the ACT and their catchments according to the predominant water use or environmental value. The three types of water use are:
  1. conservation
  2. water supply
  3. drainage and open space.

  Each category has a water use policy which sets specific objectives and environmental values in the water use and catchment policies of the Territory Plan.

- **The ACT Climate Change Adaptation Strategy** facilitates the adaptation of the ACT community to the current and future impact of climate change. The synergies between the WSUD General Code and the adaptation strategy include:
  - reducing the urban heat island effect in the town centres and higher density areas of the ACT
  - mitigating the severity and impact of heat waves on the vulnerable members in our community
  - creating urban refuges in parks with cooler micro-climate conditions
  - reducing the reliance on potable water supply and increase the resilience of the water supply network in the ACT.

WSUD is influenced by, and impacts on, a range of associated ACT plans, strategies and projects including the Territory Plan mentioned above. WSUD is also integral to the following:

- **Climate change: The ACT's climate change strategy and action plan, AP2,** includes actions that require risk management and mitigation and adaptation measures in our built environment. The ACT Climate Change Adaptation Strategy (2016) identifies our priorities for adaptation and coordinates our work so we can build resilience. The strategy looks at how the built environment and urban open spaces will be developed to respond to climate change through long-term mitigation objectives.
- **Living (green) infrastructure strategy:**
  A proposed new strategy will require more consideration for the protection of soils and provision of green infrastructure (urban parks etc.). There are clear synergies with the WSUD practices, in particular in the areas of:
  - providing multi-purpose public open space, delivering public amenity and ecosystem functions
  - passive irrigation of vegetated landscapes and urban trees, providing vegetation health benefits as well as contributing to achieving water quantity and quality objectives
  - supporting business cases for provision of higher amenity or larger public open space by the inclusion of the ecosystems services function (pollutant load reduction, reduction in peak flows) in the evaluation of benefits and costs.

  Management plans and strategies focused on living infrastructure management already exist in the ACT such as those for open spaces, parks and reserves and the urban lakes and ponds.
- **Catchment management and governance:** WSUD is a useful tool for catchment management. The government is considering options for catchment governance to improve whole-of-government and regional communication, collaboration and coordination through catchment masterplans.
- **Catchment and stormwater management:** There are currently no strategic catchment and stormwater management plans for the ACT. The new long term ACT Water Strategy 2014–44: Striking the Balance, which replaced Think Water, Act Water, proposes the development of an ACT integrated catchment management plan. Consultation on the ACT Water Strategy and the WSUD review has highlighted the need for a stormwater plan or strategy that would:
  - develop an integrated blueprint for stormwater and wastewater for the ACT
  - transition Canberra to a water sensitive city and acknowledge the need to manage urban water in an integrated way

Southwell Park Retarding Basin

- address appropriate stormwater harvesting
- address flood risk in existing and future development
- support appropriate research and encourage innovation
- provide an appropriate institutional framework for implementing stormwater initiatives.

EPSDD is finalising a major study into ACT hydrology using a systems approach to provide better catchment specific information to inform better WSUD design and flood management requirements.

» **Bushfire management:** The Strategic Bushfire Management Plan guides the joint efforts of government and the community to suppress bushfires and reduce their impacts on human life, property and the environment. The plan is reviewed every five years, with version 2 currently being reviewed. A key theme of the review, urban vegetation management, relates to WSUD. Unmanaged dense native plantings on leased land present an observed significant risk in high risk areas, particularly in Inner Asset Protection Zones.

» **Flood management:** The ACT Government is currently updating its flood management policy including a strategic flood risk management plan that looks at describing the different types of floods (riverine, flash and stormwater flooding as well as floodplain management) and the types of flood risks associated with it. Stormwater quantity management is addressed in the WSUD General Code and can help mitigate nuisance flooding.

4.4 RENEWED FOCUS ON MAINTENANCE REQUIREMENTS AND OPERATING BUDGETS

Through the first generations of WSUD assets in the ACT it became clear that insufficient consideration was given to the operational phase of assets; in many instances the operation and maintenance of assets is inefficient, costly and solely the responsibility of the ACT Government.

Consequently, the new Guidelines place a much greater focus on solutions that consider how the WSUD asset is designed, constructed and established to minimise its ongoing operating and maintenance requirements. The Guidelines recommend that proponents:

» transparently determine life-cycle cost analysis and cost benefit of WSUD assets

» identify appropriate staged construction and establishment methods

» clearly document the proposed maintenance requirements

» document and cost the operating and maintenance regime under normal operating circumstances.

5. KEY OBJECTIVES OF WATER SENSITIVE URBAN DESIGN IN THE ACT

The specific requirements for the application of WSUD in the ACT have been articulated as a series of targets and objectives in the Waterways: WSUD General Code 2017 under broad categories:

- Mains water reduction (potable water use)
- Stormwater quantity (onsite retention and onsite detention)
- Stormwater quality
- Climate change adaptation (adaptation to potential future impacts of climate change)
- Entity (government agency) endorsement (municipal infrastructure has effective ongoing operation and maintenance).

This section includes a general introduction to the respective specific policy intents. This information may be used to support constructive discussions between proponents, practitioners and ACT officers.

5.1 MAINS WATER USE REDUCTION

Development is required to support increasing efficiency in potable water use. As a minimum, a reduction of 40% compared to 2003 levels is required for all new developments. This reduction in potable water use evaluates the internal water consumption in households, and outdoor irrigation and other external water uses.

It is, however, important to note that voluntary—and readily achievable—further reduction in potable water consumption can be achieved by substituting potable water with either rainwater or greywater for outdoor uses. These practices are encouraged, but not required.

New developments can now also factor in the use of landscaping (such as water efficient plants) as part of this calculation. Refer to the Waterways calculator which now includes non-irrigated pervious surface or xeriscape garden area.

5.2 MANAGEMENT OF STORMWATER QUANTITY

Developments larger than 2000 m^2 and multi-unit developments must comply with on-site stormwater retention and detention requirements to provide waterway stability and flood management.

5.2.1 On-site retention of flows

Stormwater retention or on-site retention (OSR) refers to stormwater storage and reuse of stormwater on site. This reduces the total volume of run-off, which has multiple benefits (e.g. water quality and water security).

OSR allows a significant portion of run-off to dissipate through natural processes such as infiltration, evaporation and transpiration. OSR systems promote beneficial reuse of run-off, reduce the frequent flushing flows in urban watercourses and improve catchment water quality outcomes by protecting downstream environments from scour and erosion. Reuse can include use in households and buildings for toilet flushing or other non-potable uses, in landscape watering or infiltration to groundwater.

In the WSUD General Code OSR needs to be considered for:

» developments greater than 2000 m^2

» developments within existing urban areas that increase impervious area by 100 m^2.

To comply with the rule, these developments must retain water on site; the stormwater storage capacity of 1.4 kL per 100 m^2 of total impervious area is provided specifically to retain the stormwater generated on site. Alternatively, the development must retain water on site with the site capture, storage and reuse of the first 15 mm of rainfall event falling on the site.

Why this figure?

The 1.4 kL per 100 m^2 approximately equates to the volume required to capture 15 mm of rainfall from an 80% impervious catchment. It provides a simple solution for applicants who want to avoid the calculations involved.

Other jurisdictions that regulate retention do so on a rainfall depth basis. Capturing 15 mm of rain that falls on a site focuses on reducing the total stormwater volume. It is more effective than sizing a tank based on impervious area.

To comply with the criterion, these developments must comply with one of the following:

» have a stormwater offset agreement where an equivalent volume of stormwater is stored and used at an off-site location

» or contribute to the construction of an off-site measure as a means of an offset.

Urban areas suffer when excess volumes of urban stormwater are generated as natural hydrological regimes are altered and pressure on urban creeks increased. However, this excess stormwater can be managed by the introduction of stormwater harvesting and reuse.

For many years, in particular during the prolonged Canberra drought from 1997 to 2009, stormwater harvesting had been considered a water security initiative to supplement our potable water resource.

The WSUD Guidelines suggest that stormwater harvesting be considered as an environmental impact mitigation strategy. Applying fit-for-purpose approaches, stormwater can readily be reused for non-potable demands.

OSR can be achieved at estate level, individual site level or a combination of these. This avoids duplication of mechanisms proposed at estate level or individual block level when development applications are lodged.

To achieve this retention requirement, flows can be stored for re-use or encouraged to infiltrate, evaporate or transpire through natural processes. Suitable uses include the following:

- Toilet connections – calculating all toilet connection may be regarded as contributing to this reuse requirement. Based on MUSIC, the assumption that all toilets are connected will result in total stormwater volume reduction (through usage).
- Laundry: Rainwater tanks connected to the laundry will help reduce water levels in the rainwater tank, thus making more space available to capture more water during the next storm.
- Outdoor irrigation: Rainwater tanks can be used for lawn/garden watering. Increasing the demands on a rainwater tank by attaching more uses such as outdoor irrigation saves more mains water.

Note: If retained stormwater is intended for infiltration then consideration should be made to the fact that ACT has natural clay soils that may not be conducive to this. The duration of stormwater storage should avoid it becoming septic.

5.2.2 On-site detention

Stormwater detention or on-site detention (OSD) is defined as the short-term storage and release downstream of stormwater run-off to ensure the municipal infrastructure capacity is not exceeded. Stormwater discharge to the drainage system is at a reduced rate over a longer period of time. This reduces the peak flow rate of run-off, a common cause of erosion and flooding.

Run-off is detained in these systems for up to six hours. These systems can be combined with stormwater retention/OSR systems and within lakes and ponds.

OSD is generally required for redevelopment involving commercial, industrial or multi-unit residential premises where there is insufficient capacity in the downstream municipal stormwater system to cater for the increased run-off resulting from the development.

In the WSUD General Code on site detention needs to be considered for:

- developments greater than 2000 m^2
- developments within existing urban areas that increase impervious area by 100 m^2.
- estate development plans.

Developments greater than 2000 m^2

To comply with the rule, these developments must provide stormwater detention measures designed to detain stormwater and release it over one to three days; the stormwater capacity of 1 kL per 100 m^2 of total impervious area is provided to specifically detain stormwater generated on site. Alternatively detained stormwater is designed to be released over a period of 6 hours after the storm event.

Why this figure?

The 1 kL per 100 m^2 for OSD is focused on achieving a peak flow rate mitigation goal rather than total volume reduction. This is not to be confused with the OSR requirement as they have different intentions. The 1kL figure mitigates the increase in peak flow in a frequent (1EY) storm event when going from rural to urban land use. Some QLD and NSW jurisdictions use a 24 hour release period after a storm event. Canberra's smaller urban catchments have a critical rainfall duration typically between 15 minutes to two hours. Therefore spreading the peak flow over a period of 6 hours is considered an appropriate way to reduce the risk. It also ensures that calculations do not underestimate the volume required for municipal assets to mitigate peak flow for a broad range of events.

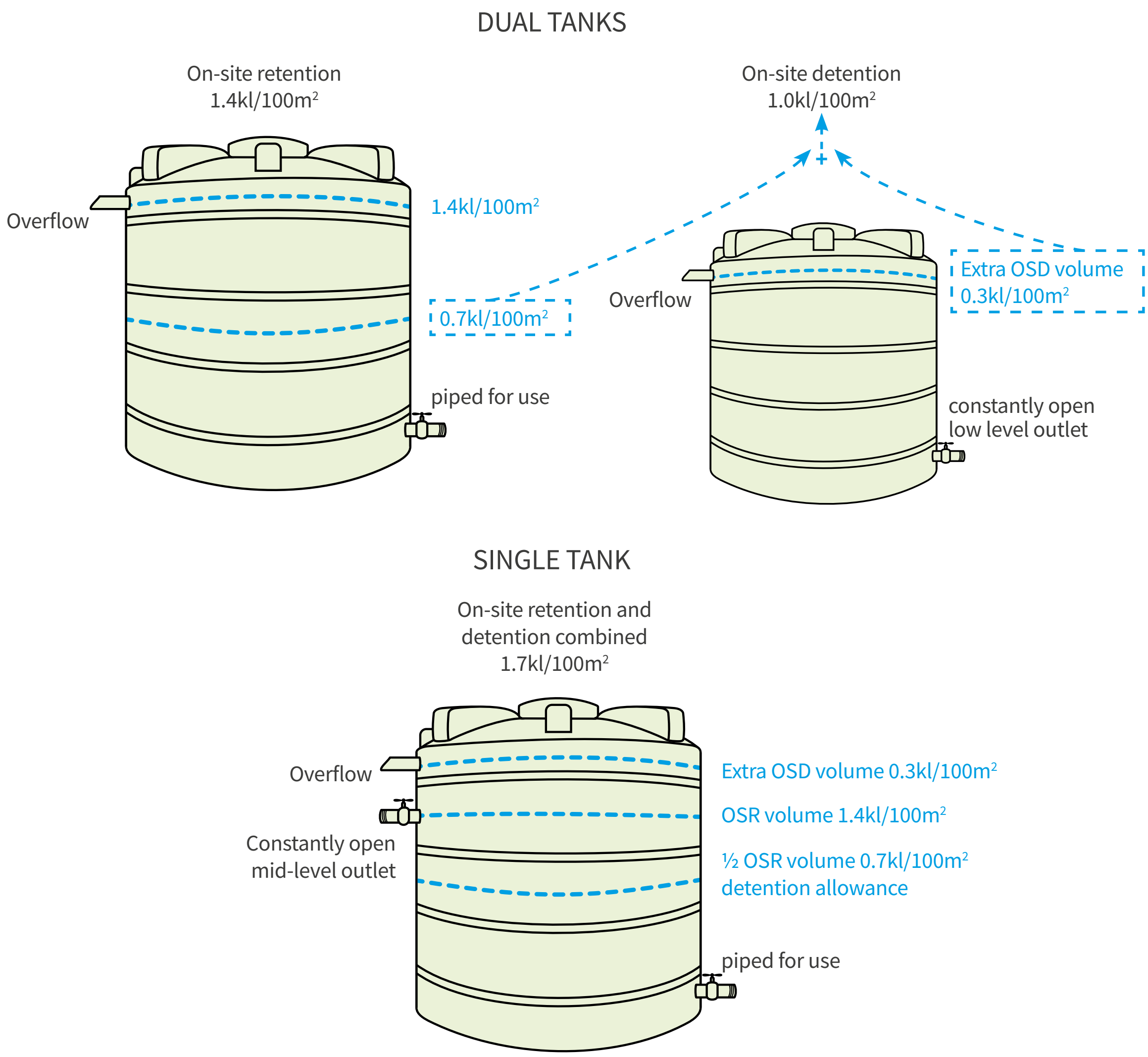
To comply with this criterion, stormwater detention measures must ensure that the peak rate of stormwater run-off from the site does not exceed the peak rate of run-off from an unmitigated (rural) site of the same area for the 1EY (Exceedances per year)[1].

1 Exceedances per year is the new probability terminology part of the Australian Rainfall and Runoff.

Why this figure?

For on-block OSD the frequent 1EY storm event was chosen to balance the need to reduce regular nuisance flooding in our suburbs and reduce the need for new underground pipe systems while minimising the costs of development. The figure chosen mitigates the increase in peak flow in a 1EY storm event when going from rural to urban land use. Note that the 20% (previously 5 year ARI) and the 1% AEP (previously 100 year ARI) event peak flow rate must still be mitigated at an estate scale.

To achieve this detention, a 2000 m^2 site with 80% of impervious area would require short-term storage with a size of 15.6 kL. This equates to 1 kL per 100 m^2 of impervious area. A constantly open low-level outlet of approximately 10 mm diameter would allow flows to leave the tank at a constrained rate throughout (and following) the storm event. Calculating on-site detention can include 50% of the volume of rainwater tanks where stormwater is used on-site. In this case, a 28 kL retention storage would reduce required detention storage by 14 kL.



N.B. Both have the same total storage so 9 times out of 10, applicants will take the single tank opproach

Note: DRAINS and XPRAFTS are examples of stormwater drainage system design and analysis programs typically used to model detention requirements. There is an unmitigated (rural) site node in these programs. Using the same area between an unmitigated (rural) site and a mitigated site provides a baseline and provides a fair comparison.

Calculations based on the rational hydrograph method would also be suitable for smaller blocks.

Estate development plans

Estate development plans require stormwater detention measures to ensure the estate does not exceed the peak rate of runoff from an unmitigated (rural) site of the same area for minor and major storms.

The major storm is described as the 1% Annual Exceedance Probability (AEP). Minor storms are as defined by Transport Canberra and City Services MIS08.

Event peak flow rate must still be mitigated at an estate scale.

OSD can be achieved at the estate development level, individual site level or a combination of the two. This avoids duplication of mechanisms proposed at estate level or individual block level when development applications are lodged.

5.2.3 OSR versus OSD

Table 3:

On-site retention	On-site detention
On-site stormwater retention is defined as the storage and use of stormwater on site. This reduces the total volume of run-off, which has multiple benefits (e.g. water quality and water security). The retained water is used on site. Examples include: » rainwater tanks plumbed into toilets and laundries and used for garden watering » shallow basin that retains water for infiltration and evaporation (no low level outlet).	Previously, OSR is defined as the short-term storage and release downstream of stormwater run-off. This reduces the peak flow rate of run-off, a common cause of erosion. Previously, OSR has been interpreted as OSD and incorrectly focused on the slow release of stormwater, which is an OSD function. Temporary storage and controlled release of stormwater is flood focused to ensure that the municipal stormwater system is not exceeded. The outflow from the storage to the existing municipal stormwater system is limited to a predetermined flow rate, which is usually the flow rate before redevelopment. Examples include: » underground (typically tanks) or surface storage, such as landscaped areas » extended detention volumes in ornamental ponds or wetlands.

5.3 MANAGEMENT OF STORMWATER QUALITY

Stormwater quality requirements have been set for developments to help protect the health of downstream receiving environments. The ACT WSUD General Code (2017) provides a series of catchment-wide targets and development targets. Catchment-wide pollutant reduction targets are adjusted for percentage catchment urbanisation and percentage imperviousness. The possible ranges on pollutant removal are between:

» 23% and 85% of the mean annual suspended solids load

» 15% and 70% of the mean annual total phosphorus load

» 15% and 60% of the mean annual total nitrogen load.

Refer to Appendix A General Code for adjustment calculation details.

Development-specific targets outlined in the General Code are provided below.

5.3.1 Load reduction targets

To reduce the impact of new developments such as residential and mixed-use on lake and waterway health, developments greater than 2000 m^2 must achieve stormwater pollutant load reductions compared with an urban catchment of the same area with no water quality management controls.

This means reducing:

» gross pollutants by at least 90% of the mean annual load

» suspended solids by at least 60% of the mean annual load

» total phosphorous by at least 45% of the mean annual load

» total nitrogen by at least 40% of the mean annual load.

These load reductions can be achieved by using current best practice stormwater treatment measures.

The baseline for stormwater quality targets has been set at an urban catchment of the same area with no water quality management controls. This is the ACT historic baseline for nutrients from changes in development. If we required sites to achieve water quality targets to match an unmitigated (rural) site, this would significantly increase the cost of development.

If the baseline was set to an unmitigated (rural) site with an allowance for additional nutrient load, the targets would need to be re-calibrated.

Canberra is commonly considered to be a largely residential community with a limited number of commercial areas and office precincts. However, the economic activity of the ACT includes some relatively large industrial and heavy industrial areas, primarily located in Mitchell, Fyshwick and Hume. Recent work carried out by the ACT Government has revealed the potentially significant environmental impact from the diffuse pollution across our industrial and commercial areas. Of particular concern is the greater abundance of heavy metals and hydrocarbons that may be washed into our waterways, lakes and ponds.

Devices that achieve the other water quality targets state that they capture hydrocarbons and heavy metals.

Compliance with this rule is consistent by this guideline and demonstrated by a report by a suitably qualified person, using the MUSIC model. If a tool other than the MUSIC model is used then a report by an independent suitably qualified person must be submitted demonstrating and confirming compliance with the code. If the parameters that are non-compliant are used then a report must also be submitted by an independent suitably qualified person stating how and why the parameters are appropriate.

The report should use Module 2 and address the different planning stages to ensure satisfaction with the WSUD Guideline. To comply with the criterion, these developments must comply with one of the following:

- have a stormwater offset agreement where an equivalent load of pollutants is captured at an off-site location
- or contribute to the construction of an off-site measure as a means of an offset.

Note: The methods above in 5.3.1. are also applicable to this section.

5.3.2 Load reduction target for transport infrastructure projects

Roads can generate large amounts of pollutants in urban areas. New major roads (including the duplication of existing major roads) must achieve stormwater pollutant load reductions compared to the unmitigated development scenario. This means reducing:

- suspended solids by at least 60% of the mean annual load
- total phosphorous by at least 45% of the mean annual load
- total nitrogen by at least 40% of the mean annual load.

Note the methods above in 5.3.1. are also applicable to this section.

5.4 CONTRIBUTING TO ADAPTING CANBERRA'S COMMUNITY TO FUTURE CLIMATE

5.4.1 Nuisance flooding and increasing rainfall intensity

Climate change projections for the ACT predict an increase in the frequency of intense storm events. This means the capacity of stormwater drainage infrastructure may be exceeded more frequently in the future. This results in increased ponding and overland flow in property, termed 'nuisance flooding'. Nuisance flooding differs from riverine flooding in that it is associated with localised cells of high rainfall intensity. Nuisance flooding represents a significant impact for properties and people in the ACT.

As overland flows always follow natural drainage paths, the provision aims to prevent natural flow paths being obstructed with buildings, fences, roads etc.

Developments may be required to carry out hydrological and hydraulic assessment.

5.4.2 Supporting the creation of green/living infrastructure in the ACT

The ACT Government promotes living (green) infrastructure and is developing a strategy to guide the promotion and inclusion of green infrastructure in the planning and design of future urban living.

WSUD practitioners should liaise with urban designers, landscape architects and environmental scientists on projects that support green infrastructure by incorporating ecosystem services including:

- combating urban heat island effect
- increasing the soil moisture recharge
- contributing to sustaining healthy vegetation and resilient urban trees via passive irrigation
- reducing the imperviousness of surfaces
- promoting stormwater reuse for irrigation (including passive irrigation).

Development within existing urban areas such as urban renewal sites that increase the impervious area of the site by 100m2 or more will need to consider living infrastructure. Note, that the WSUD General Code does not apply to single dwellings and secondary residences subject to the single dwelling housing development code. Development is required to meet a minimum of 20% target of permeable surface area through the use of green infrastructure and permeable surfaces e.g. landscaping.

Why this figure?

A target of a minimum of 20% permeable surface area is used to encourage on-site infiltration and other ecosystem functions and is achievable. This rule has been proposed in order to balance environmental and economic value. Tank storage requirements in the past have assumed a degree of site permeability. As urban infill takes place this assumption is increasingly incorrect. Tank storage alone does not mitigate all the effects of the loss of permeable surfaces and is costly for fully impervious sites. Thus this rule balances economics (e.g. tank cost, permeable material cost) with environmental considerations (e.g. urban heat island, flood mitigation).

The introduction of large areas of impervious surfaces is a central cause of detrimental impacts on urbanised catchments. However, opportunities for introducing porous pavements and permeable surfaces include:

» carparks and parking bays
» footpaths and other pedestrian areas
» public open space in general
» driveways.

Note:

The 20% target in the rule is relaxed in the criterion. That is, if a proponent cannot meet the 20% target they must ensure that they meet the other listed requirements in the WSUD Code and those listed above.

5.5 ENTITY (GOVERNMENT AGENCY) ENDORSEMENT

The new ACT WSUD Guidelines are designed to guide and support practitioners. The ACT Government has identified varying levels of quality in the design of WSUD assets over the last decade. One source of discrepancy in the level of service obtained from WSUD assets originates from the poor documentation and lack of transparency in the planning and design of the assets. The following requirements will help improve the documentation and quality of information submitted to the ACT Government.

In the interest of clarity of design, operation and function, the design and planning process of WSUD assets are required to be transparent. In particular, the ACT Government is now in the position to audit and verify the water quality improvement claims for proposed WSUD assets. In support of this, proponents will be required to:

» complete the WSUD planning and design process checklists (see Appendix B of Module 2)
» submit the WSUD water quality model files (e.g. MUSIC) for compliance check
» be available to discuss any modelling, planning or design questions following the review of their proposed design with ACT Government representatives.

Responsibility, operation and maintenance

To ensure WSUD assets continue to function as designed, on-going operation and maintenance will be required. Therefore, early identification of the responsibility for this management and the tasks required is important. It is recommended all developers have an operation and maintenance plan that identifies:

- responsible parties through the asset life, including the handover process
- construction and establishment approach
- on-going water quality monitoring (if required)
- ongoing operational requirements
- maintenance regime
- life-cycle costing for the asset.

It is recommended the developer be responsible for the construction and establishment of the WSUD asset so that when it is handed over to the future asset owner it is fully established and operational. For vegetated WSUD assets, a two-year establishment period is recommended to ensure the planting is fully grown and resilient. This is longer than required under the Municipal Infrastructure Standards but provides greater certainty to the ultimate asset owner (TCCS) that the system has been delivered successfully and is fully operational.

The ACT WSUD Guidelines—Module 2 provides advice on the possible construction and establishment approaches, required maintenance activities and the handover process for WSUD assets.

Access to Dickson Wetland for maintenance.

6. WATER SENSITIVE URBAN DESIGN ADOPTION FRAMEWORK IN THE ACT

6.1 PLANNING AND DESIGN FRAMEWORK

6.1.1 Metropolitan land use planning

At the most strategic level, the Territory Plan includes considerations for WSUD and catchment management. Proponents are required to understand the current zoning and any proposed rezoning proposals for their development.

The ACT WSUD General Code applies varying targets for different land uses. Precinct codes will provide any regional-specific provisions. Finally, the specific requirements of the respective development codes must be reflected in any WSUD strategies and proposals.

6.1.2 Structure and concept planning

At the structure and concept planning phase of larger developments, WSUD solutions are required to establish the large-scale framework for the future design and implementation of WSUD assets. In particular:

- stream and inundation corridors (up to and including 1% Annual Exceedance Probability (AEP) flood levels)
- major drainage channels
- overland flow paths for flows exceeding pipe network capacity
- location and dimensions of regional flow attenuation basin
- location and extent of regional urban space corridors and parks
- optimisation of overall water management strategy (flow attenuation, water quality improvements) according to topography, hydrographic structure and regional urban planning intents
- definition of development specific targets, outlining the respective contributions towards the larger catchment-wide objectives.

These elements need to inform and be documented in the form of precinct codes. In the absence of a precinct code, or if a precinct code is silent on water management objectives, future development applications will be evaluated against the general provisions of the WSUD General Code.

For cost-effectiveness and infrastructure efficiency, large-scale stormwater management and WSUD strategies should be captured in precinct codes.

6.1.3 Estate planning and design

In the ACT, the Suburban Land Agency's (SLA) Estate Development and Planning Guidelines offer guidance regarding the necessary planning and design considerations expected from development proponents. WSUD and stormwater drainage form part of the requirements to be documented in an EDP submission. Block specific requirements should be included on EDP planning controls, plans and developer sales documentation so this information is transferred to builders and Multi Unit/housing and development application/building application assessors.

At the estate planning level, for the continuity of WSUD treatment trains WSUD strategies need to focus on the integration of urban design and built form and the balance between public and leased land. They must refine the general (WSUD General Code) or precinct-specific (precinct code) objectives for each sub-catchment.

The SLA EDP Guidelines are currently being revised, and will contain information relating to the specific details, format and level of documentation expected for development applications in the ACT.

6.1.4 Block and section development

Development applications and building approvals are required to be submitted for new developments. The various assessment codes in the Territory Plan provide the rules and criteria that must be met in relation to WSUD.

A range of WSUD measures can be implemented depending on the nature of the development and local conditions. All developments on individual blocks, regardless of whether they are residential, commercial, industrial or institutional, are required to comply with the mains water use reduction target. Any addition or alteration to a residential property that increases the floor area by greater than 50% is also required to comply with the mains water reduction target for the whole property.

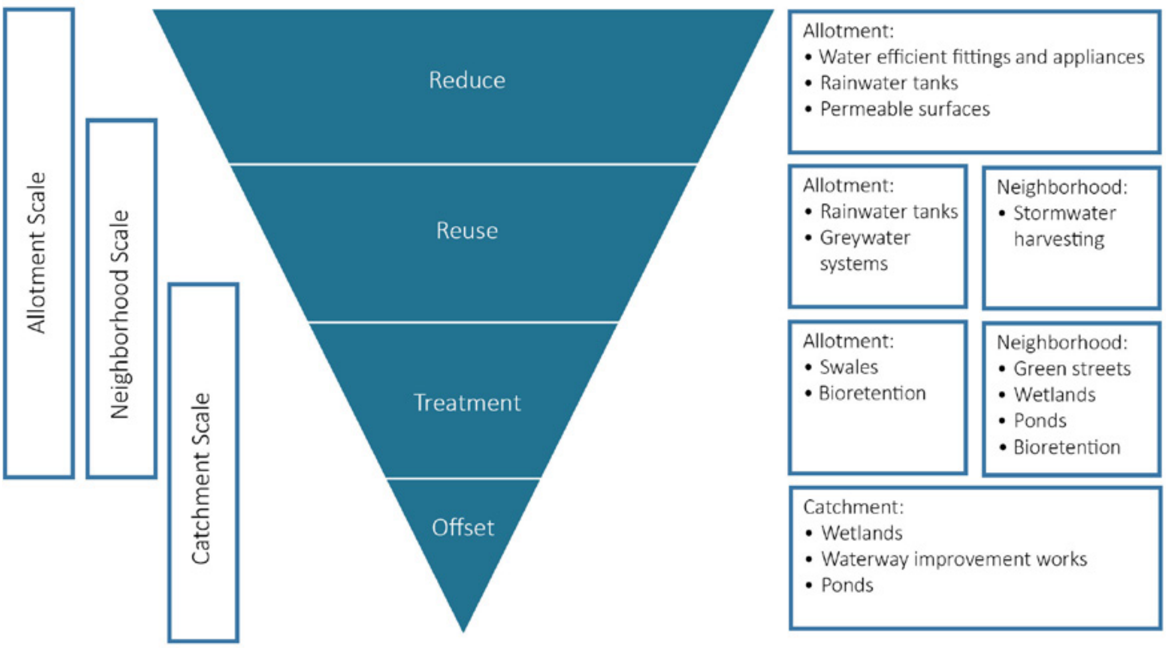
The stormwater quality and quantity targets apply to all new residential estates, all residential developments with three or more residential units and any non-residential development where the total site is greater than 2000 m^2 for quantity targets and 5000 m^2 for quality targets.

6.2 WSUD SOLUTION HIERARCHY

The development of a WSUD strategy for a site should follow a hierarchy whereby water use and generation is reduced or re-used before treatment, disposal or offsetting is undertaken. This hierarchy of use is summarised in Figure 11.

This hierarchy identifies that WSUD can be delivered at a number of different scales and by many different treatment systems. It also highlights that all components of the urban water cycle—potable, wastewater and stormwater— must be considered. The following sections describe options for how this can be delivered at the individual and on-block scale and the neighbourhood scale.

Figure 10: WSUD Hierarchy



6.3 INDIVIDUAL AND ON-BLOCK MEASURES

Measures can be implemented on-block to address the impact of development at its source and to add to both the aesthetic and environmental qualities of a development. On-block measures can be applied to any development, whether it is a single-residential dwelling, industrial or commercial block. Measures for block-scale implementation include structural and non-structural measures.

6.3.1 Structural measures

On-block structural WSUD measures are encouraged in all new developments to promote more responsible water management. Such measures will contribute significantly to achieving WSUD targets, particular in reducing potable water consumption.

Potable water use reduction

- Use water efficient appliances and fixtures. The Water Efficiency Labelling Standards (WELS) allow consumers to compare the water efficiency of different products by requiring that certain products have water rating labels at the point of sale or display/advertising. The Territory requires a four star rating.
- Install rainwater tanks to help with garden watering and internal uses (e.g. toilet, laundry cold water).
- Use greywater for irrigation and toilet flushing in individual dwellings.

