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Environment and Planning

Water Sensitive Urban Design

Review report

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Contents

Executive summary

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.[1] WSUD guidelines were released in 2007, and given further effect as part of the Territory Plan by the establishment of the Waterways: Water Sensitive Urban Design Code ('the WSUD Code') in 2009. The WSUD Code was seen as a way of encouraging a reduction in mains water use and improving stormwater quality and quantity.

On 6 June 2013, the Minister for the Environment and Sustainable Development, Simon Corbell, tabled in the Legislative Assembly the ACT Government's response to the Independent Competition and Regulatory Commission (ICRC) report on secondary water use.

The response committed the ACT Government to inquire into and report on WSUD regulation against a government objective of a 40% reduction in water usage in new developments and refurbishments/extensions (compared with pre-2003 levels). The report is to provide recommendations on significantly expanding the acceptable mandated measures to achieve the targets, and to provide maximum flexibility to developers to lower development costs.

The Environment and Planning Directorate (EPD) led the review and established a technical panel of experts in the field to assist with the review.

Review of Water Sensitive Urban Design approaches

In undertaking the review, EPD, working with other directorates in ACT Government:

- examined the current application of the WSUD Code and regulations including the Territory Plan's codes, design standards and development guidelines
- compared Australian and overseas examples, including benchmarking of the application and performance of the ACT WSUD Code against similar codes in other metropolitan centres
- looked at the whole-of-life costs of WSUD along with the triple bottom line (TBL) and cost-benefit analysis of WSUD practices, as well as assessing any potential impact on housing affordability
- assessed administrative options, including the appropriate mechanisms to implement reforms, giving consideration to administrative simplicity and appropriate staging and coordination
- recommended options for the on-going funding of the operation and maintenance of public WSUD infrastructure
- involved and engaged with the community regarding the current code and its application and recommended options for continuing community engagement and education on the practices of WSUD
- identified where further analysis and policy work is needed to improve the operation and integration of WSUD into the planning and development process.

Community engagement

Community engagement included workshops with stakeholders (practitioners, ACT Government staff and the community); public consultation through the ACT Government's Time to Talk webportal, Twitter and Facebook; an online survey distributed to 4,000 past development applicants; advertisements in local print media; and individual stakeholder meetings. Eleven written submissions were received and over 300 people completed the on-line survey. Submissions were generally supportive of WSUD principles, but there were a number of concerns expressed about the implementation of WSUD.

1 *Waterways Water Sensitive Urban Design General Code 2009* (ACT).

Feedback from the community consultation process is analysed in section 6 of this report. Issues raised during the consultation included:

- Implementation – there are failures in erosion and sediment control during the home building stage.
- Maintenance – stakeholders observed sites were not being maintained or remediated and that a budget was required for maintenance.
- Application of WSUD in the ACT is inconsistent – it should focus on water saving, water quality, retention and stormwater management.
- Flexibility should not be at the expense of adequate regulation or at the expense of water quality; flexibility should consider the current inflexible WSUD targets and an offsets scheme.
- Mandatory requirements should remain in the codes.

Analysis of issues

This report considers 16 issues arising from the review process and proposes a number of actions and recommendations. Public consultation, the ACT Government WSUD Working Group and Technical Panel have assisted in arriving at the list of issues. Analysis of recent water quality issues in Canberra's lakes, the question of impacts on housing affordability, whole-of-life costs and the environmental, social and economic issues of poor WSUD management also reinforced the need for the ACT to review the current nature of WSUD regulation. WSUD has social, environmental, economic and climate change benefits that can be better enhanced. A number of issues have been categorised into themes:

- current application of WSUD in the ACT compared to a changing environment (Theme 1)
- housing affordability (Theme 2)
- coordination and compliance of WSUD in the development and building phase (Theme 3)
- sustainable maintenance of WSUD assets (Theme 4).

Since the WSUD Code was introduced in 2009, there has been an uptake of WSUD due to the requirements in the general and development codes and also industry initiatives taking place in the ACT. While the intent of the WSUD Code is still valid, there is now an opportunity to revise the way the Territory deals with WSUD, particularly in relation to climate change, population growth and environmental, social and economic factors.

The current nature of the WSUD Code and all WSUD requirements in the development codes – and the code's relationship with the Territory Plan – was a focus of much of the review. The review found there was an opportunity to refine the codified requirements for WSUD in the Territory Plan to maximise flexibility and to support innovation as well as accommodate advances if a guideline contradicts the standard of the Territory Plan as it is not set out with rules and criteria. Furthermore the review highlighted a need to revisit all WSUD principles and requirements in the development and precinct codes.

The review identified the requirement for a review of the WSUD provisions of the Territory Plan together with the development of a comprehensive WSUD practice guideline and a review of the Water Use and Catchment Code.

Australian and overseas WSUD examples are considered in the review. While the ACT differs from other jurisdictions in relation to WSUD in a number of areas, approaches to WSUD elsewhere have informed the review in the areas of:

- WSUD guidelines[2]
- stormwater management and treatment[3]

2 Issue 1 Blacktown City Council Guideline example. Other best practice examples include Department of Environment, Water and Natural Resources (2013). *Water sensitive urban design - Creating more liveable and water sensitive cities in South Australia,* Government of South Australia: Adelaide; and Western Australian Planning Commission (2008). *Better Urban Water Management,* Department for Planning and Infrastructure (WA): Perth <http://www.water.wa.gov.au/PublicationStore/first/82305.pdf>.

3 Issue 2 Blueprint2013 and Northern Tasmanian Stormwater Program examples. Other best practice examples include Water By Design, (2011). *A business case for best practie urban stormwater management*. Retrieved from: http://waterbydesign.com.au/businesscase/. Issue 10 Aurora Estate integrated approach and Issue 12 The Little Stringybark Creek Project.

- strategic flood planning and management[4]
- green infrastructure strategy[5]
- funding models and maintenance arrangements.[6]

Improving the way the Territory implements WSUD would be positively assessed in a TBL assessment because of the benefits it has for community, the environment and the economy. An extensive literature review assessed the impacts of WSUD on the cost of housing, but could not find any substantial evidence to show that implementing WSUD in developments is impacting on affordability. Estate development is undertaken in an integrated fashion, where stormwater and WSUD requirements at the estate level are undertaken as part of the routine sustainable development of estates. There are additional costs at the individual block level for rainwater tanks for example, but as a proportion of total costs they are minimal. The proposed review of WSUD provisions would look to provide greater flexibility to developers in meeting detention and retention targets using devices other than rainwater tanks and at different scales.

Coordination and compliance of WSUD in the development and building phases was investigated. This section looks at the coordination and compliance between different ACT Government directorates and with developers and the building industry. It identified that internal administrative processes relating to WSUD and development need significant improvement. At the time of writing this report, a number of in-house discussions are being carried out. It is important that this report's findings be taken into account to further implement the recommendations. Improving WSUD administrative processes has benefits to the government and the community.

The review explores the various funding and maintenance arrangements in other jurisdictions in relation to the operation and maintenance of public WSUD infrastructure. It recommends an overall cost-benefit analysis for funding models that take into account the whole-of-life costs of WSUD infrastructure. It is also timely that reasonable maintenance requirements be identified, specified and integrated into the design of WSUD assets from the design phase onwards. This will also ensure ACT meets its obligations under the Murray–Darling Basin Plan 2012 (Basin Plan). WSUD has an important role in our commitment to the Basin Plan as it will continue to protect water quality in the ACT and ensure ongoing protection of the health of people in the ACT and down river and no net decline on water quality in the Murray–Darling Basin. WSUD contributes to Canberra's commitment to sustainability.

An opportunity exists with the recent announcement of the ACT Basin Priority Project, which has monitoring as a key first stage. The Australian and ACT governments will jointly invest in an ACT-wide water quality monitoring program that will build on existing monitoring to measure the ACT's effectiveness in meeting water quality targets of flows out of the ACT into the Murrumbidgee River and the wider Murray–Darling Basin and to audit the effectiveness of water quality treatment processes, including WSUD assets. As more data becomes available, the ACT will be in a position to strategically select and site WSUD assets in the most effective locations to ensure the best water quality and quantity outcomes.

In moving forward with the findings and recommendations in this report, the government will need to engage with the community on the outcome of this review. Any changes to how WSUD is implemented will require proactive community engagement, including education and awareness for industry and technical experts in WSUD practice.

4 Issue 6 Wagga Wagga City Council overland flooding and Brisbane City Council Floodsmart Future Strategy example.
5 Issue 7 City of Melbourne, City of Sydney and the European Union examples.
6 Issue 16.

Recommendations

The recommendations and actions can be grouped together as priority projects to ensure they are delivered to meet the government's commitment to this inquiry. All priority projects consider the information that the issues addressed and the recommendations in section 6.

Priority Project 1: Code restructure and revision

EPD leads a revision of the water sensitive urban design provisions in the Territory Plan, supported by a practice guideline to provide for greater clarity and consistency in interpretation as well as to promote innovation and increase flexibility in meeting WSUD targets.

Priority Project 2: Alternative management and funding models

EPD, Territory and Municipal Services Directorate (TAMS), Chief Ministers, Treasury and Economic Development Directorate (CMTEDD) work together to investigate alternative management and funding models for sustainable maintenance of WSUD assets, informed by cost-benefit analysis.

Priority Project 3: Housing affordability

The ACT Government will encourage WSUD approaches that maximise cost efficiency at the appropriate level (e.g. on-site versus sub-catchment) to minimise impacts on housing affordability in the ACT, as well as the maintenance burden.

Priority Project 4: Green infrastructure strategy

EPD, subject to available funding, lead development of a green infrastructure strategy for the ACT as a means of realising the social, economic and environmental values of our green assets including the integration of WSUD assets.

Priority Project 5: Design standards

TAMS, subject to available resources, continue its review of design standards for urban WSUD and related infrastructure.

Priority Project 6: Modelling and monitoring

EPD leads the development of a water quality and flows modelling and monitoring program, focusing on understanding the performance of WSUD assets against modelled results and building internal capacity within the ACT Government in modelling and monitoring.

Priority Project 7: Erosion and sediment control

EPD, through the ACT Environment Protection Authority, review the Environment Protection Guidelines for Construction and Land Development in the ACT (2011) and continue to work with the construction industry to improve their performance in erosion and sediment control during the building construction phase. EPD also investigate building certifiers to ensure compliance with site management requirements, including erosion and sediment control.

Priority Project 8: WSUD asset management transfer

CMTEDD leads the development of a guideline in consultation with TAMS to inform the effective transfer of government owned WSUD infrastructure from construction to management.

Summary of findings and recommendations

The following is a summary of findings and recommendations for the 16 issues identified as part of this review.

Theme 1. Current application of WSUD in the ACT compared to a changing environment

Issue 1: Currency of the WSUD General Code and promoting innovation

Findings

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

Recommendations

1.1) Carry out a revision of the water sensitive urban design provisions in the Territory Plan, supported by a practice guideline.

1.2) The new practice guideline should be supported by a suite of community education and awareness tools.

Issue 2: Design standards for urban infrastructure

Findings

- WSUD related design standards for urban infrastructure in the ACT are in need of review. A review has commenced and the highest priority design standards are being addressed.
- There is an opportunity to consider the merits and challenges associated with the development of WSUD asset-specific design standards to accommodate technological advances.
- Other jurisdictions have adopted strategic approaches to stormwater management at a regional level which has informed development of localised standards.
- The ACT Basin Priority Project audit of stormwater infrastructure, detailed monitoring and the development of a catchment management master plan will inform future work on design standards.

Recommendations

2.1) Review and update WSUD related design standards to reflect contemporary best practice in an ACT context.

Issue 3: Application of the Water Use and Catchment Code

Findings

- The water use code requires review to better reflect the catchment specific requirements and the changing nature of our catchments due to development and community and stakeholder values.
- The catchment categories are no longer applicable to certain areas within the ACT. Data for those areas is consequently perceived as negative due to the incorrect designation of the catchment making it difficult to comply with the water use code. For example, when land uses in a catchment designated as conservation change, they can no longer achieve the conservation targets.
- The water use code is generally poorly referenced in other codes and its objectives are poorly articulated, generally limiting its application.

Recommendations

3.1) Review the water use code and include catchment specific requirements for water quality flows etc. that accommodate land use changes and community and stakeholders expectations.

Issue 4: Estate Development Plan Guidelines

Findings

- WSUD outcomes plans received by the Territory for estate developments vary in information and quality.
- The Estate Development Plan Guidelines process for WSUD needs to be revised to articulate better WSUD requirements for proponents.

Recommendations

4.1) Review the WSUD component of the Estate Development Plan Guidelines to ensure they reflect best practice.

Issue 5: Expanding the range of acceptable on-site options for stormwater retention and detention

Findings

- The current wording in the WSUD Code and the development codes implies that rainwater tanks or central tanks are the only or the simplest approved option for on-site stormwater retention and detention.
- Other jurisdictions are working with formulas that provide flexibility in the options they choose for WSUD. These formulas can be applied at the block level or considered in an integrated approach.
- Education and community awareness is needed to inform the community of the consumer choices and the benefits of WSUD, including about rainwater tanks or other detention and retention options.

Recommendations

5.1) The rules and criteria for on-site retention and on-site detention be revisited as part of the Territory Plan amendment package.

5.2) The proposed new WSUD guideline should clearly articulate the best practice and contemporary design principles which will encourage cost-effective innovation.

5.3) Investigate options of formulating requirements at different development scales, including at the neighbourhood scale.

Issue 6: The relationship of WSUD and climate change including stormwater and flood management

Findings

- The WSUD Code does not take account of the impacts of climate change and the potential for WSUD to be an ameliorating tool in adapting to climate change.
- The review presents an opportunity to revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.
- New investigations into flooding of our local urban streams are underway, which may lead to revision of WSUD Code stormwater flow targets.
- Other jurisdictions have carried out studies to identify areas most vulnerable to high intensity rainfall, which is likely to increase with climate change.

Recommendations

6.1) Revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.

Issue 7: Green infrastructure strategy

Findings

- There is a growing need for high quality public open spaces as the trend in urban development is to increased density, smaller detached dwellings and multi-unit developments.
- The benefits or avoided costs associated with public health (physical and mental), social cohesion and improved liveability should also be considered as part of the development of green infrastructure.
- The ACT Government lacks a strategic framework for a green infrastructure strategy.
- Green infrastructure strategies are being implemented in various jurisdictions across Australia and overseas as a way to ameliorate climate change impacts.
- A green infrastructure strategy includes WSUD; coupled together they are key factors in:
  - ameliorating the intensification of summer storms and supercell storms associated with climate change
  - ameliorating the negative impacts of decreases in rainfall associated with climate change
  - enhancing the capacity of landscape to accommodate increased peak stormwater discharges associated with climate change
  - enhancing a liveable city and improving health outcomes.

Recommendations

7.1) The ACT Government develop a green infrastructure strategy, recognising the multiple and cross-sectoral benefits.

Issue 8: Urban Renewal and residential intensification

Findings

- Urban renewal and residential intensification has been identified as a priority under the Canberra Spatial Plan and the ACT Planning Strategy (2012).
- The WSUD Code does not provide sufficient guidelines to support urban renewal and residential intensification through redevelopment.

Recommendations

8.1) The new WSUD guidelines, incorporate contemporary best practice principles that support the intent of the Canberra Spatial Plan and the ACT's climate change action plan, AP2, with regard to urban renewal and residential intensification.

8.2) The new WSUD guidelines to take into consideration the requirements of residential intensification and provide merit avenues to look at areas at a precinct-by-precinct basis.

Theme 2. Housing affordability

Issue 9: WSUD and housing affordability?

Findings

- It was difficult to reach a firm conclusion about the costs of WSUD on housing affordability based on the documentary evidence, particularly as it varies substantially between locations and type of development.
- The integrated nature of estate design and construction make it difficult to attribute WSUD requirement costs over and above costs associated with addressing routine water quality and stormwater management measures for new estates.
- WSUD requirements for redevelopments and refurbishments are more easily costed and there are options available from other cities for offsetting these costs where site requirements limit on-site treatments.

Recommendations

9.1) The ACT Government will encourage WSUD approaches that maximise cost efficiency at the appropriate level (e.g. on-site versus sub-catchment) to minimise impacts on housing affordability in the ACT, as well as the maintenance burden.

Theme 3. Coordination and compliance of WSUD in the building and development phase

Issue 10: Selection of the most appropriate stormwater treatment measures

Findings

- Given the codified nature of the WSUD code, it is common for proponents to select from a limited repertoire of WSUD options.
- Enhanced monitoring will support an improvement in the range of design options.
- The staging of WSUD infrastructure, particularly in new estates, has resulted in work needing to be re-done due to the effects of subsequent development.
- Widening the range of acceptable options will place additional demands on technical assessment staff in EPD.
- Widening the scope of acceptable WSUD treatments will require consequent amendment of the design standards for urban infrastructure.
- Maintenance documentation and procedures will need to be available to support the continued efficient operation of WSUD infrastructure.

Recommendations

10.1) The ACT Government develops a handbook to guide staged development and handover processes.

Issue 11: Lack of in-house stormwater modelling skills and capacity

Findings

- There is a lack of in-house stormwater modelling skills and capacity and limited access to a current version of MUSIC (the most common modelling tool).
- There is a lack of interaction between government, industry and science about modelling relating to WSUD. There should be a community of practice between officers and industry to assist in the development of staff and industry.
- Tools like MUSIC-link provide the opportunity to give development assessors the capacity to test submitted data and have assurance that submitted information meets Territory standards.

Recommendations

11.1) The ACT Government seek to establish a community of practice between government, industry and science around stormwater modelling and the application of WSUD in the Territory.

11.2) The ACT Government adopt the eWater MUSIC-link program and a guideline to the use of MUSIC and stormwater modelling in the ACT.

Issue 12: Water quality monitoring data to provide feedback loop for future designs, maintenance planning and operation of WSUD measures

Findings

- Water quality monitoring does not take place for most WSUD assets that are implemented.
- There is currently no accepted or recognised monitoring program for urban stormwater in the ACT. Nor is there a consistent integrated shallow and deep monitoring program for WSUD elements in the ACT to test performance and function once they are installed.
- The ACT Basin Priority Project represents a real opportunity to remedy this situation, with comprehensive ACT-wide monitoring and individual performance monitoring of WSUD infrastructure into the long term.

Recommendations

12.1) The ACT Government continues to support the development and delivery of an appropriate water quality monitoring program with the assistance of the ACT Basin Priority Project to assess the behaviour of catchments and the performance of individual WSUD assets and as part of treatment trains.

12.2) EPD convene an annual review workshop on water quality data with key stakeholders to assess the outcomes of monitoring data and recommend directions for further work.

Issue 13: Soil stabilisation techniques in developments

Findings

- Soil stabilisation techniques in developments are not always effective due to a lack of knowledge and to poor on-site practices.

Recommendations

13.1) Review Environment Protection Guidelines for Construction and Land Development in the ACT (2011) to strengthen the way erosion and sediment control is staged.

13.2) The Planning and Development Forum be used as a stakeholder consultation to engage with the building industry on effective soil stabilisation.

13.3) The new guidelines should require erosion and sediment control measures are to be established during either the capital works or estate development phase by civil contractors and left in place for the house construction phase until house construction is largely complete (up to 85% development as a guideline).

Issue 14: Handover and responsibility of erosion and sediment control mechanisms

Findings

- The coordination of the handover process in estate development can be improved to avoid rectification and maintenance costs.
- The cleaning requirement for Gross Pollutant Traps (GPTs) is greatly increased during the building and construction phase and TAMS is unable to respond to this requirement consistently due to resource and budget constraints.
- There has been a significant increase in WSUD assets managed by TAMS.
- Work has already commenced between the concerned directorates to refine handover practices, although more work needs to be done.

Recommendations

14.1) As stated above, the ACT Government develop a handbook to guide staged handover processes. It is to deal with:

  – Erosion and sediment control between the land and construction phase and the building and development phase

  – Consider the siting of temporary erosion and sediment control ponds in open space or areas that do not need to be developed immediately.

14.2) The option be explored that developers undertake GPT clean-out during the building development stage until 85% of the catchment area is built.

Issue 15: Regulation and compliance with erosion and sedimentation controls

Findings

- Compliance with erosion and sedimentation, especially on small blocks, is difficult to regulate.
- Changes to the legislation relating to ‘likely’ and ‘potential’ environmental harm is considered by some as difficult to regulate. The review of the EPA Act is an ongoing process.

Recommendations

15.1) Environment Protection Regulations to be amended to include offences for non-compliance with approved erosion and sediment control on sites subject to an Environment Protection Agreement.

15.2) Investigate using building certifiers to ensure compliance with site management requirement, including erosion and sediment control.

Theme 4. Sustainable maintenance of WSUD Assets

Issue 16: Funding for maintenance of WSUD assets and their performance targets cannot be met

Findings

- The cost of routine maintenance of WSUD assets has become a significant issue in the Territory. The issue consists of a few components which ultimately come down to budgetary constraints and resources.
- TAMS is responsible for an increasing number of WSUD assets, placing a strain on budgets.
- There is a lack of funding to maintain WSUD assets due to other competing priorities.
- There are a range of mechanisms that have been employed in other jurisdictions to help fund stormwater infrastructure construction and maintenance, including levies and offset schemes.
- There is a need to look at alternative funding and management models for a sustainable WSUD network.

Recommendations

16.1) An overall cost benefit analysis be undertaken for funding models that take into account the whole of life costs of WSUD infrastructure.

16.2) Alternative funding and management models for WSUD infrastructure need to be investigated.

1. Background

Conventional urbanisation impacts on natural hydrology in a variety of ways such as increased flows, increased flash flooding and reduced infiltration, leading to erosion of watercourses, possible damage to riparian and fringing vegetation and pollution of receiving waters with sediments, hydrocarbons, nutrients and gross pollutants.

Water sensitive urban design (WSUD) is an approach to integrating the urban water cycle into urban planning and design and mitigating urban impacts on waterways.[7]

WSUD evolved from its early association with stormwater management to promote a broader framework for sustainable urban water management[8], integrating the urban built form and the urban water cycle.

Key principles of WSUD[9] are:

1. *Reducing potable water demand through water efficient appliances and seeking alternative sources of water such as rainwater and (treated) wastewater reuse, guided by the principle of 'fit-for-purpose' matching of water quality and end uses.*
2. *Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent re-use opportunities and/or release to receiving waters.*
3. *Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters.*
4. *Using stormwater in the urban landscape to maximise the visual and recreational amenity of developments*.

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 (drinking water) security.

WSUD Guidelines for the ACT were first released in 2007 and given further effect as part of the Territory Plan by the establishment of the Waterways: Water Sensitive Urban Design Code in 2009. The purpose of the code was to encourage reduced mains water use, improve stormwater quality, manage stormwater flows and promote greywater reuse.

On 6 June 2013, the Minister for the Environment and Sustainable Development, Simon Corbell tabled in the Legislative Assembly the government's response to the Independent Competition and Regulatory Commission (ICRC) report on secondary water use.[10]

The response commits the government to inquire into and report on WSUD regulation against a government objective of a 40% reduction in water usage in new developments and refurbishments/extensions (compared with pre-2003 levels). The report is to provide recommendations on significantly expanding the acceptable mandated measures to achieve the targets, and to provide maximum flexibility to developers to lower development costs. EPD led the review, establishing an inter-directorate working group to assist and a technical panel of experts in the field: Ian Lawrence, environmental engineer, planner and scientist who assisted in drafting the original code; Professor Ross Thompson, Chair of Water Science, Institute of Applied Ecology, University of Canberra; Julien Lepetit, WSUD Practice Leader (ANZ) at AECOM; Ashis Dey, Commercial Products Director, eWater; Luke McPhail, Senior Products Manager, eWater; and Rob Catchlove, Alluvium Consulting.

7 *Waterways Water Sensitive Urban Design General Code 2009* (ACT) and Black, G. W. (2012). *The investigation of the sustainability of a regional approach to Water Sensitive Urban Design using a Triple Bottom Line Assessment*. Retrieved from: https://eprints.usq.edu.au/23036/1/Black_2012.pdf.

8 Wong, T.H.F. (2006). An overview of water sensitive urban design practices in Australia. *Water Practice and Technology* 1(1), 1-8. These principles are also broadly supported by Fletcher, T. D., Deletic, A. B., & Hatt, B. (2004). An evaluation of stormwater sensitive urban design in Australia (Chapter 6). In P. Dillon & D. Ellis (Eds.), *Australian Water Conservation and Re-use Research Program: Stage 1 Review*. Adelaide: CSIRO Publishing.

9 Ibid.

10 *Government response to the Independent Competition and Regulatory Commission (ICRC) Reprot on Secondary Water Use* (2013). Retrieved from: http://www.environment.act.gov.au/__data/assets/pdf_file/0008/266858/Government_Response_to_ICRC_Report_on_Secondary_Water_Use.pdf

The working group's terms of reference articulated the methodology of the review:

- Evaluate the operation of the WSUD Code in the ACT since its inception.
- Undertake a literature review.
- Undertake a review of current WSUD practices in the ACT, Australia and overseas. This will include benchmarking of the application and performance of the ACT WSUD Code against similar codes in other metropolitan centres.
- Gather and evaluate evidence of the whole-of-life costs, the triple bottom line (TBL) and cost- benefit analysis of WSUD practices, as well as their impact on housing affordability.
- Recommend acceptable WSUD measures that will significantly widen the choice of cost-effective interventions available to achieve WSUD targets, at different scales from on block to precinct and neighbourhood level to larger whole or part catchment approaches, whilst providing maximum flexibility to developers.
- Assess administrative options, including the appropriate mechanisms to implement reforms, giving consideration to administrative simplicity.
- Recommend options for the on-going funding of the operation and maintenance of public WSUD infrastructure.
- Involve and engage with the community regarding the current code and its application, and recommend options for continuing community engagement and education on the practices of WSUD.

This work was undertaken in parallel with the government's finalisation of a new ACT Water Strategy, consideration of options for catchment management governance for the ACT and consideration of the recommendations of the Cohen Review of Institutional Arrangements for ACTEW.

2. Purpose of the report

This report represents the outcome of the review and includes:

- an assessment of the relationship between the WSUD Code and other regulations, including the Territory Plan's codes, as well as design standards and development guidelines
- a comparison between Australian and overseas examples, including benchmarking of the application and performance of the ACT WSUD Code against similar codes in other metropolitan centres
- a review of whole-of-life costs of WSUD, a TBL and cost-benefit analysis of WSUD practices, and an assessment of any potential impact on housing affordability
- consideration of acceptable WSUD measures that will significantly widen the choice of cost-effective interventions available to achieve WSUD targets, at different scales from on block to precinct and neighbourhood level to larger whole or part catchment approaches, whilst providing maximum flexibility to developers
- assessment of administrative options, including the appropriate mechanisms to implement reforms, giving consideration to administrative simplicity including encouraging discussions to happen within government and an appropriate staging and coordination process
- consideration of options for the on-going funding of the operation and maintenance of public WSUD infrastructure
- consideration of the part WSUD plays in meeting the Territory's wider obligations under the Murray–Darling Basin Agreement
- recommendations relating to the involvement and engagement of the community in the current WSUD Code and its application and consideration of options for continuing community engagement and education in WSUD practice.

The report reiterates the importance of WSUD in our environment to manage our urban water cycle, encourages discussion and the formalisation of refined whole-of-government coordination to achieve better on-ground outcomes and reduced costs, and addresses implementation of report recommendations.

The report findings are relevant to the ACT Government's consideration of:

- strategic asset management (including the TAMS Review of design standards for urban infrastructure and CMTEDD's work on further refining the ACT's emergency flood management response and flood planning)
- review of the strategies, codes, design standards and development guidelines that relate to the management of water in the Territory, such as the current Strategic Bushfire Management Plan v2 review or review of precinct codes in the Territory Plan
- climate adaptation strategies and actions under the ACT Government's new climate change strategy and action plan, AP2
- finalisation and implementation of the new ACT Water Strategy
- catchment governance arrangements.

3. The current code and its operation

WSUD guidelines were released in 2007 and given further effect as part of the Territory Plan by the establishment of the WSUD Code in 2009. The WSUD Code was seen as a way of encouraging a reduction in mains water use, improving stormwater quality and quantity, and implementing elements of the then ACT water strategy Think Water Act Water – a strategy for sustainable water resource management (TWAW) introduced in 2004. One of the strategy's six objectives was to 'facilitate the incorporation of water sensitive urban design principles in urban, commercial and industrial development.'

TWAW Targets

The specific Canberra-wide targets identified in TWAW were:

- a 12% reduction in mains water usage per capita by 2013, and a 25% reduction by 2023 (compared with 2003), achieved through water efficiency, sustainable water recycling and use of stormwater
- an increase in the use of treated wastewater (reclaimed water) from 5% to 25% by 2013
- a level of nutrients and sediments entering ACT waterways no greater than from a well-managed rural landscape
- a reduction in the intensity and volume of urban stormwater flows so that the runoff event that occurs on average every three months is no larger than it was prior to development.

TWAW committed the ACT Government to 'protect the water quality in ACT rivers, lakes and aquifers, to maintain and enhance environmental, amenity, recreational and designated use values and to protect the health of people in the ACT and down river'. A review of TWAW (2012) found this objective had been achieved. The quality of water leaving the ACT is of comparable quality to water entering the ACT and there is no net decline on water quality in the Murray–Darling Basin. This commitment must remain, as the ACT is part of the Basin and must continue to be an active and responsible participant in managing the precious and finite water resources that must be shared by all users across the Basin, as outlined in the Murray–Darling Basin Agreement 2012 (Refer to section 4).

The WSUD Code provides mandatory targets for reductions in mains water consumption and improvements in stormwater quality and in quantity management. The target for mains water consumption reduction is 40% compared to pre-2003 consumption levels. This target must be achieved in all new developments and redevelopments, whether they are single residential, multi-unit residential, estate, commercial, industrial or institutional. There are lesser requirements for compact blocks under 250 m^2.

The stormwater management targets are to be achieved on estates and larger multi-unit sites or other development sites over 2,000 m^2. For blocks over 5,000 m^2 there are requirements for reducing the average annual stormwater pollutant export from the block for suspended solids, total phosphorous and total nitrogen, compared with an urban catchment with no water quality management requirements. On previously developed blocks over 2,000 m^2 there are also limitations on the size of existing stormwater pipe connections (to a 1-in-10 year storm event) and the capacity of the existing major overland stormwater system is not to be exceeded in 1-in-100 year storm events. In the case of stormwater management, the criteria provide a developer with some flexibility to demonstrate that outcomes are being met; however, there are no criteria available for water quality management.

Current WSUD measures comprise a number of different interventions: estate scale sediment control/water quality management with ponds and wetlands, swales, rain gardens and stormwater harvesting; permeable pavements; retrofitted wetlands (with associated reticulation for reuse of harvested water; commercial and industrial scale site orientated works and multi-unit developments with stormwater detention systems. At the single residence scale, by far the most common element is the installation of rainwater tanks and water saving appliances and fittings. There is limited take-up of water sensitive landscaping, although some single, multi-unit and commercial developments have incorporated some elements into their design.

4. Wider policy environment

Basin policy context

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 of the river systems of the Murray–Darling Basin system 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 GL. The Basin Plan is to 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 Basin Plan requires the ACT to have a water resource plan and a water quality plan. This will have significant ramifications for future water supply and water quality management activities. Therefore WSUD has an important role to play in our commitment to the Basin Plan in helping continue to protect water quality in the ACT and down river, and ensure there is no net decline on water quality in the Basin.

The ACT Basin Priority 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 Basin Priority 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'.

The ACT Basin Priority Project 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.

There are two distinct phases to this project. Phase One consists of three components. The first is the development of an integrated water quality monitoring regime, incorporating detailed monitoring in the identified six priority representative sub-catchments. The sub-catchments were selected as sites that either, currently contribute significantly to poor water quality outcomes, or potentially will due to future development proposals. The sub-catchments are representative of the variety of water management challenges faced by the Territory.

The six Priority Catchments accessible in the future for the following Priority Catchments:

- Yarralumla Creek
- Lake Tuggeranong
- Upper Molonglo
- Fyshwick
- Lower Molonglo and
- Riverview (west Belconnen)

In addition, an ACT-wide monitoring study will also be conducted which will focus on an integrated catchment monitoring for the ACT catchment. The proposed integrated water quality monitoring measuring regime will enable the ACT Government to track a range of water quality parameters through the ACT and surrounding catchments. A strategic audit of existing water quality infrastructure will also be carried out as part of Phase One. The audit will look at the effectiveness of existing water quality treatment processes, within the six catchments and elsewhere, where needed.

Phase Two will involve the development of infrastructure options for each sub-catchment, based on the analysis of the data collected from the monitoring, that will assist in improving the water quality flowing from these catchments. These analyses will be used to inform the business case required for the second phase of the project – the construction of major water quality interception/improvement structures. All milestones for the ACT Basin Priority Project must be accepted and approved by the Commonwealth.

The ACT Government has until 30 June 2019 to deliver the ACT Basin Priority Project.

ACT policy context

WSUD is influenced by, and impacts on, a range of associated ACT plans, strategies and projects apart from the water related strategies mentioned above:

Climate change

The ACT's new climate change strategy and action plan, AP2, includes actions that require risk management and mitigation and adaptation measures in our built environment. A Ministerial Statement has been prepared on how the built environment and urban open spaces will be developed to respond to climate change through long-term mitigation objectives, including a review of the relevant Territory Plan development codes and design standards (including WSUD).

Catchment management and governance

WSUD is catchment management at the urban level. The government is considering options for catchment governance to improve whole-of-government and regional communication, collaboration and coordination.

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 will replace TWAW, proposes the development of an ACT integrated catchment management plan. Consultation on the 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
- 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.

EPD 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. Version 2 is currently being reviewed and a key theme of the review, urban vegetation management, relates to WSUD. There is an observed significant risk in high risk areas presented by unmanaged dense native plantings on leased land. This is a particularly important issue on Inner Asset Protection Zones.

Flood management

Flood management is an important issue in the ACT. The ACT Flood Plan, which is a sub-plan of the ACT Emergency Plan, takes into consideration flood studies of Canberra's creeks and waterways, which will directly inform improved design, construction and management of WSUD infrastructure. At present, the ACT Government is carrying out emergency management flood studies on eight urban creek systems. However, any future flood management, including risk planning and emergency responses, needs to consider WSUD.

Triple Bottom Line Assessment Framework for the ACT Government

The ACT Government introduced the TBL Assessment Framework for the ACT Government in 2012.[11] TBL assessments are a standing requirement in the preparation of policy proposals (new policy or policy changes) for government consideration.[12]

In WSUD philosophy, WSUD promotes the integration of functional landscapes within the urban setting. Functional landscapes have many advantages such as maximising water reuse and promoting amenity or helping developers meet the requirements to achieve development approvals.[13] Other positive social outcomes from functional landscapes include better health, safety, housing, living conditions and space for settlement, higher value of the environment and improved cultural linkages to the environment.[14] Reducing the impact on receiving waterways and integration of 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. However the application, implementation and policy relating to WSUD can be further enhanced to ensure a better TBL outcome. One example includes the South-East Queensland Healthy Waterways Partnership[15], which developed a business case to look at the likely costs and benefits of WSUD for low density residential, medium density residential, commercial and industrial developments. The study estimated the quantitative and qualitative costs and benefits in achieving best practice WSUD. The business case found the benefits of applying WSUD practices are likely to outweigh the costs for these typical development types. The key benefits were:

- reduced pollutant loads discharged to waterways with potential annual savings of $515 per kilogram of nitrogen removed (and in the case of the ACT, the contribution of the ACT to Basin pollutant loads)
- reduced need for rehabilitation and maintenance of downstream water environments ($200–$3,000 per metre of stream per annum)
- premiums on land values due to enhanced property values (0.25 to 1.0%)
- educational and recreational benefits.

In examining costs, the study found that, generally, WSUD treatments on block can be accommodated without loss of developable land. While local geography influences the size of WSUD treatment systems, the cost of applying WSUD practices does not significantly impact on the profitability and affordability of developments and generally equates to less than 1% of the cost of new dwellings.[16]

It is generally accepted that open spaces within the urban context have psychological and physiological benefits for people. There is also literature to indicate that poorly maintained spaces, or areas that have not been properly designed to meet with vulnerabilities such as short term disturbances like extended storm events, can have dramatic social consequences and further impact on property prices.[17]

11 Chief Minister and Cabinet (2012). *Triple Bottom Line (TBL) Assessment Framework for the ACT Government*. Retrieved from: http://www.cmd.act.gov.au/__data/assets/pdf_file/0020/331373/TBL_Assessment_Framework.pdf

12 Ibid.

13 Walker, C., Tindale, N., Roiko, A., Wiegand, A., & Duncan, P. (2010, November). An ecosystem health approach to assessing stormwater impacts on constructed urban lakes. *Refereed proceedings from the National Conference of the Stormwater Industry Association* (pp. 8-12), Retrieved from: http://www.gemsevents.com.au/Stormwater2010/assets/Walker,%20Christopher%20-%20Refereed%20Paper.pdf

14 Slootweg, R., Vanclay, F., & van Schooten, M. (2001). Function evaluation as a framework for the integration of social and environmental impact assessment. *Impact Assessment and Project Appraisal*, 19(1), 19-28.

15 South East Queensland Healthy Waterways Partnership. (2010) *A Business Case for Best Practice Urban Stormwater Management*. Brisbane.

16 *Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland*, A report for the Queensland Competition Authority. Retrieved from: <http://www.qca.org.au/files/OBPR-MainStream-Report-MRBWSUDSEQ-1212.pdf>.

17 Adger, 2006 as cited in Wong, T., & Brown, R. (2008, August). Transitioning to water sensitive cities: ensuring resilience through a new hydro-social contract. *Proceedings of the 11th International Conference on Urban Drainage, 10,* Edinburgh. Bureau of Meteorology.

No substantial evidence was found in the literature to support the conclusion that implementing WSUD in developments is increasing housing costs and reducing affordability. Too often, the statements about economic, social and environmental values were unreferenced testimonials or statements made during public consultation. There was acknowledgement of a lack of defensible WSUD cost data.[18]

Improving how the Territory implements WSUD will benefit present and future generations. 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.

Table 1 – Brief overview of current and future social, environmental and economic benefits of WSUD

Social	Economic	Environmental
Improved water quality will mean: • improved liveability for the Canberra community through recreational wellbeing, enhanced amenity to waterways and water supply security. Improved WSUD planning requirements for proponents, builders and developers will mean: • flexibility and innovation without impacting on housing affordability • accommodating changes in residential form. Continuing to have water in our urban environment through evapotranspiration of trees and vegetation helps to alleviate the effects of heatwaves in built up urban areas; for example the disadvantaged and vulnerable during these periods.	Improving the Territory's administrative processes relating to WSUD will have economic benefits including: • on productivity and innovation for the building and construction industry through clear 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.

18 Thurston et al., (2003) and US EPA, (2007) as cited in Roy, A.H., Wenger, S.J., Fletcher, T.D., Walsh, C.J., Ladson, A.R., Shuster, W.D., Thurston, H.W., & Brown, R.R. (2008). Impediments and solutions to sustainable, watershed-scale urban stormwater management: Lessons from Australia and the United States. *Environmental Management*, 42(2), 344–359.

5. Community consultation

Community engagement included workshops with stakeholders (practitioners, ACT Government staff and the community); public consultation through the ACT Government's Time to Talk webportal, Twitter and Facebook calls for submissions; an on-line survey distributed to 4,000 past development applicants; advertisements in local print media; and individual stakeholder meetings.

Eleven written submissions were received and over 300 people completed the online survey (Attachment A provides a summary of the survey). Submissions were generally supportive of WSUD principles, but there were a number of concerns expressed about the implementation of WSUD.

Feedback from the consultation process is further analysed in section 6 (Issues and recommendations). Due to the limited number of formal submissions it was difficult to identify emerging themes, however some points were raised in more than one submission including:

- compliance – there are failures in erosion and sediment control during the home building stage
- maintenance – stakeholders observed sites were not being maintained or remediated and that a budget was required for maintenance
- application of WSUD in the ACT is inconsistent – it should focus on water saving, water quality, retention and stormwater management
- flexibility should not be at the expense of adequate regulation or at the expense of water quality; flexibility should consider the current inflexible WSUD targets and an offsets scheme
- mandatory requirements should remain in the codes.

Other comments included:

- monitoring – there are deficiencies in water quality or vegetation monitoring
- self-regulation is prone to failure – there is a need for prescriptive guidelines and penalties to ensure compliance
- leaseholders and developers should be encouraged to do away with gutters wherever possible to encourage water being collected through depressions and soaks in below ground infiltration pits
- private ownership of WSUD assets is an issue – information is often inadequately disclosed to private owners of the existence of stormwater assets on properties; for example a body corporate inheriting detention tanks having limited information on their operation and performance
- the ACT Government should consult with the Cooperative Research Centre (CRC) for Water Sensitive Cities in Melbourne for advice
- there is a lack of depth of technical skills of staff in the ACT Government in this area and a technical panel of water industry experts should be created to provide expert advice on development matters
- rainwater tanks should not be required for small blocks (200-300 m^2) and new estates are designed to accommodate WSUD requirements and rainwater tanks 'disrupt the WSUD'.

Three stakeholder workshops were held with industry, government and community stakeholders. The workshops provided a useful opportunity to inform stakeholders about the review and to provide an initial opportunity to jointly identify the key issues requiring attention through the review. The workshops looked at the appropriateness of current targets, the application of the WSUD Code, the degree of flexibility of current mandated measures and the costs of compliance with the code at various scales.

The 324 respondents completing the survey included home owners, consultants, water industry practitioners, engineers and architects. Survey results indicated overall support for WSUD with many comments relating to detailed aspects of the code. Comments that stood out included: checking compliance with the code; unnecessary mandatory requirement for rainwater tanks, especially on smaller blocks; lack of guidance for using the MUSIC model[19] in the ACT and duplication of code requirements.

19 Model for Urban Stormwater Improvement Conceptualisation.

6. Issues and recommendations

This report is the response to the government's commitment to inquire into and report on WSUD regulation. The report considers 16 issues raised during the review and proposes a number of actions and recommendations with the focus to significantly expanding the acceptable mandated measures to achieve the 40% targets, and providing maximum flexibility to developers to lower development costs.

Public consultation, the ACT Government WSUD Working Group and the Technical Panel helped identify these issues. Analysis of recent water quality issues in Canberra's lakes, the question on impacts on housing affordability, whole-of-life costs and the environmental, social and economic issues of poor WSUD management reinforced the need for the ACT to review the current nature of WSUD regulation.

While this report focuses on the issues of WSUD, it must be remembered that WSUD has social, environmental, and economic and climate change benefits. This is explored to some degree in the report using best practice examples from the ACT, Australia and overseas.

A number of issues were categorised into themes:

- current application of WSUD in the ACT compared to a changing environment (Theme 1)
- housing affordability (Theme 2)
- coordination and compliance of WSUD in the building and development phase (Theme 3)
- sustainable maintenance of WSUD assets (Theme 4).

The issues were consulted on and evidence and information gathered to establish the actions and recommendations needed to be carried out following the review.