Stormwater management

- Increase the permeable surfaces (lawns, gardens and permeable paving) to reduce run-off.
- Disconnect downpipes and change impervious surfaces to permeable surfaces—and even allotment-scale swales or bioretention systems—with care not to direct flow to adjacent blocks.
- Use rainwater tanks to capture and re-use roof run-off, reducing the amount of stormwater discharged from the site.

Wastewater reuse

- Directly use untreated greywater on gardens, subject to matching soil types, plant types and water quality.
- Install a greywater treatment system for use in toilets, laundries and gardens.

6.3.2 Non-structural measures

Some non-structural demand management measures that can be adopted at the allotment scale will help achieve WSUD outcomes by targeting behavioural change, including:

- education, for example leaflets, factsheets, advertisements
- incentives, for example grants to encourage adoption of rainwater tanks
- regulation, where policies and regulations can require the adoption of WSUD and promote green infrastructure.

6.4 PRECINCT LEVEL OPTIONS

Neighbourhood or precinct scale measures can consist of a number of distributed systems throughout the development (such as street tree bioretention systems and swales) or larger end-of-pipe solutions (such as wetlands and ponds).

An appropriately sized and designed single WSUD measure at the downstream end of an estate, such as a wetland, can satisfy water quality requirements and provide recreation and amenity benefits when integrated with public open space. In large catchments containing waterways or existing water bodies, large end-of-line measures will provide no water quality benefits to those existing natural assets within the development itself. In this instance, considering a treatment train of distributed neighbourhood measures or fully integrated solutions can provide water quality benefits throughout the development and improve the local amenity.

6.4.1 Distributed neighbourhood measures

Distributed neighbourhood measures use a small systems approach to managing the urban water cycle. The distribution of WSUD measures will lessen the reliance on a single measure, improve water quality within a development and enhance both the aesthetic and environmental qualities of a development.

Distributed neighbourhood measures include:

Potable water use reduction

- Use stormwater to replace potable water for irrigation.
- Use wastewater treatment and reticulation in a recycled water network for demands that do not require water of a potable water standard.

Stormwater management

- Green streets—use bioretention or swales to capture and treat stormwater flows from streets (including passively irrigated street trees).
- Integrate bioretention, wetlands, ponds or retarding basins into small neighbourhood parks to provide stormwater quantity and quality management.
- Harvest treated stormwater in lakes or other storages for irrigation of public open spaces.

Wastewater reuse

- Construct a precinct scale sewage treatment and third pipe network to treat and distribute recycled water to buildings for re-use.

6.4.2 End-of-pipe measure at estate outlet

Reliance on a single measure alone is not the preferred approach and should only be used where a system of more distributed measures is not practical. As well as placing a high level of reliance on the single WSUD measure, it loses the opportunity to enhance the urban environment by including WSUD measures into the local landscape. If a single measure is required, the system must be appropriately sized. Generally this would be an appropriately sized wetland.

6.5 FULLY INTEGRATED ESTATE SOLUTIONS

The preferred implementation of WSUD stormwater management is in a fully integrated solution that includes on-block measures and neighbourhood scale measures in public spaces distributed throughout the development. This approach is beneficial as it lessens the reliance on individual measures and provides opportunity to enhance the urban environment by the inclusion of these measures into the local landscape.

It will also involve the adoption of a portfolio of diverse water sources such as rainwater, natural catchment water, groundwater, wastewater and stormwater that can be dynamically optimised depending on local climatic, ecological and socio-demographic condition.

Implementation of fully integrated measures can include both allotment scale and neighbourhood scale systems.

Table 4 compares the design considerations required for both at-source and end-of-pipe solutions, highlighting the benefits and risk associated with both.

6.6 WSUD IMPLEMENTATION CONSIDERATIONS

6.6.1 Operating and maintenance cost considerations

As mentioned previously, there is focus on managing the on-going operating and maintenance costs associated with WSUD assets. Key stages in the WSUD asset design, construction and establishment will impact the ongoing operation and maintenance of the WSUD asset, including:

» Design—WSUD assets need to be designed to meet best practice, including ensuring there is adequate maintenance access provided.

» Construction—the construction of a WSUD asset may need to be staged to protect it from sediment laden flows as the catchment is being built-out.

» Establishment—it is recommended that vegetated WSUD assets have two years to establish before being handed over to ensure the vegetation is successfully established and the system is operating as designed.

Table 4: Comparison of at-source and end-of-pipe solutions identifying benefits and risks for different design considerations

Design consideration	At-source approach	On-site, end-of-pipe approach
Design levels and site grades	At-source treatment systems treat flows before they enter a pipe network so the surface level is not driven by a pipe invert level. These systems need to be able to freely drain to a downstream pipe network or waterway channel.	When stormwater flows enter a pipe before being treated, the surface level of the treatment system will be determined by the level of the pipe. If pipes are too deep, the treatment system will require very large batters (significantly increasing the overall footprint and land take) or steep banks that may require fencing. This is not ideal when trying to deliver a high amenity landscape. It is also important that these systems can freely drain to the receiving waterway or pipe network. End-of-pipe solutions are therefore better suited to undulating sites which have enough grade to allow the pipes to discharge to the surface of the end-of-pipe treatment system and freely drain to downstream receiving systems.
Scale and site suitability	Bioretention systems are ideal for at-source treatment given their relatively smaller footprint compared to other treatment options, flexibility in form/shape and lack of permanent water.	Both bioretention and wetlands are suitable for distributed end-of-pipe solutions. The site characteristics and catchment size will influence treatment device selection. If they are to be co-located with detention basins, wetlands are preferred due to their resilience to sediment loads and inundation.
Integration with landscape	At-source systems can be designed as functional streetscape garden beds or street tree pits.	Distributed systems can be designed as either natural garden or water landscapes (local parklands) or integrated into the urban area as hard edged planted landscapes (e.g. within urban plazas).

More detail on each of these stages is provided in Module 2. Module 2 also provides advice on the types of maintenance activities that are typically required for WSUD assets to help inform the development of costed maintenance regimes which can assist in the planning and budgeting of ongoing operation and maintenance works.

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ACT
Government

ACT PRACTICE GUIDELINES FOR WATER SENSITIVE URBAN DESIGN

MODULE 2: DESIGNING SUCCESSFUL WSUD SOLUTIONS IN THE ACT

Director-General,
Environment, Planning and Sustainable Development Directorate,
ACT Government,
GPO Box 158, Canberra ACT 2601.

Telephone: 02 6207 1923
Website: www.environment.act.gov.au
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Contents

1. INTRODUCTION

Purpose of the WSUD guidelines

Water sensitive urban design (WSUD) is an approach to urban planning and design that aims to integrate the management of the urban water cycle into the urban development process. This includes the integrated management of stormwater to minimise water run-off and ensure that any run-off causes the least amount of damage from a water quality and quantity perspective. It includes the wise use of potable water (i.e. drinking water supplies) and reduction in the generation of wastewater (i.e. any water that has been adversely affected in quality by anthropogenic influence. Wastewater can originate from a combination of domestic, industrial, commercial or agricultural activities and is expressed as surface runoff or stormwater) to improve our urban environments.

The Practice Guidelines for Water Sensitive Urban Design in the ACT (the WSUD Guidelines) continues the ACT Government's commitment to WSUD as part of a broader strategy of responsible water resources management.

The WSUD Guidelines comprises two main documents as outlined in the following figure. The first module provides an introduction to WSUD in the ACT, summarising the need for it and the policy and regulatory framework supporting its adoption. The second module (this document) provides the practical guidance for the delivery of WSUD across the ACT, including recommendations for the planning, design, establishment, operation, maintenance and decommissioning of WSUD assets.

The WSUD Guidelines support the Waterways: Water Sensitive Urban Design Code (the WSUD Code) which is a General Code under the Territory Plan. The WSUD Guidelines provide developers, ACT Government officers and residents with support on introducing WSUD into their residential lot, streetscape, neighbourhood and estate.

Figure 1: This figure presents an overview of the two WSUD Guidelines documents, outlining the different content provided within each document

Module 1: Introduction to WSUD in the ACT

1. **Introduction**
2. **The need for WSUD in the ACT**
3. **Solutions for a water sensitive Canberra**
4. **ACT Water Sensitive Urban Design policy environment**
5. **Key objectives of Water Sensitive Urban Design in the ACT**
6. **Water Sensitive Urban Design adoption framework in the ACT**

Module 2: Designing successful WSUD solution in the ACT

1. **Introduction**
2. **Overview of the WSUD planning, design and delivery process**
3. **Critical steps to WSUD planning**
4. **Critical steps to WSUD design**
5. **WSUD treatment assets construction and establishment**
6. **WSUD treatment asset operation and maintenance**
7. **Handover of WSUD treatment assets to the ACT Government**
8. **Monitoring water quality**
9. **Asset renewal and decommissioning**

The WSUD Guidelines replace the Waterways 2007 guideline, which was codified as part of the introduction to the new Territory Plan in 2009. The revised WSUD Guidelines (2017) were updated following a comprehensive review process involving ACT Government agencies and directorates as well as a technical review panel of industry experts.

The new ACT WSUD Guidelines were revised to support the following elements:

» An updated ACT WSUD General Code (2017): simplified Territory Plan Code document providing clearer compliance criteria and a merit track.

» A newly created Introduction to WSUD in the ACT document (Module 1): offering a high level review of the ACT regulatory and policy frameworks, and establishing planning principles for the promotion and adoption of WSUD to support the ACT Government policies and the Territory Plan.

» A technical ACT Practice Guidelines for WSUD (Module 2—this document): providing guidance on how to plan, design and maintain WSUD assets in Canberra, design checklists and technical references specific to the ACT context.

This set of guidelines and reference documents will support a more cost-effective and efficient adoption of WSUD in the ACT and implement the ACT Water Strategy. These documents will also help the ACT Government and the urban development industry work with communities to ensure the planning, design, construction and retrofitting of urbanised landscapes are more sensitive to the natural water cycle.

Purpose of this document

The purpose of this document is to provide practitioners with a guideline on how to plan for and deliver successful WSUD outcomes in the ACT. The guideline can be used sequentially, stepping through the planning, design and delivery process or as a reference document to inform particular stages of WSUD delivery and operation.

Information contained in this document includes a step-by-step process to plan, design and deliver different WSUD solutions in Canberra that are suited to the site, and recommendations for the ongoing maintenance and monitoring of WSUD assets. A diagram representing the chapters and content is provided in figure 1 above.

Target audience

This document is relevant to those involved in the planning, design and delivery of WSUD projects. This includes the government agencies and utilities, developers and their planning and design teams:

» **Government agencies and utilities** with responsibilities for various aspects of water management will use this guideline to build understanding of WSUD requirements to achieve the specific targets in both their own projects and in the assessment of private developments. Government agencies and utilities include the, Land Development Agency, Transport Canberra and City Services Directorate (TCCS), Icon Water and ActewAGL.

» **Land and commercial developers**, including urban developers in both the public and private sectors, will use this guideline in the planning and design of all new urban developments and redevelopments to integrate the WSUD requirements and achieve the specific targets.

» **Planners and design consultants** will use this guideline to understand the concepts behind current best WSUD management practices and also for specific technical information to inform the planning, design and delivery of WSUD measures for new projects. This information is relevant for planners, urban designers, civil engineers, landscape architects, cultural heritage professionals and ecologists as successful WSUD delivery requires the collaboration of all of these disciplines.

» **Builders of new urban dwellings** and extensions and alterations that increase the floor area by more than 50% that are not classified as single dwellings, who are required to comply with the WSUD code. This guideline will help builders identify suitable WSUD solutions for this scale of development.

Relationship with Municipal Infrastructure Standards[1]

The Municipal Infrastructure Standards (MIS) are the approved standards for all infrastructure, providing a clear and consistent source of information to inform urban development. The MIS (in particular MIS08 Stormwater) sets the default values for practitioners and engineers to design stormwater assets that are currently acceptable by the ACT Government. However, the approach of the MIS08 is to allow some level of flexibility to industry, with MIS08 providing a caveat that "if the design standards cannot be appropriately applied, the proposed innovation should be justified in writing and discussed with and approved by TCCS and a certified engineer. The innovation should consider whole-of-life costs and ACT conditions as described in the WSUD Practice Guideline".

The information in this WSUD Practice Guideline will provide a guiding assessment framework to help the ACT Government assess and approve innovative approaches outside of the MIS; however, any municipal infrastructure that sits outside of the MIS must be justified in writing and discussed with and approved by TCCS and a certified engineer. Infrastructure and assets outside of the MIS must be considered as part of an integrated treatment train process. The decision to approve any municipal infrastructure that does not comply with the MIS series lies with the ACT Government (TCCS). Practitioners and developers should use the ACT WSUD Practice Guideline for guidance only in preparing their documentation in conjunction with the MIS or any other related documentation.

1 Please note that at the time of writing the WSUD Guidelines, TCCSwere reviewing all their documentation including the standard specifications and designs standards for urban infrastructure. Caution needs to be applied on which is the most up to date document and this can be determined by contacting Roads ACT directly through Canberra Connect on 13 22 81.

2. OVERVIEW OF THE WSUD PLANNING, DESIGN AND DELIVERY PROCESS

Key steps are required to successfully plan, design and deliver WSUD assets. These steps are summarised in Figures 2 and 3 and described in more detail throughout this document.

Figure 2 presents a summary of a typical WSUD design and delivery process for estate development. The process starts with the development of suitable WSUD strategies that reflect an understanding of the site and the required objectives, followed by the design of the appropriate treatment systems. It is critical that the planning and design of WSUD assets is undertaken with the collaboration of planners, civil engineers and landscape architects to ensure these systems are well integrated within the development and meet the treatment requirements as well as the amenity and landscape values for the site. It is also critical that the planning and design steps consider the staging, establishment and maintenance of the WSUD assets and their lifecycle costing.

The construction and establishment phase of WSUD assets is critical to ensure the ongoing function of the systems and to reduce the burden of ongoing maintenance requirements. Staging of this in the process can help protect WSUD assets from construction phase erosion and sediment impacts. Once WSUD assets are successfully established (which can take up to two years for vegetated systems), the ongoing maintenance requirements for these systems is minimised. However they do require ongoing inspections and monitoring to ensure they continue to operate as designed.

Figure 2: Summary of a typical WSUD design and delivery process for estate developments.
The blue boxes show where this process information is described in more detail in this document

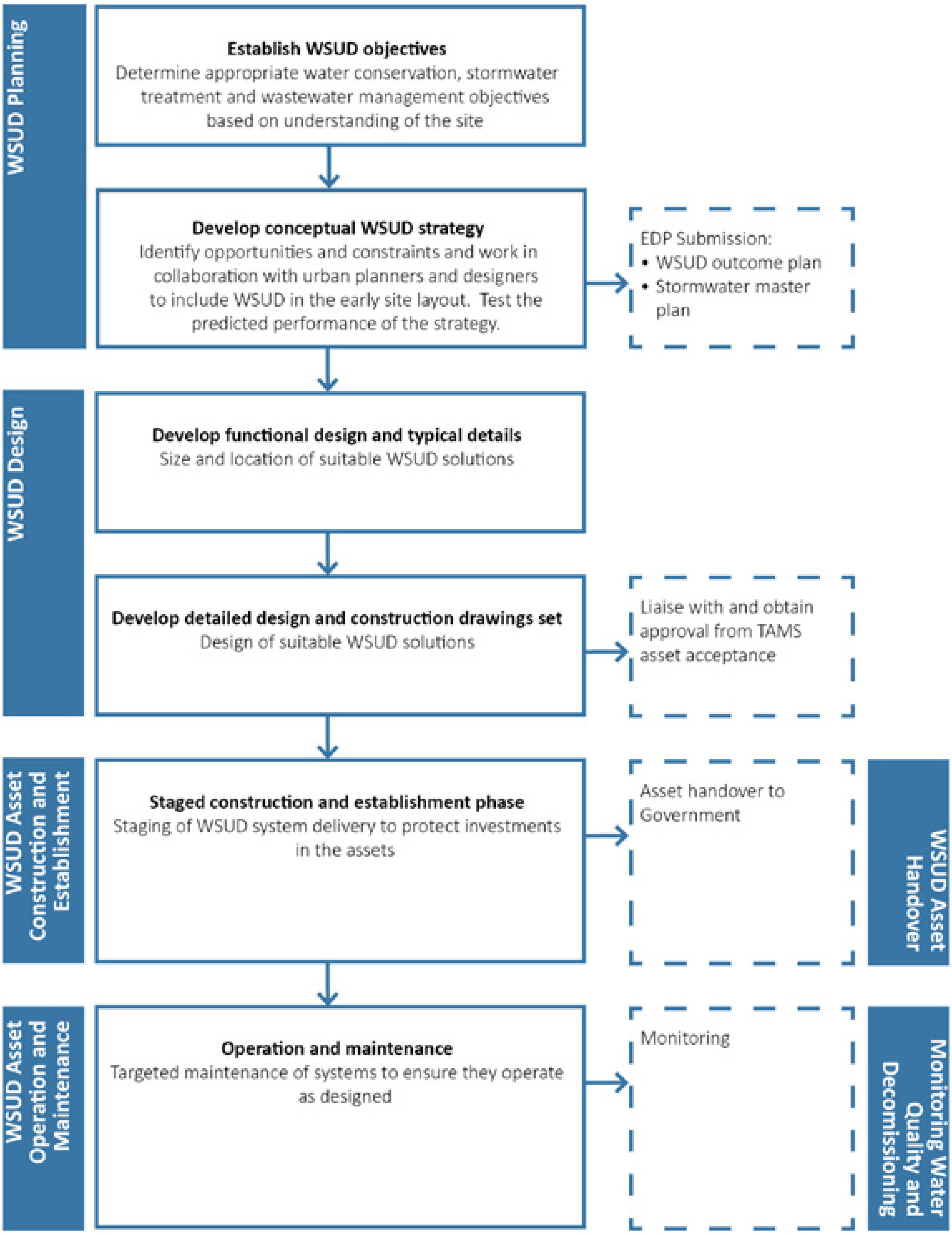
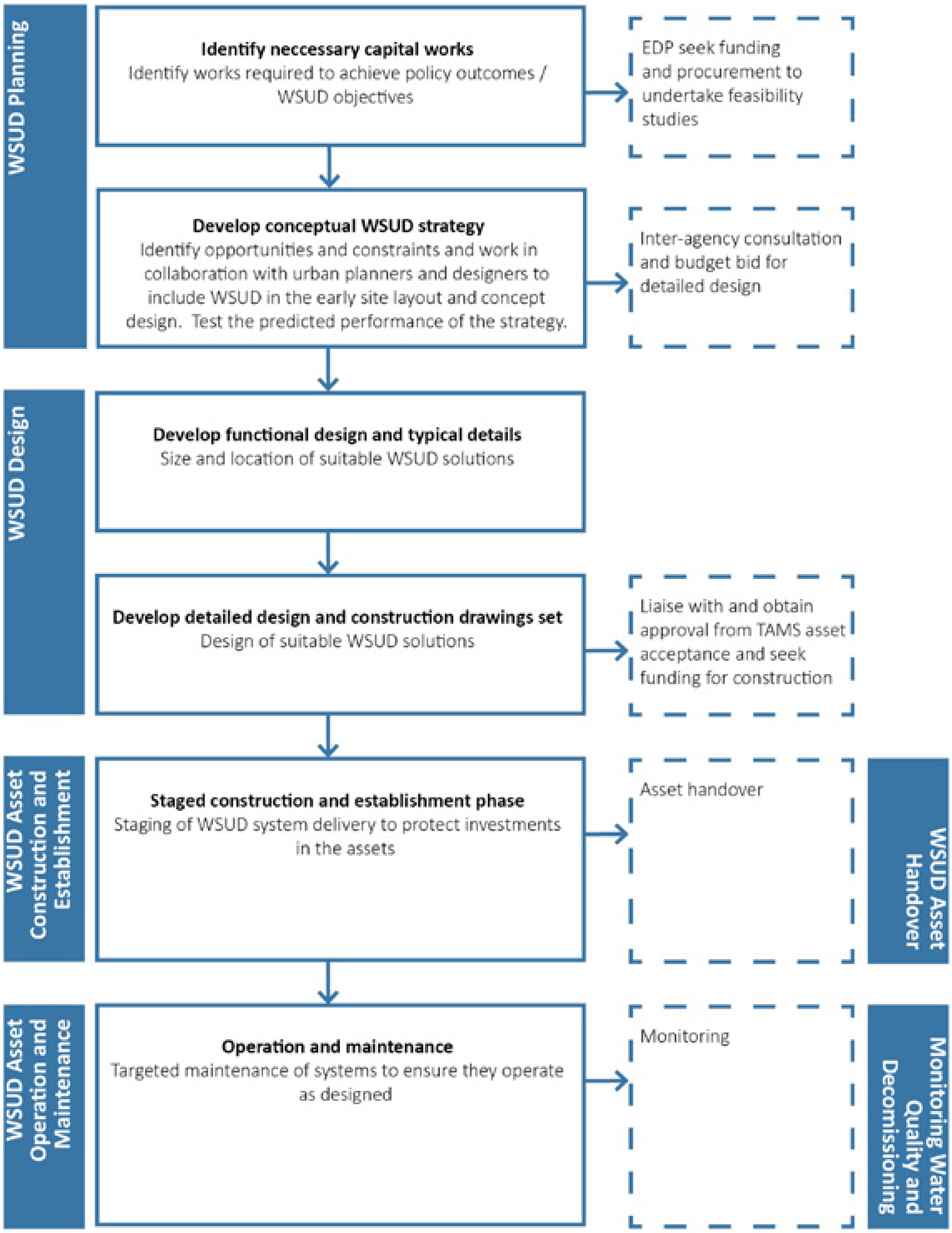


Figure 3: A summary of a typical WSUD design and delivery process for capital works projects. The blue boxes show where this process information is described in more detail in this document



3. CRITICAL STEPS TO WSUD PLANNING

The initial stage for the design and delivery of any WSUD asset is to develop a conceptual plan for the solution.

The planning process will be the same for any scale (catchment vs plot), but the outcomes will be different (different objectives will apply and different solutions will be suitable for different scales and types of development). While outside the scope of this Guideline, it is important to note the elements of WSUD planning need to start at the catchment planning and land use planning stage. WSUD considerations at these early stages can play a large role in reducing stormwater run-off and pollutants.

The key steps required for WSUD planning are:

Step 1

Identify the WSUD targets applicable to the development type and scale.

Step 2

Identify the suitable WSUD strategy for the site to meet the WSUD criteria. This may include a fully integrated solution, on-block measures or neighbourhood solutions.

Step 3

Assess the ability and effectiveness of this strategy to meet the required targets.

The following sections guide each of these steps.

STEP 1: Identify the WSUD targets applicable to the development type and scale

This initial step in the planning process identifies the targets the WSUD strategy needs to achieve. These targets will differ for different scales and types of development so it is important to have an understanding of the site characteristics to enable to identification of the required targets.

Use the WSUD General Code to help identify the suitable WSUD targets for the site based on the site and proposed development characteristics. The following table provides a summary of the types of targets applicable for different development types and scales.

Table 1: The type of WSUD targets required for different development types / site areas. More details on the specific target requirements can be found in the WSUD General Code

Development type / site area	WSUD targets[1]				
	Potable use reduction	Stormwater quantity		Stormwater quality	
		On-site stormwater retention	On-site stormwater detention	Development or redevelopment sites	Regional or catchment wide targets[2]
All assessable development and major alterations and/or extensions to existing buildings (if the work affects more than 50% of the floor area of the whole of an existing building) *except single dwellings, secondary dwellings*	★				
Sites > 2000 m^2 (developer responsibility)	★	★	★	★	
Estates / capital works (government responsibility)					★
Transport infrastructure		★	★	★	

[1] refer to Waterways: WSUD General Code for more details

[2] refer to Appendix A

To understand the planning controls and requirements for the site, refer to relevant development tables, codes and overlays in the Territory Plan. These will identify if a development is prohibited, exempt, or which assessment track and assessment codes apply. Overlays identify land characteristics which may constrain development of land and are also used to indicate where precinct codes exist. These precinct codes take precedence over other development and general codes.

STEP 2: Identify the suitable WSUD strategy

Once the WSUD targets are known (step 1), use the site characteristics to identify the suitable strategy to achieve these targets (this step).

To gain an understanding of the site and to develop an appropriate WSUD strategy to meet the WSUD targets, the following tasks will be required.

TASK 1: Identify site constraints and opportunities

Different catchments and types of development offer differing site constraints and opportunities for WSUD strategies. For example, flat sites can be problematic for getting stormwater pipes to discharge at the surface of treatment systems or to get free draining WSUD assets so potential strategies could look to keep water at the surface before treatment (using swales or streetscape treatments), thereby reducing the depths and lengths of stormwater pipes.

This first task in the development of a WSUD strategy involves preliminary research of the site including a desktop analysis and site visit to the development location. Consider the site constraints and opportunities in Table 2 in this analysis.

Table 2: Possible constraints and opportunities for different site characteristics and sources of information

Site characteristic	Possible constraints and opportunities	Potential source of information
Topography	*Flat sites (<1%)* - can be difficult for stormwater treatment and conveyance *Moderate slopes (2-5%)* - offer the most flexibility in WSUD solutions *Steep sites (>10%)* - can be risky or expensive to develop	Topography map with contours, GIS system such as ACTMAPi
Receiving environments	*Waterways* – need to protect waterway stability, water quality and in-stream environments *Lakes and ponds* – need to ensure good water quality by reducing pollutant loads *Water levels* – the water level in the receiving environments will set the levels of the stormwater treatment systems within the development to ensure they are free-draining	Waterway and catchment mapping, site visit outcomes
Vegetation and habitat	*Existing protected and significant species* – protection requirements *Native vegetation* – protect where possible and use as a local planting palette where appropriate	Threatened species register
Soil	*Impermeable soils* – reduced opportunities for infiltration to occur[1]	Soil landscapes map
Existing infrastructure	*Capacity* – the capacity of existing infrastructure may not be able to accommodate additional inflows and therefore may require expensive upgrades or on-site solutions are required to reduce discharge volumes *Levels* – the level of existing infrastructure will set the levels of the stormwater treatment systems within the development to ensure they are free-draining	Water (potable, stormwater and wastewater) network mapping and planning
Pollution type and load	*Pollutant types* – understanding this will help to identify the preferred stormwater treatment train for the site	MUSIC modelling tool / guidelines

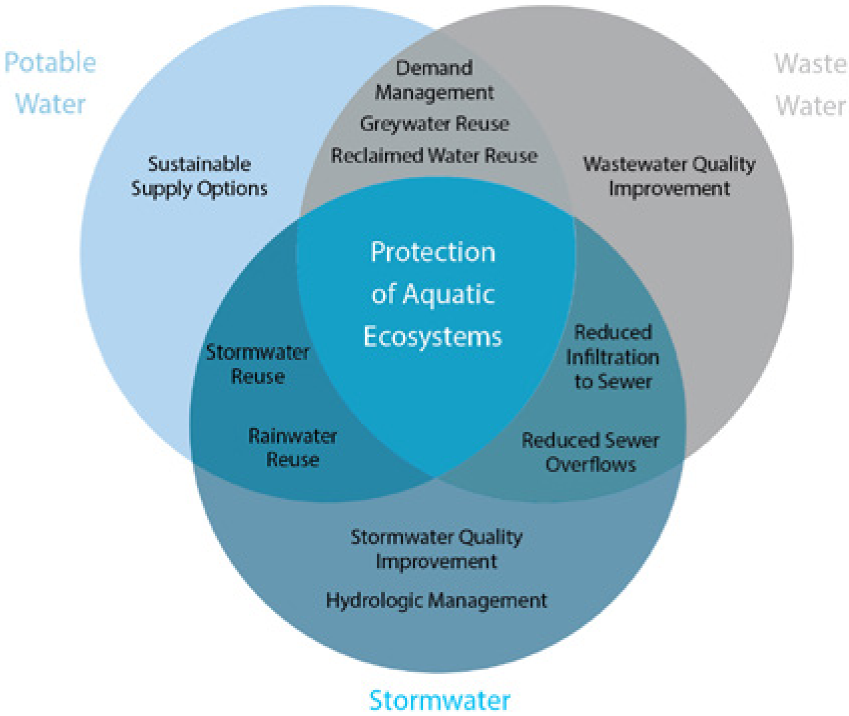
1 Canberra soils are generally clay-based and therefore do not absorb water quickly. They also have fine particle sizes, so can be easily eroded. This does not preclude the use of WSUD in the ACT, but it does mean that WSUD strategies for all types and scales of development are recommended to achieve the following:

- soil stability and management of flow velocities to prevent erosion and sedimentation;
- use of porous underdrainage to support infiltration type assets (e.g. porous pavements); and
- encourage enhanced water penetration through soil improvement and retention of upper soil moisture.

TASK 2: Identify Total Water Cycle Management (TWCM) Strategy

WSUD considers all elements of the urban water cycle including potable water, stormwater, wastewater and groundwater. This holistic consideration of the urban water cycle is described as Total Water Cycle Management (TWCM).

Figure 4: The concept of Total Water Cycle Management (TWCM) considers all elements of the urban water cycle and their interactions. TWCM is an important component of WSUD (Hoban & Wong 2006)



Understanding the WSUD targets and the characteristics of the site will help build the requirements of the TWCM strategy for the site. For example:

» Sites with limited capacity in downstream wastewater infrastructure may need to consider on-site treatment and re-use of wastewater as a primary driver for the TWCM strategy.

» Sites with sensitive receiving waterways may need to consider on-site treatment and re-use of stormwater for the management of (excess) flows as a primary driver for the TWCM strategy.

» Sites with requirements for potable water conservation may need to consider the use of alternative water supplies on site as a primary driver for the TWCM strategy.

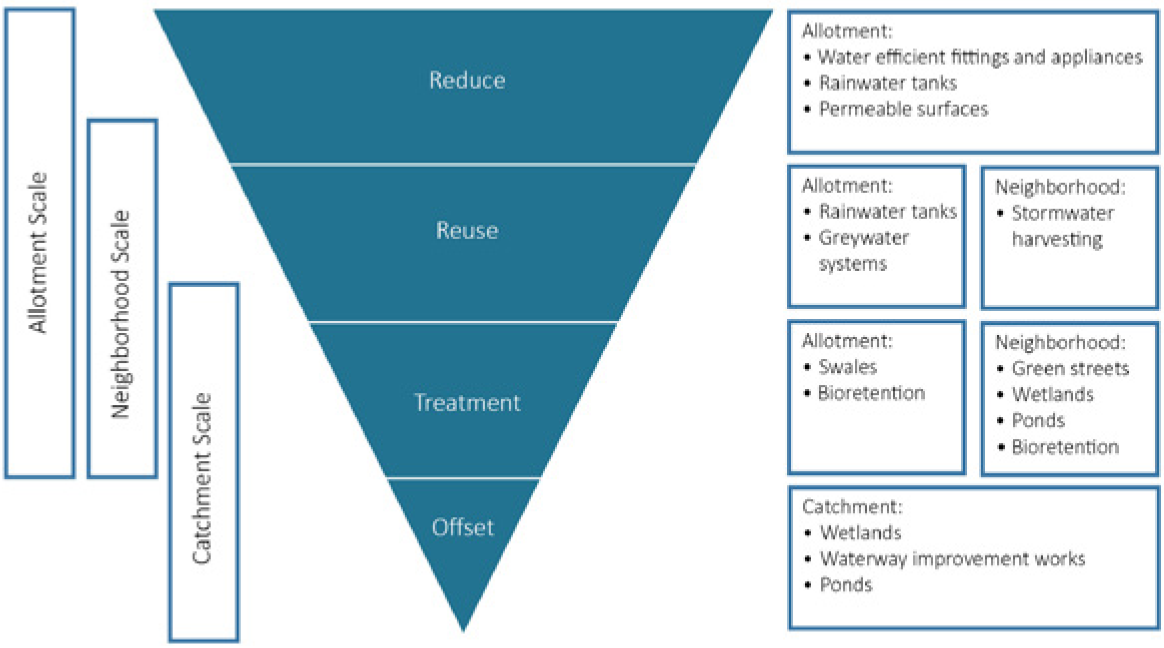
» Sites with regional initiatives located downstream of the site but within the catchment (e.g. regional stormwater treatment measures) may influence the TWCM strategy for the site.

Once the objectives and strategic direction for the TWCM strategy have been determined, suitable solutions can be identified.

TASK 3: Identify of lot-scale solutions

Once the TWCM strategy has been identified, the specific WSUD solutions can be investigated. It is always best to try and follow the WSUD hierarchy when selecting solutions that focus on 'reduce and reuse' before treatment, disposal or offsetting is undertaken (refer Figure 5). Figure 5 shows that the allotment scale presents opportunities for the reduction, reuse and treatment of urban water.

Figure 5: The WSUD hierarchy promotes the adoption of solutions that reduce or re-use water before treatment, disposal or offsetting is undertaken.



The incorporation of lot-scale WSUD solutions has a range of benefits and can help achieve the TWCM strategy requirements by reducing:

» the potable water consumption at the source by using water-efficient fittings and appliances and alternative water sources (e.g. rainwater)

» the generation of wastewater at the source (using water conservation techniques, fittings and appliances)

» the generation of stormwater at the source (reducing impervious areas and harvesting roofwater)

» the export of sediment and nutrients at the source (using water quality treatment systems to treat stormwater before it is discharged to the stormwater pipe network).

TASK 4: Configuration of urban layout

Allotment-scale solutions can help reduce the volume of stormwater and wastewater discharging from a development, but they may not always be able to meet the overall performance targets for the development or catchment. This is because there will still be other areas (roads, common areas, etc.) that will produce stormwater run-off in excess of pre-development conditions that may require treatment. As such, a holistic and integrated approach to planning is required. Task 4 requires the collaboration and input from urban planners, civil engineers and landscape architects to design and configure the site and drainage layout to maximise the opportunities for the inclusion of WSUD solutions across the site by considering some of the following:

- Slope: Having roads designed along the contours reduces the grade and allows for at-source streetscape WSUD solutions to be integrated.
- Road layouts: The width of verges, location of pathways and underground services and any traffic calming devices can either prohibit or allow for the integration of at-source streetscape WSUD solutions.
- Parklands: Successful end-of-line solutions integrated within parklands require stormwater network levels to be designed to allow for at-surface discharge of stormwater flows. It also requires sufficient flat land for the treatment system; otherwise the batter widths and slopes can be problematic. There is also opportunity to maximise the potential for stormwater harvesting for irrigation of large parklands by having sufficient catchment area draining to the site.
- Receiving waters: While it may appear to the community that stormwater from developments discharges to pipes and concrete channels in many cases, and therefore have limited impact on natural waterways, this is not the case; all urban stormwater will eventually discharge to a natural environment (creek, river or lake). Therefore it is important that the receiving waterway condition is considered in the planning of the urban layout and selection of WSUD solutions. For example, lakes are not as susceptible to erosion as waterways, but they can have issues when large volumes of sediments and nutrients are discharged into them. Conversely, waterways can be eroded easily if the volume and velocity of stormwater discharge is not managed.
- Catchment: The scale of the development and the planning of the broader catchment will also influence the WSUD solutions. It is therefore important to understand what is planned for the broader catchment so the development and the WSUD strategy complement this broader planning.

TASK 5: Treatment train selection

Once the layout of the development has been progressed, the WSUD treatment trains can be identified across the site. The treatment trains will differ based on development type, scale and context, but the process for identifying treatment trains remains the same.

The configuration of a successful treatment train will incorporate a range of treatment types in a logical sequence, removing large pollutants first and fine particulates and nutrients last. There will also be no double-up of treatment process, which adds unnecessary costs and assets to a development project. Note: bioretention and wetland systems have inbuilt treatment trains (i.e. a constructed stormwater treatment wetland consists of an inlet pond for coarse sediment removal and a macrophyte zone for nutrient removal; and bioretention systems often include sediment forebays). Additional treatment systems may be required in the treatment train to remove gross pollutants (e.g. a GPT as the first element in the treatment train for a commercial catchment).

The configuration of the treatment train will depend on the site characteristics, including the scale, development type, slope, and expected pollutant characteristics. For example, a suitable treatment train for a large and undulating residential development may include rainwater tanks (on lots connected to suitable end uses), a sediment inlet pond and macrophyte wetland (located within a neighbourhood parkland). A commercial development with limited space may include rainwater tanks (to toilets), permeable paving, water smart landscaping and at-source bioretention tree pits.

TASK 6: Test and refine with broader design team

Throughout the development of the conceptual WSUD strategy, input should be sought from the urban planners, civil engineers and landscape architects to ensure the proposed strategy integrates with and is reflected in the site layout and civil and landscape plans, which will also be developed at this stage.

Tools to assist in Step 2: Development of a suitable WSUD Strategy

The following tables can be used throughout Step 2 to identify which WSUD solutions are most suitable for different site characteristics. More details on the function, design and constraints for these WSUD solutions are provided in Section 3: Critical steps to WSUD design.

Table 3 can be used in the early stages of the planning process to identify the types of WSUD solutions that can help achieve the WSUD targets for the site. This information is based on an industry accepted understanding of the general performance level of WSUD solutions to meet water reduction, re-use, treatment and flow/flood management targets.

Appendix B provides a checklist that can be used to help guide and document outcomes in the development of a WSUD strategy.

Table 3: The effectiveness of WSUD solutions to achieve WSUD targets. Solutions are identified as generally suitable ✓, generally not suitable ✗, or possibly suitable with design modifications ? (based on Joint Steering Committee for Water Sensitive Cities, 2009).

WSUD solution	Objectives											
	Potable water reduction		Stormwater quality			Stormwater quantity		SW harvesting	Wastewater		Climate change adaption	
	Provides alternative water source	Reduce potable demand	Gross pollutant removal	Coarse -medium particle removal	Fine particles & dissolved nutrients removal	Reduce urban excess (e.g. infiltration or storage)	Provide detention to ensure pipe capacity is not exceeded	Allow stormwater /roof water harvesting	Allows wastewater re-use	Reduce wastewater flows	Encourages evapotranspiration	Helps address nuisance flooding
Reduce												
Water Efficient Fittings and Appliances		✓								✓		
Porous Pavements	✓	✗	✗	✓	✗	✓	?	?			✓	✓
Infiltration Systems	✗	✗	✗	✓	✗	✓	?	?			✓	✓
Re-use												
Rainwater Tanks	✓	✓	?	?	?	✓	✓	✓		✓		✓
Stormwater Harvesting/ Reuse	✓	✓	?	?	?	✓	✓	✓				✓
Reticulated Recycled Water	✓	✓							✓	✓		
Greywater Treatment/ Reuse	✓	✓							✓	✓		
Treatment												
GPTs	✗	✗	✓	✗	✗	✗	✗	✗			✗	✗
Buffer Strips	✗	✗	✓	✓	?	✓	✗	✗			✓	✓
Swales	✗	✗	✓	✓	?	✓	?	✗			✓	✓
Bioretention Swales	✗	✗	✗	✓	✓	✓	?	✗			✓	✓
Bioretention Basins	?	?	✗	✓	✓	✓	✓	✗			✓	✓
Ponds	?	?	✗	✓	?	✓	✓	✓			✓	✓
Sediment Basins	?	✗	✓	?	✗	?	✓	?			✓	✓
Constructed Wetlands	?	?	✗	✓	✓	✓	✓	✓			✓	✓
Flood management												
Retarding basin	✗	✗	?	?	?	?	✓	?			?	✓

Table 4 will assist in identifying treatment trains based on development type and scale. This information is based on an industry accepted understanding of what WSUD solutions can be generally applied successfully for sites with different scale and pollutant characteristics (for example, GPTs are typically most suited to commercial developments with large volumes of anthropogenic litter compared to residential sites, which generate more leaf litter, which can become problematic in GPTs[2]).

Table 4: The suitability of WSUD solutions for various development types and scales. Solutions are identified as generally suitable ✓, generally not suitable ✗, or possibly suitable with design modifications ? (based on Joint Steering Committee for Water Sensitive Cities, 2009).

WSUD solution	Household	Medium density	High rise	Commercial and industrial	Subdivision	Urban retrofit
Reduce						
Water Efficient Fittings and Appliances	✓	✓	✓	✓	✓	?
Porous Pavements	✓	✓	?	✓	✗	✓
Infiltration Systems	?	?	✗	✓	✓	✓
Re-use						
Rainwater Tanks	✓	✓	✓	✓	✓	✓
Stormwater Harvesting/Reuse	✗	✗	?	✓	✓	✓
Reticulated Recycled Water	✗	✗	✓	✓	✓	✗
Greywater Treatment/Reuse	✓	✓	✓	?	✓	✓
Treatment						
GPTs	✗	?	✗	✓	?	?
Buffer Strips	✓	✓	✗	✓	✓	?
Swales	✓	✓	✗	✓	✓	?
Bioretention Swales	?	✓	✗	✓	✓	?
Bioretention Basins	✓	✓	?	✓	✓	✓
Ponds	✗	✗	✗	?	✓	?
Sediment Basins	✗	✗	✗	✗	✓	✗
Constructed Wetlands	✗	✗	✗	?	✓	?
Flood management						
Retarding basin	✗	?	✗	?	✓	?

Table 5 is similar to Table 4 and can be used to identify the types of WSUD solutions appropriate for a development. It provides the next level of detail to enable WSUD solutions to be shortlisted based on the specific site characteristics. For example, use Table 4 to identify potentially suitable WSUD solutions for a commercial site and Table 5 to shortlist those solutions based on site characteristics.

2 In wet sump GPTs, organic matter such as leaf litter, can break down under anaerobic conditions (i.e. lack of oxygen) resulting in the release of nutrients. Under these circumstances, the GPTs produce pollutants that can be washed down to the receiving waterway rather than removing pollutants.

This information is based on an industry accepted understanding of what WSUD solutions can be generally applied successfully for sites with different characteristics (for example, wetlands are not ideally suited to steep sites as they are typically larger and will therefore require steep batters to fit into the undulating topography, compared to bioretention systems, which are smaller and can be designed as tiered systems to accommodate grade changes).

Table 5: The suitability of WSUD solutions for different site characteristics. Solutions are identified as generally suitable ✓, generally not suitable ✗, or possibly suitable with design modifications ? (based on Water by Design, 2009)

WSUD solution	Steep site	Flat site	Shallow bedrock	Acid sulphate soils	Low permeability (e.g clay)	High permeability (e.g. sand)	High water table	High sediment input	Land availability
Reduce									
Water Efficient Fittings and Appliances	✓	✓	✓	✓	✓	✓	✓	✓	✓
Porous Pavements	✗	✓	?	✗	✗	✓	✗	✗	✓
Infiltration Systems	✗	✓	?	✗	✗	✓	✗	✗	✓
Re-Use									
Rainwater Tanks	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stormwater Harvesting/ Reuse	?	?	?	?	✓	?	?	?	?
Reticulated Recycled Water	✓	?							
Greywater Treatment/Reuse	✓	✓							
Treatment									
GPTs	✓	?	?	?	✓	?	?	✓	✓
Buffer Strips	✗	✓	✓	?	✓	✓	✓	?	✓
Swales	?	?	?	?	✓	✓	✗	?	✓
Bioretention Swales	✗	?	?	?	✓	?	✗	?	✓
Bioretention Basins	?	✓	?	?	✓	?	✗	?	✓
Ponds	?	✓	?	?	✓	?	?	✗	?
Sediment Basins	?	✓	?	?	✓	?	?	✓	✓
Constructed Wetlands	✗	?	?	?	✓	?	?	?	?
Flood management									
Retarding basin	?	✓	✓	?	✓	✓	✓	?	?

STEP 3: Documenting and testing the WSUD strategy

Once the WSUD Strategy has been developed, assess its performance. This process will identify if the strategy is achieving the targets identified in Step 1 or if further changes are required. This testing should be done using numerical modelling and reported against the required objectives of the ACT WSUD General Code that were relevant for the site.

Table 6 presents a summary of the recommended tools to help develop and test the WSUD strategy performance. A new requirement under the revised WSUD General Code is the submission of modelling files for auditing by the Development Assessment team.

Table 6: A summary of the recommended tools that can assist in the WSUD planning process

Assessment tool	Type of analysis undertaken	Recommended Use
MUSIC	Stormwater quality and quantity (on site retention)	» Required **(Default parameters in MIS08)** » Current primary tool to assess stormwater quality performance » Industry accepted tool which is adequate and suitable for purpose
SWMM	Stormwater quality and quantity (on site retention)	» Optional » Current secondary tool to assess stormwater quality performance » Note this tool requires specialist training, but allows complex hydrologic and hydraulic processed to be analysed, and can help deliver integrated stormwater designs.
STORM (Victoria)	Stormwater quality and quantity (on site retention)	» Recommended for simple designs as it is user friendly » Requires local adaptation and configuration
MUSIC Auditor	Model assessment	» Strongly recommended » Supports and checks MUSIC assessment
ACT Water Reduction Calculators	Mains water reduction	» Recommended » Current primary tool to assess potable water reduction performance
BASIX (NSW)	Mains water reduction	» Recommended » Part of a broader sustainability assessment which can be used to complement the ACT Water Reduction Calculators
Green Star rating	Mains water reduction	» Optional » Part of a broader sustainability assessment which can be used to complement current ACT Water Reduction Calculators
Development checklist (Single Dwelling)	Mains water reduction and wastewater re-use	» Simple to use checklist to ensure you have considered everything » Stormwater quantity or quality is not included
Development checklist (Multi-unit Dwelling)	Mains water reduction, on-site retention and detention and wastewater re-use	» Simple to use checklist to ensure you have considered everything » Stormwater quantity or quality is not included
Development checklist (Commercial, industrial and institutional)	Mains water reduction, on-site retention and detention and wastewater re-use	» Simple to use checklist to ensure you have considered everything » Stormwater quantity or quality is not included
Development checklist (Estate development)	Mains water reduction, pollution and flow reductions, wastewater re-use	» Simple to use checklist to ensure you have considered everything » Detail on all WSUD assets is not included
DRAINS	Stormwater quantity (detention)	» Stormwater drainage system design and analysis program typically used to model peak stormwater flows. **(Default parameters in MIS08)**
XPRAFTS	Stormwater quantity (detention)	» Used in the peak stormwater flow analysis and management of both urban and rural catchments **(Default parameters in MIS08)**

The outcomes of the planning process should be documented for assessment. This documentation of the WSUD strategy and its expected performance could include:

» description of the proposed development/works and existing site conditions including the receiving environments
» summary of the relevant site objectives (water quality, quantity etc.)
» description of the opportunities and constraints for the application of WSUD solutions on the site (e.g. steep slopes preventing use of swales etc.)
» description of the WSUD assets selected for the site and design approach
» site plans showing the key features for the site (e.g. drainage pathways) and location of the proposed WSUD assets (also known as a WSUD Concept Plan)
» MUSIC modelling approach and results demonstrating compliance with site objectives.

The above items can act as a typical table of contents for a WSUD strategy/stormwater master plan for a site in the ACT.

4. CRITICAL STEPS TO WSUD DESIGN

Once the WSUD strategy has been developed for the site, the WSUD systems need to be designed. It is important for this design process to be undertaken correctly by suitably qualified persons to ensure the systems can be effectively constructed and established, are integrated into the landscape and can be maintained to ensure ongoing function.

The key steps required for WSUD design are:

Step 1

Undertake the sizing and design for each WSUD measure. This design needs to ensure that future maintenance is considered.

Step 2

Select the appropriate plants for the WSUD system.

Step 3

Document the WSUD measures and confirm the WSUD targets are met.

Step 4

Undertake lifecycle costing/cost-benefit analysis

The following sections provide guidance for each of these steps.

STEP1: Functional and detailed design of WSUD assets

The first step after the WSUD Strategy is the development of the concept into a functional design—a detailed design which documents all of the elements and levels that will make the system function correctly. This may include confirming levels and batter slopes, sizing of pits and pipes, design of outlet controls and planting and soil specifications.

This section outlines the important considerations that will assist practitioners to design WSUD assets to ensure they will operate effectively in the ACT. The type of information provided for each asset includes:

» function, describing the asset and how it works

» key design considerations, outlining the key components of the asset

» design constraints and key risk factors, providing a description of the types of site conditions that may make this asset unsuitable and identifies key potential risks that may impact on asset function and which need to be considered and addressed during design

» sizing guidance, providing guidance on the typical sizing required for the asset

» WSUD performance summary, an assessment of the WSUD asset and how well it achieves the ACT WSUD Code requirements

» detailed design considerations, providing guidance on best practice design parameters for the WSUD asset.

Note: All municipal infrastructure will need to comply with the Municipal Infrastructure Standards (MIS). The MIS (in particular MIS08 Stormwater) sets the default values for practitioners and engineers to design stormwater assets that are currently acceptable by the ACT Government.

The ACT Government is also developing Municipal Infrastructure Technical Specifications which will be providing requirements related to the planning through to construction processes.

Documentation to support these stages must be submitted and may include considerations such as materials to be used and how they will be tested before they can be utilised. The MITS provides standardised hold points and witness points making it clear for applicants to understand contractual agreements between them and the authority.

This document provides guidance in relation to best practice design to help the ACT Government assess and approve innovative approaches outside of the MIS. Innovative approaches should align with the best practice design approaches documented in this guideline and be justified in writing and discussed with and approved by TCCS and a certified engineer.

The following table identifies the WSUD assets described in this guideline compared to the assets included in MIS08.

Table 7: Comparison of the WSUD assets desribed in this guideline and MIS08

WSUD assets in this guideline	WSUD asset in MIS08	Comments
Water efficient fittings and fixtures	Not included in the MIS08	
Porous pavement	Permeable pavements	Different name for the same type of asset.
Infiltration systems	Infiltration systems	In the MIS, infiltrations systems are considered as all pervious surfaces and include vegetated landscapes, buffer strips, passively watered tree pits and permeable pavement. In these guidelines, infiltration systems are a separate asset specifically designed to promote the infiltration of stormwater.
Rainwater tanks	Tanks	Different name for the same type of asset.
Stormwater harvesting and re-use	Stormwater harvesting and re-use	
Greywater harvesting and reticulated recycled water	Not included in the MIS08	
GPT	GPT	
Buffer strips	Buffer strips	
Not included as a separate asset in the Guideline	Tree pits	This guideline provides a section on bioretention systems which can be designed as tree pits.
Swales (for stormwater treatment and conveyance)	Swales	
Bioretention swales	Bioretention swales (considered as waterways in MIS08)	
Bioretention basins	Bioretention basins (MIS Bioretention Systems)	
Ponds	Ponds	
Wetlands	Wetlands	
Permanent sediment basins	Long term water retaining assets	
Retarding basins	Water retaining assets – retardation	
Not included in the Guideline	Waterways	In best practice WSUD, waterways are considered as receiving environments and thus all treatment and flow management should occur upstream. In the MIS, waterways are intended for overland water conveyance. Examples include: constructed and natural channels, floodways, swales and cut off drains.

WSUD solutions to reduce watercycle impacts

Water efficient fittings and fixtures

Function

Water efficient fittings and fixtures refer to appliances and other plumbing fittings designed to reduce the amount of water required within the building. They help reduce use of potable water and the generation of wastewater. Some typical examples of water efficient fittings and fixtures include low use water taps and shower roses, dual flush toilets and front-loading washing machines.

Key design guidance

The Water Efficient Labelling and Standards (WELS) scheme is an Australian scheme that "requires certain products to be registered and labelled with their water efficiency in accordance with the standard set under the National Water Efficiency Labelling and Standards Act 2005".[3] It is recommended that water efficient fittings and fixtures are chosen with regard to their WELS rating.

Design constraints and key risk factors

Typically, water efficient fittings and fixtures are easily installed in new builds or retrofit scenarios. However, if there is an existing problem with transporting solids within the sewer network (possibly due to low pipe grades and low dry weather flows), water efficient fittings and fixtures may not be suitable to retrofit as they will reduce the dry weather flows and may further impact the sewer network flows.

Sizing guidance

The design and the type of water efficient fitting and fixture will depend on the design and requirements of the building and the water demands.

Table 8: Water efficient fittings and fixtures WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Water efficient fittings and fixtures are designed to reduce the volume of water used.	Water efficient fittings and fixtures can significantly reduce the amount of potable water being used.
Element 2: Stormwater quantity	N/A	N/A
Element 3 Stormwater quality	N/A	N/A
Element 4: Climate change adaptation	N/A	N/A
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations

Refer to the WELS website (http://www.waterrating.gov.au/about-wels) to find out more about registered products, regulations and standards for water efficient fittings and fixtures.

3 http://www.waterrating.gov.au/about-wels

Porous paving

Function

Permeable pavements are an alternative to typical impermeable surfaces. They come in many different forms, from brick paving where water infiltrates between the cracks to paving material designed so water can move through the blocks. The intent is to create a paved surface where water can infiltrate into the underlying soil. In the ACT, soils are predominately clay, so porous paving usually requires a drainage sub-layer of material to transport excess water laterally to the drainage system. Stormwater retention, such as infiltration through porous paving, helps to facilitate dissipation of run-off. This function can also be achieved by incorporating green infrastructure including vegetated green spaces and sustainable water systems such as stormwater harvesting.

Pavements fall into two categories:

1. Porous pavements, which comprise a layer of highly porous material
2. Permeable pavements, which comprise a layer of paving blocks, typically impervious, specially shaped to allow the ingress of water by way of vertical 'slots' or gravel-filled 'tubes'.

Key design guidance

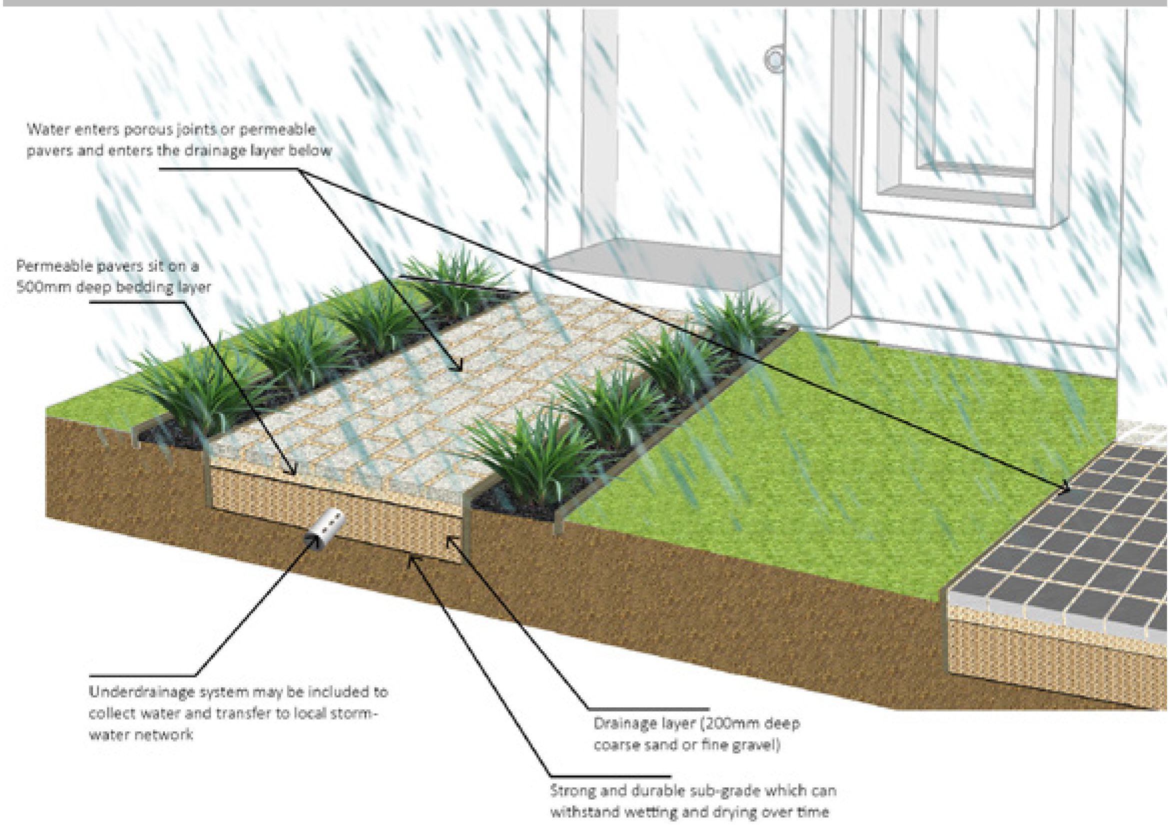
The porous pavement solutions will typically have the following elements:

» An area of permeable surface (whether it is the porous pavement itself, or the permeable areas between pavers)

» Underlying bedding and drainage layer (typically coarse sand or gravel)

» Subgrade material and underdrainage system (optional)

Figure 6: Typical porous pavement features



Design constraints and key risk factors

- Attention is to be given to the risk of clogging in porous pavements and the materials that are used. They are not suitable in locations with high sediment loads and heavy traffic.
- Pretreatment may be required to minimise the potential for clogging and to protect groundwater quality. Pretreatment measures may include providing leaf and roof litter guards along roof gutters, vegetated swales, sediment forebays or buffer strips.
- Infiltration will be impacted if the in-situ soils are impermeable. Performance can be improved by creating below ground storage (e.g. deeper gravel drainage layer for storage and slow infiltration).
- The materials used should satisfy filter criteria which prevent movement of fine sediment between the bedding layer and drainage layer. This will avoid clogging and pavement subsidence.
- Where there are contaminated flows or issues of soil salinity, an impermeable liner needs to be placed between the subgrade and in-situ soils to protect the quality of groundwater. Drainage pipes will be required to covey flows in excess of the retention capacity, preferably to downstream treatment measures.
- Overflows or surface flows (i.e. flows in excess of the storage capacity, underdrainage capacity and/or infiltration capacity) should be diverted towards the stormwater system. The design will need to demonstrate that overflows will not be directed towards or cause damage to buildings, structures and services.
- The surface level of the porous pavement should be flat or as close to this as possible to ensure uniform distribution of flow and to prevent hydraulic overloading on a small portion of the surface. Generally, porous pavement should be on a slope of less than 3% and should not generally be considered for slopes greater than 5%. If used on slopes >5% extreme care and consideration needs to be given to the likely infiltration rate and the structural integrity of any areas used by vehicles.
- The design will have to consider the expected vehicle load and demonstrate structural integrity of the pavement to a standard consistent with the MIS.

Sizing guidance

Porous pavements are used in lieu of typical impermeable surfaces, so the size will depend on the use of the pavement and suitable area available. They are well suited to sites with light vehicle weights and low-traffic streets in residential and commercial areas; footpaths; driveways and parking bays.

Table 9: Porous pavements WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	N/A	N/A
Element 2: Stormwater quantity	Porous pavements are designed to infiltrate stormwater into the underlying soils.	The infiltration minimises the volume of stormwater entering downstream systems.
Element 3: Stormwater quality	They provide treatment through the removal of particulate pollutants.	There is some stormwater quality benefit attributed to the infiltration of flows and removal of particulates, however porous pavements are unable to provide best practice stormwater treatment.
Element 4: Climate change adaptation	Porous pavements infiltrate and retain water in the soil.	Local microclimate benefits are provided by keeping water in the soil and infiltration reduces the peak volumes entering stormwater networks which also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations

The detailed design of permeable pavements may involve the following:

» Confirmation of concept design and treatment performance
» Pretreatment design, if required
» Determination of design flows
» Size of the porous pavement system
» Specify the underdrainage design
» Check the emptying time of detention volume following the cessation of rainfall
» Check the requirement for impermeable lining
» Specify porous pavement layers
» Size of the overflow pit/ pipe
» Specify the bedding structures and expected vertical and tractive loads

Further information on the design of permeable pavements is provided in Australian Run-off Quality (Engineers Australia 2006) and Planning Scheme Policy 11, Section 13.11 Porous and Permeable Paving (Gold Coast City Council, Amended 2007) and the Water Sensitive Urban Design Technical Manual for the Greater Adelaide Region (Department of Planning and Local Government, Government of South Australia, 2010).

Infiltration systems

Function

Infiltration systems capture and detain flows to encourage infiltration, which can help minimise the volume of stormwater run-off from a development and recharge groundwater. While other permeable WSUD assets such as swales and porous pavements provide opportunity for stormwater to infiltrate into the ground, the infiltration systems described below are assets designed specifically for enhanced infiltration. They will not be widespread in the ACT due to the predominance of heavy soils with lower potential for infiltration, but may be considered on sites with less clay/higher infiltration rates. In general, infiltration systems should have high catchment area ratios (>25%) and principally be designed to manage and treat their own catchment area.

Key design guidance

Infiltration systems typically consist of:

» detention volume – can be located above or below ground and is designed to detain a volume of stormwater for infiltration
» infiltration area – this is the surface between the detention volume and the in-situ soils which the stormwater will infiltrate into.

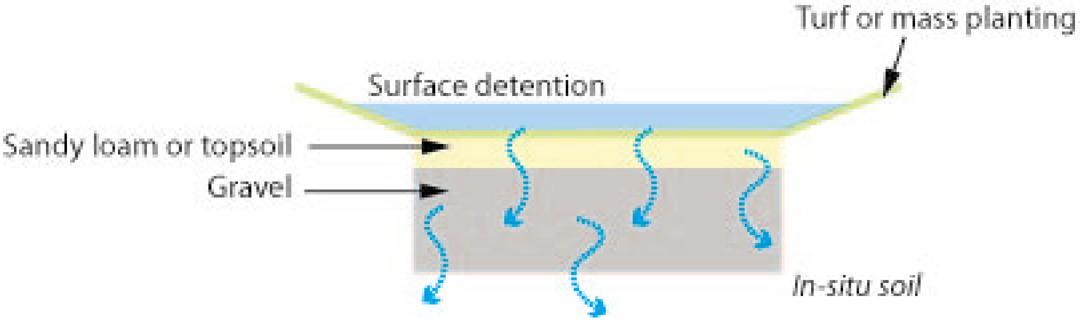
These are designed to detain flows at-source and contain suitable porous materials (e.g. coarse sand or gravel) to allow rapid infiltration or sized with sufficient area to allow infiltration in heavier soils. Overflow systems can be connected to the local stormwater network.

In low catchment area ratio systems (<25%), pretreatment to remove coarse and medium sediments and litter is required to avoid blockage of the infiltration system. If the infiltration systems do not have a densely vegetated surface, additional pretreatment to remove fine particulates, nutrients and metals will be required to protect groundwater quality. Pretreatment measures may include the provision of upstream vegetated swales, bioretention systems or even constructed wetlands.

Infiltration systems can range in their designs and may include the following types:

» Leaky well: Water enters the top of a well which consists of a vertical perforated pipe with an open base. These openings are covered with geotextile and the well is surrounded by clean gravel. When the volume of the well is exceeded, an overflow pipe discharges flows to the local stormwater network.
» Infiltration trench: Consists of a trench which is filled with gravel and lined with geotextile and sits under topsoil, which can be planted. Stormwater is directed into the trench via a pipe.
» Infiltration basin: This is a depression which is designed to capture and stormwater run-off on the surface prior to infiltration into the in-situ soils.