The following discussion around the issues is structured as follows. Each issue is supported with context and most are also supported by boxes that explain the issue. The boxes have the following hierarchy:

- Grey boxes provide an explanation of the issue within the Territory context. They are described as example boxes, which present a basic summary of the issue. They also provide supporting evidence collated from the working group and technical panel.
- Blue boxes provide case studies, including case studies from the literature review and the technical panel. These boxes also provide evidence to support the issue.
- Orange boxes provide best practice examples, including examples from the literature and the technical panel. These boxes provide alternative solutions to resolve the issue.
- Green boxes provide feedback from the public consultation.

Theme 1. Current application of WSUD in the ACT compared to a changing environment

Current codes, design standards and development guidelines

Issue 1: Currency of the WSUD Code and promoting innovation

The object of the Territory Plan, made under the *Planning and Development Act 2007*, is:

> *'ensure, in a manner not inconsistent with the National Capital Plan, the planning and development of the ACT provide the people of the ACT with an attractive, safe and efficient environment in which to live, work and have their recreation.'*

The Territory Plan, through the statement of strategic direction, provides a policy framework for the administration of planning in the Territory. To give effect to these directions, the Territory Plan contains a series of objectives and development tables for each land use zone, supported by general, development and precinct codes. Each zone has its own objectives setting out the principles intended to be achieved in applying the relevant development tables and codes.

WSUD guidelines were released in 2007 and given further effect as part of the Territory Plan by the establishment of the Waterways: Water Sensitive Urban Design (WSUD) Code (WSUD Code or code) in 2009. The guideline and subsequent WSUD Code were seen as a way of contributing to potable water reduction targets and to manage stormwater quality and quantity against specific targets in order to meet the objectives of the Territory Plan and ACT Government water conservation policy.

The WSUD guidelines were codified following consultation with government and industry to reduce complexity in applying WSUD requirements. In doing so, the WSUD Code was brought into the Territory Plan with minimal change from its original guideline format. Rules state explicit quantifiable requirements to meet targets, whereas criteria leave the discretion to the applicant to demonstrate that a particular method achieves the target.

WSUD requirements were subsequently reflected in specific development codes for different types of development, including residential, multi-unit, commercial and estate developments. Proposals in the 'code track' must comply with all rules under the set out in development codes. Proposals in the 'merit track' have the option to comply with rules or criteria, unless the rule is mandatory.

The current structure of the WSUD rules and criteria in the development codes requires refinement to better articulate the differences between rules and criteria, where rules are explicit requirements and criteria outline the options the proponent can undertake if they cannot meet the rule or would like to be innovative in their approach to meeting targets. For example, many rules in the development codes do not have a corresponding criteria to allow merit consideration of proposals.

Given the presence of specific rules and criteria in development codes, the usefulness of the current WSUD code is diminished. Its value is then as a practice guideline to the appropriate application of the codified requirements and as a guide to how WSUD principles can be applied to development in the ACT. The practice guideline would also accommodate current information of water quality and stormwater modelling at the appropriate scale. There is also a need to review the WSUD Code requirements across the development codes to ensure consistency in language and application.

There is a trend towards reduced block sizes, larger building envelopes and reduced streetscape provision. This is evident in the move to include 'compact blocks' as part of Territory Plan Variation 306 and the encouragement of secondary dwellings/residences (granny flats). Increase in impervious areas creates fewer opportunities on-block to incorporate WSUD measures, reducing opportunities to mimic natural flow processes. It suggests the WSUD Code could be more responsive to changes in residential development form, which would require adaptation of the urban form in terms of green streetscape, waterway corridors and communal spaces.

Under Territory Plan Variation 2013-12 to the Territory Plan, secondary residences (also referred to as 'granny flats') are not classified as multi-unit development and will need to comply with the WSUD requirements set out in the Residential Zone Development Code and not the Multi-unit Development Code. With these secondary residences, the ACT Government recognises the need to accommodate changes in lifestyle and the Territory's

ageing demographic. Accordingly, identifying alternative and flexible WSUD measures at neighbourhood level that meet multiple objectives such as social, environmental and economic benefits will be important.

There is a need to have an adaptable and comprehensive WSUD practice guideline to assist proponents and assessors in the changing environment. Blacktown City Council has such a guideline.

BEST PRACTICE in guidelines: Blacktown City Council

Blacktown City Council has produced the Developer Handbook for Water Sensitive Urban Design.[20] The handbook is an instrument to support the Council's Integrated Water Cycle Management Development Control Plan. The NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) requires councils to develop local environmental plans (LEP) to guide planning decisions for local government areas. The EP&A Act also requires councils to develop development control plans, which apply to specific development on areas of land and provide detailed development guidelines and controls. This is similar to the general, development and precinct codes in the ACT.

The developer handbook assists developers and includes:

- issues to be considered when assessing the natural attributes of a site
- advice on selection of the typical treatment measures for potable water conservation, stormwater quality and waterway stability
- examples of how treatment measures can be integrated into streetscapes
- guidance on MUSIC modelling
- an indicative plant list for treatment areas for the Blacktown LGA.

The handbook bridges the gap between the planning requirements that exist in codes and regulations and the design requirements from design standards. The handbook is supplemented by a series of well-designed information sheets that provide specific detailed information of particular WSUD aspects, such as vegetated swales and buffer strips, streetscape system or bio-retention systems. This package of information provides very precise specification about the standards of design that are acceptable.

Findings

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

Recommendations

1.1) Carry out a revision of the water sensitive urban design provisions in the Territory Plan, supported by a practice guideline.

1.2) The new practice guideline should be supported by a suite of community education and awareness tools.

20 Blacktown City Council (2013), *Developer Handbook for Water Sensitive Urban Design*, Retrieved from: < www.blacktown.nsw.gov.au/.../Developer_Handbook_for_WSUD.pdf>

Issue 2: Design standards for urban infrastructure

Territory and Municipal Services Directorate (TAMS) is responsible for the Territory's Design Standards for Urban Infrastructure, a number of which are relevant to WSUD. TAMS is conducting a review of these standards. There is an opportunity to strengthen WSUD principles in these standards.

While progress with the review of these standards is dependent on resourcing, TAMS is giving priority to reviewing DS01 Stormwater Infrastructure, which was last updated in 2002 and contains a number of objectives for stormwater design principles and standards relevant to WSUD. Consultants have also been engaged to review two other design standards relevant to this review:

- DS14 Urban Open Space (currently underway – a draft design standard has been prepared to include comments from an across ACT Government workshop)
- DS22 Soft Landscape Design (TAMS consultation has commenced).

Other relevant design standards where a review has been identified as urgent, but no resources are available to address, are:

- DS16 Urban Wetlands and Ponds
- DS17 Shopping Centres and other public urban spaces
- DS20 Urban Edge Management Zones

DS01 (Stormwater Infrastructure) also needs to be updated to reflect technological advances, climate change impacts and maintenance requirements in a budget constrained context. Dated design standards could potentially impose additional costs on the Territory as older technology continues to be employed at the expense of more contemporary, effective designs. Dated standards will also inhibit innovation in WSUD applications in estate development or other public works projects where TAMS will be hesitant to accept designs outside the scope of the standard.

Strategic approaches to stormwater management

Other jurisdictions have undertaken a strategic approach to stormwater management through a regional strategy or a framework that has then informed their design standards at the ground level. At present, the ACT does not have such a comprehensive approach, although the proposed catchment management master plan to be prepared as part of the ACT Basin Priority Project as well as the audit of WSUD infrastructure and enhanced monitoring program will inform future strategic approaches to stormwater infrastructure development and management.

BEST PRACTICE in strategic regional stormwater management planning: Northern Tasmania

The regional stormwater management planning for Tamar Estuary and Esk Rivers Catchment[21] engaged a stormwater officer to coordinate and progress stormwater management in the northern Tasmanian Natural Resource Management (NRM) region. The need was identified for a regional stormwater management plan to inform the six local government councils in the region of their individual stormwater management plans. This will ensure the individual plans complement the regional strategy and, more importantly, that actions within jurisdictions will not adversely impact neighbouring jurisdictions.

The stormwater officer also has enforcement powers. The councils sharing this regional officer believe this has imposed consistency across the region. Application of consistency was important because the area was experiencing slow growth and therefore many planning requirements were not properly imposed on developers as councils did not want to impose extra costs. Consistency also helps educate developers. To date, the Tamar Estuary and Esk Rivers Catchment program has provided strategic direction for the northern Tasmania stormwater program, which has enabled the development of priority projects to be carried out including:

- stormwater training program for councils and industry
- collating existing, and collecting new, stormwater mapping data
- stormwater monitoring
- stormwater management planning.

21 NRM North (2014). Northern Tasmanian Stormwater Program <http://www.nrmnorth.org.au/teer-stormwater> and Mcarthur, J (2013), 'Developing a catchment wide WSUD implementation strategy – decision support tool' at the *8th International Water Sensitive Urban Design Conference 2013.*

BEST PRACTICE in contemporary stormwater management planning: *Blueprint2013*

A significant resource for guidance in contemporary WSUD practice in Australia is the CRC for Water Sensitive Cities based in Melbourne, which has developed a shared vision for WSUD around Australia based on solid research.

Blueprint2013[22], the third of this kind, is an evolving document articulating that through a holistic approach to the management of urban stormwater, Australian cities can transition to 'Water Sensitive Cities'.

The notion of the water sensitive city consists of cumulative socio-political drivers that incorporate intergeneration equity and resilience to climate change. Its service delivery function must be adaptive, multi-functional infrastructure and urban design reinforcing water sensitive behaviours.

The purpose of Blueprint2013 is to foster discussion and innovation in harnessing the potential of stormwater to overcome water shortages, reduce urban temperature and improve waterway health and the landscape of Australian cities in their transformation into water sensitive cities.

Blueprint2013 suggest stormwater management needs an overarching vision in order to be a water sensitive city. Blueprint2013 is structured around three pillars:

- Cities as water supply catchments – meaning access to a range of different water sources at a diversity of supply scales.
- Cities providing ecosystem services – meaning the built environment supplements and supports the functions of the natural environment.
- Cities comprising water sensitive communities – meaning socio-political capital for sustainability exists and citizens' decision-making and behaviour are water sensitive.

Blueprint2013 provides a number of principles and initiatives under each pillar that guide the management of urban stormwater and the integration of appropriate management technologies into Australian urban design practice in the planning of urban development and redevelopments. Blueprint2013 is a useful tool that is adaptable to the appropriate scale whether it is at a precinct, local government or state government level. It provides guidance on urban water policies for cities of the future and complements the various planning strategies in major metropolitan areas, such as the Melbourne Metropolitan Planning Strategy (May 2013), Brisbane's WaterSmart Strategy and Sydney's Draft Metropolitan Strategy for 2030 (2013).

Blueprint2013 is an industry benchmarking guideline that is continuously looking at cities of the future and making them water sensitive cities. Contemporary research in integrated urban water cycle management has highlighted that a water sensitive city will involve significant departures from conventional urban water management approaches and that the transformation of cities will require a major socio-technical overhaul of conventional approaches.

Findings

- WSUD related design standards for urban infrastructure in the ACT are in need of review. A review has commenced and the highest priority design standards are being addressed.
- There is an opportunity to consider the merits and challenges associated with the development of WSUD asset specific design standards to accommodate technological advances.
- Other jurisdictions have adopted strategic approaches to stormwater management at a regional level which has informed development of localised standards.
- The ACT Basin Priority Project audit of stormwater infrastructure, detailed monitoring and the development of a catchment management master plan will inform future work on design standards.

Recommendations

2.1) Review and update WSUD related design standards to reflect contemporary best practice in an ACT context.

22 Wong T.H.F., Allen R., Brown R.R., Deletić A., Gangadharan L., Gernjak W., Jakob C., Johnstone P., Reeder M., Tapper N., Vietz, G. and Walsh C.J. (2013) blueprint2013 – *Stormwater Management in a Water Sensitive City*. Melbourne,.

Issue 3: The application of the Water Use and Catchment Code

The current Water Use and Catchment Code (water use code) became effective on 17 April 2009. Its purpose is to identify waters of the ACT in terms of the permitted water uses and environmental values and to identify the water quality and streamflow criteria related to the full protection of these uses and values. To facilitate the management of the Territory's water resources and to ensure integrated land and water planning and management, the development of policies has been undertaken in a total catchment context.

Waters of the ACT and their catchment have been classified in three water use catchment categories:

- Conservation
- Water supply
- Drainage and open space

To support the objectives of the water use catchment categories a number of policies are codified within the water use code.

The water use code, as detailed in its introduction below, drives many policies, guides, targets, licences, authorisations, regulatory limits and management plans.

'The purpose of this code is to identify waters of the Australian Capital Territory in terms of the permitted water uses and environmental values, and to identify the water quality and streamflow criteria related to the full protection of these uses and values.

To facilitate the management of the Territory's water resources, and to ensure integrated land and water planning and management, the development of policies has been undertaken in a total catchment context. Waters of the ACT and their catchments have been classified into three Water Use Catchments (as specified above).

The classification of the catchment relates to the predominant water use or environmental value within that catchment. The mechanisms for ensuring that the principles relating to each of these catchments are implemented will generally be one of:

- *the identification of appropriate provisions in the relevant land use policies in the Territory Plan*
- *the issue of licences to discharge to streams or to divert or abstract water for use or to undertake activities on or in waters*
- *the preparation of management plans by the relevant authority responsible for the land management and the preparation of water-sharing plans by the relevant authority responsible for administration of the Territory's water resources.*

These licences or plans must not be inconsistent with either the Territory Plan or the National Capital Plan.'

The example below describes the issue of the application of the water use code for the Environment Protection Authority.

EXAMPLE of the issue with the application of the Water Use and Catchment Code

The designations in the water use code have implications for legislation in the ACT including the *Environment Protection Act 1997* (ACT), in particular relating to Schedule 3 (Pollutants entering waterways taken to cause environmental harm), and the Environment Protection Regulations 2005 for Schedule 4 (Ambient environmental standards). However the issue relates to incorrect designations of catchments because land uses have changed. For example, the Molonglo River downstream of Lake Burley Griffin is classified as being in a Conservation Catchment; however the extensive urbanisation occurring in the Molonglo Valley will mean the aspirations associated with a Conservation Catchment are not achievable. The water use code should be updated to reflect actual land use.

The other issue relates to the authorisation of activities within these catchments, which must refer to the water use code in order to set conditions and ensure consistency is being achieved in the values of the relevant catchment category. Setting the conditions to achieve the values of certain catchments is almost unachievable.

For the *Water Resources Act 2007* (ACT), the water use code influences the water sharing plan, environmental flow guidelines and conditions when issuing licences. Other management instruments such as the Lakes and Ponds Plan of Management (2001) and the ACT Guidelines for Recreational Water Quality (2010) take direction from this code.

The water use code requires updating, in particular to catchment designations to reflect changes to land use. Also greater articulation about uses and community and stakeholder values would enable better application of regulatory limits, and drafting of conditions for licences and authorisations.

Input from the Environmental Protection Authority, 2014

Findings

- The water use code requires review to better reflect the catchment specific requirements and the changing nature of our catchments due to development and community and stakeholder values.
- The catchment categories are no longer applicable to certain areas within the ACT. Data for those areas is consequently perceived as negative due to the incorrect designation of the catchment making it difficult to comply with the water use code. For example, when land uses in a catchment designated as conservation change, they can no longer achieve the conservation targets.
- The water use code is generally poorly referenced in other codes and its objectives are poorly articulated, generally limiting its application.

Recommendations

3.1) Review the water use code and include catchment specific requirements for water quality flows etc. that accommodate land use changes and community and stakeholders expectations.

Issue 4: Estate development plan guidelines

The Guidelines for the Preparation of Estate Development Plans (May 2009) apply to all proposals for land subdivision which require an estate development plan (EDP) as defined by the Territory Plan and Section 94 of the *Planning and Development Act 2007* (ACT). The guideline outlines:

- the pre-application processes and timelines for the planning and land authority and entity consultation and endorsement
- the minimum information/documentation that must be included when preparing an EDP submission.

A WSUD outcomes plan is required to illustrate proposed WSUD outcomes in accordance with the WSUD Code as part of the minimum documentation provided when preparing the EDP submission. The WSUD outcomes plan must include:

- the location and types of proposed water quality measures such as filter strips, bio-swales, constructed waterways, retarding basins, on-site retention/detention proposed to meet water quality targets
- the means of achieving a 40% reduction in mains water use
- any stormwater reuse opportunities and initiatives.

The Water Sensitive Urban Design Estate Development Checklist must be completed as included at Appendix A in the Waterways: WSUD Code.

The requirements for a WSUD outcomes plan are brief and the plans received by the Territory vary in information and quality. It is important to receive information that is of high quality that does not compromise flexibility and innovation. There is an opportunity to update the guidelines to articulate better WSUD requirements for proponents without compromising best practice, flexibility or innovation.

The example below highlights the issue of the estate development guidelines process relating to WSUD.

EXAMPLE of the estate development plan guidelines process for WSUD

The Guidelines for the Preparation of Estate Development Plans (May 2009) requires a WSUD outcomes plan which is essentially the template form from the WSUD Code plus a plan showing the location of WSUD infrastructure. It is important to articulate better requirements. The WSUD estate development checklist in the WSUD Code is similar to Issue 1. The codification of the checklist and the structure of the checklist are onerous. In its present form, the checklist is described as clunky and needs to be simplified.

Input from Technical Panel

Findings

- WSUD outcomes plans received by the Territory for estate developments vary in information and quality.
- The estate development plan guidelines process for WSUD needs to be revised to articulate better WSUD requirements for proponents.

Recommendations

4.1) Review the WSUD component of the estate development plan guidelines to ensure they reflect best practice.

Application of WSUD to a changing climate and environment

Issue 5: Expanding the range of acceptable on-site options for stormwater retention and detention

The development, general and precinct codes require some form of WSUD consideration relating to stormwater retention and stormwater detention. The WSUD Code describes on-site detention (OSD) as:

> *'the temporary storage and controlled released of stormwater runoff generated within a block and is generally required on redevelopment sites to ensure the capacity of 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. Storages can be either underground (typically tanks) or surfaced storage, such as landscape areas, carparks or other paved areas.'*

On-site retention is described as:

> *'holds stormwater on a site with runoff typically draining at low flow rates into soils or away from the site over a period of one day or longer. This allows a significant portion of runoff to dissipate through natural processes such as infiltration, evaporation and transpiration. However, the natural clay soils in the ACT are not conducive to infiltration. Consequently, a small outlet is often installed in storages to slowly discharge stored water into the local drainage system. Rainwater tanks are a form of on-site retention that capture roof runoff in frequent storms and reduce the rate and volume of stormwater runoff from a site.'*

Rainwater tanks and central tanks are often the choice of WSUD infrastructure for on-site detention and on-site retention. Rainwater tanks have additional benefits as they collect rainwater, which can reduce the use of mains water use/reduce water consumption, have stormwater retention benefits and provide water for garden watering. Rainwater tanks also support the government's objective of a 40% reduction in water usage in new developments and refurbishments/extensions (compared with 2003 levels).

The Little Stringybark Creek best practice example in Issue 12 highlights how the design of rainwater tanks can help to mimic natural flow processes by retaining rainwater and using dripper hoses to constantly disperse water slowly into an adjacent garden or lawn area, helping to restore water into the sub soils. However, while it is a requirement to connect all external taps to rainwater tanks, the use of rainwater for infiltration and improving soil moisture is not widely promoted.

The following examples explain how rainwater tanks and central water tanks are sometimes seen as the only acceptable options for stormwater retention and detention, especially for single dwelling and multi-unit housing development.

EXAMPLE of issue for flexible options for stormwater retention in single dwellings

Mid-sized blocks must take into consideration s. 6.1 of the Single Dwelling Housing Development Code which states the following rule and criteria:

'***Rule R43 b)*** *on mid-sized blocks -*

i) minimum on-site water storage of water from roof harvesting is 2,000 litres

ii) 50% or 75 m^2 of roof plan area, whichever is the lesser, is connected to the tank and the tank is connected to at least a toilet, laundry cold water and all external taps.'

The criteria for the mid-sized block:

> ***Criteria C43:*** *Evidence is provided that the development achieves a minimum 40% reduction in mains water consumption compared to an equivalent development constructed in 2003, using the ACTPLA on-line assessment tool or another tool. The 40% target is met without any reliance on landscaping measures to reduce consumption.*

Criteria C43 **-** Option B for mid-sized blocks states:

> *'A greywater system captures all bathroom and laundry greywater and treats it to Class A standard. The treated greywater is connected to all laundry cold water, toilet flushing and all external taps.*

For this rule minor extension means an extension where the increase in the combined roof plan area, driveway, car manoeuvring areas and car parking areas is less than 25% of the total of the areas of these components at the date of lodgement of the development application or building application, whichever is earlier.'

It is incorrectly assumed by proponents that blocks that are greater than 250 m^2 (previously greater than 300 m^2) require a rainwater tank. As shown above the rule states that a minimum on-site storage is required. It does not specifically state that a 'rainwater tank' is required. The criteria suggests that for all new dwellings, the development must achieve a minimum 40% reduction in mains water consumption compared to an equivalent development constructed in 2003. In order to achieve the minimum 40% reduction, proponents often opt to install a rainwater tank as the easiest option. This option has been perceived as the rule when developing blocks of greater than 250 m^2 or seen as the easiest option to meet the 40% reduction. This has impeded innovation.

The perception that developments require 'rainwater tanks' may relate to the wording which states that the water storage *'is connected to the tank and is connected to at least a toilet, laundry cold water and all external taps'*. The references to 'on-site water storage' and to 'tank' are deceptive as it makes proponents believe they must install a rainwater tank. There are other alternatives to rainwater tanks and grey water systems on the market that provide innovative technologies.

The rule regarding a minimum *** WELS rating is also mentioned in the WSUD Code and therefore duplicates this rule.

The community consultation WSUD survey highlighted that of 160 people who responded to whether they installed a grey water system, 20 people responded that they had.

EXAMPLE of issue for flexible options for stormwater retention in multi-unit housing development

Under s. 8.1 of the Multi-unit Housing Development Code, the rules and criteria relating to WSUD for multi-unit development on blocks greater than 2000 m^2 states:

*'**Rule R87**: This rule applies to all multi-unit housing except minor extensions. On sites larger than 2,000 m^2 stormwater management measures comply with all of the following:*

a) provision for the retention of stormwater on the block is equivalent to at least 1.4 kl per 100 m^2 of impervious area

b) the retained stormwater complies with one or more of the following -

i) it is stored for later reuse

ii) it is released to the stormwater system over a period of not less than 1 day. Rainwater tanks connected to at least the toilet and all external taps may be counted towards this requirement.

***Criteria C87:** On sites larger than 2,000 m^2 all of the following stormwater management measures are achieved:*

a) the equivalent of 1-in-3 month stormwater peak pre-development stormwater run-off is retained on the block

b) the retained stormwater complies with one or more of the following -

i) it is stored for later reuse

ii) it is released to the stormwater system over a reasonable period.

Compliance with this criterion is demonstrated by a report by a suitably qualified person.'

The WSUD Code states that storages for multi-unit housing can contain surface storage such as landscaped areas, car parks or other paved areas. The WSUD Code design checklist for multi-residential unit development states that washing machine and dishwashers are optional appliances that can be used in the calculations for mains water use. However, central water tanks are often the choice of on-site detention and connection to appliances is often selected to comply and subsequently impacts on innovation. It is also described as the last resort option because WSUD requirements are not considered until the end of the design scoping phase. A possible explanation for this is due to the checklist style format for development applications which lists WSUD requirements towards the end of the checklist.

PUBLIC CONSULTATION: Flexible options for stormwater retention and detention

During the public consultation process a number of comments looked at flexible options for stormwater retention and detention, a proponent stated:

> *'The usual methodologies we consider for water savings in multi-unit residential are either water reuse (which requires multiple plumbing systems and is prohibitively costly) and/or the provision of water saving appliances such as washing machines. Washing machines are ordinarily not provided but are less costly than water reuse so are preferred. However, we receive multiple requests to delete the washing machine as downsizers and investors do not require washing machines - they or their tenants provide their own. We are concerned this produces huge wastage in the appliances, whether new appliances or old appliances are discarded before the end of their economic life.'*

Another proponent stated:

> *'We have undertaken development applications for large (greater than 60 ha) land developments for new suburbs. With this several multi-unit and large commercial/community blocks are created. WSUD is provided for the whole estate/suburb yet the individual codes for multi-units, commercial and community facilities requires these blocks to also provide WSUD. This becomes a large cost impost on them particularly the stormwater retention component. These codes need to be amended to recognise that in new estates/ suburbs a holistic approach has been adopted across the entire estate.'*

Public consultation statement from member of the public:

> *'Broadly, the code is reasonable and requirements are typically in line with other jurisdictions...*
> *We need to consider how to address detention requirements for smaller scale blocks. In new estate developments, it is likely more practical to have single basin that can provide detention for upstream blocks. However, if the upstream blocks are multi-unit dwellings over 2000 m2, then the developer also has to provide on block detention - this leads to overservicing and provision of unnecessary basins.'*

EXAMPLE of issue for flexible options for stormwater retention

The ACT Government's requirement in the Single Dwelling Housing Development Code for mid-sized blocks and up specifies a percentage or square metre consideration when it comes to on-site water storage. It is suggested that having a requirement of a minimum on-site water storage based on a fixed percentage or square metre figure adds to the rigidness of the code and furthermore has other environmental and economic impacts. For example, the ACT Government specifying a need for a minimum of 2,000 litres on-site storage means that economically this is pre-empting and pre-determining this market through economies of scale. Codifying that figure has not been proven to have better environmental impacts. It is important to consider a flexible calculation to consider the real tank size required for that roof plan area as described in the Blacktown City Council best practice for this issue below.

Input technical panel

The marketplace contains alternative options to rainwater tanks and stormwater detention as explained below.

BEST PRACTICE for expanding the options of stormwater retention and detention

Technological advancement has meant stormwater retention systems have come a long way from metal or plastic rainwater tanks. The marketplace now offers consumers options for high strength, modular stormwater infiltration or storage tanks. Hidden tank liners, which use the building to provide the structure, is another option. Or alternatively, systems offer cavity-like structures. The systems are more evolved than the average rainwater tanks and provide other environmental alternatives.

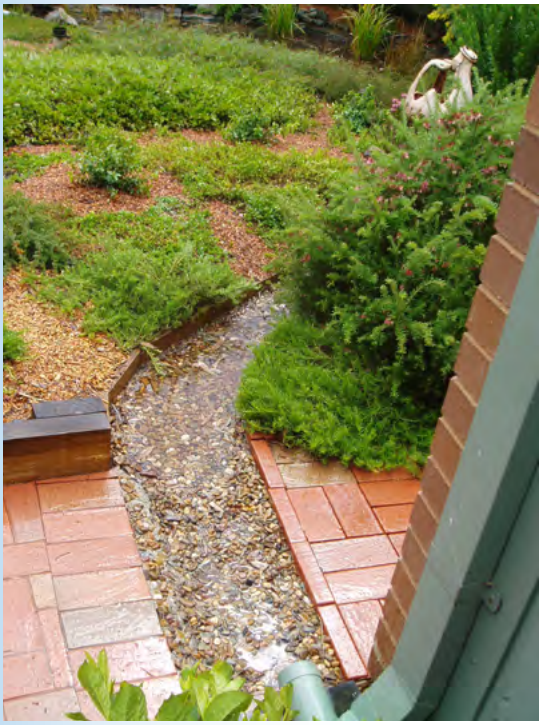
Stormwater detention systems have also advanced for multi-unit housing development as opposed to the standard central water tank. The WSUD Code outlines that on-site detention can encompass surface storage such as landscaped areas, car parks or other paved areas and it does not solely depend on central water tanks.

Blacktown City Council[23] has developed a sizing curve for rainwater tanks that has been developed for residential and commercial developments. The formula is based on the size of the roof area of 100 m^2; however if it is outside this range it is scaled. If the roof area needs to be scaled, the water demand must also be reduced by the scaling factor to reflect the water demand of an industry/commercial development with a roof area of 100 m^2. An appropriate tank size to achieve a given demand efficiency can be read from the sizing curve. The tank size is then multiplied by the scale factor to give the real tank size required.

Lawrence Residence: Backyard pond and swale, ACT

BEST PRACTICE of the application of WSUD approach at the residential block level: ACT

The need to replace the 30 year old fencing around their block in 2000 provided Ian and Helen Lawrence[24] with an opportunity to change their 'cottage garden' to a 'waterwise – water sensitive urban design based garden'. They removed their lawn and impervious driveway and pavement around their house, replacing the grass with native shrubs, groundcovers, trees and mulch, and the impervious pavements with open pavers or gravel pavers.



Lawrence Residence: Downpipe and swale, ACT

Several rainwater tanks were installed, and roof downpipes were disconnected from the stormwater and connected to the rainwater tanks. The tanks are connected to garden dripper irrigation lines via a pump and automatic garden watering controller. Garden watering is supplemented by grey water when rainwater storage is depleted over extended dry periods.

A total of 220 m length of swales (shallow drains, lined with geofabric and gravel) were installed to collect surface runoff and overflow from rainwater tanks, providing detention of stormwater and promoting infiltration into the soil. The swales feed to a 16 m^2 extended detention pond at the lower corner of the block, providing a major landscape feature, and further detention of stormwater prior to discharge to the public stormwater drain on the block boundary.

The changes to the garden, together with installation of waterwise appliances within the house, have yielded a 70% reduction in town mains water use, a 90% reduction in the peak 1 in 3 year stormwater discharge rate, and a 60% increase in rainwater infiltration into soils across the block.

23 Blacktown City Council (2013), *Developer Handbook for Water Sensitive Urban Design*, Retrieved from: < www.blacktown.nsw.gov.au/.../Developer_Handbook_for_WSUD.pdf>

24 I. Lawrence, personal communication, 24 February 2014.

Education and community awareness are important in making people realise the benefits of stormwater retention and detention. This includes making the community aware of the wider environmental, economic and social benefits to WSUD than reduction in mains water use and water efficiency. Beneficial environmental impacts include improved water quality from our urban catchments.

Providing formulas rather than dictating a percentage or square metre figure in relation to tank sizes could be considered in expanding our acceptable mandated measures. The changing residential development form and smaller blocks may mean we need to look at economies of scale of the block and roof plan compared to the neighbourhood and its sub-catchment. Providing flexible options is important in achieving a good environmental, social and economic outcome.

Findings

- The current wording in the WSUD Code and the development codes implies that rainwater tanks or central tanks are the only or the simplest approved option for on-site stormwater retention and detention.
- Other jurisdictions are working with formulas that provide flexibility in the options they choose for WSUD. These formulas can be applied at the block level or considered in an integrated approach.
- Education and community awareness is needed to inform the community of the consumer choices and the benefits of WSUD, including about rainwater tanks or other detention and retention options.

Recommendations

5.1) The rules and criteria for on-site retention and on-site detention be revisited as part of the Territory Plan amendment package.

5.2) The proposed new WSUD guideline should clearly articulate the best practice and contemporary design principles which will encourage cost-effective innovation.

5.3) Investigate options of formulating requirements at different development scales, including at the neighbourhood scale.

Issue 6: The relationship of WSUD to climate change including stormwater and flood management

The WSUD Code reflects a desire provide a more sustainable approach to the management of the total water cycle within the urban environment. This is achieved by a range of measures aimed at:

- *'minimising disruption to natural drainage pathways (e.g. retention of native vegetation, mulched pervious areas, dispersed overland flow paths, vegetated natural waterways, wetlands and floodplains)*
- *minimising impervious areas and enhancing the permeability of remaining pervious areas (e.g. mulching, protection from vehicle compaction)*
- *reducing the hydraulic connectivity of the stormwater system by the use of swales, vegetated waterways, wetlands and ponds rather than pipes and lined channels*
- *offsetting the impacts of development by incorporating retention capacity (e.g. infiltration, rainwater tanks, swales, wetlands, ponds and retarding basins)*
- *minimising water requirements and reducing stormwater runoff by adopting landscaping strategies (e.g. mulching, reduce lawn areas, water efficient lawns, ponds and gardens)*
- *conserving water by installing water efficient fixtures and appliances*
- *harvesting rainwater with storage in rainwater tanks (or other storage devices) for internal (e.g. toilet flushing, washing machines) and external (garden irrigation) use*
- *use of greywater and treated effluent for non-potable purposes.'*

While the WSUD Code was a pioneer in identifying the importance of managing water quality and stormwater flows in ways that reflect the total water cycle, WSUD is silent on the significant issue of climate change impacts. WSUD provides significant opportunities for adapting to climate change.

WSUD as a concept continues to evolve. Many jurisdictions are adopting a total water cycle management framework (TWCM) or integrated water cycle management (ICWM) which are similar concepts that focus more on the social and environmental aspects of water management.[25] ICWM also recognises that every decision with water will influence the entire water cycle. ICWM focuses on solutions that involve every relevant aspect of the water cycle instead of focusing on one facet, such as the reduction of water use.[26] ICWM recognised there are complex linkages between the different elements of the urban water cycle (water supply, sewage and stormwater) that need to be addressed to ensure cost effective and efficient water management.[27]

The stormwater quality intent in the WSUD Code states it is:

> *'To provide water quality management systems which ensure that disturbance to natural stream systems is minimised, and stormwater discharge to surface and underground receiving waters, both during construction and in developed catchments, does not degrade the quality of water in the receiving domains.'*

It sets a number of performance targets for stormwater quality management. These targets must be met for all developments greater than 2000 m^2 (p.26):

Targets for stormwater quality management

	Development or redevelopment sites	Regional or catchment-wide
Reduction in average annual suspended solids (SS) export load	60%	85%
Reduction in average annual total phosphorous (TP) export load	45%	70%
Reduction in average annual total nitrogen (TN) export load	40%	60%

Many jurisdictions also include a gross pollutant target or litter target of 90% removal.

25 Sponsor, O. S. (2012). *Assessing Boroondara's Water Use and Stormwater Quality*. (Doctoral dissertation). Retrieved from: <https://www.wpi.edu/Pubs/E-project/Available/E-project-022912-210006/unrestricted/Assessing_Boroondaras_Water_Use_and_Stormwater_Quality.pdf>.
26 Ibid.
27 Office of Water (2014), *Integrated Water Cycle Management*. Retrieved from: <http://www.water.nsw.gov.au/Urban-water/Country-Towns-Program/Best-practice-management/Integrated-Water-Cycle-Management/default.aspx>.

The stormwater quantity intent of the WSUD Code states that the intent is:

> *'To provide minor and major drainage systems which: adequately protect people and the natural and built environments at an acceptable level of risk and in a cost-effective manner, in terms of initial cost and maintenance; and contribute positively to environmental enhancement of catchment areas.'*

Stormwater quantity also has performance targets (p. 38):

Performance targets for stormwater quantity

Stormwater quantity	Target
Reduction of runoff peak flow to no more than the pre-development levels and release captured flow over a period of 1 to 3 days	3 month ARI*
Reduction of peak flows to pre-development levels	5 year to 100 year ARI

*Average Recurrence Interval (ARI)

In achieving the stormwater quantity intent, the WSUD Code suggests developers consider a stormwater system designed to have the capacity to control flows up to the relevant design flood and that the capacity of downstream stormwater systems is not exceeded.

The review has observed that the WSUD Code in this context applies well to estate development, but presents challenges when applied to other types of broad acre development (e.g. Stromlo Forest Park master planning) or because of the local context (e.g. Kenny Planning and Design Framework).

Flood hazard and management through flood protection and mitigation is also a focus of the WSUD Code and should remain as a focal planning principle when considering any land development. However, industry experts suggest that WSUD assets are designed for mitigation of peak flow of up to 1 in 20 Average Recurrence Interval. Any further flood risk management is required in a strategic flood management framework and is outside the scope of WSUD.

With the announcement of the ACT Basin Priority Project the opportunity provided by enhanced monitoring and modelling capability presents an opportunity to consider the development of sub-catchment or area specific targets that reflect the specific sub-catchment characteristics in setting achievable targets levels. This would allow for the appropriate design of WSUD infrastructure to meet sub-catchment needs rather than general requirements.

Similarly, more intensive flood studies of our urban streams now underway will provide a clearer understanding of flood risks and need to be considered in any review of stormwater quantity targets. Our understanding of the relationship between water quality measured in terms of total load and its relationship to flows is increasing and needs to be considered in a review of these targets.

The following example highlights the issue with stormwater quantity targets.

EXAMPLE of issue with current stormwater quantity target

The current stormwater quantity management targets correspond to the understanding of urban water systems as it was nearly a decade ago. It is important to note that more recent guidelines and approach seek to translate to Australia the long established rationale in the USA for Total Maximum Daily Limits, which take into account some of the environmental vulnerability to short term shocks that would not be captured in annual load considerations.

The current stormwater quantity management targets correspond to the understanding of urban water systems as it was nearly a decade ago. It is important to note that more recent guidelines around flow management also point to important new potential objectives such as number of flow days which represent a capture of the ephemerality of streams, particularly in inland Australia. Another parameter is the Stream Erosion Index proposed in Victoria and NSW.[28]

Input Technical Panel

28 Source: Draft MUSIC guidelines for NSW available from http://www.wsud.org/wp-content/uploads/2012/07/Draft-MUSIC-Modelling-Guidelines-31-08-201011.pdf

Urban heat island effect and climate change

The urban heat island effect is an impact of climate change identified by most major cities in Australia, and Melbourne in particular. Increases in average and peak temperatures due to UHI effects have a number of implications for urban centres, including detrimental effects on human comfort in the public spaces, increased costs of energy use in buildings and, subsequently, increasing green house gas emissions and increases in health stress and related mortality rates.[29] The main contributing factors are changes in the characteristics of the urban surface (albedo, thermal capacity and heat conductivity), replacing vegetation with asphalt and concrete and decreasing surface moisture available for evapotranspiration.[30] Urban heat island characteristics usually contain more heat-absorbing materials than surrounding areas.[31]

The City of Sydney is collecting information to see how shade trees and pavement colour affect urban temperatures.[32] It has been identified that cities can be a few degrees warmer than regional areas because surfaces such as roads, footpaths and the sides of buildings absorb and release energy from the sun. The City of Sydney has also installed monitoring systems at Chippendale and Redfern that contain poles with a temperature and humidity meter and a pole containing a pyranometer which measures the strength of the sun. Real time results can be viewed on a website and the Council intends to work with the University of New South Wales to work out costs and benefits of solutions to reduce the urban heat island effect.

The ACT Government's AP2 states that:

> *'climate change is expected to affect our region by making it drier and hotter. Climate change is likely to result in lower than average, less evenly distributed and less predictable rainfall, meaning drier overall conditions but also increased flash flooding. These changes have far-reaching implications for water security, planning, nature conservation, disaster management and human health, which need to be addressed through practical evidence-based policy.'*

WSUD that is considered in a total IWCM framework can help to alleviate some of these impacts.

The urban heat island effect also creates storm-flow temperature surges.[33] Supercell storms have been linked to the urban heat island effect phenomenon.[34] On 27 February 2007, a supercell storm hit Canberra, with hail covering the ground to a depth of 20cm and creating one metre high hail drifts in Civic.[35] The issues it caused included people being stranded, birds being killed by the hail and roofs of several buildings collapsing under the weight of ice.[36] Canberra is surrounded by bushland and rural land; the mixing of the heat from built up urban area and the cooler climates at the boundary can have detrimental consequences as demonstrated by the supercell storm of 2007. It is important to prepare for such events but it is more important to mitigate and ameliorate these events from happening. This is explored in greater detail in the following issue – green infrastructure strategy.

Flood risk planning is currently being reviewed in the Territory. A natural hazards development code that takes flood planning into consideration is being developed. In developing this code and further strategic flood planning management, the following best practice examples from across Australia could be considered. Brisbane City Council and Wagga Wagga City Council have carried out studies to identify their jurisdiction's must vulnerable areas to cope with high intensity rainfall, which is likely to increase with climate change impacts.

The ACT Government has prepared a Ministerial Statement in ACT climate change adaptation. Climate changes will place greater strain on our stormwater system through more frequent and intense storm events. Effectively designed and maintained WSUD infrastructure will be critical in ameliorating these impacts on stormwater flows and protecting water quality.

29 GHD 2012 as cited in Martin, E. and Pitman, S. (2012). *Green Infrastructure – Life support for human habitats*. Department of Environment, Water and natural Resources: Adelaide.

30 Loughnan, M. E. (2009). *Hot Spots Project: Spatial vulnerability to heat events in Melbourne Australia*. Climate School of Geography and Environmental Science Monash University. Retrieved from: <http://soac.fbe.unsw.edu.au/2009/PDF/Loughnan%20Margaret.pdf>.

31 AECOM, (2012). *Economic Assessment of the urban heat island effect – Prepared for the City of Melbourne*. Retrieved from: <https://www.melbourne.vic.gov.au/Sustainability/AdaptingClimateChange/Documents/UHI_Report_AECOM.pdf>.

32 City of Sydney (2014), *Urban Heat Island Effect*. Retrieved from: <http://www.cityofsydney.nsw.gov.au/vision/sustainability/carbon-reduction/urban-heat-island>.

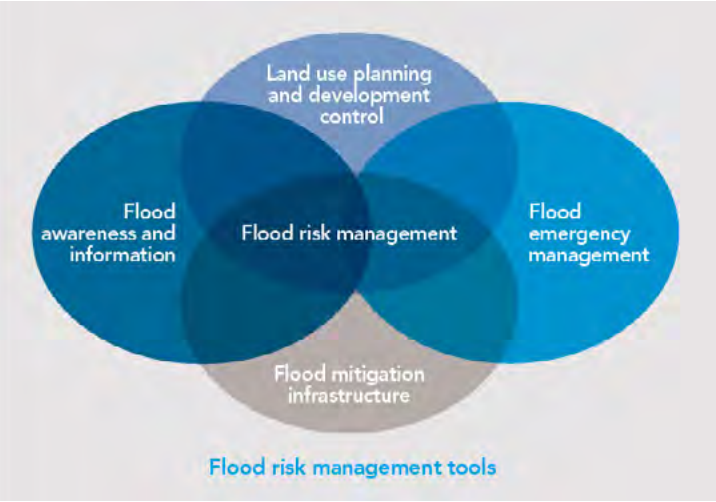
33 Somers, K. A., Bernhardt, E. S., Grace, J. B., Hassett, B. A., Sudduth, E. B., Wang, S., & Urban, D. L. (2013). Streams in the urban heat island: spatial and temporal variability in temperature. *Freshwater Science*, 32(1), 309-326.

34 Bornstein, R., & Lin, Q. (2000). Urban heat islands and summertime convective thunderstorms in Atlanta: three case studies. *Atmospheric Environment*, 34(3), 507-516. A supercell storm is a thunderstorm that is characterised by the presence of a mesocyclone which is a deep and persistently rotating updraft.

35 "Summary of Significant Severe Thunderstorm Events in NSW- 2006/07: 27 February 2007 Severe hailstorm Canberra City". Australian Government: Bureau of Meteorology.

36 Australian National Audit Office, "In the event of a disruption: Activating and deploying the plan", in *Business Continuity Management*. Retrieved from: <http://www.anao.gov.au/betterpracticeguides/section07/sec07page01.html>.