Figure 7: Typical infiltration basin features



Design constraints and key risk factors

- Infiltration systems are not ideally suited to sites with very low permeability soils (i.e. medium or heavy clays with saturated hydraulic conductivities of < 3.6 mm/hr). This does not preclude the use of infiltration systems however the required storage may become prohibitively large.
- Infiltration systems should be avoided in locations where there are sodic/saline soils, dispersive soils, shallow groundwater or shallow rock or shale.
- Shallow groundwater may result in localised mounding of the groundwater level. Investigations need to be carried out to ensure mounding/raising groundwater levels will not cause problems to nearby structures.
- The base of the infiltration system should always be above the seasonal high groundwater level.
- It is not ideal to locate these systems beside a building or other structural footings that may be affected by saturated soils. Ensure the required minimum building setback distances are achieved.
- Infiltration into steep terrain (>5-10%) can result in stormwater re-emerging onto the surface at some point downslope. This is most likely to occur on sites with duplex soils and shallow soil over rock.
- On steep terrain there is a risk of slop instability. A detailed engineering assessment will need to be undertaken in such cases.
- The surface of the infiltration system should be as flat as possible to ensure uniform distribution of flows to avoid hydraulic overload on part of the infiltration surface.
- To avoid overloading and clogging of the infiltration system, ideally 'above design' flows should be bypassed.

Sizing guidance
The size of the infiltration system will depend on the infiltration rates and the storage volume. When modelling a system's performance in the ACT, it is recommended that heavy clay infiltration rates be used unless testing shows the site's soils have a different infiltration rate.

Table 10: Infiltration system WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	N/A	N/A
Element 2: Stormwater quantity	Infiltration systems are designed to infiltrate stormwater into the underlying soils.	Infiltration minimises the volume of stormwater entering downstream systems.
Element 3: Stormwater quality	Infiltration systems will remove some pollutants as they are filtered through infiltration materials and in-situ soils.	Infiltration systems are not designed to provide stormwater treatment, rather to facilitate groundwater recharge and therefore are most appropriate to be used at the end of a treatment train.
Element 4: Climate change adaptation	These systems infiltrate and retain water in the soil.	Local microclimate benefits are provided by keeping water in the soil and infiltration reduces the peak volumes entering stormwater networks which also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations

The detailed design of infiltration systems may involve the following:

» Confirm site conditions with site and soil evaluation

» Confirm design objectives and concept design

» Select infiltration type

» Determine pretreatment requirements and design

» Determine design flows

» Size infiltration system

» Locate infiltration system

» Set infiltration depths (sub-surface systems only)

» Specify detention volume media/materials

» Design flow management components (e.g. inflow pipes, overflow pipes and pits)

Further information on the design of infiltration systems is provided in WSUD Technical Design Guidelines for South East Queensland (Healthy Waterways, 2006).

RE-USE WSUD SOLUTIONS

Rainwater tanks

Function

Rainwater tanks capture and store rainwater from a roof catchment. Rainwater tanks can make an important contribution towards minimising potable water demand and decreasing stormwater peak flows and volumes, which can improve hydrology downstream.

Water captured from the roof catchment is stored and then used in place of mains water for commercial, industrial or domestic uses that do not require a potable standard of water. On a residential block, stored rainwater can be used for garden watering, toilet flushing and laundry use. Using rainwater for hot water systems is a possibility that is currently under review in many jurisdictions.

Recommended end uses (by order of priority) are:

» toilet flushing

» garden watering

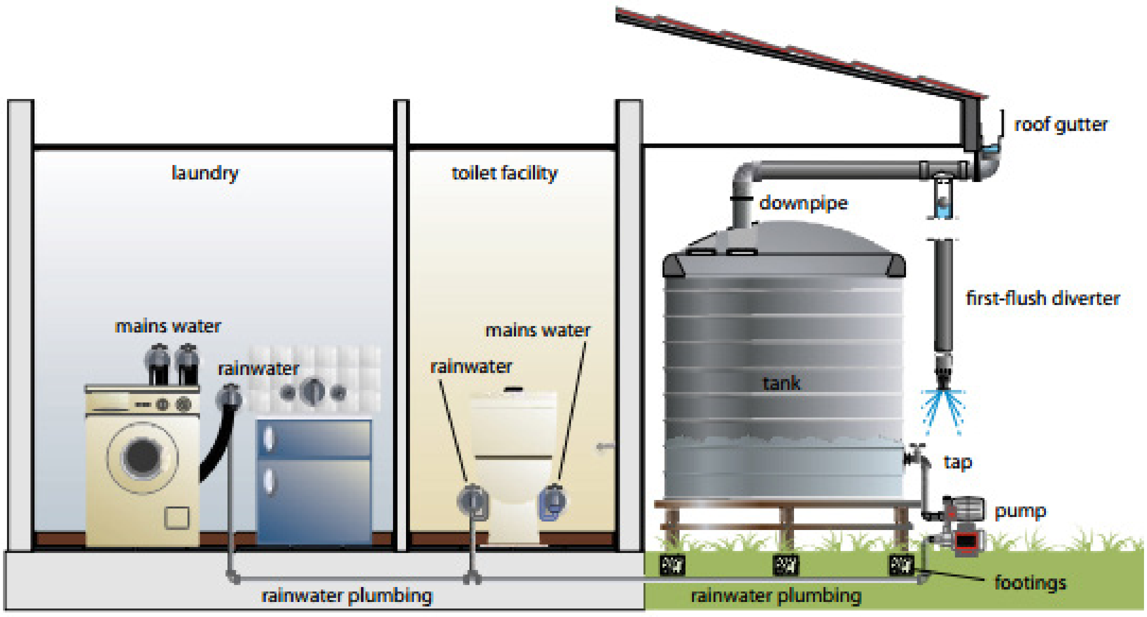
» laundry.

Rainwater tanks are currently not mandated for developments but are often specified as part of the solution. Deemed to comply conditions are associated with tanks when they are used.

Key design guidance

Rainwater tanks will typically have a first flush diverter and protection mesh screen to reduce the risk of contaminants and mosquitoes entering the tank via the down-pipe. Modern tanks have an enclosed roof to restrict pest access (birds and mosquitoes). The outlet can either be an external connection only, or can be connected to internal uses as well. A pump is typically required and potable water back-up will be required if it is used for internal uses. The rainwater tank will also have an overflow system which will discharge water to the local stormwater network when it is full.

Figure 8: Basic and internal configuration for rainwater tank features
(from Rainwater tanks – Guidelines for residential properties in Canberra (ACT Government, 2010))



Design constraints and key risk factors

» Underground systems can be problematic where there is shallow bedrock or high groundwater.
» Aboveground tanks require suitable areas; however, due to the large range of product sizes and shapes available, this should be achievable for most sites.
» The use of rainwater for drinking purposes is not recommended where a reticulated supply is available. In urban areas, airborne contaminants and other pollutants may find their way into rainwater tanks.
» To minimise any water quality associated risks, replace or coat any lead flashings on the roof, screen all openings to prevent leaves, insects or other foreign material from entering the tank and use a first flush device to divert dirty roof water away.
» Ensure contaminated groundwater does not infiltrate underground rainwater tanks.
» Ensure tank overflows or discharge from purposely designed 'leaky tanks' does not enter adjacent properties or pond under floors or flood around building foundations.
» Closed (rooved) tanks limit mosquito access to tanks. Inflow litter screening and a dark environment limit food sources for mosquitoes in closed screened tanks.

Sizing guidance
Maximising the roof area connected to the tank and the demand of suitable regular end-uses will yield the greatest benefits from rainwater tanks. To determine the most appropriate size of the tank, assessments can be undertaken of roof area, rainfall volume collected and demand. This data can be used to generate sizing curves and identify volumetric reliability. A reasonable reliability for a rainwater tank is 65–75%. While the required connected roof area in the ACT is 50% (under the WSUD General Code), it should be noted that connecting 100% roof area to the tank typically delivers improved use/reliability of the tank.

Table 11: Rainwater tank WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Rainwater tanks provide a source of low risk alternative water which can be used for a number of uses that typically use potable water.	If sized correctly and plumbed to suitable end-uses, rainwater tanks can reduce potable water use significantly.
Element 2: Stormwater quantity	Rainwater tanks capture and store rainwater which can be re-used, reducing the volume.	Rainwater tanks detain the initial volume of rainfall, reducing peak flows entering waterways. If the water is re-used with good demands, the volume of stormwater entering the waterways is also significantly reduced.
Element 3: Stormwater quality	Water captured in rainwater tanks can be re-used for many end-uses.	The re-use of rainwater reduces the volume and associated pollutants entering waterways.
Element 4: Climate change adaptation	Rainwater tanks captures and reduces the volume of water flows entering the stormwater network.	Reducing the volume of rainwater entering the stormwater pipe network which also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations
Refer to Rainwater Tanks, Guidelines for Residential Properties in Canberra, ACT (2010) for detail on the design of small (<20 KL) rainwater tanks. Refer also to the Municipal Infrastructure Standards which identifies access requirements for public access maintenance which may apply.

Leaky Rainwater Tanks

Objectives: Harvesting and attenuation

Benefit: Improved reduction in volume of stormwater conveyed to receiving waters with limited impact on supply

Sizing: To achieve 25-30% 'leaky volume'

Status: Voluntary only

Connection:

- Supply to toilets, etc.
- Slow drainage to network or kerb

Set-up: The passive irrigation tank can take a variety of forms such as:

- a completely separate tank that takes the overflow from a tank that is already used to supply the indoor uses (such as the toilet)
- the top portion of a larger tank, where the water only leaks out from the top part leaving the water in the base of the tank for reuse

Figure 9: Example of a typical tank system

Stormwater harvesting

Function

Stormwater harvesting schemes are designed to store and supply an alternative to potable water that can be used for fit-for-purpose demands. This reduces the volume of discharge of urban stormwater excess to waterways.

Key design guidance

Stormwater can be stored in a number of different systems, including tanks and open water storages.

Typical stormwater harvesting tank at Dickson

When deciding on the appropriate design of the stormwater harvesting system the following should be considered:

» Demand volume
» Required storage for buffering
» Diversion requirements (is pumping required?)
» Water quality of stormwater and risk of end use (is additional treatment required?)
» Operational, maintenance costs of infrastructure including pumps
» Licensing and operational requirements

Design constraints and key risk factors
Open water storage design will need to consider the following possible site constraints:

» Space required for the storage and batters
» Ensuring draw down of water does not impact plant health on batters

Underground storages may not be suitable for sites with:

» shallow bedrock
» high groundwater.

Sizing guidance
Sizing of the storage will depend on the rainfall, catchment and demand. Optimal sizing is site specific. With the exception of single household systems, optimal storages for precinct reuse schemes will typically be sized to deliver between 70–80% reliability. To reduce pumping and infrastructure costs, the demands are likely to be located within 2 km of the point of supply.

To size the storage, use a water balance assessment including the main supply and demand requirements.

Table 12: Stormwater harvesting WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Stormwater harvesting schemes are designed to capture and store stormwater for re-use.	Harvested stormwater can be used for a range of fit-for-purpose demands which will reduce potable water use.
Element 2: Stormwater quantity	These systems capture and store stormwater from rainfall events.	The storage and re-use of stormwater removes this water from the volume entering downstream waterways. They have the greatest impact on reducing flow volumes associated with frequent flow events.
Element 3: Stormwater quality	Stormwater harvesting schemes are typically located at the end of a treatment train	Stormwater harvesting schemes benefit downstream environments by ensuring a large portion of stormwater and its associated pollutant loads are do not enter the receiving waters.
Element 4: Climate change adaptation	Stormwater harvesting schemes can involve a range of solutions such as open water storages or tanks.	Open water storages provide local microclimate benefits by keeping water in landscape. The storage and re-use of water in all solutions helps to address downstream flooding. Outdoor re-use of water can be very effective as a source of irrigation for green spaces, providing local microclimate benefits by keeping water in the soil and the process of evapotranspiration.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations
The design of stormwater harvesting and re-use assets will differ significantly as they can range from tanks through to open water bodies. However, the Municipal Infrastructure Standards identifies that design documentation of stormwater harvesting systems must demonstrate the following as a minimum:

» End-use requirements for water quality and quantity
» The reliability of supply including the design frequency of instances without supply and the average duration of instances without supply
» If designing for irrigation, this should be designed to MIS21

It also identifies the importance of stormwater harvesting and re-use assets to minimise their public health risks and environmental risks by:

» providing appropriate stormwater quality treatment
» minimising mosquito habitat
» minimising contaminant inputs downstream of the final treatment facilities
» minimising public exposure to untreated stormwater
» minimising cross-contamination with mains water distribution networks or confusion with mains water supplies
» extracting sufficient water to meet the end use requirements without compromising downstream aquatic ecosystems
» potentially stopping collection in the event that stormwater is contaminated by an incident within the catchment
» minimising the risk and/or impact of upstream flooding.

Greywater systems and reticulated recycled water

Function
Wastewater is the 'liquid wastes normally collected in a sewer system and processed in a treatment plant'. It comprises two components—blackwater (e.g. from toilets) and greywater (e.g. from shower and washing machines).

The re-use of greywater (typically at a building scale) and recycled wastewater (typically at a precinct scale) reduces the potable water requirements and the volume of treated wastewater entering receiving environments.

A greywater system enables re-use greywater from buildings[4] The average Australian household can re-use around 1500 litres of greywater each week. There are simple and complex systems, but all involve reusing water that would otherwise enter the sewer network. Some systems involve storing the water and treating it to remove impurities.

A reticulated recycled water system typically involves a third pipe (purple pipe) being connected to buildings to allow recycled water to be distributed to customers from a central treatment location.

Refer to the Australian Guidelines for Water Recycling (2006) for more details on the safe use of recycled water.

4 Greywater from the kitchen is not recommended for use due to it typically being heavily polluted with food particles, oils, fats and other wastes, which can cause blockage and promote the growth of micro-organisms. It is also often chemically pollutant with detergents and cleaning agents, particularly those from dishwashers, which are very alkaline and over time may damage the soil.

Key design guidance

Table 13: Fit-for-purpose re-use of wastewater requires recycled water to be treated to a quality which is suitable for the intended use. Therefore the type of treatment required will depend on the type of recycled water and its intended end use. The following table provides examples of reuse.

Type of Re-use
Uncontrolled public access – e.g. irrigation, ornamental water bodies
Residential uses – e.g. garden watering, toilet flushing, car washing
Controlled public access – e.g. irrigation, dust suppression
Ornamental water bodies with restricted public access
Pasture, fodder and horticulture
Turf farms and non-food crops
Food crops in direct contact with water – e.g. sprays
Food crops not in direct contact with water or processed or cooked before sold

Design constraints and key risk factors
It is essential that public health and the environment are protected when recycled water is used. It is also important to consider public and industry knowledge and confidence to ensure the scheme is well understood, supported and managed.

The following site characteristics may preclude the use of recycled water for irrigation:

» **Steep sites:** Slopes above 10% are not suitable for pasture spray irrigation, but trickle irrigation can be used for plants such as trees and vines on these steeper slopes. Note: Retention banks may be required to prevent run-off from the site on steep slopes.

» **Water bodies and receiving environments:** Need to protect surface water systems used as a domestic supply from contamination. Buffer distances are very site specific but typically a 500 m distance between the irrigation area and surface water system is required.

» **Groundwater:** Need to protect groundwater from contamination by recycled water. Typically a 3 m depth to groundwater is required.

» **Soil types:** Clay soils can be difficult due to low infiltration and low hydraulic conductivity. Sandy and gravel soils can also be difficult as their infiltration capacity and permeability are so high the recycled water is not retained long enough for effective plant use and results in rapid movement to the receiving environments.

Sizing guidance
The size of the treatment and reticulation system will depend on the scale of the network (e.g. ranging from an on-site greywater treatment system to a development-wide recycled water network). The design of the system will also depend on the volume of wastewater the system is able to collect, treat and distribute. On average, a two to three person Canberra household generates:

» 185 litres of greywater per day from the hand basin, shower and bath

» 121 litres of greywater from the laundry per day.

Table 14: Greywater systems and reticulated recycled water WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	These systems are designed to provide fit-for-purpose water for uses which don't require potable water.	Greywater and reticulated recycled water systems are very successful at reducing the potable water used in developments as there are many demands which can be met with this recycled water (e.g. toilet flushing and irrigation).
Element 2: Stormwater quantity	N/A	N/A
Element 3: Stormwater quality	N/A	N/A
Element 4: Climate change adaptation	Recycled water can be used throughout the year as a suitable irrigation source.	The constant supply of recycled water in our urban environments means that recycled water can be very effective as a source of irrigation for green spaces, providing local microclimate benefits by keeping water in the soil and the process of evapotranspiration.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations

A recycled water system will need to consider how water is managed from the source through to the application site or receiving environment. Typically, recycled water systems will include the following:

» Recycled water source and characteristics: Consider where the water is coming from and its characteristics e.g. flows, pollutant constituents, variability, etc.

» Treatment system: This will include a range of different equipment designed to provide varying levels of treatment (primary, secondary, tertiary, etc.).

» Storages: Consider size, public accessibility, etc.

» Distribution systems, application and receiving environments: Consider how the treated recycled water will be used and the water quality requirements for that use.

TREATMENT WSUD SOLUTIONS

Gross Pollutant Traps (GPTs)

Function

GPTs were first developed in Australia in the ACT in the late 1970s and 1980s. A GPT treats catchment run-off prior to its discharge to a downstream stormwater treatment system or waterway by removing litter, debris and coarse sediment. There are numerous proprietary devices developed for trapping gross pollutants that may be suitable for use in Canberra.

Key design guidance

The most common types of GPT in Canberra to date have been the 'Minor DUS GPT' and the 'Major DUS GPT', as defined in the Municipal Infrastructure Standards. These GPTs consist of a concrete sediment basin with a fixed trash rack at the downstream end of the basin.

Figure 10: Example of a GPT

Design constraints and key risk factors

GPTs can be placed in many locations throughout a catchment to capture gross pollutants in a screening process. These systems will not operate effectively if the site has the following characteristics:

» Backwatering: Materials captured in the GPT can be resuspended.

» High leaf litter loads: Collecting and storing organic litter in saturated devices can be problematic as it can result in the leaching of nutrients. GPTs that retain water may not be appropriate in catchments with deciduous trees.

» Limited maintenance access: Without regular maintenance, GPTs build up litter which affects their capacity to filter flows and can create amenity issues.

Sizing guidance

Appropriate catchments exceeding 5 ha should be equipped with a DUS GPT. Proprietary GPTs may be considered for smaller catchments with predominantly commercial land use. The land take requirement of the GPT system will depend on the type of system used; however, they typically require less area than other stormwater treatment devices.

Table 15: GPT WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	N/A	N/A
Element 2: Stormwater quantity	N/A	N/A
Element 3: Stormwater quality	GPTs target the removal of gross pollutants from stormwater, such as litter.	GPTs are effective primary treatment devices in treatment trains that target the removal of large pollutants. They are effective at removing litter from stormwater but unable to achieve the best practice pollutant load reductions for other pollutants.
Element 4: Climate change adaptation	N/A	N/A
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design considerations
The Municipal Infrastructure Standards and Standard Drawings contain details on the design requirements of GPTs in Canberra. These highlight the importance of designing GPTs with the following as considerations:

» Lifecycle costing
» Footprint and depth of the unit
» Hydraulic impedance and requirements
» Occupational health and safety
» Ease of maintenance (e.g. special equipment required)
» Maintenance requirements: Design the GPT for maintainability and operability including the following considerations:
  - Ease of maintenance and operation
  - Allowance for dewatering
  - Access to the treatment site
  - Frequency of maintenance
  - Special equipment requirements
  - Disposal

Buffer strips

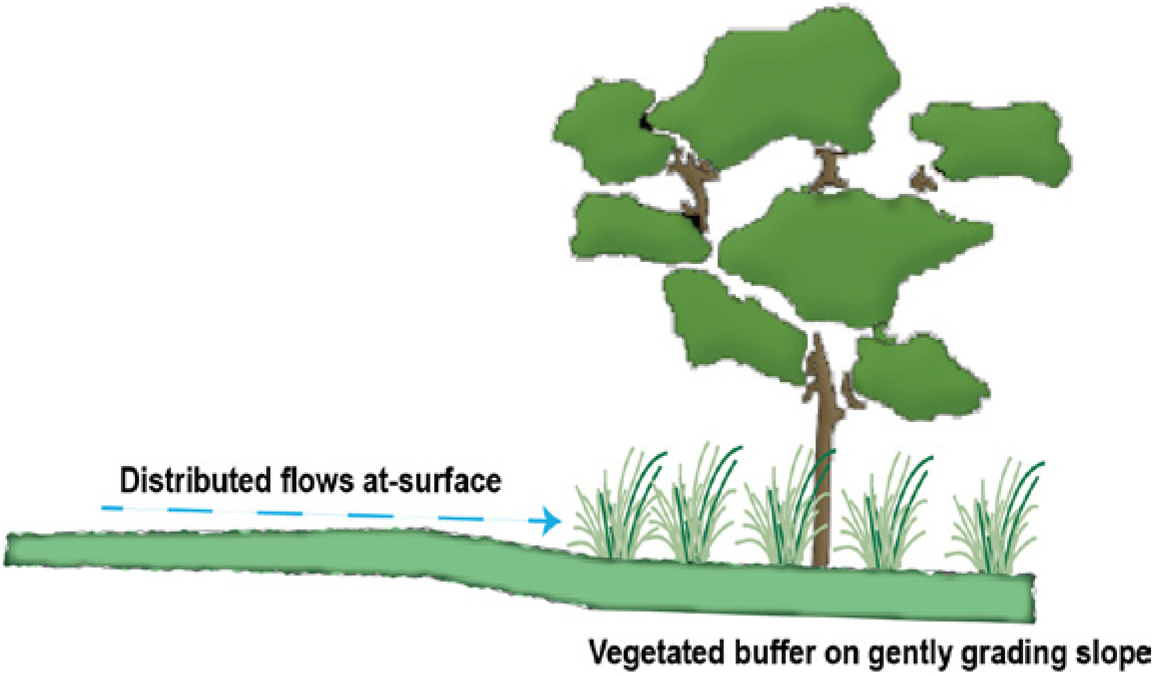
Function

Buffer strips are zones of vegetation designed to intercept and treat surface stormwater flows. Stormwater treatment occurs as shallow stormwater passes through the dense vegetation, which slows velocities causing sediments to deposit.

Key design guidance

Vegetated buffers require uniformly distributed sheet flow and are therefore most often combined with riparian edges that accept surface flows or in conjunction with swales when they are used along roads that have a flush kerb.

Figure 11: *Typical buffer features*



Design constraints and key risk factors

Buffer strips are not ideally suited to sites:

- **in the lower reaches of catchments** (beyond first order drainage reaches)
- **with steep topography (>4%):** Flow velocities are likely to move quickly through the buffer area, reducing treatment performance.
- **with a large catchment (>1–2ha):** Flow volume and velocities will be too large to achieve optimal treatment performance.
- **with channelised flows:** Buffers require distributed surface flow and are unable to provide optimal treatment for channelised flows.

Sizing guidance

Typically, buffer strips are applicable for smaller scale contributing catchments up to 1–2 ha. Run-off from larger catchments is likely to be already within drains and the larger flows will be difficult to manage and disperse.

The width and slope of the buffers will influence treatment performance. Wider buffers provide more treatment surfaces while steep slopes increase flow velocities and decrease treatment potential.

Table 16: Buffer WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	These systems are passively irrigated from impermeable surfaces.	Passively irrigated landscape feature which does not require potable water for on-going performance.
Element 2: Stormwater quantity	N/A If systematically applied from the top of the catchment buffers could reduce the time of concentration of a catchment.	N/A Site specific applications would need to be clearly documented to contribute to meeting overall stormwater management objectives.
Element 3: Stormwater quality	Buffers target sediments and particulates but provide limited dissolved nutrient removal.	Buffers are unable to meet best practice requirements by themselves. Treatment performance will depend on the width, vegetation cover and slope.
Element 4: Climate change adaptation	Buffers retain water in the soil and provide evapotranspiration through the vegetation.	Local microclimate benefits are provided by keeping water in the soil and the process of evapotranspiration. If systematically applied from the top of the catchment buffers could reduce the time of concentration of a catchment.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Table 17: Detailed design consideration

Design consideration	Design rationale
Sizing	
Buffer area	User defined based on length and width.
Inlet properties	
Inlet types	Buffers required distributed flows and therefore are not ideally suited to piped inflows unless a flows can be spread using flow spreaders before they enter the buffer area. The buffer should accept distributed overland flows.
Vegetation set down from inlet area	Vegetation is recommended to be below the inlet invert to ensure flows pass through the vegetation.
Buffer properties	
Slope	The maximum design of slopes needs to be selected to reduce risk of erosion (slower velocities) and provide stability and allows for mowing.
Velocity	Riparian zone vegetation can withstand maximum velocity as outlined in the MIS depending on the vegetation community. The lateral flow velocity of water flowing through the riparian and entering the waterway should be considered. Vegetation communities have different properties for example riparian species is acceptable for slower velocities and turf is acceptable for faster velocities.
Flow distribution	Even flow distribution across the buffer strip is important as it is required to ensure there is no short circuiting of flows and minimises the risk of erosion. Dense and even vegetation is effective to ensure no short circuiting of flows and rilling of surface. Flow spreaders help to distribute flows. Spreading flows evenly through the vegetated buffers allow sedimentation to occur .

Vegetated Swales

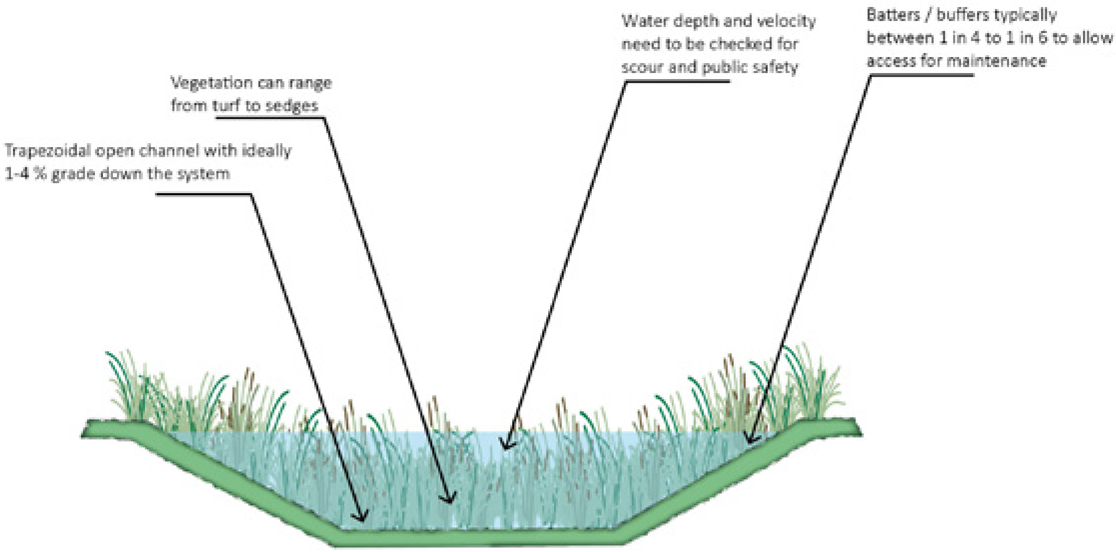
Function

Swales are stormwater conveyance and treatment measures that primarily treat run-off through filtering and deposition of sediments. To facilitate stormwater treatment, swales are typically vegetated with turf, native grasses or sedges. Note: The MIS considers swales as waterways (conveyance systems).
In the context of this WSUD Guideline, vegetated swales are considered as vegetated treatment and conveyance systems that would be located upstream of natural waterways to help protect the water quality and hydrology of the receiving waterway. Treatment and conveyance swales do not permanently retain water and may incorporate subsurface drainage on flat/low grade sites.

Key design guidance

Vegetated swales are typically shallow channels/drainage lines with a trapezoidal cross section. The vegetation in the vegetated swale enhances treatment by filtering the stormwater. The vegetation can vary from mown turf to sedges; however, treatment performance is best in systems with dense vertical plantings. The species, height and density of plants specified will influence the roughness of the swale (Mannings 'n') and hence the conveyance capacity and treatment performance. Mown turf will provide a relatively high conveyance capacity compared with sedges, but sedges will provide a greater level of stormwater treatment through increased contact with stormwater flows. Careful consideration needs to be given to the longitudinal grade of the swale and flow velocities. Steep grades can result in high velocities and scour. Relatively flat longitudinal grades can result in wet and boggy swale inverts unless subsurface drainage is provided.

Figure 12: Typical swale features



Design constraints and key risk factors

Vegetated swales are not ideally suited to sites with:

» **steep topography (>4%):** Check whether dams may be required for these slopes to protect the swale from scour. Higher maintenance costs are also likely due to more difficult machinery operation requirements.

» **Flat topography (<1.0%):** Vegetated swales can become waterlogged or boggy if they are unable to drain effectively. Consider using underdrainage within the invert of the swale and planting with taller grasses and sedges rather than turf.

» **Large catchment (>2 ha):** There is an optimal size for all systems. Vegetated swales can be designed and built at any scale. However, catchments <2 ha are generally better suited to the application of swale technology unless adequate space is available.

» **Driveway crossovers:** Vegetated swales may be inappropriate where they result in the need for driveway crossovers due to high cost, difficulties with maintenance and inconsistency in maintenance.

Sizing guidance
Where vegetated swales are employed they would typically form the start of the minor drainage system and be sized to convey the five exceedances per year (EY) flow. Water quality improvement and treatment performance would occur within this context.

Vegetated swales should typically be trapezoidal in section and for maintenance purposes, larger swales in public open space that need to be mown, need to be at least 3 m wide at the base.

Table 18: Vegetated swale WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	These systems are passively irrigated from impermeable surfaces.	Passively irrigated landscape feature which does not require potable water for on-going performance.
Element 2: Stormwater quantity	Vegetated swales slow stormwater flows. Depending on the underlying soils, they can also enhance infiltration.	Vegetated swales can help to reduce the volume of water entering downstream systems. If combined with an underlying infiltration trench losses can be enhanced.
Element 3: Stormwater quality	Vegetated swales target sediments and particulates but provide limited dissolved nutrient removal.	Vegetated swales are typically unable to meet best practice requirements by themselves. Treatment performance will depend on the vegetation and infiltration. Determining an appropriate infiltration rate is critical to assessing swale treatment performance.
Element 4: Climate change adaptation	Vegetated swales retain water in the soil and provide evapotranspiration through the vegetation	Local microclimate benefits are provided by keeping water in the soil and the process of evapotranspiration. The slowing of flows also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Table 19: **Detailed design consideration**

Design Consideration	Design rationale
Sizing	
Swale area	User defined based on swale length, base width and top width.
Inlet properties	
Low flow bypass	No low flow bypass
Inlet types	Flush kerbs or designated inlet zone means swales wales can receive distributed lateral inflow along its length or accept point source discharge
Vegetation set down from kerb inlet	Vegetation is recommended to be below the kerb inlet to ensure flows pass through the vegetation.
Swale properties	
Bed slopes	Longitudinal slopes will determine the use of subsoil drains beneath the invert and designed avoid waterlogging; steeper slopes require check dams to distribute flows, reduce velocities and potential for scour.
Batter slopes	For stability and access for mowing (if turf)
Vegetation height / Manning's N	Lower vegetation (e.g. turf) has less roughness (lower Manning's n) and provides less stormwater treatment. Higher vegetation (e.g. sedges) have higher roughness (higher Manning's n) and provide more stormwater treatment.
Velocities	Vegetation will influence the minor flood and major flood flows therefore needs to be considered. It should be noted that turf will provide less stormwater treatment than longer grasses.
Depth / velocity	The maximum ponding depth and velocity (v x d) will be determined by TCCS and is aimed at ensuring public safety will not be impacted
Exfiltration rate	Only use heavy clay infiltration rates unless there is testing to demonstrate soil has higher infiltration rates
Outlet properties	
Overflow pit	Overflow pits to be provided for when flow capacity of swale is exceeded. This ensures higher flows enter the drainage network and don't result in local flooding.
Maintenance access	
Swale and structures	For turf swales, ensure batter grades and base widths are suitable for ride on mowers. Ensure access to overflow pits or other structures is provided for inspection and general maintenance. Dedicated access tracks or ramps are typically not required for swales. Maintenance is usually by foot access or ride on mowing (for turf).

Bioretention swales

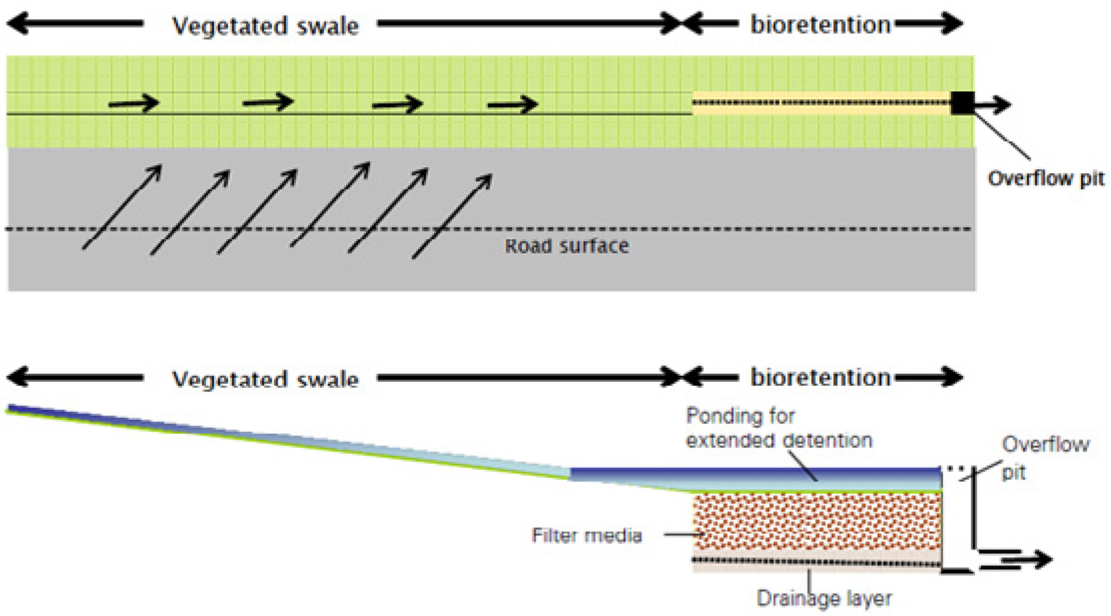
Function

Bioretention swales are swales with the addition of a bioretention trench with filter media and an underlying pervious (slotted) collector pipe. The intent of bioretention swale is to both convey and treat stormwater flows by infiltrating frequent low flow events through the filter material, providing both physical and biological treatment, while higher flows are carried within the swale.

Key design guidance

The swale is a graded vegetated channel which coveys flows. It also provides pre-treatment (removal of sediments) of stormwater before it enters the bioretention component of the system. There are two possible design configurations for bioretention swales. The bioretention component can be located at the downstream end of the swale or provided as a continuous 'trench' along the full length of a swale. The choice of bioretention location within the overlying swale will depend on a number of factors, including area available for the bioretention filter media and the maximum batter slopes for the overlying swale. Typically, when used as a continuous trench along the full length of a swale, the desirable maximum longitudinal grade of the swale is not greater than 4%. For other applications, the desirable grade of the bioretention zone is either horizontal or as flat as possible to encourage uniform distribution of stormwater flows over the full surface area of bioretention filter media and allowing temporary storage of flows (extended detention) for treatment before bypass occurs.

Figure 13: Typical bioretention swale features with bioretention component located at the downstream end of the swale (from SEQ HWP 2006)



Filter media specifications and sourcing

Bioretention systems require special filter media as specified in the Adoption Guidelines for Stormwater Biofiltration Systems (CRC Water Sensitive Cities, 2015). Early consideration of where these materials can be sourced will be required; they should be locally sourced if possible.

Design constraints and key risk factors

Bioretention swales are not ideally suited to sites with:

» steep slopes: Bioretention swales require a relatively low surface grade (between 1% and 4%) to allow for effective treatment.

» large catchments: Flow depths, velocities and large loads of sediment from larger catchments (>1ha) can impact vegetation and can clog or scour the filter media. Therefore, they are not ideally suited at the end of large catchments.

Sizing guidance

Bioretention swales can be sized to meet best practice treatment objectives. This treatment performance is influenced by rainfall characteristics, swale vs bioretention area, catchment size, land use and filter media saturated hydraulic conductivity and depth. The Model for Urban Stormwater Conceptualisation (MUSIC) is used to test and refine bioretention size to meet the site's objectives.

Table 20: Bioretention swale WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Bioretention swales are passively irrigated from impermeable surfaces.	Passively irrigated landscape feature which does not require potable water for on-going performance.
Element 2: Stormwater quantity	Bioretention swales capture and attenuate frequent flow events as water is filtered through the system.	The attenuation of flows reduces the peak volume entering waterways and stormwater networks.
Element 3: Stormwater quality	Bioretention swales provide treatment of stormwater, targeting fine sediments, metals, particulate and dissolved nutrients	Bioretention swales can achieve the best practice pollutant load reductions when sized correctly.
Element 4: Climate change adaptation	Bioretention swales retain water in the soil and provide evapotranspiration through the vegetation. They also infiltrate flows reducing the peak volume of flows entering the stormwater network.	Local microclimate benefits are provided by keeping water in the soil and the process of evapotranspiration. The reduction of peak volumes entering the stormwater network also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Table 21: Bioretention swale detailed design consideration

Design Consideration	Design rationale
Sizing	
Swale area	User defined based on swale length, base width and top width.
Filter area	If systematically applied from the top of the catchment swales could reduce the time of concentration of a catchment. Dependent on swale area, catchment land use, imperviousness, extended detention depth and filter media saturated hydraulic conductivity and therefore is user defined.
Inlet properties	
Low flow bypass	No low flow bypass
High flow bypass	No high flow bypass
Swale properties	
Bed slopes	Longitudinal slopes will determine whether the swales require check dams to distribute flows, reduce velocities and potential for scour. The greater the grade on the swale the less effective the bioretention treatment component will be.
Batter slopes	For stability and access for mowing (if turf).
Vegetation height / Manning's N	Lower vegetation (e.g. turf) has less roughness (lower Manning's n) and provides less stormwater treatment. Higher vegetation (e.g. sedges) have higher roughness (higher Manning's n) and provide more stormwater treatment.
Velocities	Vegetation will influence the minor flood and major flood flows therefore needs to be considered. It should be noted that turf will provide less stormwater treatment than longer grasses.
Depth / velocity	The maximum ponding depth and velocity (v x d) will be determined by TCCS and is aimed at ensuring public safety will not be impacted.
Exfiltration rate	For modelling purposes set exfiltration rate to zero.
Bioretention properties	
Extended detention	Designed to provide additional water quality and infiltration. Depths over the maximum may impact on plant health and pose public health and safety risks.
Filter media area	Filter media surface areas will be dependent on catchment land use, imperviousness, extended detention depth and filter media saturated hydraulic conductivity. Additional area will be required for batters. Considerations for master planning may be 0.5-2% of the catchment (filter media surface area).
Filter depth	Shallower depths are at risks of drying out and may not be able to support vegetation.
Filter media properties	
Saturated hydraulic conductivity	Avoid higher hydraulic conductivities as the media will have low water holding capacity and result in drought-stressed plants. For performance modelling purposes long term hydraulic conductivity is unlikely to be consistently greater than 200mm/h.
Nutrient Content	Prevents leaching of nutrients from the media.
Organic matter content	Some organic matter helps retain water for vegetation and can benefit pollutant removal, however higher levels may lead to nutrient leaching.
Grading of particles	Smooth grading provides a stable media, avoiding structural collapse from downward migration of fines.
pH	AS 4419-2003 Natural Soils and soil blends helps with soil pH and plant growth.
Electrical conductivity	AS 4419-2003 Natural Soils and soil blends helps with plant growth.

Design Consideration	Design rationale
Horticultural suitability	Media must be capable of supporting healthy vegetation (assessment by horticulturalist). To support healthy vegetation over the long term. Trees and shrubs are generally not supported to be planted in the filter media. Clarification will need to be sought by TCCS for municipal infrastructure. Trees and shrubs can be provided outside of the filter media for shade. Deciduous trees should be avoided at all times.
Transition layer properties	
Material	Clean well-graded sand prevents filter media washing down into the saturated zone.
Depth	Depths avoid migration of fines from the filter media and to avoid inundation of the filter media by the saturated zone.
Hydraulic conductivity (Ksat)	
Fine particle content	Prevents the bioretention system leaching nutrients.
Particle size distribution	Bridging criteria- the smallest of sand particles must bridge with the largest of filter media particles to avoid migration of the filter media downwards into the transition layer.
Saturated zone properties (only on bioretention systems with flat surface)	
Material	The pore space between the sand//fine aggregate grains retains the water. If sand is used, sand has a greater capillary rise and will be most beneficial during extended dry periods.
Saturated zone depth	Provides storage of water to maintain soil moisture and enhance nutrient removal.
Outlet properties	
Overflow pit	Overflow pits to be provided for when flow / extended detention capacity of bioretention swale is exceeded to ensures higher flows enter the drainage network and don't result in local flooding.
Underdrainage pipes	Standing water in the filter media section of bioretention results in leaching of nutrients. Having regular underdrainage pipes ensures the system drains effectively and the water level within the saturated zone does not rise to inundate the filter media. Inspection access allows pipes to be inspected and flushed. The drainage aggregate avoids material falling into the slots of the drainage pipes.
Maintenance access	
Vegetation and outlet	Most maintenance for bioretention systems is undertaken by hand. However, batter grades should allow access and if the swale components are turf, it is recommended these are flat enough to be suitable for ride on mowers. Ensure access to overflow pits or other structures is also provided for inspection and general maintenance. Dedicated access tracks or ramps are typically not required for bioretention swales. Maintenance is usually by foot access or ride on mowing (for turf).

Raingardens / bioretention systems

Function

Bioretention systems are depressed garden beds that detain flows within a defined extended detention area. These flows then percolate down through a prescribed filter media and a saturated zone. This saturated zone provides plants with access to water (soil moisture) during extended periods of dry weather. It also enhances nitrogen removal through denitrification processes. Treatment is provided by filtering and nutrient processing on the densely vegetated surface as well as within the filter media. Swales can be used upstream of bioretention systems in a treatment train. Rain gardens are also bioretention systems that are situated in streetscapes and urban environments.

Key design guidance

Bioretention systems typically contain the following elements:

» Inlet area, which may incorporate a coarse sediment forebay

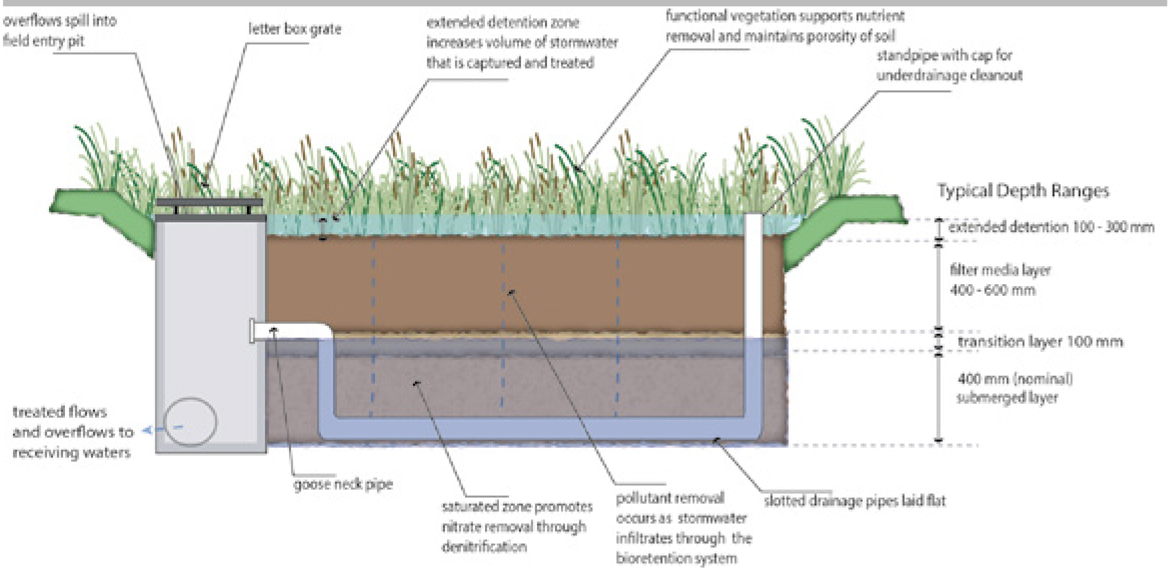
» Filter media, transition layer and saturated zones

» Densely vegetated surface and batters

» Extended detention set by outlet structure, which diverts high flows to local stormwater network

» Pipework for the collection and discharge of treated flows to the local stormwater network and to allow for underdrainage cleanout (standpipe)

Figure 14: Typical bioretention features



Filter media specifications and sourcing

Bioretention systems require special filter media as specified in the Adoption Guidelines for Stormwater Biofiltration Systems (CRC Water Sensitive Cities, 2015). Early consideration of where these materials can be sourced will be required; they should be locally sourced if possible.

The ACT has a draft design for bioretention systems (which only relates to larger systems) - MIS Bioretention systems. Assets built between 2007 and 2015 have shown high variability in their design, performance, maintenance requirements and need for rectification. TCCS are still evaluating a range of possible designs that may form a standard in the future. In the meantime, all bioretention designs require individual submission and approval from TCCS Development Review and Coordination.

Streetscape bioretention systems or raingardens are not included in the MIS Bioretention systems and will be treated on a case-by-case basis at development application level with submission and approval from TCCS.

Design constraints and key risk factors

Bioretention systems are highly flexible in their design and size, although the following site conditions provide some design constraints:

- **Steep slopes (slopes greater than 4–5%)** – bioretention systems require a flat surface and, therefore, on steeper slopes, smaller bioretention systems are preferred or larger systems engineered as stepped systems to reduce batter widths and slopes.
- **Large catchments (> 2.5 ha)** – large loads of sediment can smother plants and clog the filter media. In addition, high velocity flows can result in scour of the bioretention surface. Therefore, they are not ideally suited at the end of large catchments and require additional infrastructure including sediment capture devices and energy dissipation.
- **Single large systems (< 500 m^2)** – Single cell systems over 500 m^2 can be difficult to construct and also have a high risk of ongoing issues associated with difficulty establishing and maintaining vegetation, scour from high velocity flows, clogging, soil moisture gradients, uneven flow distribution and poor amenity. They are unacceptable to the ACT Government.
- **Large systems (> 500 m^2)** – Systems over 500 m^2 requires the systems to be broken into cells, with cells being no greater than 500 m^2. It should be noted that cells towards this size have a number of design and operational risks therefore should be broken into much smaller cells, however the use of large systems needs to be carefully evaluated.
- **Within retarding basins** – bioretention systems within retarding basins are highly susceptible to clogging due to sediment loading. If systems are located in flood retarding basins they should be located to be protected from retarding basin inundation for all events less than the 1 in 20 (5%) annual exceedance probability (AEP).

Sizing guidance

The required size of a bioretention system is influenced by rainfall characteristics, catchment size, land use, presence or absence of rainwater tanks, extended detention depth, filter media, saturated hydraulic conductivity and depth. In the ACT, bioretention systems are typically sized between 0.5% and 2% of the contributing catchment area. The Model for Urban Stormwater Conceptualisation is used to test and refine bioretention size to meet the site's objectives.

Table 22: Bioretention WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	These systems are passively irrigated from impermeable surfaces.	Passively irrigated landscape feature which does not require potable water for on-going performance.
Element 2: Stormwater quantity	Bioretention systems capture and detain frequent flow events as water is filtered through the system.	The temporary detention of flows reduces the peak volume entering waterways and stormwater networks.
Element 3: Stormwater quality	Bioretention systems provide treatment of stormwater, targeting fine sediments, metals, particulate and dissolved nutrients.	Bioretention systems can achieve the best practice pollutant load reductions when sized correctly.
Element 4: Climate change adaptation	Bioretention systems retain water in the soil and provide evapotranspiration through the vegetation. They also infiltrate flows reducing the peak volume of flows entering the stormwater network.	Local microclimate benefits are provided by keeping water in the soil and the process of evapotranspiration. The reduction of peak volumes entering the stormwater network also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Table 23: Bioretention design consideration

Design Consideration	Design rationale
Sizing	
Filter area	Dependent on catchment land use, imperviousness, extended detention depth and filter media saturated hydraulic conductivity. Additional area will be required for batters. Considerations for master planning may be 0.5-2% of the catchment (filter media surface area). Note: that the filter media of the contributing catchment is encouraged not to be broken up into multiple systems across a catchment (e.g. 50 small little rain gardens)
Total bioretention area	Total footprint area will depend on slope and required batter extent. Considerations for master planning may be 0.7-4% of the catchment (filter media surface area). Vertical retaining walls may be used but will increase cost and may impact visual amenity and public safety (typically only suitable for small systems).
Inlet properties	
Low flow bypass	No low flow bypass.
High flow bypass	Large bioretention systems can have an upstream sediment pond with a bypass weir to divert high flows around the bioretention system. Streetscape bioretention systems can backwater to the street to divert excess flows to a side entry pit. This avoids excess flows , scour and sediment loading.
Sediment capture area	Sediment forebays can be provided at the pipe outlet into bioretention systems to maintain inlet conditions. Depending on the catchment context, a sediment pond may be provided upstream of large bioretention systems. Where sediment ponds are employed up-stream of bioretention systems care is required in the sizing of the basin to ensure the basin does not prevent frequent flows from entering the bioretention system.
Bioretention properties	
Extended detention	Site characteristics will influence depth. Streetscape bioretention systems are typically suited to 100mm extended detention to reduce level difference with road and pavement surfaces and to reduce overall foot print in these constrained spaces. Depths over 300 mm may impact on plant health and pose public health and safety risks.
Filter media area	Dependent on catchment land use, imperviousness, extended detention depth and filter media saturated hydraulic conductivity. Additional area will be required for batters. Considerations for master planning may be 0.5-2% of the catchment (filter media surface area).
Filter depth	Shallower depths are at risks of drying out and may not be able to support vegetation.
Filter media properties	
Saturated hydraulic conductivity	Avoid higher hydraulic conductivities as the media will have low water holding capacity and result in drought-stressed plants.
Nutrient Content	Prevents leaching of nutrients from the media.
Organic matter content	Organic matter helps retain water for vegetation and can benefit pollutant removal, however higher levels may lead to nutrient leaching.
Grading of particles	Provides a stable media, avoiding structural collapse from downward migration of fines.
pH	AS 4419-2003 Natural Soils and soil blends helps with soil pH and plant growth.
Electrical conductivity	AS 4419-2003 Natural Soils and soil blends helps with plant growth.

Design Consideration	Design rationale
Horticultural suitability	Media must be capable of supporting healthy vegetation (assessment by horticulturalist). To support healthy vegetation over the long term.
Transition layer properties	
Material	Clean well-graded sand will prevents filter media washing down into the saturated zone.
Depth	To avoid migration of fines from the filter media and to avoid inundation of the filter media by the saturated zone.
Hydraulic conductivity (Ksat)	
Fine particle content	Appropriate sizing of fine particle content prevents the bioretention system leaching nutrients.
Particle size distribution	Bridging criteria- the smallest of sand particles must bridge with the largest of filter media particles to avoid migration of the filter media downwards into the transition layer.
Saturated zone properties	
Material	Clean sand or fine aggregate means the pore space between the sand/ aggregate grains retains the water. Sand has a greater capillary rise and will be most beneficial during extended dry periods.
Saturated zone depth	Provides storage of water to maintain soil moisture and enhance nutrient removal.
Outlet properties	
Overflow pit / weir	Over flow pit with letter box grate or overflow weir to receiving waterway or swale takes flows in excessive of the extended detention capacity
Underdrainage pipes	Standing water in the filter media section of bioretention results in leaching of nutrients. Having regular underdrainage pipes ensures the system drains effectively and the water level within the saturated zone does not rise to inundate the filter media. Inspection access allows pipes to be inspected and flushed. The drainage aggregate avoids material falling into the slots of the drainage pipes.
Maintenance access	
Inlet zone	Inlet zones are required for large bioretention systems with dedicated sediment forebays. Most maintenance of bioretention systems is typically manual/ by hand. Consider access for a maintenance vehicle and where it can conveniently park for general inspection and maintenance activities.
Outlet	

Wetlands

Function

Stormwater treatment wetlands are specifically designed to accept and treat stormwater. They are densely vegetated water bodies that use enhanced sedimentation, fine filtration, adhesion and biological uptake and transformation processes to remove pollutants from stormwater. Water levels in the wetland rise during a rainfall event and are detained and slowly released over two to three days.

In the ACT, wetlands are generally constructed offline. There are a number of considerations required from the ACT Government if wetlands are to be online and it will be treated on a case-by-case basis. Contact the local authority for further information. Offline wetlands are located adjacent to a drainage line or waterway. A proportion of flow is diverted from the waterway into the sediment basin of the wetland system for water quality treatment. Wetlands may also be within a drainage path but may feature a bypass system to divert stormwater events of a given zone around the wetland to protect the integrity of the system. An online wetland is located within the waterway or drainage line with base flow and high flows pass through the system.

Key design guidance

Wetlands will typically have the following elements:

- A sedimentation zone to treat sediments of greater than >125 µm in the stormwater prior to discharge to the vegetated wetland zone. This zone will typically incorporate a high flow bypass system to avoid damage to vegetated areas and resuspension of trapped sediments in storm events larger than the wetland design storm
- A vegetated wetland (macrophyte) zone to provide treatment via uptake the uptake, decomposition and transformation of stormwater pollutants and plant litter. The wetland zone should also include an inlet pool to enable even flow distribution through the vegetated areas, intermediate pools between areas of dense plantings to mitigate short circuiting of flows, and an outlet pool to minimise the risk of blockage of the outlet
- Balance pipes to ensure open water zones have a consistent water level and to enable the wetland to be drawn down for maintenance
- An outlet system that acts as a hydraulic control to ensure the wetland operates as per the design hydrological regime

A typical wetland layout is shown in Figure 15 and Figure 16.

Figure 15: Typical wetland schematic plan view

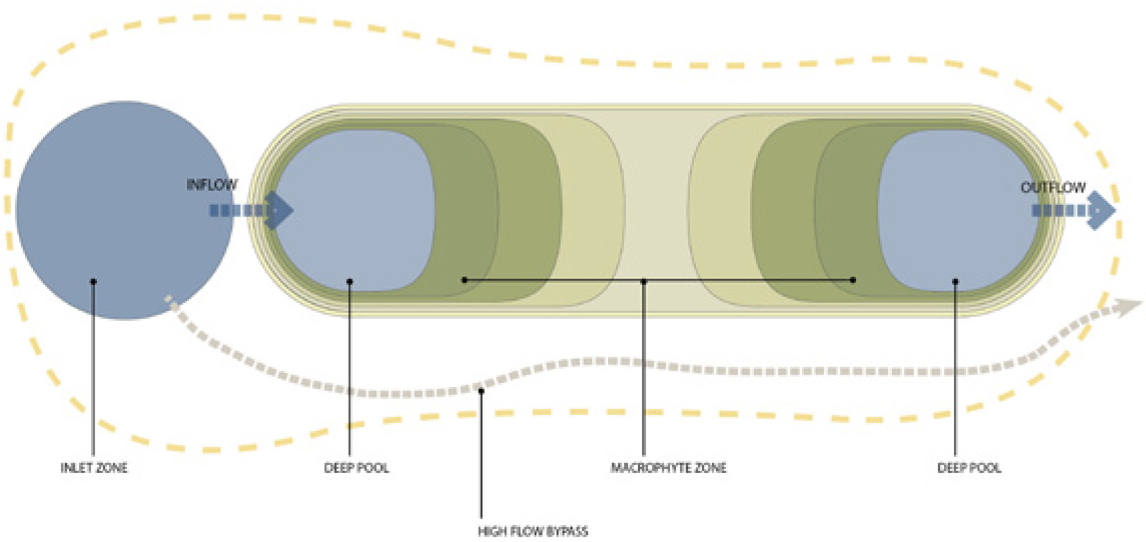


Figure 16: Typical wetland longitudinal section

Design constraints and key risk factors

Wetlands are not ideally suited to sites with:

» undulating and steep topography (>5%): A cross fall >2 m can be problematic for the depth of embankments required for the large, flat wetlands.

» limited space:
  - If there is less than 100 m^2 available, the combination of width, depth and edge profile will prevent the flow being uniformly distributed in the wetland and instead be dominated by edge effects. Smaller systems may require hard edges and heightened safety considerations.
  - If the macrophyte area available is less than 4% of the upstream catchment, performance might be compromised through, for example, insufficient detention time, high velocities causing scour or vegetation damage.

» shallow bedrock, high water tables and sandy soils: These wetlands may be difficult to construct.

» high water levels: Vegetation can be difficult to establish and maintain if water levels are too deep. It is recommended that extended detention depths not exceed 0.35 m and wetlands with a small area compared to catchment ratio need to have inundation frequency analysis undertaken to inform appropriate planting designs as these systems will experience flows more frequently.

» large flow volumes and velocities: Systems which are online or within floodplains need to be carefully designed to control how infrequent flows enter and flow through the wetland to maintain velocities less than 0.5 m/sec.

Although these site characteristics do not preclude the use of wetlands, they trigger the requirement for additional design considerations with potential cost implications.

The loss or lack of emergent wetland vegetation poses a key risk to the overall treatment function and resilience of the wetland. Some constructed wetlands do not establish or sustain adequate plant coverage. Some potential causes of this include:

» the normal water level is too deep for healthy plant growth

» damage to plants from waterfowl

» prolonged inundation during rainfall events, due to the wetland being poorly sized for its catchment, outlet not having sufficient capacity, or outlet being prone to blockage.

Sizing guidance

Wetlands can be constructed on many scales, from lot scale to regional scales. They can be designed with hard edges and be part of a streetscape or forecourt or they can designed to be more natural looking.

They will typically be sized between 7–10% of the catchment (including sediment basin, batters and macrophyte zone).

It is important to use the following sizing guidance to inform the design of the system:

» Sediment basin is typically around 5% of the macrophyte zone area.

» Inlet and outlet ponds are typically 10% of the macrophyte zone.

» Macrophyte zone covers 80% of the wetland area and bathymetry needs to accommodate a range of planting depths.

» Intermediate zone: Inbetweenthe inlet and outlet zone/pond maybe required for large wetland systems.

» High flow bypass is typically sized to convey the 1% AEP event.

Table 24: Wetland WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Stormwater treatment wetlands are a landscape feature which are designed to have permanent pools within them, reducing the requirement for irrigation which can have potable water savings.	Passively irrigated landscape feature which does not require potable water for on-going performance.
Element 2: Stormwater quantity	Wetlands capture and detain the frequent flows (typically the 4EY) for 48-72 hours within the extended detention volume to allow treatment processes to occur. Additional storage of larger flows can be provided above this which is released within a couple of hours (typically), providing an opportunity for some coarse sediment to be deposited, whilst not impacting on (drowning) the wetland plants.	Wetlands can be designed into the floor of flood detention basins with temporary short term flood storage above the extended detention storage when designed with a flood detention spillway which controls outflow and avoids scour of the wetland and banks.
Element 3: Stormwater quality	Wetlands provide treatment targeting fine sediments, metals and particulates and dissolved nutrients.	Wetlands meet pollutant load objectives when designed to meet best practice requirements.
Element 4: Climate change adaptation	Wetlands retain water in the landscape, provide evapotranspiration and slow and temporality store stormwater flows.	Local microclimate benefits are provided by keeping water in landscape and evapotranspiration.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Detailed design consideration

It is important that the wetland is sized appropriately for the catchment size to ensure hydraulic loading is not too large or too small to hinder the wetlands stormwater treatment performance and success for the wetland plants. The following table provides design parameters for stormwater wetlands designed in accordance with current best practice.

When designing atypical stormwater treatment wetlands, for example a wetland undersized for its catchment (i.e. with low hydrologic effectiveness), careful consideration needs to be given to outlet design, extended detention depth, time and normal water levels to ensure the wetland plants will be sustained and not drowned out by over inundation. Inundation frequency curves are recommended.

Table 25: Wetland design considerations

Design Considerations	Design rationale
Sizing	
Macrophyte zone	Macrophyte zones of this area will be able to achieve best practice stormwater treatment and will receive inflows often enough to support good plant health. Considerations for master planning is sizing of a minimum of 4% of contributing catchment.
Total wetland area	Total wetland is greater than the macrophyte zone area due to the inclusion of sediment pond, batters, etc. Considerations for master planning is sizing of a minimum of 4% of contributing catchment.
Inlet properties	
Low flow bypass	No low flow bypass.
Scour protection at inlet pipe	Required scour protection is dependent on pipe size and velocities rock apron, structural soil (rock mixed with soil) and/or flow resistant plant species.
High flow bypass	Bypass weir incorporated into inlet pond with sufficient length to convey above design flows. The bypass channel should have enough capacity to convey above design flows with sufficient scour protection. High flow bypass ensures protection of the macrophyte zone.
Inlet pond volume	Sediment ponds sized smaller than this will result in large particles entering the wetland, potentially smothering the vegetation. Sediment ponds sized larger than this will capture fine sediments and pollutants and will be at risk of poor water quality and algal blooms.
Inlet pond level	Inlet pond permanent pool levels to sit above the macrophyte zone permanent pool level.
Macrophyte zone properties	
Extended detention	Extended detention depths above the approved standard can result in plants drowning.
Permanent deep pools area and depth	Area – It is recommended that the total surface area of the pools be 20% of the total macrophyte zone area. Depth – deep pools should ensure permanent deep pool habitats. The deep pools ensure they provide a permanent refuge for mosquito predators during extended dry periods.
Vegetated macrophyte zone area and depth	Consideration for masterplanning means macrophyte zones need to cover 80% of the wetland to achieve best practice stormwater treatment as this is where the majority of the stormwater treatment occurs. The vegetated zone is designed to have complete vegetation cover, be gently grading and have water depths. Having a range of depths allows areas of the base soil profile to experience wetting and drying, which aids in the removal of phosphorus from the stormwater. Planting density is influenced by plant species.
Slope	Shallow slopes allow plants to grow and adapt to the wetland conditions. Steeper grades into deep water reduces the encroachment of planting into the deep pools which are designed to be open water zones. It is important all surface grading is smooth to ensure there are no isolated pools where mosquitoes can breed.
Velocities	Velocities above the standard can result in the removal of biofilms from the vegetation surface. These biofilms remove the majority of nitrogen from the stormwater. High velocity flows can also damage vegetation.

Design Considerations	Design rationale
Intermediate zone properties	
Depth	Provide the transition between the inlet and outlet zones for large wetland systems. Deep zones in the wetland help to break short-circuits when placed as intermediate pools and provide some degree of treatment via sedimentation, microbial processing in the substrate and via algal oxygenation and nutrient uptake in the water column.
Outlet zone properties	
Equivalent pipe diameter (riser outlet)	Typically sized to achieve the desired notional detention time (see below).
Overflow weir width	Typically caters for bypass of flows up to the capacity of the inlet structure. Where a wetland is fully on-line to its catchment it is recommended that high flow velocities through the wetland not exceed 0.5m/sec for the 1% AEP.
Notional detention time	Preferred time allows contact time for nutrient processing to occur whilst supporting plant health (not inundated for long durations) and drains to provide detention capacity for the next storm event.
Maintenance access	
Inlet zone	Provide access for maintenance machinery to measure and remove sediment. Access ramp and sediment dewatering area is required to allow sediment clean out when the basin is half full (sizing of sediment basin should result in clean-out every 5 years).
Dewatering area or drying pad	Area located next to the sediment pond for the placement of excavated sediments to allow dewatering. Water draining from the sediments is encourage to flow back into the sediment pond. This will reduce the cost of transporting sediment offsite. Sediments may also be spread to negate taking it offsite (if classified as low hazardous waste). These areas will be infrequently used and so can be grassed and part of the general landscaping. Some re-instatement may be required after a clean-out depending on the landscape design.