BEST PRACTICE in overflow flood management: BRISBANE (QLD)



Brisbane's Floodsmart Future Strategy 2012-2031[37] was implemented following the devastating 2011 flood in Brisbane. The strategy, endorsed by Brisbane City Council, identifies the need to meet the challenges of the future such as climate change and increasing development, which will require adaptive approaches to flood risk management. As part of the integrated and adaptive strategic approach, Brisbane City Council must consider the implications of a changing climate in all forward planning activities. The third strategic outcome is for smart planning and building which expresses the importance to 'plan now for rising sea levels, bigger storm tides and heavier rainfalls associated with our changing climate'.

An example of flood risk management includes the implementation of backflow prevention devices after identifying 11 stormwater systems vulnerable to flooding. These systems are engineered to reduce the risk of flooding. The importance of this strategy is to prepare and mitigate the impacts of flooding. The Council adopted a risk-based approach to flood management.

BEST PRACTICE in overflow flood management: WAGGA WAGGA (NSW)[38]

The main recognised mechanism for flooding in Wagga is the Murrumbidgee River, although flooding can also be caused by local rainfall. Events in 2010 highlighted that numerous areas, including commercial and residential areas, are liable to flooding following intense rainfall. The Wagga Wagga Major Overland Flow Flood Study identified the major overland flow branches in the study area and looked at climatic vulnerability of sites, including modelling an event of 7% increase in rainfall. The modelling looked at the base flow to high tail water and tested scenarios of where the pipes and drainage systems may become blocked and a number of other factors. The results indicated that in a 1% Annual Exceedance Probability event, there appeared to be reasonable planning controls that would limit the number of household/commercial operations likely to experience over floor flooding. The study identified a number of vulnerable areas and recommended areas for improved design diversion mechanisms or enhancements to the flow capacity into other assets.

Findings

- The WSUD Code does not take account of the impacts of climate change and the potential for WSUD to be an ameliorating tool in adapting to climate change.
- The review presents an opportunity to revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.
- New investigations into flooding of our local urban streams are underway, which may lead to revision of WSUD Code stormwater flow targets.
- Other jurisdictions have carried out studies to identify areas most vulnerable to high intensity rainfall, which is likely to increase with climate change.

Recommendations

6.1) Revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.

37 Source: Brisbane's Floodsmart Future Strategy 2012-2031 (Brisbane City Council, 2012, p. 10).
38 Source: WMA Water (2011), *Wagga Wagga Major Overland Flow Flood Study.* Retrieved from: <http://www.wagga.nsw.gov.au/__data/assets/pdf_file/0016/4372/Wagga_Wagga_MOFFS_Final_Report.pdf>..

Issue 7: Green Infrastructure Strategy

Green infrastructure can include parks and reserves, backyard gardens, waterways and wetlands, streets and transport corridors, pathways, farms and orchards, squares and plazas, roof gardens and living walls, sports fields and cemeteries.

There is an opportunity to build on the ACT Government's new climate change strategy and action plan, AP2, which provides a pathway with options to incrementally achieve the Territory's 2020 greenhouse gas reduction target commitments through actions that help the Territory adapt to and mitigate the effects of climate change.

Adapting and preparing cities for climate change through the use of green infrastructure is well understood.[39] Urban heat island effects can be reduced by using WSUD elements. Maximising temperature reduction effects of vegetation with shading and the use of evapotranspiration of plants requires the maintenance of adequate soil moisture levels. Coutts *et al*[40] believe that WSUD can provide a source of water across Australian urban environments for landscape irrigation and soil moisture replenishment to maximise the urban climatic benefits of existing vegetation and green spaces. Researchers consider that mitigating responses to the urban heat island effect could place particular emphasis on the implementation of WSUD technologies and green infrastructure including trees, irrigated landscapes, vegetated stormwater treatment, green roofs and green walls and parks and water bodies.[41]

The South Australian Green Infrastructure[42] research program found that vegetation, particularly canopied trees, can provide significant climatic benefits through shading and evapotranspiration effects. Retention of water in urban areas to maximise tree canopy cover and evapotranspiration is also important. Urban trees and light reflecting surfaces can help improve the urban heat island effect. The South Australian research program concluded that green infrastructure could play a role in climate change mitigation and more importantly in adaptation to unavoidable climate change. The program recommended that successful implementation of green infrastructure design principles be underpinned by five ideologies including:

- Integration: Green infrastructure is fundamental to urban planning and design frameworks for both new growth areas and redevelopments.
- Nature-based: Green infrastructure utilises natural processes to provide essential services and functions that improve the quality of urban water, air, soil, climate and wildlife habitat.
- Collaboration: The design, development and maintenance of green infrastructure require open and on-going collaboration between government, industry and communities.
- Evidence: Green infrastructure policy, planning and design are grounded in science and the lessons of experience, and are informed by emerging practices and technologies.
- Capacity: Green infrastructure requires commitment to building motivation, knowledge, skills and access to resources.[43]

While local councils across Australia have adopted green infrastructure strategies, the Territory does not have an overall green infrastructure strategy. The following provides best practice examples from the City of Sydney, the City of Melbourne and the European Union.

BEST PRACTICE on Green Infrastructure Plan (City of Sydney)

The City of Sydney's Green Infrastructure Plan, part of the Sustainable Sydney 2030 program, is working to reduce the use of potable water for non-potable water uses while encouraging water-saving by residents and business to help improve stormwater quality and to keep pollutants from entering Sydney Harbour and the Cooks River. Sydney relies on Warragamba Dam for nearly all its water.

39 Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. *Built Environment* (1978-), 115-133; Feng, Y., Burian, S., & Pomeroy, C. (2014). A Review of the Impact of ET on Green Infrastructure and Urban Runoff. *Bridges,* 10, 9780784412312-022; Kleerekoper, L., van Esch, M., & Salcedo, T. B. (2012). How to make a city climate-proof, addressing the urban heat island effect. *Resources, Conservation and Recycling*, 64, 30-38.

40 Coutts, A. M., Tapper, N. J., Beringer, J., Loughnan, M., & Demuzere, M. (2013). Watering our cities The capacity for Water Sensitive Urban Design to support urban cooling and improve human thermal comfort in the Australian context. *Progress in Physical Geography*, 37(1), 2-28.

41 Wong, T. H. F. (2011). *Blueprint 2011. Stormwater Management in a Water Sensitive City*. Melbourne, The Centre for Water Sensitive Cities, Monash University.

42 Martin, E. and Pitman, S. (2012). *Green Infrastructure – Life support for human habitats*. Department of Environment, Water and natural Resources: Adelaide.

43 Ibid, p. 340.

The City of Sydney was the first local council in Australia to be certified carbon neutral. The jurisdiction states it is: *'committed to innovative plans for producing energy, collecting and treating waste and using water'*. The City of Sydney has implemented its Green Infrastructure Plan and will invest $12 million in renewable energy for the next five years, a decentralised water network for non drinking purposes, and in using advanced waste technologies to collect and treat waste. The decentralised water network is improving water efficiency of buildings and operations and sourcing water locally for non-drinking purposes while improving the quality of the waterways. 80% of water used in the local government area is for non-drinking purposes such as irrigation and toilet flushing. The Green Infrastructure Plan follows on from the City of Sydney's commitment to reduce mains water use through installing rain gardens to filter stormwater and promote greening to help cool the city. Improving park irrigation systems, installing rainwater tanks and stormwater harvesting has reduced the use of drinking water by 17%.[44]

BEST PRACTICE on Green Infrastructure Plan (City of Melbourne)

Melbourne is often referred to as the Garden State, with vegetation and green spaces long considered an integral part of Melbourne's look and feel. The tree canopy cover in the public realm is approximately 22% according to the City of Melbourne's Urban Forest Strategy. However, due to a decade of drought, severe water restrictions and periods of extreme heat, combined with an ageing tree stock, the trees are in an accelerated state of decline. The City of Melbourne predicts a loss of 27% of current tree population in the next decade and 44% in the next 20 years. The City of Melbourne's implementation of permanent water use rules add to this challenge. The Urban Forest Strategy seeks to manage this change and protect against future vulnerability by providing a strategic framework. To encourage evapotranspiration and reduce the urban heat island effect, climate change policies incorporate WSUD and other actions including funding the urban forest strategy, improving water efficiency in parks and gardens and trialling cool roof technologies. The green roofs, wall and facades program is a green infrastructure initiative that is attempting to cool urban temperatures, reduce stormwater drainage, provide a layer of soil-like material and plants, and help insulate buildings all year round. The City of Melbourne identified that without the efficient use of water, green infrastructure would be impossible to implement and maintain.[45]

BEST PRACTICE on Green Infrastructure for the European Union (EU)

In May 2011, the EU adopted a Biodiversity Strategy to halt biodiversity loss in Europe by 2020. The strategy is built around six interrelated targets that address the main drivers for biodiversity loss. Target 2 aims to ensure that by 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15% of degraded ecosystems. In May 2013 a Green Infrastructure Strategy was published to promote the use of green infrastructure across Europe. The new strategy has four main aspects:

- promoting green infrastructure in main EU policy areas (regional cohesion, climate change and environment, disaster risk management, health and agriculture)
- supporting EU level green infrastructure projects
- improving access to finance for green infrastructure projects
- improving information and promoting innovation.

The EU sees green infrastructure as an approach to the creation and management of natural assets to deliver multiple benefits:

- environmental (clean water, pollutant removal for air and water, pollination enhancement, protection from soil erosion, rainwater retention, increased pest control, improvement in land quality, mitigation of land take and soil sealing)
- social (better health and human well being, job creation, diversification of local economy, more attractive and greener cities, higher property values and local distinctiveness, more integrated transport and energy solutions, enhanced tourism and recreation opportunities)
- climate change adaptation and mitigation benefits (strengthening ecosystem resilience, carbon storage and sequestration, mitigation of the urban heat island effect, disaster prevention and alleviation (storms, floods and fires))
- biodiversity benefits (improved habitat, ecological corridors and landscape permeability).[46]

44 Source (City of Sydney, ***Sustainability,*** Retrieved from: http://www.cityofsydney.nsw.gov.au/vision/sustainable-sydney-2030/sustainability)
45 Source (City of Melbourne, http://www.melbourne.vic.gov.au/Sustainability/Pages/Sustainability.aspx)
Source: European Union, Retrieved from: <http://ec.europa.eu/environment/nature/ecosystems/>.

Findings

- There is a growing need for high quality public open spaces as the trend in urban development is to increased density, smaller detached dwellings and multi-unit developments.
- The benefits or avoided costs associated with public health (physical and mental), social cohesion and improved liveability should also be considered as part of the development of green infrastructure.
- The ACT Government lacks a strategic framework for a green infrastructure strategy.
- Green infrastructure strategies are being implemented in various jurisdictions across Australia and overseas as a way to ameliorate climate change impacts.
- A green infrastructure strategy includes WSUD; coupled together they are key factors in:
  - ameliorating the intensification of summer storms and supercell storms associated with climate change
  - ameliorating the negative impacts of decreases in rainfall associated with climate change
  - enhancing the capacity of landscape to accommodate increased peak stormwater discharges associated with climate change
  - enhancing a liveable city and improving health outcomes.

Recommendations

7.1) The ACT Government develop a green infrastructure strategy, recognising the multiple and cross-sectoral benefits.

Issue 8: Urban renewal and residential intensification

In its present form, the WSUD Code addresses requirements for greenfield developments, but has limited application and design principles for brownfield developments. The WSUD Code could be improved by providing specific guidance for urban renewal, redevelopment projects and developments in established areas.

Urban renewal and residential intensification through redevelopment projects provides an opportunity for contemporary best practice relating to WSUD and integrated water cycle management. As identified earlier, the increase in urban surfaces and removal of established vegetation to accommodate redevelopment and urban renewal will result in warmer temperatures in these areas. Water efficiency is also needed to help establish new vegetation in these areas and ameliorate the heat. The ACT population is projected to reach 500,000 by 2033 and 681,187 by 2052.[47] The Canberra Spatial Plan 2004 and the ACT Planning Strategy 2012 outlines a strategic direction that will manage change and provide growth to achieve the social, environmental and economic sustainability of Canberra.

Given that urban renewal has been identified as an opportunity for housing families and providing accommodation for older people, who are most vulnerable to warmer temperatures, this is an opportunity to provide WSUD guidelines that take into consideration integrated water cycle management and the use of green infrastructure as a cooling mechanism for built up areas.

The WSUD Code states at section 1.6.2:

> ***'Redevelopment projects***
>
> *There will be a continuing demand for urban redevelopment as areas of the city change and adapt. Consistent with the current ACT Planning Strategy, there will be continuing growth in inner city and town centre residential redevelopments. Redevelopment projects in existing neighbourhoods offer significant opportunities to apply WSUD principles. Typically, these opportunities are generally more constrained than in new estates and will generally be limited to block scale measures.*
>
> *There are opportunities to capture and use rainwater for garden irrigation, toilet flushing, laundries and, in larger buildings, even in air-cooling towers. Greywater use systems can generally be easily installed in single residential developments, but may be more complex to implement in multi-unit developments because of the need to adequately address public health issues.'*

The merit path of the development application process gives developers an opportunity to be innovative and provides flexibility in their approach to redevelopments as outlined in the extract above. In considering an innovative approach to design considerations, the intent, the merit, the stormwater treatment trains and a maintenance plan need to be considered. However, the lack of any further guidelines or design principles makes it difficult for developers considering urban renewal projects and limits proponents on what they can implement.

Findings

- Urban renewal and residential intensification has been identified as a priority under the Canberra Spatial Plan and the ACT Planning Strategy (2012).
- The WSUD Code does not provide sufficient guidelines to support urban renewal and residential intensification through redevelopment.

Recommendations

8.1) The new WSUD guidelines incorporate contemporary best practice principles that support the intent of the Canberra Spatial Plan and the ACT Planning Strategy and AP2 with regard to urban renewal and residential intensification.

8.2) The new WSUD guidelines to take into consideration the requirements of residential intensification and provide merit avenues to look at areas at a precinct-by-precinct basis.

47 Chief Minister and Treasury Directorate, (2014), *ACT Population Projections 2013 Edition*, ACT Government. Retrieved from: <http://www.cmd.act.gov.au/policystrategic/actstats/projections/act/total>.

Theme 2. Housing affordability

Issue 9: WSUD and housing affordability

An extensive literature review was conducted to assess the impacts of WSUD on the cost of housing. The literature could not find any substantial evidence to show that implementing WSUD in developments is increasing housing cost and affordability.

There are cost-benefit analyses conducted for WSUD as outlined earlier in Section 4 relating to TBL. However, there is limited cost-benefit analysis or TBL assessment that has considered WSUD and housing affordability. It was difficult to reach a firm conclusion about the relationship between WSUD and housing affordability based on the documentary evidence.

Housing affordability is a topical issue in Australia. The Global Property Guide (2013)[48] says Australian housing is expensive with not enough new supply. It is a challenge to balance the need for affordable housing and sustainable development. The links between housing affordability and sustainability are complex; while sustainability measures such as solar panels and water tanks can be seen as an initial expense, implementing such sustainability elements can lead to more energy and water efficient dwellings, meaning lower (or even no) bills during the lifecycle. Positioning homes near public transport can also reduce oil dependency.[49]

There appears to be no central factor that impacts on housing affordability, however MacKillop (2012)[50] says there are several factors that affect pricing in housing markets and adoption of sustainability in Australia including:

- Regulation and taxes: Rising tax and infrastructure charges has placed increases in house prices across the country. Government regulations such as greenbelts and smart growth ordinances to control growth and obligation for home warranty insurance can push the cost of housing up.
- Population and economic growth: The housing supply in Australia has been slow in responding to population growth, particularly the growth that occurred before the Global Financial Crisis.
- Personal wealth and government strategies: Apart from homeowner subsidies, the history of the past few decades show that the government has withdrawn from the provision of housing and there has been a decline of public housing since the 1990s.
- The lack of progress on sustainability: MacKillop (2012) said there is a misunderstanding of what 'sustainability' means in terms of housing and communities, with major commercial developers focusing on building 'communities' and 'social sustainability' mainly through employment and shared facilities such as community halls and recreation areas.

Similar issues had been previously flagged by the Reserve Bank of Australia (RBA) in the Productivity Commission Inquiry on First Home Ownership in November 2003.[51] In their submission to the Inquiry, the RBA highlighted that housing prices had increased at an unusually large rate since the mid 1990s, both by the standards of Australia's past and by comparison with experience abroad. The household debt-to-income ratio was also relatively high by international standards. The most commonly cited 'affordability measure' is the ratio of average household income to the income required to meet debt repayments on a typical house. An alternative measure of affordability is based on the size of the deposit required to purchase a given home; in particular, the ratio of the average required deposit to household income.

Adding to MacKillop's point above, the RBA says that the structural demand has risen and the supply has not caught up. The RBA adds that social factors need to be taken into consideration when it comes to supply and demand in terms of the growth in the number of households. The decline in the persons per household compared to the growth in the number of households relate to the increase in number of divorces, the decline in the number of children per household and the ageing population.

The RBA's submission also speaks of regulation and taxes such as stamp duty and how they add to the difficulty experienced by first-home buyers entering the market due to the large upfront cost.

48 Global Property Guide (2013), Housing market slowly recovering in. *Global Property Guide* (18 July 2013). Retrieved from: http://www.globalpropertyguide.com/Pacific/Australia.

49 MacKillop, F. (2012). Balancing the need for affordable housing with the challenges of sustainable development in South East Queensland and beyond. *Proceedings of the 18th Annual Pacific Rim Real Estate Society Conference* (pp. 15-18).

50 Ibid, p. 4-6. Statistics quoted in this paper regarding 'regulation and taxes' were quoted from the HIA (2011). Statistics quoted for 'population and economic growth' were obtained from HIA (2011), the ABS (2010) and NHSC (2010). Refer to the MacKillop's reference list for further details.

51 Reserve Bank of Australia, (2003). *Submission by the Reserve Bank of Australia in the Productivity Commission Inquiry on First Home Ownership.*

The RBA states that there are claims that the First Home Owner Grant (FHOG) and the Commonwealth Additional Grant (CAG) have been said to contribute to the deterioration of housing affordability by pushing up prices.

The financial conditions have also changed for prospective homebuyers with the increase in borrowing capacity.

The last factor raised by the RBA and not considered in MacKillop's findings is the demand for property as an investment.[52] The demand by investors for rental properties has added to the general upward pressure on housing prices and consequently made it difficult for first-time buyers to buy into the market.

The Productivity Commission Inquiry Report[53] to the First Home Ownership Inquiry looked at housing affordability and provided a final report following public consultation and addressing a lot of the RBA's submission. The Inquiry's report found that there was a supply lag. The Inquiry generally agreed with the points raised in the RBA submission including the increase in property investments, the role of cheaper and more accessible finance and the role of taxation. Other findings included demand being outstripped by supply and the impact that additional investments were having on affordability. They further recommended that the reduction in stamp duties for first home buyers should be considered and that the FHOG be targeted at lower income households rather than for all first home buyers.[54]

The Inquiry also looked at major economic infrastructure and basic economic infrastructure charges and analysed whether they were excessive. Large estate scale major (shared) economic infrastructure includes trunk water, sewerage and drainage, gas, electricity, telecommunications, urban rail services, major roads and airports. Basic economic infrastructure or private infrastructure includes connections to major infrastructure such as roads, water, sewerage, gas and electricity connections. Social or community infrastructure includes parks, libraries and sportsgrounds. The Inquiry's finding was: '*while infrastructure charges, like other costs of bringing housing to the market, have increased over time, they cannot explain the surge in house prices since the mid-1990s*'.[55] At a trunk infrastructure level, the Inquiry found that developer charges for those items of social or economic infrastructure have generally been relatively small; however it recommended that such infrastructure should desirably be funded out of general revenue sources. Even if the cost of providing infrastructure to new developments shifted onto the wider community, the Inquiry said that housing affordability would not be greatly enhanced.

Based on the literature review, two economic analyses were conducted on regulatory burden and the hedonic price approach. These two economic analyses did not utilise a CBA or TBL approach however provide some information on WSUD elements and its relationship with housing cost.

CASE STUDY LITERATURE REVIEW: Regulatory burden of rain water tanks using the MainStream model

The Queensland Competition Authority (QCA) commissioned MainStream to look at the regulatory burden of rainwater tanks. As part of the regulatory requirement, rainwater tanks were considered a mandatory WSUD requirement under the Queensland building Code 4.2 and 4.3.

The MainStream report concluded: '***a simple measure of the regulatory burden is not sufficient information base for robust decisions to change regulation. The benefits of regulation also need to be assessed. This can only be achieved through robust benefit cost analysis of proposed changes in regulation***'.

However, since the study was conducted, the mandatory requirements for the installation of rainwater tanks or another water saving system (such as grey water treatment systems) for new houses have been repealed in Queensland.

The economic assessment looked at eight key regulatory instruments including state and local legislative instruments, policies and other subordinate regulatory requirements. It also found that WSUD can constrain the net developable area in greenfield developments, but the financial burden is often negligible. Another key finding in the MainStream report was that loss of developable areas was often mitigated or negated when stormwater solutions with higher impacts on developable areas, such as constructed wetlands, were put in because they generally resulted in price premium blocks.

52 Ibid. The RBA submission goes into detail about the demand for property as an investment and provides data on rental yields and other financial information.
53 Productivity Commission, (2004). First Home Ownership in Productivity Commission Inquiry Report No. 28, 31 March 2004.
54 Ibid. The full list of key findings is in the report.
55 Ibid, p. 155.