Ponds and lakes

Function

Lakes with the primary function of providing landscape amenity and recreation opportunities should be considered as receiving environments and have stormwater treatment systems located upstream to protect the water quality.

Ponds are typically constructed open water bodies with fringing vegetation and submerged macrophytes. They retard storm flows and provide some stormwater treatment, predominantly through the capture and settling of sediments (down to coarse to medium silts).

Constructed wetlands are more effective at treating stormwater than ponds, particularly in relation to the removal of fine suspended particles and dissolved pollutants. However, where space or topographic constraints preclude the use of constructed wetlands (e.g. steep terrain), ponds may be appropriate as they have a smaller surface area to volume ratio. The use of stormwater treatment ponds should be limited to constrained sites with catchment geology predominantly yielding coarse to medium sized silt particles (Australian Run-off Quality (Engineers Australia 2006) Chapter 12 Constructed Wetlands and Ponds—Peter Breen, Tony Wong and Ian Lawrence).

When designing ponds for stormwater treatment there are key design considerations as outlined below.

In the ACT, ponds are generally constructed offline. Similar to offline and wetland, offline ponds are considered situated adjacent to a waterway while an online pond is located within the waterway or drainage line. There are a number of considerations required from the ACT Government if the pond is to be online and will be treated on a case-by-case basis. For example, the use of flumes to route water from the pond to a desired location. Contact the local authority for further information.

Key design guidance

Key design elements for ponds ensure they are sustainable systems with reduced risk and maintenance requirements. These include:

- simple shape and inlet and outlet placement to promote uniform distribution of flow velocity and to eliminate short-circuit flow paths and stagnant zones
- design of outlet control compatible with the hydrology and size of contributing catchment. Typically a riser outlet for control of extended detention and a bypass channel for high flows
- consideration of inundation depth and frequency of inundation at various depth ranges to inform and support fringing vegetation
- wedge shaped (deepest end towards the outlet) or a flat bottom with depths between 1–4 metres to encourage good vertical water column mixing and avoidance of persistent stratification
- size compatible with the hydrology and size of the catchment to promote flushing of the system and avoid problems associated with stagnant water and algal blooms
- good quality inflows or pretreatment to reduce the accumulation of organics, nutrients and fine sediments which impact water quality
- densely vegetated batters to reduce weed growth and provide a barrier for improved public safety
- factoring the draining and dredging of ponds into the design process for future operation and maintenance. Silted ponds can become a water quality and stormwater quantity issue (e.g. flooding).

Design constraints and key risk factors

- Ponds are not ideally suited to sites with shallow groundwater, bedrock or highly permeable soils as they can be difficult to construct.
- Poor water quality inflows (e.g. high proportion of fine particulates and/or organics) can lead to the accumulation of nutrients in the system which can lead to algal blooms and water quality issues.
- In high profile/highly visible locations (e.g. regional or district parklands) competing primary objectives are likely (i.e. landscape amenity versus stormwater treatment/pollutant retention).

» Erosion of inlets, outlets or batters occurs if hydraulics and hydrology are not appropriately considered in the design.

Sizing guidance

The size of a pond should depend on the catchment size (volume of inflows) to ensure that the residence time (turn-over of water) is less than 50 days.

Table 26: Pond WSUD performance summary

ACT WSUD Code Requirements	Function	Performance
Element 1: Mains water use reduction	Ponds can be used to store water to be used for alternative water demands such as irrigation.	The reliability and volume of water that the pond can store for alternative uses depends on the catchment size and associated volume of stormwater, the demand and also the size of the system (it is important that water draw-down does not impact the batter vegetation health).
Element 2: Stormwater quantity	Ponds can be designed as part of the flow quantity management for a site, detaining storm flows. This volume of detention can also be increased if water is stored for alternative uses.	The retention of flows in ponds reduces the volumes of water entering downstream waterways.
Element 3: Stormwater quality	Ponds provide some level of treatment, targeting sediments and attached nutrients. However storing untreated stormwater in these open water bodies for prolonged periods of time lead to water quality issues and associated issues such as algal blooms.	Ponds are unable to treat stormwater to meet best practice load reductions. They can contribute however if they are integrated into a treatment train as a stormwater harvesting storage which results in less stormwater (and pollutants) entering downstream environments.
Element 4: Climate change adaptation	These retain water in the landscape and store stormwater flows	Local microclimate benefits are provided by keeping water in landscape. The reduction of peak volumes entering the stormwater network also helps to address nuisance flooding.
Element 5: Entity (Government agency) Endorsement	Refer to Section 6	Refer to Section 6

Figure 17: Typical cross sections of a lake (from Melbourne Water, 2005)

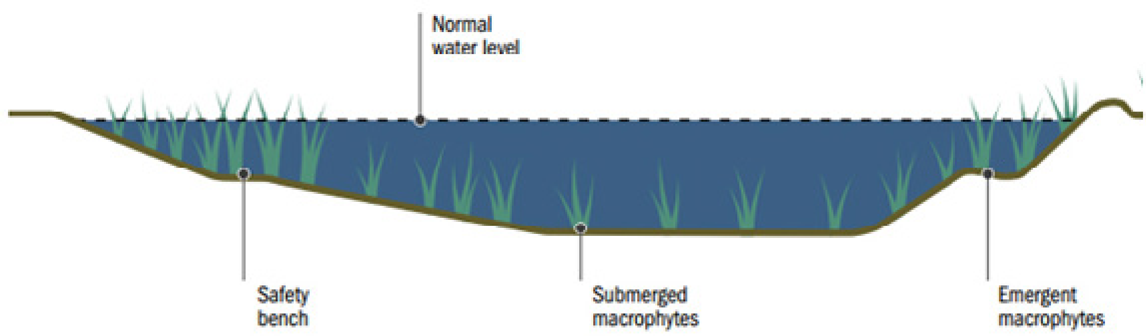


Table 27: Pond design considerations

Design Considerations	Design rationale
Sizing	
Pond area	Considerations for master planning may be 2-4% of the urban catchment. This is a rule of thumb to be used with caution. Sizing should be informed by residence time analysis and water quality objectives to be achieved (MUSIC modelling).
Residence time	Residence time help to reduce risk of algal blooms.
Inlet properties	
Inlet	The placement of inlets shall eliminate short-circuit flow paths and stagnant pools and reduce scour during periods of high inflow rates.
Low flow bypass	No low flow bypass.
High flow bypass	No high flow bypass required.
Batter properties	
Vegetation	Perimeter vegetation protects banks and improves public safety. Submerged plants provide oxygen to the sediments which helps to maintain good water quality. Floating plants can limit the availability of dissolved oxygen, block sunlight and contribute to organic matter and nutrient loading (due to rapid breakdown of soft leaf tissues).
Slope	The appropriate batter slope a safety bench for the public (i.e. should they venture into the water they can sense the water getting deeper and can easily retreat). TCCS may consider steeper batter slopes (e.g. 1:4) if required and if adequately protected with specially chosen plants and increased planting density. Handrails required for certain batters.
Open water zone properties	
Depth	Maximum depth is to reduce stratification of the water column. Minimum depth is to maintain open water zones and permanent pool.
Shape	Simple shape designs (not convoluted) with a minimum length to promote good mixing and eliminate stagnant zones.
Extended detention	Maximising the extended detention for water quality out comes up to the design minor storm such as to avoid over inundation of fringing vegetation.
Outlet properties	
Overflow pit / weir	A primary outlet system helps to convey a proportion of the design flow to the outlet without compromising the other elements of the asset. A secondary outlet or spillway helps to prevent overtopping of embankments up to the design flood event.
Maintenance access	
Inlet	Access ramp and sediment dewatering area may be required to allow sediment clean out when the pond is half full.
Outlet	Access for maintenance shall be provided to all outlets.
Dewatering area	Area located next to the sediment pond for the placement of excavated sediments to allow dewatering. Water draining from the sediments is encourage to flow back into the pond. This will reduce the cost of transporting sediment offsite. Sediments may also be spread to negate taking it offsite (if classified as low hazardous waste). These areas will be infrequently used and so can be grassed and part of the general landscaping. Some re-instatement may be required after a clean-out depending on the landscape design.

FLOOD MANAGEMENT SOLUTIONS

Retarding Basins

Flood retarding basins are not considered a WSUD solution. They are a flood mitigation measure. They temporarily store stormwater from a drainage catchment for flood events and allow the downstream flow rates to be kept within the design capacity of the drainage system. The control of peak flow rates provides environmental protection to the downstream waterway. These basins are usually designed to reduce downstream flooding impacts (for the protection of human life and infrastructure/assets) associated with events up to a 1% AEP flood level.

Retarding basins are increasingly being recognised for their opportunity to be designed or retrofitted as a multifunctional asset combining flood mitigation function during flood events and incorporating a WSUD treatment element (such as a wetland) in the floor of the basin for water quality improvements during more frequent rainfall events.

The hydraulic performance of a retarding basin should be in accordance with the Municipal Infrastructure Standards. The standards state that sizing is tested using a range of 'design' storms up to the 72 hour event to determine the maximum storage requirements, the critical storm duration, the peak flood level, sizing of the primary outlet structure and discharge from the retarding basin. The design of flood retarding hydraulic controls should aim for reduced structure complexity and the promotion of blockage/fail safe design solutions. The AEP capacity of the secondary spillway capacity must be determined from a Consequence Category assessment of the risk of failure of the retarding basin embankment in accordance with NSW Dam Safety Committee guidelines.

In a new development area, flood retarding basins can be readily delivered by the developer. Managing and minimising the extent of impervious area and preserving floodplains will also contribute to flood management outcomes. Designs should allow space for water and ensure overland flow paths are not restricted. Responsible floodplain management and planning needs to be considered not only within the bounds of a development site but beyond the site to ensure no worsening of flood conditions/levels upstream and downstream of the site. There should be no net loss of floodplain storage.

STEP 2: Plant Selection

Vegetation is an important component of many of the WSUD systems described in the previous sections. It is important to ensure suitable vegetation is used for the different systems so they establish successfully and survive.

While the identification of appropriate vegetation would actually be undertaken during the design process (step 1), it has been separated out as a step in these guidelines for ease of use.

Planting selection will depend on:

» inundation tolerances

» tolerance to exposure (e.g. hot dry conditions as well as cold and frosty conditions).

The following table provides a list of suitable plants for WSUD systems in Canberra. These species are either recommended for their known treatment performance and/or are known to occur in the ACT area and therefore should be adapted to the extreme climate conditions. Other species can be used to supplement these core species in treatment systems to ensure there is design diversity for WSUD across the ACT. These additional plants should be chosen carefully from local palettes to ensure they can tolerate the inundation conditions in the WSUD system.

Table 28: Recommended WSUD planting species for ACT

Vegetation species	Plant type	Suitable planting zone
Bioretention / swales / batters		
Imperata cylindrica	Grass	Bioretention
Carex appressa*	Sedge	Bioretention
Lepidosperma laterale	Sedge	Bioretention
Juncus amabilis*	Rush	Bioretention
Juncus flavidus*	Rush	Bioretention
Juncus fockei	Rush	Bioretention
Juncus usitatis	Rush	Bioretention
Lomandra multiflora	Rush	Bioretention
Lomandra longifolia	Rush (decorative flowers)	Bioretention
Leptospermum continentale*	Shrub (decorative flowers)	Bioretention
Kunzea muelleri	Shrub (decorative flowers)	Bioretention
Kunzea parvifoia	Shrub (decorative flowers)	Bioretention
Kunzea ericoides	Shrub / tree (decorative flowers)	Bioretention
Leptospermum granifolium	Shrub / tree (decorative flowers)	Bioretention
Leptospermum lanigerum	Shrub / tree (decorative flowers)	Bioretention
Leptospermum micromyrtus	Shrub / tree (decorative flowers)	Bioretention
Melaleuca pallida	Shrub / tree (decorative flowers)	Bioretention
Melaleuca paludicola	Shrub / tree (decorative flowers)	Bioretention
Wetland / ponds		
Baloskion australe	Rush	Littoral (edge) zone
Juncus usitatis	Rush	Littoral (edge) zone
Schoenoplectus pungens	Sedge	Littoral (edge) zone
Lepidosperma laterale	Sedge	Littoral (edge) zone
Carex appressa	Sedge	Littoral (edge) zone
Carex fascicularis	Sedge (decorative flowers)	Littoral (edge) zone
Gratiola peruviana	Herbaceous / flowering plant	Littoral (edge) zone

Vegetation species	Plant type	Suitable planting zone
Lycopus australis	Herbaceous (decorative flowers)	Littoral (edge) zone
Lythrum salicaria	Herbaceous (decorative flowers)	Littoral (edge) zone
Persicaria decipiens	Herbaceous (decorative flowers)	Littoral (edge) zone
Veronica derwentiana	Herbaceous (decorative flowers)	Littoral (edge) zone
Baumea rubiginosa	Sedge	Littoral/shallow (0.0-0.2m deep)
Carex tereticaulis	Sedge	Littoral/shallow (0.0-0.2m deep)
Cyperus lucidus	Sedge	Littoral/shallow (0.0-0.2m deep)
Eleocharis acuta	Sedge	Littoral/shallow (0.0-0.2m deep)
Eleocharis equisetina	Sedge	Littoral/shallow (0.0-0.2m deep)
Gahnia subaequiglumis	Sedge	Littoral/shallow (0.0-0.2m deep)
Schoenoplectus mucronatus	Sedge	Littoral/shallow (0.0-0.2m deep)
Triglochin multifructa	Herbaceous (decorative flowers)	Littoral/shallow (0.0-0.2m deep)
Alisma plantago-aquaticum	Herbaceous (decorative flowers)	Littoral/shallow (0.0-0.2m deep)
Phragmites australis	Grass	Shallow (0.2m deep)
Bolboschoenus caldwellii	Sedge	Shallow (0.2m deep)
Bolboschoenus medianus	Sedge	Shallow (0.2m deep)
Schoenoplectus validus	Sedge	Deep (0.35m)
Eleocharis sphacelata	Sedge	Deep (0.35m)
Bolboschoenus fluviatilis	Sedge	Deep (0.35m)

* As recommended in Adoption Guidelines for Stormwater Biofiltration Systems, CRC for Water Sensitive Cities

Note: MIS 25 Plant Species for Urban Landscape Projects can be used in conjunction with the above list as a guide for the terrestrial planting around the WSUD assets.

Typically it is preferred that more than one species is used for each planting zone. This provides diversity and resilience in the design of the system (i.e. if one plant species does not establish successfully, the others will hopefully survive and replace it through natural recruitment). To support plant growth and reduce the risk of weeds, it is recommended that planting densities are between 6–10 plants/m^2.

Deciduous trees should be avoided due to the sudden nutrient deposition in winter.

STEP 3: Documenting WSUD designs and their expected performance

Once the design of the WSUD systems has been undertaken, the detailed designs need to be documented for consideration and approval. Following this approval, the systems can then be constructed.

To obtain this approval, TCCS require a lodgement process that includes the following:

1. Submissions from individual consultants for separate elements of work for the same project and in the same location must be presented together.
2. TCCS Development Review and Coordination undertakes a contents check to ensure the minimum requirements for lodging a Design Acceptance submission have been met. A response acknowledging receipt will be issued the day after the submission is received.
3. Incomplete submissions and those that do not meet all the requirements are returned to the applicant for completion.
4. TCCS Development Review and Coordination issues a Certificate of Design Acceptance once all requirements are met.

See additional details on the document and process requirements on the TCCS website, www.tccs.act.gov.au/Development_and_Project_Support.

It is recommended that, at this stage of the design and approval process, the staging of the WSUD asset construction and establishment is identified and a clear lifecycle cost analysis undertaken to provide TCCS with confidence that the proposed WSUD asset can be delivered successfully and is the most appropriate solution for the site.

Table 27 presents a summary of the recommended tools to help inform and test the WSUD asset designs.

Appendix B provides a checklist which can be used to help guide and document the design of WSUD assets.

Appendix D includes all the development application checklists to be submitted with development applications.

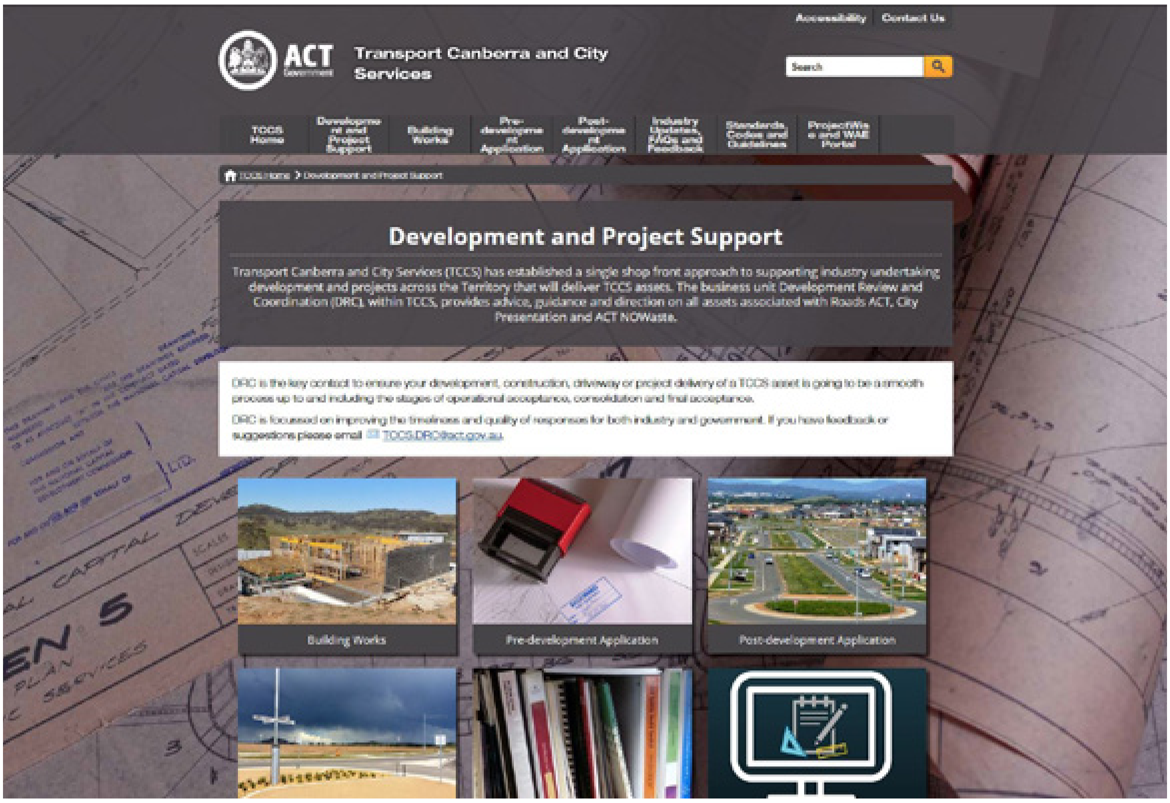


Table 29: A summary of the recommended tools which can be used to assist in the WSUD design process

Assessment tool	Type of analysis	Recommended use
MUSIC	Stormwater quality and quantity continuous simulation	» Required » Current primary tool to assess stormwater quality treatment performance » Industry accepted and it is adequate and suitable for the purpose
SWMM	Stormwater quality and quantity continuous simulation	» Optional » Current secondary tool for stormwater quality assessment that is difficult to set up and not typically used
MUSIC Auditor	Model assessment	» Strongly recommended » Supports and checks MUSIC assessment
ACT Water Reduction Calculators	Water balance	» Recommended » Current primary tool to assessment potable water reduction
BASIX (NSW)	Water balance	» Recommended » Part of a broader sustainability assessment that can be used to complement the ACT Water Reduction Calculators
Green Star rating	Water balance	» Optional » Part of a broader sustainability assessment that can be used to complement the ACT Water Reduction Calculators
ACT Rainwater tank guidelines	Estimate	» Required
Deemed to comply tables	Prescription	» Optional for simple designs
MUSIC	Hydrology only	» Recommended for estimating benefit of WSUD on small and frequent events
TUFLOW, MIKE, SWMM or similar	Hydraulics and hydrology	» Recommended for understanding impact of WSUD on flow routing and flood extents
DRAINS	Hydraulics primarily	» Optional
RORB, XP-RAFTS or similar	Hydrology only	» Optional » Note that the representation of WSUD in this tool is difficult

STEP 4: Lifecycle costing and cost-benefit analysis

An important part of a WSUD strategy is presenting the business case for investment.

A lifecycle costing includes consideration of both upfront and ongoing costs to provide a full picture of the investment requirements. Where all WSUD options provide similar benefits (or are designed to meet a performance target), lifecycle costing can assist in the direct comparison and selection of a preferred option.

Where it is important to demonstrate the benefits achieved by the proposal relative to the cost, or to compare several options that offer various benefits, a cost-benefit analysis can be undertaken whereby the immediate and long-term benefits are also estimated and compared with the lifecycle cost. WSUD projects often provide a range of benefits such as amenity, water quality improvement, flood mitigation and mains water use reduction—these can be estimated and used to compare options to determine overall value for money.

The following sections describe how to estimate the lifecycle cost, and how to estimate benefits to develop a cost-benefit analysis.

Lifecycle Cost

Lifecycle costing is a process to determine the sum of all expenses associated with a project or product. In carrying out a lifecycle assessment, it is recommended that the evaluation consider:

» capital expenditure

» operation

» maintenance (scheduled and corrective)

» replacement costs (i.e. vegetation replacement, desilting/sediment removal)

» lifespan

» renewal or decommissioning costs.

The following table provides details of what the assessment may consider in further detail.

Table 30: This table presents a summary of the key considerations recommended for a lifecycle assessment

Lifecycle Staging	What to consider?
Capital expenditure	The value to be incurred by the purchaser who will buy or construct the WSUD asset or add value to an existing asset (i.e. retrofitting). Capital expenditure will include all costs of products, materials and labour required for installation and establishment. It is important to consider specific landscaping costs for integration of WSUD features into surrounding environments. Any design, management and approval fees required for construction should also be included.
Operation	WSUD devices are usually passive devices without moving parts or ongoing energy or water needs. Some systems may include a pump which will have an ongoing energy cost.
Maintenance	It is recommended an ongoing maintenance plan be developed which will help to estimate the expected ongoing costs of maintenance. In estimating the cost of maintenance, consider: • What maintenance activities are required? Certain activities may require the skills of different work crews (e.g. landscaping, litter removal, pipe and pit maintenance). • How regularly does the asset needs to be maintained? • Will a higher level of maintenance be required in the establishment period? The labour and material costs related to maintenance can be estimated through review of the maintenance plan, or an overall estimate may be obtainable from reference projects. Generally, there are two broad categories of maintenance: - Frequent scheduled maintenance, which is predicted by a maintenance plan. - Unscheduled corrective maintenance, due to unexpected extreme events or due to breakage or fault. A contingency could be allowed for corrective maintenance. Time for regular inspections should be accounted for as part of the maintenance plan. During these inspections scheduled maintenance may be able to be completed, and required corrective maintenance can be identified and scheduled.
Replacement costs	Some WSUD assets may have staged replacement scenarios rather than require being completely replaced. For example a raingarden may need to have certain sections of filter media replaced at certain times or after certain events rather than require being replaced completely. These replacement costs need to be factored into the lifecycle costings. Replacement scenarios should be itemised. It is recommended that the timing for significant expenditure also be considered so there are no surprises on the expenditure.
Lifespan	A number of assets such as GPTs will have a product calculation of its lifespan. However the lifespan will be calculated in optimal conditions such as being maintained as per the schedule of maintenance. Many asset managers face the reality of being unable to maintain the asset to the maintenance schedule and will apply a blanket rule in scheduling maintenance. Considering the likely maintenance frequency, it is recommended a realistic lifespan be factored into the lifecycle assessment.
Decommissioning or renewal costs	Some assets will require decommissioning once they have reached the end of their product life, while some assets will require decommission from asset failure. Decommissioning costs will need to consider the cost to remove the asset (including labour and equipment hire); disposal cost and a replacement cost if required. Other assets may be renewed or reset. Costs will need to consider which components can be retained and reused and which components need to be replaced.

When summing or annualising the various components of a lifecycle cost, a discount rate should be applied to future costs to calculate totals to a present day value.

In completing a lifecycle cost estimate, it is also important to identify cost-bearers. WSUD is often delivered and managed by different parties. For example a land developer may contribute the upfront capital cost, while TCCS, a site manager or local community groups may be responsible for ongoing maintenance. Costs to different parties should be clearly delineated in the lifecycle cost assessment.

Cost–benefit Analysis

The costs of an asset can be estimated with relative ease. However, the benefits that are both directly accrued to the development, and indirectly attributed to the works within the development are typically more difficult to monetise.

Multi-functional WSUD landscapes have many advantages such as maximising water reuse and promoting amenity or helping developers meet requirements to achieve development approvals. Other positive social outcomes from WSUD landscapes could include better health and wellbeing, improved safety, enhanced liveability and amenity values, improved resilience, higher value of the environment and improved cultural linkages to the environment. Reducing the impact on receiving waterways and integration of WSUD treatment elements into adjoining natural areas is a positive environmental outcome.

The current application of WSUD in the Territory has many social, environmental and economic benefits. The following table provides a brief overview of the current and future social, environmental and economic benefits of WSUD and the importance to improve on WSUD in the Territory which could be considered in cost–benefit analyses.

Table 31: This table presents a brief overview of current and future social, environmental and economic benefits of WSUD

Social	Economic	Environmental
» Improved liveability for the Canberra community through recreational wellbeing, enhanced amenity to waterways. » Water supply security. » Opportunities to create and enhance green spaces and introduce water into the urban landscape, benefiting the appeal of neighbourhoods. » Having water in our urban environment through evapotranspiration of trees and vegetation helps to alleviate the effects of heatwaves in built up urban areas, particularly for vulnerable communities.	» Increased productivity and innovation for the building and construction industry through the application of clear WSUD guidelines » Improved skills and education of this industry. » Improved water quality has positive benefits for investment and economic impacts including enhancing community use and tourism activities. » Positive economic impacts through implementing WSUD reform include that future assets are not compromised by flooding, excessive stormwater retention and detention and poor water quality. » Continuing to reduce mains water usage has positive economic impacts for the consumer.	» Improved water quality and implementation of WSUD will enhance the current environmental benefits including biodiversity, development, positive landscape changes, improved management of natural resources and improved environmental quality and water. » The future benefits of WSUD include alleviating climate change impacts, such as less predictable rainfall and increased flash flooding, and reduced impacts of the urban heat island effect and heat waves. » Continuing to reduce mains water usage has environmental benefits on water resources.

The estimation of the scale of these effects can broadly be done in three ways:

- Qualitative assessment
- Quantitative assessment
- Monetised assessment

A qualitative assessment is undertaken by judging the likely relative scale of benefit expected and making a comparison between the performance of options. It may be suitable to agree a rating or score for the benefits achieved between a group of stakeholders. The lifecycle cost and a summary of the qualitative assessment (e.g. a score or set of traffic light indicators) can be compared together to assess options or present the overall recommendation.

A quantitative assessment involves the measurement of benefits through modelling or other means. Some quantifiable benefits which can commonly be estimated for WSUD include the following:

- Reductions in pollutants (TN, TSS, TP)
- Supplied amount of non-potable water for reuse
- New vegetated area
- Reduction in flood risk / flood storage provided

A mixed qualitative–quantitative assessment could be used to appraise all relevant benefits by allocating thresholds and scores for each value.

Thirdly, a monetised assessment can be developed, where benefits are estimated in equivalent dollar terms. To 'monetise' a benefit, evidence is needed to relate the scale of the benefit to a dollar value. Ideally, evidence should be drawn from studies or documentation from a relevant context and which has been conducted recently. Some examples of benefits that have been monetised for WSUD projects include:

- uplift in surrounding property values due to improved amenity offered by enhanced waterways, WSUD or green infrastructure
- value of nitrogen and phosphorous removal from sensitive waterbodies (estimated as the equivalent cost/tonne of removal measures elsewhere in the city to provide protection
- value of substitution of mains potable water supply (taking into account long term marginal costs of supply and transfer)
- value of increased land productivity and tree canopy cover.

Monetising of benefits may require specialist economics advice to ensure it is fair and representative. Once dollar values have been allocated these can be directly compared with the lifetime cost to create a benefit/cost ratio.

Further guidance on cost-benefit assessment can be found at:

- VISES 2015, Green Infrastructure Economic Framework, Victoria University, Melbourne
- Jones, R.N., Symons, J. and Young, C.K. 2015, Assessing the Economic Value of Green Infrastructure: Green Paper, Climate Change Working Paper No. 24, VISES, Victoria University, Melbourne.

Step-by-step process to develop a cost–benefit analysis

Step 1: Select the options you would like to compare.
You may select several different WSUD designs. As a minimum, select the preferred WSUD design and an alternative but well understood option to compare it to. This may be a 'conventional' or 'business-as-usual' drainage solution which is typically defined as an urban development with water quantity control but not quality control

Step 2: Set the lifecycle period for analysis.
A life cycle cost includes all costs incurred throughout the 'lifecycle' of the project. A suitable lifecycle period should be selected for analysis, typically 20–50 years. The lifecycle period must be the same for all options so they are compared on a fair basis.

Step 3: Estimate the costs of each option over the lifecycle.
Refer to the discussion in the section above regarding life cycle costs. A lifecycle cost includes all costs throughout the lifecycle period, including capital construction costs, operation and maintenance costs and replacement and decommissioning costs. All costs should be estimated, noting the year in which the cost is anticipated to occur. Costs estimates can be estimated from similar built projects, based on advice from quantity surveyors or using published rates.

Step 4: Estimate the net present cost for each option.
A net present value (NPV) can be calculated to combine the present values of all costs into a single figure. A suitable discount rate should be selected in order to calculate present values. Discount rates between 3–7% are common for infrastructure.

Step 5: Estimate the non-monetised benefits of each option over the lifecycle.
As discussed in the section above, benefits could be estimated using qualitative and quantitative assessment. Select a suitable assessment method based on information and time available. The assessment should allow all options to be assessed for the same benefits, and for a comparison to be drawn for each. As a simple comparison, benefits can be assessed as 'low', 'medium' or 'high' or given a score out of 10.

Step 6: Estimate the net present benefit for each option.
If benefits have been monetised (equated to a dollar value), they need to be treated the same way as costs, whereby a discount rate is used to calculate a net present value from benefits that occur at different points in time. If using qualitative or quantitative assessment of benefits, benefits that occur in the future should be suitably discounted to represent a fair 'present value'.

Step 7: Compare the cost–benefit of each option.
Compare the net present cost of each option with net present benefit. If benefits have been monetised, a cost–benefit ratio can be created for each option by dividing the net present cost by the net present benefits. This should be supported by a score or traffic light assessment used to assess other non-monetised benefits to allow options to be comprehensively compared.

5. WSUD TREATMENT ASSETS CONSTRUCTION AND ESTABLISHMENT

It is critical that WSUD assets are constructed and established correctly to ensure they will function as designed and have low ongoing maintenance requirements.

The inflow of sediment-laden stormwater run-off can impact the establishment and long-term function of WSUD assets. It is therefore critical to protect these systems while the contributing catchment is being built-out. This protection can come from:

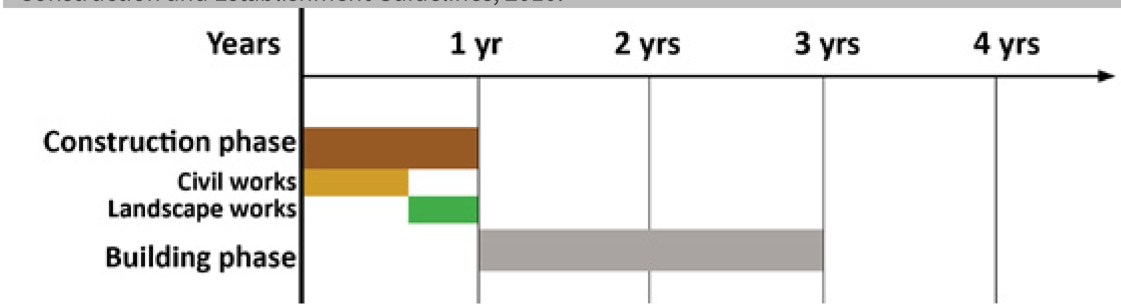
» effective erosion and sediment controls in the catchment

» protection measures around the WSUD asset

» staged construction and establishment methods.

Typically this protection is required through construction phase and until the building phase is 90% complete.

Figure 18: Construction and building phases of urban development Figure from Water By Design Construction and Establishment Guidelines, 2010.



The Environment Protection Guidelines for Land Development and Construction in the ACT provide guidance on the preferred methods for pollution control design, construction, operation and maintenance (http://www.environment.act.gov.au/__data/assets/pdf_file/0011/574850/EPA-Guidelines-for-Construction-and-Land-Development-ACCESS.pdf). This includes sediment and erosion control, noise pollution, air quality and spoil management. These guidelines should be followed for all development and construction projects in the ACT.

This section of the guidelines provides additional recommendations specifically on how WSUD assets can be constructed and established successfully using current best practice approaches to protect them during the construction and building phases. The following table summarises the WSUD assets included in this section of the guidelines and the reasons that others are not.

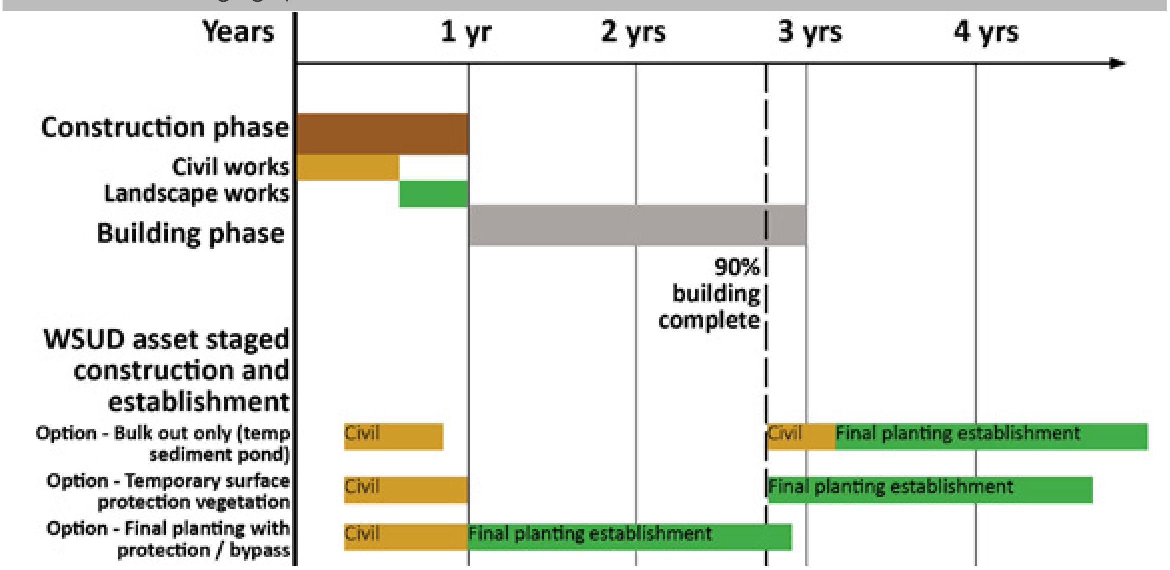
Table 32: Summary of WSUD assets described in this section of the guideline and the reasons that others are not

WSUD assets in this guideline	Construction and establishment advice	Reasons
Water efficient fittings and fittings	No	These can be installed at any stage of the building.
Porous pavement	Yes	
Infiltration systems	Yes	
Rainwater tanks	No	These can be installed at any stage and construction advice is provided in the Rainwater Tank Guidelines.
Stormwater harvesting and re-use	No	These systems will vary greatly, ranging from tanks through to open water bodies. The construction will depend on the type of system used.
Greywater harvesting and reticulated recycled water	No	The timing of this will depend on the civil infrastructure components of the development.
GPT	No	These systems are robust and can be constructed at any time during the development.
Buffer strips	Yes	
Swales	Yes	
Bioretention swales	Yes	
Bioretention basins	Yes	
Ponds	Yes	
Sediment basins	Yes	
Wetlands	Yes	

Staged construction and establishment approaches

Even with erosion and sediment control measures in place, some WSUD assets are at high risk during the building phase. To reduce this risk, staged construction and establishment methods can be adopted which aim to isolate the WSUD asset from the sediment-laden run-off. Options for this staged approach for each of the assets each has benefits and constraints. For example, early establishment of vegetation can provide high amenity outcomes, but the risk of failure is also higher.

Figure 19: Overview of typical construction and building phases of urban development with recommended staging options for WSUD assets



Porous pavements and infiltration systems

The primary function of porous pavements and infiltration systems is infiltration and therefore they are at high risk during the construction and building of the catchment as sediment laden run-off can clog the systems. It is recommended that these systems are staged so they are protected until the catchment is built out. Table 33 provides a summary of this recommended option, including the benefits and disadvantages.

Table 33: Recommended staged construction and establishment approach for porous pavements and infiltration systems

	Install system with surface protection and bypass
Building phase	
Actions	Construct functional elements of the system
	Install protective measures to bypass stormwater and ensure suitable erosion and sediment control is in place
90% building complete	
Actions	Remove protection devices
Benefits	
Water quality treatment during building phase	Low
Landscape amenity during building phase	Low
Disadvantages	
Delayed timing of final asset	No
Risk of sedimentation and asset failure	Moderate

Buffer strips and swales

Buffer strips and swales are vegetated systems which typically don't have any infiltration materials underlying the vegetation. Therefore there is little risk that sediment laden flows will clog the system, but they can impact the growth of vegetation. There is also little opportunity for these systems to act as sediment basins in the initial build out phase as they are designed to allow flows to pass through them at surface. The two proposed staging options are to either plant with sacrificial plants, which can be removed and replaced once building is almost complete, or to plant out with the final vegetation at the start. Table 34 provides a summary of these options, including the benefits and disadvantages.

Table 34: Recommended staged construction and establishment approaches for buffers and swales comparing benefits and disadvantages of options

	Staging option	
	Option 1: Temporary vegetation to provide surface protection	Option 2; Final planting to provide surface protection
Building phase		
Actions	Construct civil infrastructure	Construct civil infrastructure
	Topsoil shaped and turf or sterile rye used to protect surface	Topsoil and final planting
90% building complete		
Actions	Remove sediment build-up and replace temporary grass with final plantings	
Benefits		
Water quality treatment during building phase	Moderate	Moderate
Landscape amenity during building phase	Low	High
Disadvantages		
Delayed timing of final asset	Yes	No
Risk of sedimentation and asset failure	Low	Moderate

Bioretention systems

Bioretention systems (both bioretention swales and bioretention basins) are vegetated systems which rely on the filter materials for treatment of stormwater flows. Therefore it is very important to protect this filter media from clogging due to sediment laden flows through the construction and building phases in the upstream catchment. If this staging is not undertaken correctly, there is a risk that the bioretention filter media will clog and the system will need to be re-set completely. There are three proposed staging options for bioretention systems. The first is to build out the system and leave as a sediment basin; this option is not suitable for bioretention swales). The other options have the filter media installed at the start but either protected by covering with sacrificial protective layers (e.g. filter cloth, topsoil and turf) or bypassing flows around the system; this last option may also be difficult for bioretention swales. Table 35 provides a summary of these options, including the benefits and disadvantages.

Table 35: Recommended staged construction and establishment approaches for bioretention swales and bioretention basins comparing benefits and disadvantages of options

	Staging option		
	Option 1: Build out only (leave as sediment basin) – suitable to bioretention basins only	**Option 2: Temporary surface protection vegetation**	**Option 3: Final planting with protection / bypass**
Building phase			
Actions	Build out system and install hydraulic structures (do not plant)	Construct civil infrastructure	Construct civil infrastructure
	Allow to operate as sediment basin	Install filter media materials	Install filter media materials and plant out with final planting
		Install protection measures on top of filter media(e.g. filter cloth + topsoil + turf)	Bypass stormwater around system
90% building complete			
Actions	Clean out sediment, install underdrainage, filter media and final vegetation	Remove protective layers and establish final vegetation	Remove bypass
Benefits			
Water quality treatment during building phase	High	Moderate	Low
Landscape amenity during building phase	Low	Moderate to high	High
Disadvantages			
Delayed timing of final asset	Yes	Yes	No
Risk of sedimentation and asset failure	Low	Low	Moderate

Wetlands and ponds

The water and sediment quality within wetlands and ponds can be impacted by the accumulation of sediment laden run-off during the construction and building phases. The vegetation in the macrophyte zones in the wetlands can also be smothered by the sediments, impacting their growth and survival. Therefore it is recommended that if these systems are constructed and established early and accept sediment laden flows, they are treated as a sediment basin and de-silted once the building phase is almost complete. If wetland vegetation is to be established early to provide a high amenity landscape, it is recommended that the stormwater flows bypass the system until the building phase is almost complete. Table 36 provides a summary of these options, including the benefits and disadvantages.

Table 36: Recommended staged construction and establishment approaches for wetlands and ponds comparing benefits and disadvantages of options

	Staging option	
	Option 1: Bulk out only (leave as sediment basin)	**Option 2: Final planting with protection / bypass**
Building phase		
Actions	Build out system and install hydraulic structures	Construct civil infrastructure
	Allow to act as sediment basin	Install topsoil and plant final vegetation
		For wetlands - disconnect inlet pond from macrophyte zone
90% building complete		
Actions	Clean out pond and macrophyte zone (for wetland), install topsoil and final planting	Clean out pond and for wetlands - remove disconnection from macrophyte zone
Benefits		
Water quality treatment during building phase	High	Moderate
Landscape amenity during building phase	Low	High
Disadvantages		
Delayed timing of final asset	Yes	No
Risk of sedimentation and asset failure	Low	Moderate

Sediment basins

Sediment basins can be appropriate systems to use as part of an erosion and sediment control plan during the construction and building phases of a development. Therefore these systems can be built at the start of the development. However, they will need to be de-silted at the end of the building phase so they can operate as designed for the built catchment.

Construction and establishment considerations

Once the construction and establishment approach has been determined, early consideration of the following is required to ensure the successful construction and establishment of WSUD assets. The following sections provide some advice on the key steps that may be required through this construction and establishment phase.

Understanding the construction requirements

Existing specifications for the construction and establishment of assets in the ACT may need to be considered for the construction of WSUD assets. They include:

» Standard specification – 02 Earthworks

» Standard specification – 03 Underground services (includes stormwater)

» Standard specification – 09 Landscape

These specifications are located on the TCCS website: www.tccs.act.gov.au/ Development_and_Project_Support/pre-development-applications/estate-development-plans/ Standard-Specification-for-Urban-Infrastructure-Works[5]

The following sections provide some additional general guidance which may assist in the planning and construction and establishment of WSUD assets.

General guidance for WSUD asset construction and establishment

Ordering materials

To ensure the works are efficient, it is recommended that materials are ordered and supplied to site before construction starts. Typical materials include:

» pits

» pipes

» liners

» underdrainage

» topsoil

» filter media, transition layers, drainage layers

» plants

» sediment fences.

Construction tolerances

Achieving the correct tolerances is critical for the ongoing function of the WSUD assets. It is therefore recommended that 'as constructed' surveys be undertaken to ensure these tolerances have been met. Typical elements with tolerances that must be checked include:

» hydraulic structures (overflow pit, pipes, etc.) –/+25mm

» underdrains –/+25mm

» earthworks (base of systems) –/ +50 mm

» drainage and transition layers –/+25 mm

» surface levels –/+25 mm

» embankments and bunds –/+50 mm

5 Please note that at the time of writing the WSUD Guidelines, TCCS were reviewing all their documentation including the standard specifications and designs standards for urban infrastructure. Caution needs to be applied on which is the most up-to-date document and this can be determined by contacting Roads ACT directly through Canberra Connect on 13 22 81.

Bioretention media specification and certification

The filter media is critical to the function of bioretention systems and must therefore be demonstrated that it meets the specifications set out in the Adoption Guidelines for Stormwater Biofiltration Systems (CRC Water Sensitive Cities, 2015). It is recommended that testing is undertaken on all bioretention media to ensure they meet these specifications.

The following table is taken from the Adoption Guidelines and presents the essential filter media requirements. More detail on the specifications for the other media components (e.g. transition layers and drainage layers) are provided in Appendix C of the guideline.

Saturated zones need to include a carbon source mixed throughout the submerged layers to drive denitrification. The carbon source should ideally:

» decompose in the first one to two years of operation while plant roots develop (which provide carbon over the longer term)

» be low in nutrients (appropriate materials include sugar cane mulch, pine chips (without bark) and pine flour ('sawdust').

It is recommended that the carbon source comprise approximately 5% (v/v) and include a mixture of mulch and hardwood chips (approximately 6 mm grading) by volume.

Topsoil specification and installation

» Standard specification – 09 Landscape details the type of soil which is suitable for different applications of use. This table is provided below.

Table 37: This table is from Standard specification – 09 Landscape and provides the class of topsoil to be supplied for landscape works in the ACT

Soil Type	Applications
Type "A" Sandy Soil	Irrigated shrub beds with minimum depth of 500mm and subsoil drains
Type "B" Sandy loam	All irrigated turf areas except where specified otherwise with minimum depth of 200mm
Type "C" Silt - Clay loam	Dryland grass areas and roadside verges
Type "D" Coarse Sand	Surrounding sub-soil drainage pipes, irrigation pipes and where specified
Type "S" Amended Growing Medium	Shrub beds with no provision for sub-soil drainage (minimum depth of 300 mm)
Tree Planting Soil.	As backfill to planting positions in pavement. Topsoil Type 'A' enriched with well rotted animal manure or recycled green waste compost at the ratio of 65% soil to 35% manure or compost and placed as backfill within the planting position but to a maximum 400mm depth surrounding the rootball.

http://www.TCCS.act.gov.au/__data/assets/pdf_file/0005/397121/SS09_Landscape_01_00.pdf

Quality of the topsoil is recommended to be tested to ensure it is suitable for supporting the design vegetation and is free from weed banks. These tests will identify any amendments that are required before the topsoil can be used. If suitable, the existing site can be stripped and stockpiled for use, otherwise topsoils may need to be imported.

The installation of the topsoil will require the following:

» Stripping and stockpiling of existing topsoil

» Earthworks to ensure subsoil levels allow for required topsoil depth (see table)

» Deep ripping of subsoils using a non-inversion plough

» Re-application of stockpiled topsoils with remedial treatments if required

» Adding imports topsoils where required

If the topsoil is being used within a wetland, it is recommended it is treated with gypsum or lime which facilitates flocculation, reducing the turbidity of the water column and allowing light to reach the plants. The gypsum should be applied at a rate of 0.4 kg/m^2. The application of lime may be required where the soil tests identify potential soil pH problem (pH <5).

Planting

It is critical that the correct planting considerations are undertaken to ensure successful establishment of vegetation in the WSUD assets. Establishment will typically take two growing seasons (two years) and will be considered successful if:

- greater than 90% of plants survive and provide at least 80% coverage
- at least 5 plants/m^2 but preferable 6–10 plants/m^2.
- preferably more than one species
- plant height increases at least 50% during the establishment phase
- propagation is occurring, with more than 2–3 stems and through seeding
- no weeds.

Types and densities

Correct plant species and densities need to be used to ensure successful establishment of vegetation in the WSUD assets. Ensuring the plants are suitable for the substrate and water level conditions and that there is high densities (6–10 plants/m^2) and diversity (at least two species per system) increases the likelihood of quick establishment of a dense and mature planting which will provide a high amenity landscape, good water quality treatment and will also shade out weeds.

It is recommended the plant stock be mature when planted (300–500 mm high), sun-hardened and contain a fully established root ball. Key things to look for in plant stock that would impact their growth include:

- signs of pest and disease
- signs of nutrient deficiency (yellow wilting leaves)
- root-bound plants
- weeds.

The following tube stock sizes are recommended:

Table 38: Recommended tube stock sizes for WSUD vegetation

Tube type	Tube dimensions	Minimum height
Viro tubes	50 x 90 mm	300 mm
50 mm tubes	50 x 75-90 mm	300 mm
Native tubes	50 x 125 mm	300 mm

Mulch

Organic mulch cannot be used in zones where the systems are permanently or frequently inundated (e.g. base of wetlands). In bioretention systems, mulch that can break down quickly (e.g. sugarcane mulch) can be used during the establishment phase to maintain soil moisture; however, this will need to be pinned down with biodegradable netting (e.g. open weave jute mesh). Gravel mulch is not recommended as it can increase surface temperatures and kill the underlying root zones.

Watering

Regular watering is essential for successful plant establishment, especially in the ACT climate. The frequency of watering will depend on rainfall, maturity of planting stock and the water-holding capacity of the soil. Table 39 provides a summary of recommended watering regimes for to support vegetation during establishment.

Table 39: Recommended watering for WSUD asset vegetation establishment

Establishment period	Irrigation frequency
Week 1–6	5 times per week
Week 7–10	3 times per week
Week 11–16	2 times per week

After this initial four month period, additional watering may still be required, especially during dry periods. Watering requirements can be determined during inspections.

Water level manipulation

To maximise the success of vegetation establish in wetlands and ponds, it is recommended that the water levels are manipulated during the early stages of growth. This is especially important for the establishment of deep marsh zone vegetation which are too small for the design water depth when first planted. Water levels therefore need to be lowered to ensure the deep marsh vegetation have half of their stem above the water level.

This water level manipulation can be done by closing off the connection into the wetland or pond from the catchment and using the maintenance drain to set the desired establishment water level. When it is evident the vegetation is growing well and at the desired height (typically after 6–8 weeks planting), the connection can be temporarily opened to allow slow filling of the wetland or pond to the desired water depth. It is critical for the ongoing success of the vegetation growth that half of the vegetation stem is above this design water level at this time.

6. WSUD TREATMENT ASSET OPERATION AND MAINTENANCE

Best practice WSUD asset management

Stormwater treatment assets require ongoing operational and maintenance works to ensure they function effectively and meet the desired performance indicators (such as treatment performance, amenity, public health and safety, etc.). WSUD infrastructure that is unable to perform to its original design has detrimental impacts. It places a strain on TCCS in the maintenance process, which in turn has a social and amenity impact on the community, an environmental impact and an economic impact. Concerns over maintenance are a common issue that pops up during public consultation for new proposals by concerned community members. However, if these assets have been established successfully (see Section 5), their operation and maintenance should be no different to any other landscaped area.

Operation vs Maintenance
Operation: The use of the asset to perform the designed function.
Maintenance: Actions undertaken to ensure the asset functions as designed.

The Municipal Infrastructure Standards (MIS08) outline some requirements for maintenance for stormwater assets, including maintenance access requirements. This section of the guidelines provides additional recommendations on how WSUD treatment assets could be effectively and efficiently maintained, including frequency of maintenance and the types of maintenance which may be required. The following table summarises the WSUD assets which are included in this section of the guidelines and the reasons that others are not.

Table 40: Summary of WSUD assets desribed in this section of the guideline and the reasons that others are not

WSUD assets in this guideline	Maintenance advice provided	Reasons
Water efficient fittings and fittings	No	This section focuses on public stormwater management assets, and not plumbing fittings and fixtures within a building which will be maintained as part of building maintenance.
Porous pavement	Yes	
Infiltration systems	Yes	
Rainwater tanks	No	Maintenance advice is provided in the Rainwater Tank Guidelines.
Stormwater harvesting and re-use	No	These systems will vary greatly, ranging from tanks through to open water bodies. Maintenance requirements will depend on the system type.
Greywater harvesting and reticulated recycled water	No	This section focuses on public stormwater management assets, and not on-site greywater systems or broader recycled water networks which will be maintained either by the building manager or water utility.
GPT	Yes	
Buffer strips	Yes	
Swales	Yes	
Bioretention swales	Yes	
Bioretention basins	Yes	
Ponds	Yes	
Sediment basins	Yes	
Wetlands	Yes	
Retarding basins	No	This section focuses on public stormwater management assets, and not flood mitigation assets.

Reasonable WSUD asset maintenance regime

Inspection frequency

It is recommended that routine inspections and regular operational actions are undertaken to ensure WSUD systems function as designed. Early detection of operational issues allow actions to be taken quickly, which can be more cost effective than leaving the issue unmanaged and later requiring costly maintenance (for example, the removal of weeds as they first appear is more cost effective than letting them establish throughout the system ,which will then require mass re-planting; prolonged high water levels in a wetland will drown out the vegetation, which is significantly more expensive to replace than changing the wetland outlet early before plant failure has occurred).

It is recommended that the following inspection frequencies are adopted for the different WSUD systems. This includes inspections after significant rainfall events.

Table 41: Recommended inspection frequency for WSUD assets

	Porous pavements and infiltration systems	Gross pollutant traps	Swales and buffers*	Bioretention swales and basins	Wetlands	Ponds	Sediment basins
Inspection frequency	3 months	Varies	4 months	3 months	3 months	3 months	3 months

*turf swales require more frequent inspections and regular operational works for mowing

If a system is consistently not meeting the performance indicators, the frequency of inspections may need to increase. If this increased frequency of operational inspections is not resolving the problem, maintenance actions to rectify the situation may be required.

Inspection activities

Frequent inspections and regular operation works undertaken on vegetated WSUD assets will typically include:

» cleaning out litter and debris from inlets and outlets and from the surface or batters

» desilting / removal of accumulated sediments

» weeding (terrestrial and aquatic weeds)

» mowing (e.g. turf swales)

» revegetation.

Additional activities which may also be required include:

» repairing inlets and outlets

» addressing erosion and uneven surface levels

» hydraulic testings (bioretention systems)

» removal of surface crusts (bioretention systems)

» cleaning of underdrains (bioretention systems)

» adjusting water levels (wetlands and ponds)

» water quality monitoring (ponds)

» nuisance fauna

» mosquitoes.

Table 42 provides more detail on these inspection items, including the recommended performance target and the part of the asset to be inspected for each inspection item.

Table 42: Recommended inspection items for WSUD assets, including the suggested performance target the element of the WSUD asset to be inspected

Inspection item	WSUD asset element to be inspected	Suggested performance indicator	Porous pavements	Infiltration systems	Gross pollutant traps	Swales and buffers	Bioretention swales and basins	Wetlands	Ponds	Sediment basins	Retarding basins
Litter / debris	» Inlet /outlet » Surface » Batters	Minor litter or debris present	★	★	★	★	★	★	★	★	★
Sediment accumulation	» Inlet/outlet » Surface » Batters » Open water zones	Minor amount of coarse sediment accumulation	★	★	★	★	★	★	★	★	★
Weeds	» Surface » Batters » Open water zones	Maximum 10% cover of weeds No declared weeds	★	★		★	★	★	★	★	★
Mowing[7]	» Surface » Batters	No overgrown turf				★					★
Vegetation health	» Surface » Batters » Open water zones	Minimal bare patches Healthy plants				★	★	★	★	★	★
Structures	» Inlet/outlet	No damage posing public safety or structural integrity risk		★		★	★	★	★	★	★
Erosion	» Inlet/outlet » Surface » Batters	Minor erosion that doesn't pose public safety risk and would not worsen if left unattended		★		★	★	★	★	★	★
Permeability / hydraulic testing	» Surface	System is draining freely as designed	★	★			★				
Surface crusting	» Surface	No surface crusting (fine sediments)		★			★				
Underdrain / clean out points	» Under drainage	Clean out points not damaged and end caps in place	★				★				

Inspection item	WSUD asset element to be inspected	Suggested performance indicator	Porous pavements	Infiltration systems	Gross pollutant traps	Swales and buffers	Bioretention swales and basins	Wetlands	Ponds	Sediment basins	Retarding basins
Water levels	» Open water zones	System is retaining water as designed (no more than 0.3m below NWL						★	★	★	
Surface levels	» Surface » Batters	No surface mounding > 100 mm (can impact system drainage and treatment performance) No depressions > 100 mm (can result in isolated ponding and mosquito breeding)		★		★	★	★	★	★	★
Water quality	» Open water zones	No odours or oil/ grease Maximum 10% surface cover of algae/moss						★	★	★	
Nuisance fauna	» Surface » Batters » Open water zones	No nuisance fauna causing issues to the function of the asset				★	★	★	★	★	
Mosquitoes	» Open water zones	No problematic mosquito populations Permanent open water that can support mosquito predators						★	★	★	
Maintenance access provided	» All	Adequate maintenance access is provided to the asset	★	★	★	★	★	★	★	★	★
Public health and safety issues	» All	No features that will be cause potential public health and safety issues (e.g. tripping, drowning, structural integrity)	★	★	★	★	★	★	★	★	★

Operational and maintenance activities

The regular inspections may identify items that are not meeting the performance target and will therefore require actions to address this non-conformance. Depending on the scale of the non-conformance, remedial works required may be:

» simple, regular maintenance works that can be done during the inspection

» additional maintenance that may require some specialist skills or machinery and needs to be undertaken following the inspection

» extensive retrofit or rectification works if the issue is severe.

Actions are predominantly manual and can be undertaken using basic tools such as rakes, spades, shovels and hoes. The use of machinery and boats may be required depending on the type and scale of actions required.

The works will either be for landscape or civil components. Depending on the organisation structure, the inspections and actions may be undertaken by separate groups for these different items or they may be coordinated by one department.

The following table provides some guidance on how to undertake maintenance activities. Common, simple maintenance tasks are provided as well as additional maintenance works including uncommon or major rectification works.

Table 43: Guidance on how to undertake typical maintenance activities, identifying those which are simple to undertake as well as other and major rectification works

Action	**Scale of works required**		**Civil or landscape components**
	Simple maintenance	**Major works / rectification maintenance**	
Litter/debris removal	Litter and debris can be removed by hand during inspections. Boats or waders may be required to remove litter and debris from sediment basins, wetlands and ponds.	If litter is a continual issue, additional measures may need to be retrofitted – e.g. installation of GPT.	Civil
Sediment removal / desilting	Removal of minor sediment accumulation can be undertaken by hand. This also reduces risk of damage to vegetation.	Large scale removal will require larger machinery and need full replanting. If sediment removal is required from sediment basins, ponds, lakes or wetlands, dewatering will also be required. Vegetation will also need to be replaced if damaged during sediment removal. If sediment cleanout is required at an unacceptable or sustainable frequency, addition measures may be required (e.g. sediment basins).	Civil

Action	Scale of works required		Civil or landscape components
	Simple maintenance	Major works / rectification maintenance	
Weed removal	Weeds should ideally be removed as part of regular works. This is mandatory for declared weeds. A low level of undeclared weeds may be ok if it does not affect the function of the asset. Terrestrial weeds can be removed by hand or spot spraying. Aquatic floating weeds can be removed using floating booms or nets.	Persistent weed growth or excessive weed growth may require more regular inspections to be undertaken. If mass removal of weeds is required, this will need replanting of design species at high densities to provide cover and shade to inhibit the growth of weeds. Persistent weed growth may not be able to be managed through regular operational activities and may require investigation to identify the cause, for example uncontrolled weeds in the catchment which may require a broader weed management program.	Landscape
Mowing	Mowing can be undertaken as part of a regular mowing regime for assets which are designed with turf (e.g. swales).	If mowing is not possible due to consistent boggy conditions, the WSUD asset may need to be modified (e.g. underdrainage installed).	Landscape
Revegetation	Replanting small areas can be done using stock transplanted from elsewhere within the assets (e.g. for wetlands). Mature plants from a similar water depth can be divided by splitting at the base and directly planting into the new area. Use plant species which are growing well in other parts of the assets. Plant at density of between 6-10 plants / m2 and use a minimum of 2 species.	Major plant failure may be due to: » Poor planting substrate. » Selection of the wrong vegetation. » Poor establishment methods. » Disease or insect damage. » Damage by fauna (e.g. carp, birds). The cause should be identified and addressed to ensure plant failure does not occur again following revegetation.	Landscape

Table 44: Guidance on how to undertake additional maintenance activities, identifying those which are simple to undertake as well as other and major rectification works (in grey)

Action	Scale of works required	
	Simple maintenance	**Major works / rectification maintenance**
Repairing structures	If the damage is not causing any issues, monitor the condition.	If the damage is causing issues to the structural integrity or public health and safety, repair or replace structure. Identify cause of damage and identify opportunities to reduce re-occurrence.
Repairing erosion	Minor erosion can be re-profiled using hand tools during inspections.	Large washouts may require large machinery and new fill materials and plantings. If erosion continues to occur, additional measures may need to be retrofitted – e.g. flow disposal or velocity dissipation options.
Uneven surface levels	Uneven surfaces can affect how water flows through a system and can also create isolated ponds. Minor depressions and mounds can be re-profiled by hand.	Major profile issues may require survey to identify how the surface needs to be reprofiled by machinery to achieve the design levels.
Hydraulic testing	Hydraulic testing can be undertaken on bioretention systems to test infiltration rates.	If infiltration is poor, it could be due to clogging due to fine sediments. Addressing this may require the removal and replacement of the top 100mm of filter material and replanting, or it may require a full re-set of the system.
Removing surface crust	Ponding in WSUD systems can be due to crusting of the surface (e.g. in bioretention systems). If this crusting is minor, it can be scrapped back using hand tools without impacting the vegetation.	If the crusting is severe and there is major clogging of the filter material, a full re-set of the system may be required.
Cleaning underdrains		Clogged underdrainage can be cleared out using high pressure water jetting. If there are blockages in PCV pipes, a drain cleaning machine can also be used.
Adjusting water levels	If it has not rained for 3 days and the water levels are still high, the outlet should be checked for blockages (which may be removed by hand). If the water level is low, check the inlet for blockages.	If the levels are high and there are no blockages, the outlet structure need to be modified or replaced. If the water level is much lower, the system may be leaking, too large for the catchment, the bathymetry may be too low or the inlet and outlet structures may not have been designed appropriately. These would all need investigation and would require replacement or re-profiling.
Mosquitos	Remove the breeding habitat (e.g. fill isolated depressions or remove dead or rafting vegetation around deep pools which can create isolated pockets of water that are protected from predators). Check water levels are able to maintain permanent water for mosquito predators.	If isolated pools or boggy conditions are continually occurring in a system which is not designed to hold water permanently (e.g. swales, bioretention systems, infiltration systems) then investigations are required to find out why they are not draining after rain and this needs to be addressed (e.g. underdrainage or outlet works might be required). If there are excessive mosquitos in the system, consult a mosquito specialist.