The results of the economic assessment on the regulatory burden of WSUD found that average substantive costs[56] for detached dwellings ranged from $4,900 to $8,200, averaging around $6,000. For attached dwellings the cost of WSUD per property ranged from $4,100 to $6,900, with an average around $5,000.

The MainStream report highlights that WSUD typically accounts for 1.2% of the construction costs of a new home, however it emphasises the substantive cost is burdened by the requirement of having rainwater tanks. It says there are tradeoffs for having WSUD infrastructure, with approximately 6.7 fulltime jobs created in the construction industry per development according to the Queensland Treasury. MainStream estimates that this would infer WSUD activities account for between 950 and 1,600 full time equivalent jobs a year in Queensland.

Since the legislative requirement for rainwater tanks or heat pump hot water systems was removed, there have been reports in the media[57] that making rainwater tanks optional for new homeowners will reduce the cost of building new homes by as much as $5,000. The media reports also acknowledge that the relaxation on the requirement is likely to have a negative impact on the rainwater tank industry. The installation of rainwater tanks is optional unless a local council has mandated it under a local planning scheme.

The removal of the mandate requirement of a rainwater tank and other water saving systems is still in its early days in Queensland and therefore there are no further details about the impact it has had on housing affordability or the broader spectrum of the construction industry.

MainStream were also commissioned by the Master Builders Association[58] in 2012 to provide an economic analysis relating to the cost of rainwater tanks specifically relating to water supply costs, impact on cost of building and potential policy changes. The key points from this analysis found that rainwater tanks are likely to increase construction costs by 1.2% in Brisbane and 1.1% in Cairns. However a CBA was not conducted.

CASE STUDY LITERATURE REVIEW: WSUD impacting on housing affordability - Hedonic price approach

The hedonic pricing method is used to estimate economic values for ecosystem or environmental services that directly affect market price. In relation to the hedonic price approach used in both Portland, Oregon and Perth, Western Australia it should be noted that the method did not look into the lifecycle costs, including the cost of maintenance and the relationship it has with the cost of the premium blocks. It is also not a cost benefit analysis.

A study conducted by Mahan et al (2000)[59] looked at the value of wetland amenities in the Portland, Oregon metropolitan area using the hedonic property price model. This study used residential housing and wetland data and compared it to the sale prices of properties. The structural characteristics, neighbourhood attributes and amenities of wetlands and other environmental characteristics were also considered. The measures of interest included the distance to the wetland, the size, the different types of wetlands (open water, emergent vegetation, scrub-shrub and forested) and the distance to them. The first stage analysis yields estimates of the marginal willingness to pay or price for environmental attributes. The study found that increasing the size of the nearest wetland and decreasing the distance to the nearest wetland increases house values. There appeared to be no preference on the type of wetland.

The marginal implicit price looked at distances from the house to wetlands, nearest stream or lake. According to the study's results, wetlands were not as desirable to live near as lakes, but somewhat more desirable to live near than streams. The study concludes that the hedonic property price method has some advantages but also limitations in that it provides a limited measure of total economic benefits.

A hedonic property value approach was used in Perth[60] to evaluate urban wetlands. It was the first published hedonic property value approach in Australia.

56 Key substantive costs of WSUD include design costs, capital costs of rainwater tanks and other WSUD infrastructure, operations and maintenance costs, the opportunity cost of land foregone, and training and capacity building costs from Mainstream Economic & Policy, (2012a). *Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland*, A report for the Queensland Competition Authority. Retrieved from: <http://www.qca.org.au/files/OBPR-MainStream-Report-MRBWSUDSEQ-1212.pdf>.

57 Helbig, K (2013), 'Newman Government drops mandate for tanks and energy-savign measures on new homes builtin Queensland', *Courier Mail* (online), retrieved from: <http://www.couriermail.com.au/news/queensland/newman-government-drops-mandate-for-water-tanks-and-energy-saving-measures-on-new-homes-built-in-queensland/story-e6freoof-1226536863912>.

58 Mainstream Economics & Policy, (2012b). *Domestic rainwater tanks in Queensland: cost effectiveness of impacts on housing costs for Master Builders Association*. Retrieved from: http://www.masterbuilders.asn.au/__data/assets/pdf_file/0005/58415/Rainwater-tanks-assessment-Final.pdf

59 Mahan, B.L,. Polasky, S. and Adams, R.M. (2000), Valuing Urban Wetlands: A Property Price Approach. *Land Economics*, 76(1)1, 100-113

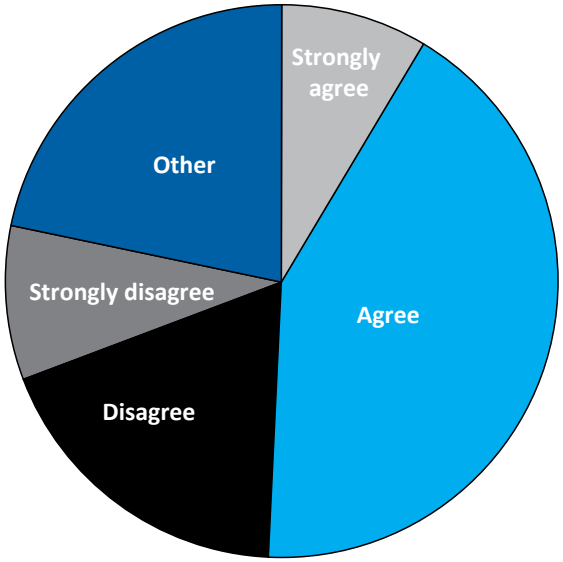
60 Tapsuwan, S., Ingram, G., Burton, M. & Brennan, D. (2009). Capitalized amenity value of urban wetlands: a hedonic property price approach to urban wetlands in Perth, Western Australia. *The Australian Journal of Agricultural and Resource Economics*, 53(4), 527-545.

In context, up to 60% of potable water supplied to Perth is extracted from the groundwater system that lies below the northern part of the metropolitan area. Many of the urban wetlands are groundwater-dependent and excessive groundwater extraction and climate change have resulted in a decline in water levels in the wetlands. The purpose of the study was to provide a beneficial analysis of the economic value of wetlands and whether it was worth conserving an existing urban wetland given the impacts of climate change and excessive groundwater extraction for urban use.

In the Perth study area, the mean number of wetlands within proximity to a property was 2.37. The maximum number of wetlands found within close proximity to the property was 12. The study found that the price of a property located near two wetlands will increase by 0.88%.

The formula adjusted the average sales prices to AU$794,922 for the hedonic property value approach. Structural attributes such as bedrooms, bathrooms, study and carpark and how they impact on house pricing can be found in the report. Evidently extra bedrooms, bathrooms, studies and game rooms all increase sale prices, but extra car parking spaces and dining rooms negatively influence sale prices. The mean distance to the edge of the wetland nearest the property was 943 m.

The most significant influence to sale price is the distance to the beach, which averaged at 4074.46 m. The marginal implicit price is the additional amount that must be paid by any purchaser to move to a property with a better level of a particular characteristic, while the levels of all other attributes are held constant. The marginal implicit price of distance to the beach was $151.73 compared to that of a wetland of $42.40 per metre within the 1 km premium. How the wetlands correlate to the beach was not properly explained in this research. It is assumed being located close to the beach adds to the property price as demonstrated by the marginal implicit price. The premium price of having two or more wetlands was $6,976 on the average house but the study did not analyse the premium price of one wetland.



Public consultation on WSUD and housing affordability

During public consultation a survey was sent to previous building applicants. Over 170 people responded to a question asking if people agree that '*WSUD Code requirements have a small effect on the cost of development*'.

In general, 28% of respondents strongly disagreed or disagreed that the WSUD Code requirements have a small effect on the cost of development.

It is clear that in new estate developments, the management of stormwater and the protection of water quality are expected requirements of best practice development. The management of these issues is distributed between elements on individual blocks and those in the public domain. The size and complexity of WSUD assets depends on the characteristics of the estate or the redevelopment. Modelling is used to design WSUD assets in the public domain and assumes WSUD infrastructure like rainwater tanks are in place and performing detention and retention functions. Without these elements being in place, the stormwater treatment train would be different and larger in the public domain. It was also observed that some developers invest more than is necessarily required in WSUD infrastructure, such as more elaborately planted swales, in order to enhance the amenity of their developments. Some of this evidence is provided in Issue 16.

Estates are generally designed and developed in an integrated fashion, reflecting goals for sustainable development and it is difficult to tease out the separate costs of WSUD elements.

The Land Development Authority advises that their raw land costs are between $60,000 and $80,000 and that they are unable to provide definitive data on the actual cost of WSUD requirements to the individual block level without a detailed study. Even so, a study may find it difficult to make definitive attribution of costs given the integrated design and construction process.

In the case of redevelopments, where flow detention tanks or the like are required, it may be possible to establish a cost impact, but these tanks do serve to reduce the requirement to upgrade public stormwater infrastructure to accommodate increasing urban densities. Melbourne Water operates an offset scheme that recognises developers may not always be able to meet their targets for water quality protection and flow attenuation on-site at reasonable cost and provide the option to contribute the cost equivalent of the unmet targets to a common fund that Melbourne Water uses to construct WSUD infrastructure in neighbourhoods to accommodate redevelopment.

Findings

- It was difficult to reach a firm conclusion about the costs of WSUD on housing affordability based on the documentary evidence, particularly as it varies substantially between locations and type of development.
- The integrated nature of estate design and construction make it difficult to attribute WSUD requirement costs over and above costs associated with addressing routine water quality and stormwater management measures for new estates.
- WSUD requirements for redevelopments and refurbishments are more easily costed and there are options available from other cities for offsetting these costs where site requirements limit on-site treatments.

Recommendations

9.1) The ACT Government will encourage WSUD approaches that maximise cost efficiency at the appropriate level (e.g. on-site versus sub-catchment) to minimise impacts on housing affordability in the ACT, as well as the maintenance burden.

Theme 3. Coordination and compliance of WSUD in the building and development phase

The WSUD Code states that WSUD is to be incorporated into all levels of the planning and development process. The stages include metropolitan land use planning, structure and concept planning, estate planning and design, and block and section development. The review has highlighted there is room for improvement in coordination across the various directorates in relation to WSUD and in particular at the estate planning and design stage.

Land development and infrastructure construction phase

Issue 10: Selection of most appropriate stormwater treatment measures to meet required outcomes

The WSUD Code provides a broad guideline of the scope of application for WSUD for greenfield developments, redevelopment projects and established urban areas. The literature review found there were many concerns relating to the performance and maintenance of WSUD assets.[61] There is also evidence to show that incorrectly engineered sites that do not suit the catchment area can have detrimental consequences for water quality during storm events. Local councils are often left with the responsibility of maintaining these assets. Assets are also installed at a bottom of the catchment approach rather than considering a regional scale approach.[62] This adds to the uncertainty of selecting the most appropriate stormwater treatment measure.

The following example highlights the problems that maintenance coordinators endure when an asset is inappropriately designed to the capability and resourcing of the maintenance team. The asset was given design approval. This makes it confusing when trying to make the best selection of stormwater treatment measures that meet the required outcomes.

EXAMPLE of the issue relating to selection of most appropriate stormwater treatment measures

Lesson learnt from Coombs Pond experience

The Coombs Pond contains a GPT and flood channel off the pond. The new design compared to the existing designs that the Territory and Municipal Services (TAMS) services showcases challenges many jurisdictions face as technology advances and are forced to accept unfamiliar assets including:

- *The drying pad outside the GPT where the material is meant to dry after removal from the GPT is a gravel pad. In other circumstances this areas has been concrete or bitumen area. As a result the gravel pad has washed away and discharged into the GPT.*
- *The handrails on top of the GPT are of a solid construction. Other locations have been built with a collapse type handrail. Therefore if a large item comes down the stormwater channel, these handrails need to be replaced.*
- *The dam valve at the bottom of Coombs Pond was approved with an access grid that cannot be removed without hiring a crane to remove it. The valve is located approximately 30 m up a culvert creating access issues during maintenance.*

Input from TAMS

The issue above highlights several problems relating to the design, the design approval process, the construction, asset acceptance and the maintenance of the asset. The design of the GPT and floodwater channel off Coombs Pond is different to other assets around Canberra.

The asset acceptance process is currently being reviewed by TAMS. The example above demonstrates the importance of involving line areas that are responsible for the different stages of the WSUD lifecycle to be involved in the project planning stage. This includes the asset acceptance officers and the maintenance team. However, given the resourcing constraints experienced by TAMS, this is an issue that needs to be rectified.

The staged handover process is currently being reviewed between various key stakeholders such as CMTEDD, LDA and TAMS. It is important that the issues highlighted in this report are also taken into account.

61 Adger, 2006 as cited in Wong, T., & Brown R (2008). Transitioning to water sensitive cities: ensuring resilience through a new hydro-social contract. *Proceedings of the 11th International Conference on Urban Drainage*, 10, Edinburgh. Bureau of Meteorology

62 Mitchell, V. G. (2006). Applying integrated urban water management concepts: A review of Australian experience. *Environmental Management,* 37(5), 589-605.

The best practice examples highlight two approaches to stormwater management. One is an integrated catchment approach. The other relates to a tool that is helping one local council with its raingarden design, assessments and implementation.

BEST PRACTICE in integrated stormwater management approach, Aurora Estate (Victoria)

Aurora Estate is situated within Epping North (the City of Whittlesea), 25km north of the Melbourne CBD. Aurora Estate is a planned satellite town of over 8,500 residential lots.[63] Approximately 50% of the development site will be open space; streams will be restored and existing forest protected. The development is a low impact urban design development (LIUDD) with low to medium density proposed and two high-density nodes adjacent to the railway line and town centre. Aurora Estate is approximately 600 m to the east of Edgars Creek, which is part of the larger Merri Creek catchment. Edgars Creek is an ephemeral stream and has been degraded in some sections.

The most significant design aspect of Aurora Estate is that it involves an integrated WSUD approach to improve water quality.[64] The original master planning of the estate envisioned two wetlands. VicUrban decided to remove the requirements for the wetlands by implementing various WSUD assets throughout the estate. They looked at planning approaches at a block, street and precinct level. The site includes rain gardens, swale nature strips, recycled water and shared outdoor areas. Studies conducted at the project conception stage anticipated that through these WSUD techniques, Aurora Estate would achieve its stormwater quality objectives including reducing 80% of suspended solids and 45% each of total nitrogen and total phosphorous at the point of discharge into Edgars Creek.

The aim of the development is to reduce potable water consumption by approximately 70% (or 55% without the rain water tanks) when compared with conventional servicing arrangements. The drivers for a changed development form included the absence of sewage servicing beyond the existing city edge, the need to reduce nitrogen loads entering Port Phillip Bay, a shortage of potable water and the impact of conventional development on water cycle. The Aurora Estate introduced a dual-pipe reticulated water supply, which was a challenge at the time because of the infrastructure provisions and incorporating new business operations such as dual-metering and customer billing.[65] The estate will be finished by 2023. Maintenance is carried out by the City of Whittlesea and the estate development required extensive consultation between the developer and council to an agreeable sustainable maintenance plan due to a number of issues in the beginning of the project.

The estate uses community education to educate homeowners and potential buyers on the WSUD measures across the site. This has assisted in most homeowners looking after the WSUD features on their blocks. Education and communication plays an important part of the success of this project.

Site of the proposed (now removed) wetland Aurora Estate, Victoria

A report[66] conducted for the Merri Creek Management Committee (MCMC), published in October 2013, assessed and analysed the practical implementation of WSUD at Aurora and concluded that the findings were generally inconclusive and that the water testing results showed no overall change in the water quality of Edgar's Creek, which indicated that the development of Aurora Estate in a previously rural area has at least not negatively altered the water quality of Edgar's Creek.

63 van Roon, M. (2007). Water localisation and reclamation: Steps towards low impact urban design and development. *Journal of Environmental Management*, 83(4), 437-447.

64 VicUrban, *Aurora Development Plan: Part 1* (Whittlesea, 2003), retrieved from: <http://www.whittlesea.vic.gov.au/building-planning-and-transport/planning-and-development/planning-for-the-future/epping-wollert-plans/~/media/Files/Building%20Planning%20and%20Transport/Future/Aurora%20Development%20Plan%20-%20Part%201.pdf>.

65 Farrelly, M., & Brown, R. (2011). Rethinking urban water management: Experimentation as a way forward?. *Global Environmental Change*, 21(2), 721-732.

66 Stevens, L., Nicholson, S., Caralhaes, T., Hammond, R., Eltringham, E. & D'Aprano, A (2013). *Aurora water sensitive urban design: An assessment of the existing water sensitive urban design installations at Aurora Estate*, VIC. A report for the Merri Creek Management Committee. ISP Consulting.

BEST PRACTICE in WSUD Raingarden Standard Design, Moreland City Council (Victoria)

Moreland City Council's[67] WSUD Raingarden Standard Design Scenario Package provides a suite of design elements and standard drawings to assist in the efficient design and successful implementation of raingarden and tree pit projects. The decision support tool was developed to assist in determining the most appropriate type of rain gardens and tree pits and assist the Council and the contractor with their successful implementation. Prior to its conception Moreland City Council identified an issue with proponents submitting standard drawings that Council felt did not achieve the best WSUD outcome and there were misunderstandings on the best way to implement raingardens.

The tool provides four factors (description, pros, cons and application) to help decisions on the best option to implement. The package provides information relating to:

- contextual information
- design procedure summary
- illustrated catalogue of raingarden elements
- supplementary information
- construction cost estimate, maintenance cost estimate and safety codes and guidelines
- library of AutoCAD details
- construction specification template
- design basis memorandum template
- maintenance checklist template.

The design procedure consists of a nine step process to help with successful implementation. Each step provides a user friendly guideline:

1) Complete prerequisite items

2) Determine configuration

3) Reconfigure standard layout

4) Select civil works design features

5) Create detailed drawing sheets

6) Select planting options

7) Undertake detailed design checks

8) Prepare documentation (including construction configuration and maintenance checklist)

9) Prepare cost estimates (including construct cost estimate and maintenance cost estimate)

The selection of the most appropriate stormwater treatment measures should also take into consideration the protection of receiving waters downstream of developing catchments. In order to do this, an integrated approach that considers cumulative impacts of developments within the catchment is needed.

Appropriate staging of WSUD infrastructure, informed by the recently announced ACT Basin Priority Project, and the development of more detailed monitoring and performance assessment for WSUD infrastructure will provide the opportunity for more sub-catchment specific targets and design options. Moving from modelled to actual data about the performance of WSUD infrastructure will allow for more cost-effective solutions and efficient systems.

67 va der Peet, M. (2013), 'Streamlining and standardising WSUD implementation in Moreland City Council' at the *8th International Water Sensitive Urban Design Conference 2013* and Moreland City Council (2014), Moreland's streetscape raingarden and tree pit design package. Retrieved from Moreland City Council website: <http://www.moreland.vic.gov.au/environment-and-waste/water/wsud-design-package.html>.

Findings

- Given the codified nature of the WSUD code, it is common for proponents to select from a limited repertoire of WSUD options.
- Enhanced monitoring will support an improvement in the range of design options.
- The staging of WSUD infrastructure, particularly in new estates, has resulted in work needing to be re-done due to the effects of subsequent development.
- Widening the range of acceptable options will place additional demands on technical assessment staff in EPD.
- Widening the scope of acceptable WSUD treatments will require consequent amendment of the design standards for urban infrastructure.
- Maintenance documentation and procedures will need to be available to support the continued efficient operation of WSUD infrastructure

Recommendations

10.1) The ACT Government develops a handbook to guide staged development and handover processes.

Issue 11: Lack of in-house stormwater modelling skills and capacity

There is a lack of in-house stormwater modelling skills and capacity within the ACT Government due to the outsourcing of the majority of expertise. This places significant pressure on those in directorates with the skills to assess development applications and related proposals.

Most development application assessment relies on the submission of checklists, calculators and modelling results. Development proposals in the ACT for sites greater than 2000 m^2 must demonstrate that the required water quality criteria will be achieved. The WSUD Code states: '*use of the MUSIC (Model for Urban Stormwater Improvement Conceptualisation) model to demonstrate compliance will be accepted. Other models may be used with the agreement of the ACT Planning and Land Authority (EPD)*'. The WSUD Code outlines the assessment tools that will be considered including MUSIC, XP-AQUALM, PURRS, Aquacycle and others. MUSIC is by far the most common model used by industry.

EPD has limited capacity to verify the results being submitted with development applications because they generally do not have access to MUSIC or are not trained in the application of MUSIC. There is also a lack of ongoing interaction between government, industry and science around water quality and flow modelling, although the review process itself has stimulated significant engagement.

BEST PRACTICE in modelling software – MUSIC-link

MUSIC-link[68] is a new modelling tool released by e-Water in November 2013 to assist development approval agencies in assessing stormwater modelling for compliance with local criteria.

MUSIC-link streamlines the process for assessing the compliance of water sensitive designs against specific guidelines of the approval agency. It generates efficiencies in the development process by not only providing very specific modelling parameters to designers, but also speeding the assessment process and thus saving valuable time. MUSIC-link ensures that modelling is being done using the correct default settings for the region or for specific sub-catchments. Approving agencies can also readily run spot checks of modelling to ensure compliance and maintenance of standards of work.

The main benefit of MUSIC-link is a significant reduction in the time spent examining models that support developer proposals, to ensure they comply with planning requirements to do with water quality targets and allowable performance parameters for stormwater infrastructure. Approving authorities can automatically generate reports from MUSIC about the performance of proposed stormwater designs and check these for compliance, rather than painstakingly gathering this information from the MUSIC models that developers have submitted.

68 e-Water, *MUSIC-link*. Retrieved from e-Water website: <http://www.ewater.com.au/products/ewater-toolkit/urban-tools/music/music-link/>.