Action	Scale of works required	
	Simple maintenance	Major works / rectification maintenance
Water quality	Minor slicks can be left if they are not impacting the vegetation or function of a WSUD asset (e.g. wetlands are good at processing low to moderate concentrations of hydrocarbons). Floating filamentous algal mats are often seasonal and do not require action. Removal may be undertaken by hand using rakes, etc. to improve visual amenity.	<u>Oil spills</u> - The impact of moderate or major oil slicks should be minimised immediately through the use of barriers such as floating booms. The outlet of the asset should also be closed to avoid the risk of the oil spill entering downstream environments. For major spills it will be necessary to remove the bulk of the spill with an adductor truck. Medium to small spills in stormwater treatment systems could be manage in-situ by the application surfactants to break up the oil. <u>Algae</u> - If there is presence of blue-green algae or if there are other public health and safety concerns, signage should be placed around the WSUD asset and public access should be restricted through temporary fencing etc. Specialist advice should be sought before actions are undertaken. Excessive biomass of filamentous algae can impact asset function by blocking inlets and outlets and smothering vegetation. If the algae are impacting aesthetics of function of the wetland system, it can be removed by hand using rakes or with specialist machinery. If significant algae growth is observed on consecutive inspections, investigations should be undertaken to identify cause of algal growth. <u>Odour</u> - Odours are typically caused by decomposing organic matter, blue green algae, anoxic sediments or poor water quality. Investigations should be undertaken to identify cause of odour and appropriate management actions identified, such as removal or floating plants, blue green algae management, removal of sediment, management of oil slicks / spills and nuisance bird management. See Section 8 for recommendations for water quality monitoring.
Nuisance fauna	If large bird populations are causing issues to the bank stabilisation or water quality (such as ducks) signage can be installed to encourage the public not to feed the birds.	If Carp (common pest fish species) is present and causing damage to banks, vegetation and water quality, electrofishing can be used to remove the fish, however this is only practical in predominantly open water bodies. In heavily vegetated systems where electrofishing is not as effective, water level draw-down can be used to create a drying period which can control and eliminate carp. However this draw down period needs to be managed to it will dry the system long enough to kill the fish, but not to kill the vegetation. A fish poison such as rotenone could also be used but would require approvals. If bird populations are causing ongoing issues, look to remove their preferred habitat (e.g. islands and roosts).

Action	Scale of works required	
	Simple maintenance	Major works / rectification maintenance
Lack of maintenance access		To ensure actions can be undertaken on the treatment systems, maintenance access is required to structures and treatment areas. If this has not been provided, this will need to be retrofitted.
Unacceptable public safety		Permanent water (ponds and wetlands) can pose a potential safety hazard if there are steep matters, uncontrolled access and lack or perimeter planting. A risk assessment should be undertaken to identify the risk and to identify actions which would be required to address this (such as fencing, vegetation or batter re-profiling).

Considerations for undertaking maintenance

The following sections provide guidance on the types of considerations that are recommended when planning and undertaking maintenance.

Receiving environment protection

Care needs to be taken to ensure activities do not negatively impact on receiving environments. For example, de-silting operations have the potential to release sediments to the receiving environment. Maintenance staff must be aware of these considerations when carrying out excavation of accumulated sediments. This would normally be done in the dry season when the risks of overflow to receiving environments is low.

Weeds also need to be managed and disposed of carefully to reduce risk of weed propagation throughout the downstream environment.

Safety and access

Occupational health and safety

Working near water and roads can potentially be a dangerous activity. It is therefore recommended that personnel be appropriately trained before undertaking maintenance work. Weather forecasts should be reviewed before undertaking maintenance activities and maintenance staff should be wearing Personal Protective Equipment (PPE) appropriate to their task or activity and consistent with relevant guidelines.

Up-to-date 'Dial Before You Dig' records are recommended so maintenance staff are aware of the location of existing services (i.e. sewer mains, power, communications). These services need to be appropriately protected before maintenance commences.

Public safety

If an activity is likely to pose a risk to public safety, it is recommended that access to the work area be appropriately screened to restrict public access.

Use of earthmoving equipment for de-silting operations will require a Traffic Management Plan to ensure pedestrian and traffic safety.

Note: Thick edge vegetation can be an important component to restricting general public access to a sediment basin, wetland or pond. Therefore it is recommended that vegetation be kept well maintained and in good condition, with dead plants replaced as soon as practical.

Maintenance access

Maintenance access should be considered and provided for all WSUD systems to allow for periodic works, including sediment and gross pollutant removal. The location of this maintenance access should be identified prior to undertaking maintenance. Note: It is also recommended that all activities close to water or roads be conducted according to pre-defined safety procedures.

WSUD asset operation documentation requirements

It is recommended that outcomes from the inspections and operation activities be recorded, identifying clearly ongoing maintenance activities required. This information should be kept in an appropriate operation and maintenance record file for future reference.

Using documentation to inform management decisions

Once the condition and maintenance requirements for WSUD assets are understood, the planning and funding of future maintenance works can be undertaken. Due to limited resources, WSUD asset maintenance typically requires prioritisation to ensure money is best spent.

Non-conformances should be recorded in a log and a corrective action plan logged and undertaken. Repetitive non-conformances need to be thoroughly reviewed to understand the root causes and take appropriate maintenance actions.

It is recommended that the following are used to prioritise maintenance works:

- Public health and safety: Higher priority is given to works which will address key public health and safety issues (for example flooding issues or embankment instabilities).
- Water quality treatment: Higher priority is required for systems where maintenance is required to rectify issues that impact the water quality performance of the system, especially if this system is upstream from a sensitive receiving environment.
- Simplicity of works: Higher priority should be given to works that can be easily undertaken or cheaply completed.
- Visibility and amenity: Higher priority is given to WSUD assets that are highly visible to address works that are impacting amenity (e.g. priority would be given to a streetscape system on a main street compared to a WSUD asset hidden behind fences at the back of a development).

Developing a fully costed maintenance schedule

To assist the long-term planning and budgeting of WSUD maintenance activities, it is recommended that the asset operation documentation is used to develop a fully costed maintenance schedule. This costed maintenance schedule would reflect the maintenance requirements required during the asset establishment period, the frequency of these actions and the cost to undertake these actions. This information can then be documented and provided to TCCS at the time of asset handover so there is a clear understanding of the ongoing maintenance requirements and costs for the WSUD asset.

Maintenance checklists

To assist in the inspection and maintenance process, template checklists have been developed as part of this guideline. These checklists, which can be used to guide and to record outcomes from inspections and maintenance activities, are at Appendix C.

7. HANDOVER OF WSUD TREATMENT ASSETS TO THE ACT GOVERNMENT

Typically, operational and maintenance activities are undertaken by the constructing party for the period until the asset is established and on-maintenance period is completed and the asset is handed over to the long-term asset owner.

Municipal infrastructure is handed over to TCCS and requires a handover process. TCCS requires a clear and accountable asset handover that outlines an operational procedure with maintenance requirements in order for maintenance to be carried out effectively.

Constructed municipal infrastructure assets are handed over to TCCS after the following timeframes:

» 'Hard' civil infrastructure are handed over after a 12 months civil defects period has expired.

» 'Soft' landscape assets are handed over after a 13 week defects period (minimum)*.

The handover requirements for assets to TCCS is outlined on the ACT Government website: www.tccs.act.gov.au/Development_and_Project_Support/post-development-application. This provides information about the lodgement process and provides the required forms.

*Due to the importance of the successful establishment of the vegetation in the majority of the WSUD treatment assets, it is recommended that the establishment and ultimate handover of vegetated WSUD assets differs to typical civil and landscape assets. This is because it requires two growing seasons (two years) before the asset is fully established and can be handed over. At this point the vegetation has a well-established root zone, ensuring the WSUD system is resilient (e.g. natural recruitment of vegetation to fill small gaps and porosity naturally maintained in bioretention systems).

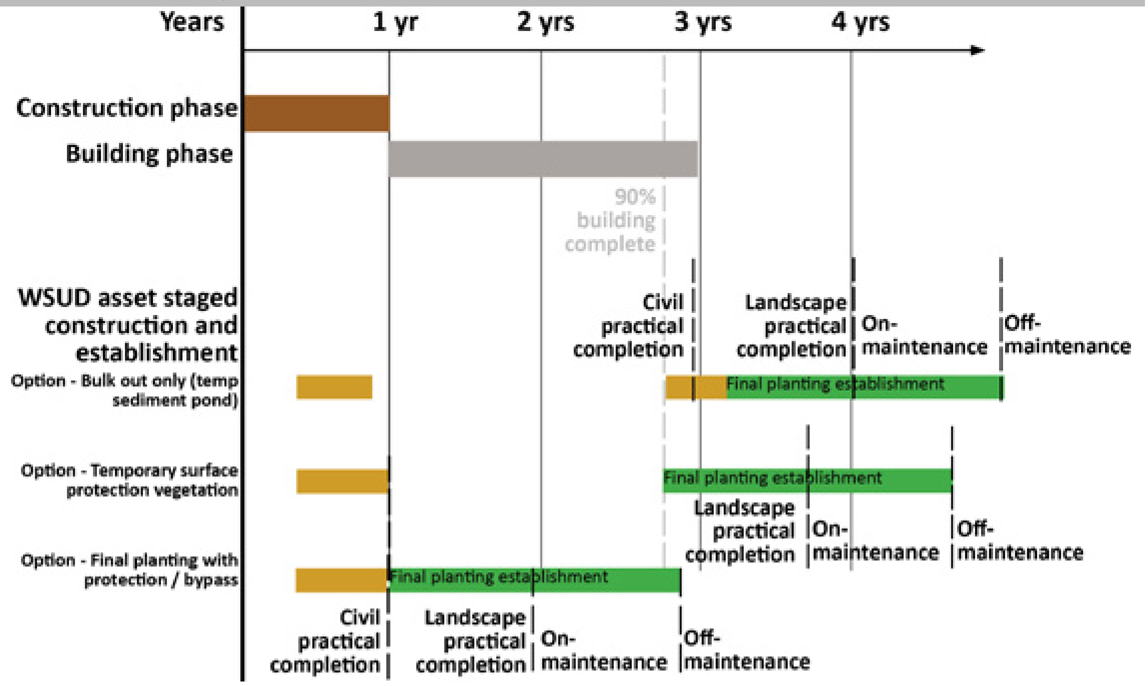
The timing of handover will therefore depend on when vegetation is planted and established in the WSUD system.

Note at the time of publication TCCS were working on a technical specification for water quality plant establishment. Contact TCCS for further information.

It is in the interest of the asset owner that the WSUD systems are fully established and operating to the desired performance targets at the time of handover as this will ensure the system is likely to continue to function as designed with minimal maintenance. If an asset is handed over to the asset owner before it is established or with design and construction issues which impact operational performance, the asset is likely to cost more in terms of long term maintenance and possible rectification.

Having clear guidance on the expected condition of the assets at the time of handover reduces the risk to both the constructing party and the eventual asset owner. The following provides a recommended multi-step handover process aimed to reduce risk throughout the handover process.

Figure 20: Recommended handover processes for WSUD assets associated with different construction and establishment options



Recommended multi-step handover process aimed to reduce risk throughout the handover process

PRE-START

» This inspection takes place before any work has been undertaken on the WSUD asset.

» Purpose of this meeting is to ensure that the developer, contractor and compliance officer ae clear on the approval conditions, desired construction outcomes and the handover process.

PRACTICAL COMPLETION

» This inspection takes place once the WSUD asset has been constructed and planted before it is accepted for on-maintenance.

» This is the stage to identify if the asset has been constructed and planted as per the designs. If the asset is non-compliant, a request can be made to undertake major changes to the asset before pratical completion is signed-off.

ON-MAINTENANCE

» Inspections can be undertaken throughout the on-maintenance period to ensure maintenance is being regularly undertaken by the developer / contractor as per the conditions of approval.

OFF-MAINTENANCE

» This inspection takes place at the completion of the on-maintenance period before it is accepted by the ultimate owner as thier asset.

» The purpose of the inspection is to ensure the asset is free from defects, is fully established and is functioning as designed so the asset that is inherited is healthy, functional and stable, requiring only typical ongoing maintenance (i.e. no major works required).

The following tables can be used at each of these inspections to assist in the process.

Table 45 provides a summary of the inspection items which could be considered at the practical completion stage, before the stormwater asset is accepted onto on-maintenance. At this stage of the handover process, it is important that the asset has been constructed and planted as designed.

Table 45: Typical practical completion inspection requirements

Inspection item / requirements	**Porous pavements**	**Infiltration systems**	**Gross pollutant traps**	**Swales and buffers**	**Bioretention swales and basins**	**Wetlands**	**Ponds**	**Sediment basins**	**Retarding basins**
Civil components									
Certification requirements									
As constructed documentation	★	★	★	★	★	★	★	★	★
Designers certification of functional elements	★	★	★	★	★	★	★	★	★
Civil engineers certification of structural elements	★	★	★	★	★	★	★	★	★
Soil suppliers certification of topsoil				★		★	★	★	
Soil suppliers certification of filter media, transition layers and drainage layers with lab testing results					★				
Asset performance									
As constructed survey showing surface levels and structures (e.g. inlets, outlets, underdrains, connector pipes) are within acceptable limits of design levels	★	★	★	★	★	★	★	★	★
Minimum topsoil depths for planting provided				★		★	★	★	
Outlets and underdrains are free draining (no backwatering) and clear of debris		★	★	★	★	★	★	★	★
Outlets are controlling water levels to the required height to allow establishment of vegetation						★	★	★	
Extended detention depths not exceeding design levels					★	★		★	
Filter media, transition media and drainage media meet specifications					★				
Test results show hydraulic conductivity meets design requirements					★				
Temporary protection measures in place as per agreed construction and establishment approach				★	★				
Inlet sediment capture devices is installed as per design (e.g. sediment forebay in bioretention or sediment basin in wetlands)					★	★			

Inspection item / requirements	Porous pavements	Infiltration systems	Gross pollutant traps	Swales and buffers	Bioretention swales and basins	Wetlands	Ponds	Sediment basins	Retarding basins
Landscape components									
Certification requirements									
As constructed drawings				★	★	★	★	★	
Designers certification of plant species				★	★	★	★	★	
Asset performance									
Surface levels are consistent with design levels	★	★	★	★	★	★	★	★	★
Design species and planting densities achieved				★	★	★	★	★	
Plants healthy and free from disease				★	★	★	★	★	
No weeds or litter	★	★		★	★	★	★	★	★
No erosion	★	★		★	★	★	★	★	★
No sediment accumulation	★	★	★	★	★	★	★	★	★
Test results show hydraulic conductivity meets design requirements					★				
Inlet sediment capture device is operating correctly					★	★			
No leaking of water from permanent pools						★	★	★	
No permanent ponding water on surface	★	★		★	★				★

Table 46 provides a summary of the inspection items that could be considered at the end of the on-maintenance period, before it is accepted as an asset by TCCS. This is an important inspection to ensure the asset is operating as it should and that the vegetation has been successfully established to ensure on-going maintenance should be minimal.

Table 46: Typical off-maintenance inspection requirements

Inspection item / requirements	Porous pavements	Infiltration systems	Gross pollutant traps	Swales and buffers	Bioretention swales and basins	Wetlands	Ponds	Sediment basins	Retarding basins
Certification requirements									
Evidence of any rectification works required	★	★	★	★	★	★	★	★	★
Completed maintenance forms from the on-maintenance period	★	★	★	★	★	★	★	★	★
Asset performance									
Design species and planting densities achieved				★	★	★	★	★	
Plants healthy and free from disease				★	★	★	★	★	
No weeds or litter	★	★		★	★	★	★	★	★
No erosion visible or surface depressions	★	★		★	★	★	★	★	★
No accumulated sediment	★	★	★	★	★	★	★	★	★
Inlet sediment capture device is operating correctly and is clear of sediment					★	★			
In-situ hydraulic conductivity >50mm/hr (100mm/hr preferred)					★				
Underdrainage clean out pipes have secured caps					★				
Extended detention depths not exceeding design levels					★	★			
No leaking of water from permanent pools						★	★	★	
No permanent ponding water on surface	★	★		★	★				★
Outlets are clear and free draining (no backwatering)	★	★	★	★	★	★	★	★	★

Monitoring water quality

Monitoring the water quality performance of WSUD assets is no easy task; it can be expensive and may not be necessary. It is important that the objectives of the monitoring program are clearly identified. If seeking to understand if a system is performing optimally, visual inspections to assess the condition of the asset to determine the appropriate course of action (as outlined in the maintenance section) should be undertaken. Visual assessment may include:

» flow pattern (most relevant to wetlands and ponds) to identify the presences of short-circuiting that may inhibit the uniform distribution of inflow and optimal treatment performance

» duration of inundation (most relevant to swales, wetlands, infiltration systems, bioretention swales and bioretention basins) to assess the operating detention time of these systems and to highlight potential clogging of soil media (bioretention systems) or blockages at the inlet/outlet structures that would have a direct impact on its performance in water treatment

» sediment accumulation

» vegetation density and health.

Water quality monitoring

Occasional sampling (grab samples) of permanent pool water quality in ponds and wetlands can be useful to determine the operation and health of the system. Sampling of the ambient water quality (sample taken at least five days after a flow event) can identify if the system is operating as expected and the quality of the water being flushed from the system for the next flow event is understood.

The ambient samples taken from ponds can also include an assessment for algal growth to identify a potential or existing human and ecological health concern with the water. If chlorophyll a values are recorded over 10 ug/L it is recommended that an algal cell count and species identification test is undertaken. Once this has been undertaken, the risk to the public and ecological health can be determined and appropriate management actions undertaken.

If seeking to quantify hydraulic performance (% of total flow treated, % of flow bypassed, water levels, etc.) or water quality performance (pollutant loads captured) then long term datasets are required. Performance monitoring of WSUD assets can be undertaken through detailed water sampling and laboratory analyses for contaminant concentrations. It will be necessary to set up field monitoring sites to undertake the water quality sampling at inlet and outlet of systems. The water quality parameters which are typically monitored include:

» TSS

» TP

» FRP

» TN

» NOx

» NH3

The following points should be considered when undertaking a performance monitoring program:

» Auto-sampling with partial or full composite samples is most cost effective.

» Monitoring should be accompanied by continuous flow and depth observations.

» Design of monitoring set up and sampling intervals is site dependent.

» Water quality parameters should be analysed in registered laboratories.

» Erroneous performance assessment may occur when:

  – the volume of an inflow event is less than the permanent pool volume of system (most relevant to wetlands and ponds).

  – inaccurately accounting for the volumetric balance of inflow, outflow, or soil moisture replenishment.

Asset renewal and decommissioning

It is anticipated that WSUD assets will need to be renewed once they reach the end of their useful life. The useful life for each WSUD asset will be different and related to:

» whether the system has been designed, constructed and maintained according to best practice.

» catchment characteristics (influences the quality of the stormwater).

» general health of the system – the type of plants that have been used in the system.

Most WSUD assets will be renewed and never decommissioned as they are constructed to comply with environmental regulations, either as part of a development or as part of a responsible authorities relevant plan. However, it is recognised that well established assets such as wetlands and ponds may continue to function effectively well beyond this time and not require renewal as long as they are maintained effectively. Conversely, some assets may have failed due to poor design, construction or establishment issues leading to premature failure. These assets may need to be renewed or decommissioned before their expected useful life.

The decision to renew or decommission an asset may be influenced by the following considerations:

» Is the asset impacting (rather than protecting) the downstream receiving environment?

» Is the WSUD asset an ongoing liability to the asset owner and/or manager?

» Is an improved treatment system required to better protect the downstream receiving environment?

» Is it more cost effective to replace it with an alternative treatment system?

» Is there new technology available that will provide a better cost-benefit outcome?

8. REFERENCES

ACT Planning and Land Authority *Waterways: Water Sensitive Urban Design General Code*

ACT Government *Municipal Infrastructure Standards*

ACT Environment and Health Wastewater Reuse Guidelines (1997)

ACT Government (2016) *Rainwater Tanks - Guidelines for Residential Properties in Canberra*

ACT Government (2016) *Greywater Use – Guidelines for residential properties in Canberra*

CRC Water Sensitive Cities (2015) *Adoption Guidelines for Stormwater Biofiltration Systems*

Engineers Australia (2006) *Australian Run-off Quality*

Gold Coast City Council (Amended 2007) *Porous and Permeable Paving*

Hoban, AT and Wong, THF (2006) *WSUD and Resilience to Climate Change*. 1st Australian National Hydropolis Conference, Perth WA.

Joint Steering Committee for Water Sensitive Cities (2009) *Evaluation options for Water Sensitive Urban Design – a national guide*.

Jones, R.N., Symons, J. and Young, C.K. (2015), *Assessing the Economic Value of Green Infrastructure: Green Paper,* Climate Change Working Paper No. 24, VISES, Victoria University, Melbourne.

Melbourne Water (2005) *Constructed Shallow Lake Systems – Design Guidelines for Developers.*

National Resource Management Ministerial Council (2006) *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks*

Rossrakesh, S., Walsh, C.J., Fletcher, T.D., Matic, V., Bos, D.G., and Burns, M.J. 2012. *Ensuring protection of Little Stringybark Creek: evidence for a proposed design standard for new developments*. Technical Background Report.

SEQ Healthy Waterways Partnership (2006) *WSUD Technical Design Guidelines for South East Queensland*

VISES (2015) *Green Infrastructure Economic Framework*, Victoria University, Melbourne.

Water by Design (2009) *Concept Design Guidelines for Water Sensitive Urban Design*. South East Queensland Healthy Waterways Partnership, Brisbane.

Water by Design (2010) *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands. Appe*

Reference documents

A number of detailed guidelines are available nationwide. Where practitioners seek additional information, reference can be made to the guidelines listed below. Where there are inconsistencies, the guidance provided in this document (ACT Practice Guidelines) takes precedence.

Concept Design

Water by Design (2009) *Concept Design Guidelines for Water Sensitive Urban Design*. South East Queensland Healthy Waterways Partnership, Brisbane.

Detailed

CRC Water Sensitive Cities (2015) *Adoption Guidelines for Stormwater Biofiltration Systems*

Engineers Australia (2006) *Australian Runoff Quality*

Engineers Australia (2016), *Australian Rainfall and Runoff*

Melbourne Water (2015) *Design, construction and establishment of constructed wetlands: design manual*

SEQ Healthy Waterways Partnership (2006) *WSUD Technical Design Guidelines for South East Queensland*

Water by Design (2014) *Bioretention Technical Design Guidelines*

Construction, Establishment & Maintenance

Water by Design (2010) *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands.*

Melbourne Water (2015) *Design, construction and establishment of constructed wetlands: design manual*

Water by Design (2012) *Maintaining Vegetated Stormwater Assets*

Water by Design (2012) *Rectifying Vegetated Stormwater Assets*

Water by Design (2012) *Transferring Ownership of Vegetated Stormwater Assets*

9. APPENDICES

Appendix A

Catchment-wide TSS / TP / TN Reduction Targets (%) Adjusted for Urbanisation and Urban Imperviousness (after WaterWays WSUD General Code)

	Urban Imperviousness							
Urbanisation	20%	30%	40%	50%	60%	70%	80%	90%
0% - 10%	23 / 15 / 15	27 / 18 / 18	31 / 21 / 21	35 / 23 / 23	38 / 26 / 26	41 / 28 / 27	43 / 30 / 29	45 / 31 / 30
11% - 20%	39 / 26 / 26	44 / 31 / 30	48 / 34 / 33	52 / 37 / 35	55 / 40 / 37	57 / 42 / 39	59 / 44 / 40	61 / 45 / 42
21% - 30%	50 / 36 / 34	55 / 40 / 38	59 / 43 / 40	62 / 46 / 42	64 / 49 / 44	66 / 50 / 46	68 / 52 / 47	69 / 53 / 48
31% - 40%	59 / 43 / 40	63 / 47 / 43	66 / 50 / 46	68 / 52 / 47	70 / 54 / 49	72 / 56 / 50	73 / 57 / 51	74 / 58 / 51
41% - 50%	65 / 49 / 45	69 / 53 / 48	71 / 55 / 49	73 / 57 / 51	75 / 59 / 52	76 / 60 / 53	76 / 61 / 53	77 / 61 / 54
51% - 60%	71 / 55 / 49	73 / 57 / 51	75 / 59 / 52	77 / 61 / 53	78 / 62 / 54	78 / 63 / 55	79 / 63 / 55	79 / 64 / 56
61% - 70%	75 / 59 / 52	77 / 61 / 54	78 / 63 / 55	79 / 64 / 55	80 / 64 / 56	80 / 65 / 56	81 / 65 / 57	81 / 66 / 57
71% - 80%	79 / 63 / 55	80 / 64 / 56	81 / 65 / 57	81 / 66 / 57	82 / 66 / 57	82 / 67 / 58	82 / 67 / 58	83 / 67 / 58
81% - 90%	82 / 66 / 57	82 / 67 / 58	83 / 68 / 58	83 / 68 / 58	83 / 68 / 59	3 / 68 / 59	84 / 68 / 59	84 / 68 / 59
91% - 100%	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60	85 / 70 / 60

Denotes cases where consideration should be given to off-line regional measures Urbanisation Percentage of a Catchment Zoned Urban Ie. Residential, Industrial, Commercial + Urban Open Space

Example: 100 ha of land is zoned for urban development and is located in a 180 ha catchment. Expected overall imperviousness of the development is 50%.

What are the catment-wide reduction targets?

Urbanisation= 100/180 = 0.555 = 55.5%
Urban Imperviousness = 50%

Catchment-wide Reduction Targets: TSS = 77%, TP = 61%, TN = 53%

Appendix B

Planning and design checklist

Step	Requirement	Outcome[1]	
WSUD Planning	Establish WSUD objectives	Potable water use reduction requirements	
		Stormwater quantity requirements	
		Stormwater quality requirements	
	Understand site characteristics	Site area	
		Topography	
		Receiving environments type and condition	
		Existing vegetation and habitat	
		Soil type	
		Existing infrastructure present	
		Expected pollutant type and loads	
	Identify Total Water Cycle Management (TWCM) key drivers and requirements	Wastewater capacity	
		Sensitive receiving environments	
		Potable water conservation	
	Develop WSUD Strategy	Lot scale solutions	
		Neighbourhood solutions	
		Treatment trains	
	Assess performance of strategy	Potable water use reduction performance	
		Stormwater quantity performance	
		Stormwater quality performance	
	Document strategy	Reporting meets requirements of assessment agency	

Step	Requirement	Outcome[1]	
WSUD Design	Develop design of treatment train elements	Treatment type	
		Treatment area	
		Design flows	
		Maintenance access provided	
		Civil structure design	
		Planting design	
		Landscape integration	
	Verification of designs	Treatment performance	
		Velocities	
	Documentation of designs	Documentation detail meets requirements of assessment agency	
		Lifecycle costing and cost benefit analysis undertaken	
		Staged construction, establishment and maintenance plans developed	

1. Insert details of how these have been considered and/or addressed.

Appendix C

WSUD inspection checklist - Sediment Basins

WSUD Asset:	Inspected by:
Weather:	Date of last rainfall:

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Litter/debris	Minor litter or debris present	» Inlet / outlet			
		» Open water zones			
		» Batters			
Sediment accumulation	Minor amount of coarse sediment accumulation	» Inlet / outlet			
		» Batters			
		» Open water zones			
Weeds	"Maximum 10% cover of weeds No declared weeds"	» Batters			
		» Open water zones			
Vegetation health	"Minimal bare patches Healthy plants"	» Batters			
		» Open water zones			
Structures	No damage posing public safety or structural integrity risk	» Inlet / outlet			
Erosion	Minor erosion that doesn't pose public safety risk and would not worsen if left unattended	» Inlet / outlet			
		» Batters			
Surface levels	"No surface mounding > 100 mm (can impact system drainage and treatment performance) No depressions > 100 mm (can result in isolated ponding and mosquito breeding)"	» Batters			
Water levels	System is retaining water as designed (no more than 0.3m below NWL	» Open water zones			

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Water quality	"No odours or oil/ grease Maximum 10% surface cover of algae/moss"	» Open water zones			
Nuisance fauna	No nuisance fauna causing issues to the function of the asset	» Batters			
		» Open water zones			
Mosquitoes	"No problematic mosquito populations Permanent open water that can support mosquito predators"	» Open water zones			
Maintenance access provided	Adequate maintenance access is provided to the asset	» All			
Public health and safety issues	No features that will be cause potential public health and safety issues (e.g. tripping, drowning, structural integrity)	» All			

Appendix C cont.

WSUD inspection checklist - Wetlands

WSUD inspection checklist:	Inspected by:
Weather:	Date of last rainfall:

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Litter/debris	Minor litter or debris present	» Inlet/outlet			
		» Surface			
		» Batters			
Sediment accumulation	Minor amount of coarse sediment accumulation	» Inlet/outlet			
		» Surface			
		» Batters			
		» Open water zones			
Weeds	"Maximum 10% cover of weeds No declared weeds"	» Surface			
		» Batters			
		» Open water zones			
Vegetation health	"Minimal bare patches Healthy plants"	» Surface			
		» Batters			
		» Open water zones			
Structures	No damage posing public safety or structural integrity risk	» Inlet/outlet			
Erosion	Minor erosion that doesn't pose public safety risk and would not worsen if left unattended	» Inlet/outlet			
		» Surface			
		» Batters			
Surface levels	"No surface mounding > 100 mm (can impact system drainage and treatment performance) No depressions > 100 mm (can result in isolated ponding and mosquito breeding)"	» Surface			
		» Batters			

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Water levels	System is retaining water as designed (no more than 0.3m below NWL	» Open water zones			
Water quality	"No odours or oil/ grease Maximum 10% surface cover of algae/moss"	» Open water zones			
Nuisance fauna	No nuisance fauna causing issues to the function of the asset	» Surface			
		» Batters			
		» Open water zones			
Mosquitoes	"No problematic mosquito populations Permanent open water that can support mosquito predators"	» Open water zones			
Maintenance access provided	Adequate maintenance access is provided to the asset	» All			
Public health and safety issues	No features that will be cause potential public health and safety issues (e.g. tripping, drowning, structural integrity)	» All			

Appendix C cont.

WSUD inspection checklist - Ponds and Lakes

WSUD Asset:	Inspected by:
Weather:	Date of last rainfall:

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Litter/debris	Minor litter or debris present	» Inlet/outlet			
		» Open water zones			
		» Batters			
Sediment accumulation	Minor amount of coarse sediment accumulation	» Inlet/outlet			
		» Batters			
		» Open water zones			
Weeds	"Maximum 10% cover of weeds No declared weeds"	» Batters			
		» Open water zones			
Vegetation health	"Minimal bare patches Healthy plants"	» Batters			
		» Open water zones			
Structures	No damage posing public safety or structural integrity risk	» Inlet/outlet			
Erosion	Minor erosion that doesn't pose public safety risk and would not worsen if left unattended	» Inlet/outlet			
		» Batters			
Surface levels	"No surface mounding > 100 mm (can impact system drainage and treatment performance) No depressions > 100 mm (can result in isolated ponding and mosquito breeding)"	» Batters			
Water levels	System is retaining water as designed (no more than 0.3m below NWL	» Open water zones			
Water quality	"No odours or oil/ grease Maximum 10% surface cover of algae/moss"	» Open water zones			

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Nuisance fauna	No nuisance fauna causing issues to the function of the asset	» Batters			
		» Open water zones			
Mosquitoes	"No problematic mosquito populations Permanent open water that can support mosquito predators"	» Open water zones			
Maintenance access provided	Adequate maintenance access is provided to the asset	» All			
Public health and safety issues	No features that will be cause potential public health and safety issues (e.g. tripping, drowning, structural integrity)	» All			

Appendix C cont.

WSUD inspection checklist - Retarding Basins

WSUD Asset: Inspected by:

Weather: Date of last rainfall:

Task Item	Performance target	WSUD element inspected	Observed condition	Maintenance required	Maintenance undertaken
Litter/debris	Minor litter or debris present	» Inlet/outlet			
		» Surface			
		» Batters			
Sediment accumulation	Minor amount of coarse sediment accumulation	» Inlet/outlet			
		» Surface			
		» Batters			
Weeds	"Maximum 10% cover of weeds No declared weeds"	» Surface			
		» Batters			
Mowing	No overgrown turf	» Surface			
		» Batters			
Vegetation health	"Minimal bare patches Healthy plants"	» Surface			
		» Batters			
Structures	No damage posing public safety or structural integrity risk	» Inlet/outlet			
Erosion	Minor erosion that doesn't pose public safety risk and would not worsen if left unattended	» Inlet/outlet			
		» Surface			
		» Batters			
Surface levels	"No surface mounding > 100 mm (can impact system drainage and treatment performance) No depressions > 100 mm (can result in isolated ponding and mosquito breeding)"	» Surface			
		» Batters			
Maintenance access provided	Adequate maintenance access is provided to the asset	» All			
Public health and safety issues	No features that will be cause potential public health and safety issues (e.g. tripping, drowning, structural integrity)	» All			