MUSIC-link also provides a customised online interface enabling the updating of requirements or the conveyance of information about development requirements for WSUD without the need for additional publications or communication processes.

A number of local governments around Australia are using MUSIC-link:

- Blacktown City Council*
- Newcastle City Council
- Lake Macquarie Council
- Brisbane City Council
- City of Onkaparinga
- Port Stephens Council
- Ku-ring-gai Council

*Blacktown City Council's Developer Handbook for Water Sensitive Urban Design[69] encompasses instructions on using MUSIC-link.

Access to MUSIC-link would allow staff members to provide much clearer guidance of water quality and quantity requirements for a given site. It is a powerful tool that would allow EPD to plan for the future.

Findings

- There is a lack of in-house stormwater modelling skills and capacity and limited access to a current version of MUSIC (the most common modelling tool).
- There is a lack of interaction between government, industry and science about modelling relating to WSUD. There should be a community of practice between officers and industry to assist in the development of staff and industry.
- Tools like MUSIC-*link* provide the opportunity to give development assessors the capacity to test submitted data and have assurance that submitted information meets Territory standards.

Recommendations

11.1) The ACT Government seek to establish a community of practice between government, industry and science around stormwater modelling and the application of WSUD in the Territory.

11.2) The ACT Government adopt the eWater *MUSIC-link* program and a guideline to the use of MUSIC and stormwater modelling in the ACT.

69 Blacktown City Council (2013), *Developer Handbook for Water Sensitive Urban Design*, Retrieved from: < www.blacktown.nsw.gov.au/.../Developer_Handbook_for_WSUD.pdf>

Issue 12: Water quality monitoring data to provide feedback loop for future designs, maintenance planning and operation of WSUD measures

EPD manages a monitoring program for the ACT's water resources that includes collection of water quality, stream flow and biological data[70]. The monitoring program is based on regular sampling of lakes and rivers from 33 sites. This data is used to determine whether water flowing through the ACT is of appropriate quality and if the management strategies used to achieve or maintain water quality are adequate. This information contributes to a long term understanding of water quality in the ACT. The collected data is contributed to a single database managed by EPD and published annually through the ACT Water Report and data is sent to other government agencies for data input.

Shallow water quality data is collected by community volunteers through the Upper Murrumbidgee Waterwatch network. Waterwatch volunteers monitor nearly 210 sites throughout the region on a monthly basis; this data complements that collected by EPD and may be used as primary data on those occasions where there are gaps in monitoring data.

Water quality data is also collected by other government agencies, research institutions and authorised dischargers of water, such as ACTEW Water and the Queanbeyan City Council. However, this data is not consolidated as part of a single database or reported on centrally.

The data provided by EPD monitoring, Waterwatch and other sources provides long-term historical data on how waterways have changed, demonstrates whether activities to protect or restore waterways are having desired effects, identifies emerging local issues and contributes to catchment planning.

Monitoring of the performance of individual interventions to protect water quality, such as WSUD assets, is far less systematic and sporadic. Data collected in this way is also not housed centrally and resides with a variety of custodians. This makes it difficult to draw any firm conclusions about the performance of WSUD assets against their modelled performance.

An opportunity exists with the recent announcement of the ACT Basin Priority Project, which has monitoring as a key first stage of the project. The Australian and ACT governments will be jointly investing in an ACT-wide water quality monitoring program that will build on existing monitoring to measure the effectiveness of the ACT in meeting water quality targets of flows out of the ACT into the Murrumbidgee River and the wider Murray–Darling Basin and to audit the effectiveness of water quality treatment processes, including WSUD assets. This project will include a performance audit of all WSUD infrastructure in the ACT, the establishment of a new ACT-wide monitoring program (building on existing monitoring) and more detailed monitoring in six priority sub-catchments, five of which are urban catchments in the ACT.

EXAMPLE ISSUE 12: Water quality monitoring in the ACT

The most known shallow water quality monitoring conducted in the ACT would be the community based Upper Murrumbidgee Waterwatch, which collects water quality data throughout the catchment. The data is collated and tabled into an online database hosted by the Atlas of Living Australia. The Waterwatch volunteers monitor 210 sites throughout the region on a monthly basis.

In 2013 Upper Murrumbidgee Waterwatch commissioned the University of Canberra (UC) to review the strengths and weaknesses of their water quality data. The study focussed on Waterwatch data within the ACT that overlapped with sites from 'ACT government collected data' (this included UC data). Although the data was restricted to the last ten years, Waterwatch data in the ACT region goes back to 1996. Thirty sites were compared along rivers and creeks and two were compared at Lake Ginninderra and Lake Tuggeranong. While dissolved oxygen, pH, turbidity and electrical conductivity were reviewed at all these sites, phosphates were only reviewed at the lake sites due to data availability.

The results revealed there was '*good correlation between Waterwatch and government collected water quality data for electrical conductivity, pH and dissolved oxygen*'. Turbidity and phosphate did not correlate as well, but this was believed to be more of a result of different measuring tools and sampling times.

70 ACT Environment and Sustainable Development Directorate. (2013). ACT Water Report 2011-12. Canberra

The UC report also stated that *'...the Waterwatch database provides a good quality baseline dataset for assessing water quality in the ACT'* and that where there has been *'sufficiently regular collection...of data, it is possible to use Waterwatch data in an early warning context'.*

The data co-provided by Waterwatch can provide historical data on how the waterways have changed over time, demonstrate whether activities to protect and restore waterways are having the desired effect, identify emerging local issues and contribute to catchment planning. With the release of this report, it is predicted that catchment managers will feel more confident in using Waterwatch data, resulting in an increase in its use.

The results of the report are a credit to the quality assurance processes conducted by Waterwatch staff, who work closely with volunteers to ensure the best results. It is also a testimony to all the dedicated Waterwatch volunteers who go out every month and collect good quality data that the region relies on to help manage the upper Murrumbidgee catchment.

The following best practice example from Little Stringybark Creek, Victoria is a program which involves extensive stormwater treatment initiatives and an advanced monitoring program.

BEST PRACTICE in stormwater treatment measures and monitoring program

LITTLE STRINGYBARK CREEK MONITORING PROGRAM: Stormwater management to improve the health of Little Stringybark Creek

Little Stringybark Creek is located at Mt Evelyn, Yarra Ranges and is a degraded creek due to urban development. Little Stringybark Creek Project has been operating since 2008 and is implementing new water saving and stormwater treatment initiatives within the 450 ha catchment.[71] The primary objective of the retention measures in Little Stringybark Creek catchment was to protect the stream by reducing the frequency of runoff, which is postulated as a major ecological impact of urban development. It found that the degradation of Little Stringybark Creek was caused by the stormwater drainage system.[72] In the conception stage of the project, the project team modelled the response of a range of ecological indicators to piped stormwater drainage. It found that impervious areas like roofs and roads have much less effect on streams if they do not drain directly to a stream through stormwater pipes.[73] Modelled data indicated that if the project reduced the area of directly connected impervious surfaces from the existing 5.5% of the catchment area to around 2% of the catchment area, they could reduce the stormwater impact to Little Stringybark Creek to about the same level experienced by streams of the region that are in very good condition.

The project is funded through Commonwealth and state government grants and Melbourne Water and is supported through Monash and Melbourne universities. The project involves a combination of private and public land implementing initiatives at a range of scales funded through different business models including community auctions, environmental benefit calculations and priority funding. For private land owners (both households and businesses), financial incentives and direct assistance (in design and plumbing advice) are offered to install rainwater tanks and other stormwater retention measures.[74] For public land owners (local government, schools), staff are educated on the benefits of stormwater retention measures and financial incentives provided to support on-ground implementation. Good use of signage helps to promote the program throughout the suburb and build community trust. To facilitate these works and ensure communication of any lessons, the project has run a comprehensive engagement program, targeting residents of the catchment, the local government authority and the broader water/stormwater management industry and had one community engagement officer since the beginning of the project.

A lesson learnt from the project took place two years into the project where they found that more impervious surfaces were being created than retention measures (leaky rainwater tanks and raingardens) were being installed. An Environmental Significance Overlay (ESO) was created which is a planning overlay.[75]

71 Monash University, *The Little Stringybark Creek Project*, retrieved from: <http://www.waterforliveability.org.au/?page_id=2449>.
72 University of Melbourne, *Monitoring the Creek's Recovery*, retrieved from: <http://www.urbanstreams.unimelb.edu.au/LSmonitoring.htm>.
73 Walsh et al 2005 as cited in University of Melbourne, *Monitoring the Creek's Recovery*, retrieved from: <http://www.urbanstreams.unimelb.edu.au/LSmonitoring.htm>.
74 Monash University, *The Little Stringybark Creek Project*, retrieved from: <http://www.waterforliveability.org.au/?page_id=2449>.
75 Rossrakesh, S., Walsh, C. J., Fletcher, T. D., Matic, V., Bos, D., & Burns, M. J. *Ensuring protection of Little Stringybark Creek, Technical Background Report*, Melbourne Waterway Protection and Restoration Science Practice Partnership, retrieved from: <http://www.urbanstreams.unimelb.edu.au/Docs/LSB_ESO_Technical_report-final.pdf>.

An ESO's purpose is to ensure development is compatible with identified environmental values. Permits are required to remove, destroy or lop any vegetation subject to the ESO wording.

The Little Stringybark Creek Environmental Significance Overlay[76] requires new development creating additional hard surface areas to treat stormwater runoff. In an Australian-first, the ESO sought to go beyond the Best Practice Environmental Management Guidelines for Urban Stormwater (1999)[77] as the guideline did not adequately protect Little Stringybark Creek because it was aimed at protecting larger receiving waters such as Port Phillip Bay and it focused on reducing pollutant loads, overlooking the impact changes in creek hydrology and how it impacts on the health of urban streams.[78] The ESO was designed to ensure Little Stringybark Creek is protected and restored and remains an important environmental and community asset. It does not mean urban development or road upgrades cannot occur, rather, such developments will need to be designed and constructed in a way that retains stormwater within the catchment for infiltration, evapotranspiration or harvesting rather than through the conventional stormwater management.

To date the project has found good support from the community from residential, industrial and commercial stakeholders. The small industrial area has been very receptive to the program, installing large water tanks on-site for toilet flushing. The local petrol station/carwash owner has decided to reuse water from the site for the carwash. Of 700+ blocks, over 115 nature strip raingardens have been put in.

The catchment has three tributaries – the north sub-catchment, middle sub-catchment and south sub-catchment. All three sub-catchments are monitored by Monash University, which owns the monitoring systems, but there were issues in installing the system due to the cost and getting it right. Preliminary data suggests the north sub-catchment will be the best performing sub-catchment from the gathered data.[79]

Obtaining water quality monitoring data will be advantageous for the ACT jurisdiction as it could assist in creating a feedback loop for strategic planning of future assets. It will help the ACT Government make informed decisions about planning provisions and the design of the asset to the operation and maintenance.

Findings

- Water quality monitoring does not take place for most WSUD assets that are implemented.
- There is currently no accepted or recognised monitoring program for urban stormwater in the ACT. Nor is there a consistent integrated shallow and deep monitoring program for WSUD elements in the ACT to test performance and function once they are installed.
- The ACT Basin Priority Project represents a real opportunity to remedy this situation, with comprehensive ACT-wide monitoring and individual performance monitoring of WSUD infrastructure into the long term.

Recommendations

12.1) The ACT Government continues to support the development and delivery of an appropriate water quality monitoring program with the assistance of the ACT Basin Priority Project to assess the behaviour of catchments and the performance of individual WSUD assets and as part of treatment trains.

12.2) EPD convene an annual review workshop on water quality data with key stakeholders to assess the outcomes of monitoring data and recommend directions for further work.

76 Amendment C122 was approved by the Minister for Planning on 12 September 2013.
77 Produced by the Victorian Stormwater Committee
78 Rossrakesh, S., Walsh, C. J., Fletcher, T. D., Matic, V., Bos, D., & Burns, M. J. Ensuring protection of Little Stringybark Creek, Technical Background Report, Melbourne Waterway Protection and Restoration Science Practice Partnership < http://www.urbanstreams.unimelb.edu.au/Docs/LSB_ESO_Technical_report-final.pdf>.
79 D, Bos, personal communications, 28 August 2013.

Issue 13: Soil stabilisation techniques in developments

The Environment Protection Guidelines for Construction and Land Development in the ACT (2011), produced by the Environment Protection Authority (EPA), provides guidance on the EPA's preferred methods for pollution control design, construction, operation and maintenance. The adoption of appropriate pollution controls during construction and land development activities is important for both the environment and the developer/builder. A development without adequate pollution controls increases costs e.g. replacing washed away stockpiles, clean up costs, fines and a loss of businesses reputation.

It is a requirement under the *Environment Protection Act 1997 (ACT)* to obtain an EPA or an environmental authorisation for land development or construction activities on sites of 0.3 ha or greater, prior to works commencing. An EPA authorisation covers all sites, is valid for three years and requires no fees.

Surface stabilisation techniques in new urban areas have been identified as not always being effective. The guidelines provide some information regarding stabilisation and other techniques for the management of particular activities. For example, at the subdivision stage the guidelines suggest that large site areas should be divided into separate parts as a means of limiting the extent of exposed areas, and for implementing progressive stabilisation of works. Controls for subdivision include undertaking temporary or permanent vegetative stabilisation measures immediately after completion of final land forming or using contour ploughing and/or surface roughening of finished landform over all disturbed blocks as an aid to stabilisation and to slow water flow during rain events.

The following example highlights the sediment runoff impacts of extreme rainfall events.

EXAMPLE of stabilisation techniques in extreme rainfall events

During the rainfall event on 19 February 2014, sediment runoff at Baldwin Drive, Kaleen not only flowed into the stormwater system, but also overflowed onto the road, causing traffic disruptions. ACT Government officers were required to slow traffic and close the ACTION bus stops along the road.

This event was an extreme circumstance that highlights the difficulties developers face maintaining their sites to address sediment runoff in extreme events. As these events are expected to increase as a result of climate change, it is timely to consider other ways to manage soil stabilisation in these circumstances.

The EPA has implemented a communications strategy to engage with developers and contractors about meeting their general duties under the *Environment Protection Act 1997*.

It is important that the EPA continue to be engaged with the building industry to educate and regulate soil stabilisation techniques. Ineffective soil stabilisation techniques are detrimental to the environment and have a social and economic impact on the community.

Findings

- Soil stabilisation techniques in developments are not always effective due to a lack of knowledge and to poor on-site practices.

Recommendations

13.1) Review Environment Protection Guidelines for Construction and Land Development in the ACT (2011) to strengthen the way erosion and sediment control is staged.

13.2) The Planning and Development Forum be used as a stakeholder consultation to engage with the building industry on effective soil stabilisation.

13.3) The new guidelines should require erosion and sediment control measures to be established during either the capital works or estate development phase by civil contractors and left in place until house construction is largely complete (up to 85% development as a guideline).

Building development phase

WSUD needs to be considered in the building development phase. The issues that are relevant to the land development and infrastructure construction phase are similar to those at the building development phase.

Issue 14: Handover and responsibility of erosion and sediment control mechanisms

There is a serious problem of erosion and sediment control in the ACT, compounded by the erodible nature of ACT soils. A number of sediment ponds are being implemented and executed incorrectly during the land development and infrastructure construction phase, leading to the building phase. This includes the timing they are decommissioned and the lack of to space to accommodate such assets in the first place.

Sediment ponds play an important role during the land development and infrastructure construction phase and building development phase, trapping silt and treating contaminated water. Sediment ponds, detention dams or basins hold sediment-contaminated run-off long enough for suspended sediment to settle out. Clarified water can then be discharged to stream. The identified issue relates to the premature removal/ decommissioning of sediment ponds after the land development phase (civil works).

Another issue highlighted by the Working Group was the requirement for gross pollutant traps (GPTs) to be cleaned out frequently during the construction phase and the expectation that TAMS do this. However, due to budget constraints TAMS are unable to carry out frequent cleanouts of GPTs. This is highlighted in the example below.

GPTs are devices used to prevent pollution of waterways by large items such as takeaway containers, leaves, bottles and plastic bags. At the estate development level, GPTs use physical processes to trap solid waste such as litter and coarse sediment.

EXAMPLE of issues in the handover and responsibility of gross pollutant traps

This example should also be considered with Issue 16.

The maintenance of GPT/Track rack poses a number of issues. The process involves several components including removing material from the asset, temporary traffic management depending on the location, removal from the site to the appropriate waste facility as directed by the EPA. The waste disposal fee is dependent on the amount of waste to be removed and the classification of waste. GPTs located in suburban areas also create problems; due to their location, odour may occur as the material is removed and stored on a drying pad until it is suitable for removal.

Currently there are 172 registered GPTs, 76 more than at the last time of funding. In the near future there will be 10 new GPTs on line within the ACT. By the end of 2015 there will be 200+ on the asset register.

The requirement for GPT cleaning/inspections is a biannual inspection (and cleaning if required) of the entire asset plus a full inspection after a rain event of 25 mm or more (and cleaning if required). With the increasing incidence of rain/storm events, inspections and cleaning requirements are increasing.

From September 2013 (beginning of the current GPT cleaning contract) to the end of January 2014, there have been 173 GPT clean outs at a cost of $592,491, equating to $3,424.80 per clean.

Input from TAMS

The example above highlights the difficulties in managing the assets that are handed over to TAMS for cleaning and maintenance. The assets become TAMS' responsibility to maintain, however the budget allocated to TAMS does not reflect the expanding nature of the asset register. Consequently, assets are unable to be maintained properly and their function impacted. TAMS are expected to frequently clean out GPTs during construction, adding to further constraints.

The maintenance allocation for GPTs does not reflect the increasing number of GPTs and increasing maintenance. This needs to be rectified. This is further demonstrated in Issue 16.

Findings

- The coordination of the handover process in estate development can be improved to avoid rectification and maintenance costs.
- The cleaning requirement for Gross Pollutant Traps (GPTs) is greatly increased during the building and construction phase and TAMS is unable to respond to this requirement consistently due to resource and budget constraints.
- There has been a significant increase in WSUD assets managed by TAMS.
- Work has already commenced between the concerned directorates to refine handover practices, although more work needs to be done.

Recommendations

14.1) As stated above, the ACT Government develop a handbook to guide staged handover processes. It is to deal with:

  – Erosion and sediment control between the land and construction phase and the building and development phase

  – Consider the siting of temporary erosion and sediment control ponds in open space or areas that do not need to be developed immediately.

14.2) The option be explored that developers undertake GPT clean-out during the building development stage until 85% of the catchment area is built.

Issue 15: Regulation and compliance with erosion and sedimentation controls

The EPA is established by the *Environment Protection Act 1997* (ACT) (EPA Act). As a statutory position, the EPA is responsible for administering this Act, the objectives of which include:

- protecting the environment
- ensuring decision-making incorporates ecologically sustainable development principles
- establishing a single and integrated regulatory framework for environmental protection
- encouraging responsibility by the whole community for the environment – general environmental duty of care.

The EPA meets these objectives by granting environmental authorisations, promoting environmental awareness, entering into environmental protection agreements, developing codes of practice with industry and issuing notices, environment protection orders and a range of other instruments. The EPA Act covers all environment protection activities including air, noise, land and water pollution.

In addition to the Act, the EPA has the responsibility for administering the *Water Resources Act 2007* (ACT), which aims to ensure the use and management of the Territory's water resources are sustainable while protecting the ecosystems that depend on the waterways. It is also designed to protect waterways and aquifers from damage.

The regulation and compliance on erosion and sedimentation is captured under the provisions of the EPA Act. Pollutant is encompassed under Section 5: *'Things taken to have impact causing environmental harm'. A 'pollutant' as defined by the legislation as: 'taken to cause environmental harm if the measure of the pollutant entering the environment exceeds the prescribed measures or the pollutant entering the environment is a prescribed pollutant'*. There is a perceived limitation in the provisions of the EPA Act as the EPA needs to prove sediment has left a building site and caused pollution to be able to prosecute an offender.

A recent review of the EPA Act involved a public consultation process that included a discussion paper seeking ways to improve the work undertaken to protect the local environment. A question in the discussion paper asked: *'Should the EPA Act broaden the scope of its environmental harm offences to include those which are 'likely' or have the 'potential' to cause harm?'* Responses varied, with some respondents in support of the change from 'likely' to 'potential'. Some stakeholders did not support the wider definition and wanted it to remain unchanged because they considered it too onerous to prove the case. The review is ongoing.

Another issue relating to regulation and compliance is that the size of small blocks and erosion and sediment measures were competing with site access and building material storage requirements. Based on CMTEDD's June 2013 quarterly report of *Residential land and building activity*[80] the average size of land blocks sold was 494 m^2, up 3 m^2 from the previous quarter. Small blocks, also known as compact blocks under the provisions of the Territory Plan, can be up to 250 m^2 in area while medium blocks are up to 500 m^2 .

Monitoring of compliance with erosion and sediment control requirements on small blocks not requiring an Erosion and Sediment Control Plan (ESCP) is difficult within existing resources. A recent publicity and education program and audit of on-site performance found a lack of awareness among builders of their statutory obligations and a number of instances where required controls were not in place. Fortunately, the audit found that no significant amount of sediment had left the blocks of concern or entered waterways.

The opportunity exists to increase compliance with regulations by increasing inspections through the use of building certifiers who, with training, can check these controls are in place. Legislative changes would be required to make it a requirement to include site management controls on building plans lodged for approval.

Findings

- Compliance with erosion and sedimentation, especially on small blocks, is difficult to regulate.
- Changes to the legislation relating to 'likely' and 'potential' environmental harm is considered by some as difficult to regulate. The review of the EPA Act is an ongoing process.

Recommendations

15.1) Environment Protection Regulations to be amended to include offences for non-compliance with approved erosion and sediment control on sites subject to an Environment Protection Agreement.

15.2) Investigate using building certifiers to ensure compliance with site management requirement, including erosion and sediment control.

80 Economic Development Directorate (2013), Residential land and building activity, June 2013 Quarter, ACT Government.

Theme 4. Sustainable maintenance of WSUD assets

Issue 16: Funding is inadequate for maintenance of WSUD assets and hence their performance targets cannot be met

Regular maintenance of stormwater assets has become a significant issue in the Territory. The issue consists of a few components that ultimately come down to budgetary constraints and resources. The design of stormwater management assets is an issue because of the evolution of the industry and the ACT Government's lack of capacity to be updated with these changes. The advancement of stormwater management technologies, enhanced scientific data and the complicated designs in new developments add an intrinsic layer of complexity. Without sustainable resources it will continue to add to this complexity.

Sustainable maintenance of WSUD assets explores the lifecycle cost assessment of WSUD treatment systems, the impact of incorrect engineered designed assets and the issue of private maintenance. It also highlights the maximum potential assets can achieve if they are properly maintained. This section addresses the current issues faced by TAMS due to inadequacy of funding for maintenance of WSUD assets and the greater impact of poorly maintained assets has on the Territory and how the Territory can look at what other jurisdictions are doing with sustainable maintenance.

According to the literature, there are seven major impediments to sustainable urban stormwater management[81] that are applicable to the nature and climate at present within the ACT including:

1. Uncertainties in performance and cost
2. Insufficient engineering standards and guidelines
3. Fragmented responsibilities
4. Lack of institutional capacity
5. Lack of legislative mandate
6. Lack of funding and effective market incentives
7. Resistance to change.

The concern relating to maintenance costs featured prominently in the literature review. For example, a core values assessment undertaken in the Mackay region[82] ranked the values and concerns relating to WSUD. The top concern of the interest group related to 'financial values and concerns' and in particular to minimising costs impacts associated with stormwater treatment assets upon a development borne by Council, the developer and ultimately the home buyer. The costs of operations, maintenance and other management of WSUD assets was also identified as a cost burden initially for local government or asset owners and the final burden falls onto ratepayers in an economic assessment according to Mainstream Economics.[83]

A quantitative online survey conducted of more than 1000 practitioners in Brisbane, Melbourne and Perth cities by the National Urban Water Governance Program[84] presented broad trends on the likelihood of a social or institutional factor being perceived as a driver or barrier to the adoption of on-site technologies (such as rainwater tanks and greywater systems) and third-pipe technologies and potable reuse schemes (indirect and direct) across the three cities. In all circumstances, maintenance cost was perceived as a barrier in adoption of these on-site technologies.

The Brisbane City Council case study is a lifecycle cost assessment of WSUD treatment systems and the implications it has for asset managers.

81 Roy, A.H., Wenger, S.J., Fletcher, T.D., Walsh, C.J., Ladson, A.R., Shuster, W.D., Thurston, H.W., & Brown, R.R. (2008). Impediments and solutions to sustainable, watershed-scale urban stormwater management: Lessons from Australia and the United States. *Environmental Management*, 42(2), 344–359.

82 Black, G. W. (2012). *The investigation of the sustainability of a regional approach to Water Sensitive Urban Design using a Triple Bottom Line Assessment*. Retrieved from: <https://eprints.usq.edu.au/23036/1/Black_2012.pdf>.

83 Mainstream Economic & Policy, (2012a). *Measuring the regulatory burden of Water Sensitive Urban Design in South East Queensland*, A report for the Queensland Competition Authority. Retrieved from: <http://www.qca.org.au/files/OBPR-MainStream-Report-MRBWSUDSEQ-1212.pdf>

84 Brown, R ., Farrelly, M., & Keath, N., (2009). Practitioner Perceptions of Social and Institutional Barriers to Advancing a Diverse Water Source Approach in Australia. *International Journal of Water Resources Development*, 25(1), 15-28.

CASE STUDY LITERATURE REVIEW: Lifecycle costs of maintenance of stormwater assets assessment Brisbane City Council

The literature review found examples of poor data management. In 2007, Ecological Engineering was commissioned by Brisbane City Council to look at the lifecycle costs of WSUD treatment systems.[85] The project collected information regarding the lifecycle cost information for WSUD systems such as swales, bio-retention swales, bio-retention ponds, sedimentation basins, constructed wetlands, infiltration measures and sand filters. The consultant said there was concern among asset managers surrounding the uncertainty of ongoing maintenance costs of WSUD treatment systems. There was also inconsistency with the data collated, as records were often incomplete. The maintenance of privately developed residential estates was generally managed by a body corporate and therefore access to this data is not available. Other observations noted by the consultant included a lack of standard procedures and forms for recording maintenance costs associated with WSUD treatment systems.

In summary, the consultant estimated the average annual maintenance costs, at 2007 prices, ranged from $1,500 for smaller established bioretention systems to $30,000 for larger wetlands that incorporated GPTs. The average annual maintenance costs during the establishment period for bioretention swales, bioretention basins and constructed wetlands ranged from $7/m² to $35/m². The ongoing maintenance period annual costs estimates range between $2/m² to $12/m². The consultant recommended that the Council maintain records and costs of all elements of a WSUD treatment and that the records would need to consider the functional elements of the system as well as landscaped areas directly surrounding the system for a true and meaningful reading of the data.

Brushy Creek Wetland provides an example of where a wetland was incorrectly designed and constructed and therefore the maintenance of the site caused major issues for the council.

CASE STUDY LITERATURE REVIEW Incorrect design at Brushy Creek Wetland (Victoria) leading to limitations in maintenance

Wetlands across Melbourne and Australia have generally been designed with a notional 72 hour detention time. Water Technology[86] was engaged to investigate this theoretical 72 hour detention time at Brushy Creek Wetland, which was constructed in 2009. The wetland was found to have design failures that could have been attributed to being constructed during the drought and required the inlet structure reworked.
Both the eastern and western wetlands in the Brushy Creek Wetland were found to exceed detention times. The research found that the eastern wetland had an average detention of 168 hours and, at one point, 512 hours. The western wetland had an average detention of 113 hours and, at one point, 162 hours.
The excessive detention times were after non significant rain events. The inundation was different to the MUSIC modelling results. The data logger levels far exceeded the static water line. The investigation concluded that current design methodology reveals flaws in the currently accepted technique when designing constructed wetlands in Melbourne. Upstream catchments' details (particularly large catchments) and resulting volumetric inflows must be taken into account when designing a constructed wetland to ensure target wetland detention times are met.

The loss and lack of data such as instructions or maintenance plans leads to inadequate information sharing and also impacts on the regular maintenance of stormwater assets because asset managers do not know when and how to maintain these assets. This includes private asset managers as highlighted during public consultation for this review.

85 Ecological Engineering, (2007). *Life Cycle Costs of Water Sensitive Urban Design* (WSUD). *Treatment Systems: Summary Report, A report for Brisbane City Council – City Design*. Retrieved from <http://www.wsud.org/wp-content/uploads/2012/08/4179_Summary-Report_d001.pdf>.
86 Cousland, T., Reginato. D., Law. S., Carew, D. & Bearshaw, C (2013), *The magical 72 hours – does it exist in practice.* Retrieved from: <http://www.watech.com.au/wp-content/uploads/2013/11/The-magical-72-hours-TJC.pdf>.

PUBLIC CONSULTATION: Maintenance of assets at a body corporate level

Member of a body corporate executive committee stated:

'I have some experience with the operation of WSUD policy. Included in the common property of my owners' corporation is three 118KL tanks. The tanks are beneath a lawn area which is also part of the common property. Two of the tanks are for ground/rainwater retention while the third tank is designated for water reuse and is connected to a pumping system. All three tanks are interconnected.

My concern is that existence of storm water assets was not adequately disclosed to unit holders when properties were purchased off the plan. Also, detailed information on the way these assets need to be operated in order that WSUD objectives are met was not provided to the owners' corporation. Satisfaction of the WSUD Code appears to be little more than a box ticking exercise which must add to developer costs yet little consideration is given to assessing whether the intent of the principles will be met on an on-going basis. Also, there does not appear to have been any consideration given to the on-going costs which might result from the application of the code.

As the Territory is seeking to achieve greater urban consolidation in older suburbs the issues raised above are likely to confront body corporates established through urban redevelopment.'

Proper establishment and maintenance of WSUD assets has social, economic and environmental benefits and this is demonstrated in Australia's second oldest bioretention system in Australia.

BEST PRACTICE in establishment and maintenance at Hoyland Street Bio-retention System, Brisbane

The Hoyland Street Bio-retention Basin situated at Bracken Ridge was constructed by Brisbane City Council in 2001.[87] It is considered the second oldest bio-retention system in Australia. The site contains both trees (*Melaleuca quinquenervia*) and grasses (*Lomandra longifolia*). The bio-retention basin system is situated in a catchment size of 2.3 ha with a surface area treatment zone 675 m^2. The site is considered a benchmark asset because it opposes some conclusions made by industry practitioners that bio-retention systems have an effective stormwater treatment function for 10 to 15 years.[88] In October 2011, Water by Design inspected the underdrains of the Hoyland Street Bio-retention Basin using a pipe camera and recorded the footage.[89] They surveyed 15 bio-retention systems and found only very minor root ingress present in the systems surveyed and any root ingress appeared to be very fibrous roots. The footage showed the minor root ingress would be highly unlikely to cause any significant restriction in flow through the under-drainage.

The Hoyland Street Bio-retention System plants were considered to be well established and the Council did not dedicate any extra maintenance to the site. Mullaly believes that vegetated stormwater assets that perform well are attributed to several factors including successful establishment of trees and other plants, edge control, maintained in the initial set up and also fits with the suitability of the landscape. The research by Water by Design on this site and the 15 others surveyed concluded that bio-retention systems can have a functioning lifespan of more than 10-15 years if they follow the principles that Mullaly suggests.

Funding inadequacy is the most significant issue relating to WSUD in terms of its conception, its development, compliance and regulation, community perception and human interaction with the asset, and asset owners' maintenance responsibilities.

These are just a number of issues that relate to funding inadequacy. It is negatively perceived that aesthetically over designed soft and hard infrastructure is "WSUD". However this is not the case. WSUD is sustainable urban water management. WSUD assets are designed to meet the guiding principles of WSUD.

87 Water By Design, (2011). *Hoyland Street Bioretention System Underdrainage Inspection*. Retrieved from:<http://waterbydesign.com.au/pipecam/>.

88 Dalrymple, B, BMT WBM, 'Bioretention myths busted!!' on the Queensland Stormwater Industry Association website: <http://www.siaqueensland.info/CB1ED505-739D-4141-8C37-F55A37513CF9/FinalDownload/DownloadId-A694BA805FD230AEB71821A27395960C/CB1ED505-739D-4141-8C37-F55A37513CF9/Resources/Bioretention%20Myths%20Busted%20-%20Dalrymple%20(Low%20Res).pdf>.

89 Water By Design, *Hoyland St Bioretention basin underdrainage inspection*. Retrieved from youtube website: <http://www.youtube.com/watch?v=sbaDAtrrPEw?>. Mullaly, J. (2013). 'Vegetated stormwater assets – finding the positive deviants' at the *8th International Water Sensitive Urban Design Conference 2013*.

As outlined in the WSUD Code, WSUD seeks to provide a more sustainable approach to the management of the total water cycle within the urban environment. Soft and hard infrastructure that support the guiding principles and furthermore the intent of the WSUD Code, is considered WSUD infrastructure.

The following example box was provided from TAMS, which provided costings for the maintenance of two swales at Casey. The first site is an aesthetically urban designed swale and the second is a standard water catchment grassed swale. Both swales are WSUD assets because they have been situated in their place to support the guiding principles of WSUD. However the aesthetically urban designed swale is considered by TAMS as a complicated and overdesigned asset. It is also negatively perceived as a 'WSUD swale' due to the complex landscaping.

The literature review preliminary findings regarding swales found that they can provide moderate pollutant removal.[90] The efficiency of swales is dependent on the type of plant species selected, and the hydraulic and landscaped requirements of that area. There is also limited guidance on the selection of plant species based on their pollutant uptake potential, how to harvest vegetation to maximise pollutant nutrient uptake and the type of plant that suits that locality and climate. Therefore it is unnecessary to over design these assets.

The costings provided by TAMS to maintain an over landscaped swale at Casey was approximately $54,000 per hectare per annum whilst the grassed swale maintenance cost is $2,700 per hectare per annum.

EXAMPLE of maintenance costs faced by TAMS in maintaining assets

Swale maintenance in Casey, ACT

Water catchment grassed swale in Casey

The grass swale at Casey is constructed to TAMS specification. The site consists of grass and drains at either end of the swale for water collection. They require minimal maintenance as they are mown using broad acre tractor and slasher.

Landscaped swale in Plumsoll Avenue, Casey

The swale in Plumsoll Avenue, Casey is a landscaped swale that consists of soft landscape assets such as garden beds, dense plantings of strappy leaved plants, different surface treatments, including mulch, rocks and gravel. This site is considered a high maintenance area involving pruning shrubs and trees, mulching, spraying weeds and hand weeding, cleaning footpaths, litter picking, replanting dead shrubs, erosion rectification and removal of sediment.

Input from Territory and Municipal Services

90 Goonetilleke, A., Egodawatta, P., & Rajapakse, J. (2011). Water Sensitive Urban Design (WSUD) application auditing. Retrieved from Queensland University of Technology website: <http://eprints.qut.edu.au/60610/1/Water_Sensitive_Urban_Design_(WSUD)_application_auditing.pdf>.

The following information is the costings from TAMS relating to the maintenance of the swales at Casey.

Table 1. Annual cost to maintain a standard grass swale drain (per hectare)

Maintenance Description	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total hrs	Cost	Comments
Mowing hours				2	2	2	2		2				10	$1,400	Based on $110 per hour and fuel and operator
Tree maintenance hours						2						2	4	$600	Based on two staff and truck
Litter picking	2		2		2		2		2			2	12	$720	Based on one staff member and litter van
Total														$2,720	

Table 2. Annual cost to maintain Water Sensitive Design swale drain (per hectare)

Maintenance Description	Jul	Aug	Set	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total hrs	Materials	Cost	Comments
Mowing hours				3	3	3	3	3	3				18		$1,980	Mower plus labour
Tree maintenance			32			8						30	70	$500	$8,000	Includes formative pruning, replanting, storm damage, tree removal, programmed watering.
Cleaning paths		2		2		2		2		2			10		$1,200	Removal of silt, debris and mulch from paths
Litter picking	5		5		5			5			5		25		$1,500	Removal of litter and illegal dumpings in swale and shrub beds.
Shrub bed maintenance	120	120	45	20		20		20	45	20	120	120	650	$6,000	$33,000	Includes weed spraying, hand weeding, mulching, pruning and replanting shrubs.
Erosion maintenance					20							20	40		$8,800	Erosion resulting from storm events. Regular cleaning of silt on paths and drainage entry points through castellated kerbing. Refer to photos.
Total															$54,480	

The following example provided by TAMS relates to a number of issues including impractical designs and, more importantly, the funding inadequacy of maintenance of WSUD assets for both soft and hard infrastructure.

EXAMPLE of funding inadequacy to maintain WSUD assets

Lyneham GPT

TAMS were approached for comment during the preliminary sketch design stage. TAMS were critical of the proposal to incorporate 'Escosol Net Tech' as the solution for pollution control due to access and frequent maintenance attention.

The Ecosol Operation & Maintenance Manual for the system quotes a life expectancy of five years on all components. However after two years the polyethylene nets had to be replaced at a cost of $3,000 due to being gnawed by rats. The manual also states that the nets should be cleaned every three to four months. In reality, due to the nets being installed online, the nets quickly become full after any rain event. As a consequence the nets / GPT is cleaned on average on a monthly basis.

The cost of each clean is $3500 due to the difficulty in accessing the nets.

Cleaning the nets is a laborious task requiring a truck with a Hiab crane and a normal tipper. The crane is required to remove the Gatic covers and steel beam as well as for lifting of the nets into the body of the tipper for cleaning.

TAMs are currently working with EPD to construct a replacement GPT upstream of the existing structure. This GPT is a traditional design with a bypass and drying area that will allow for ease of access and cleaning by a small skid steer loader. The cost of construction is approximately $250k and will return a 10 year payback period in terms of savings on cleaning cost. The proposed GPT will be cleaned twice a year (or after a specific rain event) in accordance with current TAMS maintenance procedures for GPTS.

Input TAMS

The example above highlights a number of problems. Firstly, at project design stage the advice from the asset maintenance managers did not result in the final outcome. Secondly, the design of the asset was not appropriate for the catchment it was servicing. In this instance, an integrated approach may have avoided replacement of the asset prior to its advertised manufactured date. This includes consideration of the lack of infrastructure upstream of this asset. Thirdly, this example highlights the unexpected issues that arise from asset maintenance endured by TAMS and the lack of resource to support this unknown.

ASSET REGISTER

At the time of writing this report, the number of assets currently owned and managed by TAMS includes:

- 172 registered GPTs (76 more than at the last time of funding with 10 new GPTs to be accepted in the near future. It is predicted by the end of 2015, there will be 200+ on the asset register)
- 152 registered raingardens
- 10 'landscaped' registered swales
- 79 registered ponds.

The following best practice examples highlight how other jurisdictions are managing their assets using different funding and resourcing framework and models from the ACT.

BEST PRACTICE of maintenance agreements, Melbourne Water

Melbourne Water, in conjunction with the local councils situated within its network, requires developers to consider maintenance agreements when designing and constructing a wetland or retarding basin. Often a wetland or retarding basin will result in shared responsibilities between Melbourne Water and the local council and therefore a joint maintenance agreement needs to be considered where applicable. In these circumstances, a maintenance agreement is to be prepared that clearly delineates the responsibilities and details the required program. The responsibilities may include open space features (bench seats, playgrounds, barbeques, garden beds etc.) being maintained by Council while the waterbodies, hydraulic structures, aquatic and edge planting are part of the functioning Melbourne Water asset that they maintain.

In order for a development to be approved, Melbourne Water may apply the Standard Conditions for Provisions of Drainage Works by Agreement (Standard Conditions) which forms part of their planning and approval process for land development. The Standard Conditions are able to be applied through the appropriate mechanisms as provided for in the *Water Act 1989* (VIC).

The maintenance agreement clearly defines the roles and responsibilities and has been relatively effective across the different local governments and Melbourne Water. In most cases, assets will be transferred to either Melbourne Water or the council depending on the catchment size, with assets less than 60 ha catchments transferred to the council (where an agreement exists). All other drainage assets are transferred to Melbourne Water to own and maintain. There are large incentives for developers to consider maintenance agreements. The staging of the development requires different stages of approval requiring sign off by Melbourne Water. Therefore seeking guidance from Melbourne Water is always advised. The appropriate handover of assets to Melbourne Water and the council transfers the responsibility of the developer to maintain these assets and therefore adds an extra incentive post construction.

Melbourne offers a number of sites under this maintenance agreement regime imposed by the Standard Conditions.

BEST PRACTICE of development service schemes, Melbourne Water

Melbourne Water applies development service schemes – schemes on a catchment-based drainage strategy that outlines the functional designs of the relevant infrastructure required to service urban growth, and a pricing arrangement that details how Melbourne Water will recoup the infrastructure costs through financial contributions paid by developers. Development service schemes are different to development contributions like those set up in NSW (section 94). Section 94 developer contributions are monetary contributions levied on developers at the development application stage to help pay for additional community facilities and/or infrastructure such as libraries, community facilities, open space, roads, drainage and provision of car parking.

The development service schemes consist of a strategy for proposed Melbourne Water regional assets and some assets which may become local council assets. The strategy ensures that planning for urban development is conducted on a catchment basis, and meets appropriate standards for flood protection and environmental performance, including the protection and enhancement of waterway and biodiversity values. The strategy is funded by financial contributions paid when development occurs. All developable properties pay a drainage contribution on the basis of the development size and development type. The contributions include a hydraulic component which funds the flood protection works, and a water quality component which funds the water quality treatment works. Melbourne Water currently manages more than 200 schemes.

Craigieburn East Development Scheme

Development Service Scheme

The Craigieburn East Development Scheme is one of over 200 schemes currently being managed by Melbourne Water. The current base rate for standard residential is $53,000 per hectare for hydraulic and $11,000 per hectare for water quality treatment works.

BEST PRACTICE of stormwater management levies (NSW)

Stormwater management service charges were introduced into New South Wales. They identified that increasing urbanisation has resulted in a significant increase in impervious surfaces and has significantly increased the volume of stormwater flowing into urban waterways. These flows contribute substantial loads of litter, sediment and chemicals to urban waterways, as well as causing flooding in some areas.

The 'stormwater management service charge' was introduced. The *Local Government Act 1997 (NSW)* defines this as *'a service to manage the quantity or quality, or both, of stormwater that flows off land, and includes a service to manage the re-use of stormwater for any purpose'*. The NSW Department of Local Government produced a guideline for local councils to adhere too when developing their own stormwater management service charge. The guideline is comprehensive, outlining how to levy a stormwater management service charge including a strict set of rules of the charge and that a council cannot levy the charge where an existing special rate or drainage charge providing primarily for stormwater manage is in place. The upper charge limit is set at $25 for urban residential land and $25 per 350 m^2, or part thereof, for urban business land. The guideline also states what stormwater management activities will be carried as a result of this charge. Some of the activities listed include:

- cleaning up stormwater pollution incidents
- management or rehabilitation of riparian areas
- monitoring of flows in drains and creeks to assess effectiveness of flow management (flooding) controls
- planning, construction and maintenance of drainage systems, including pipes, channels, retarding basins and waterways receiving urban stormwater
- replacement of stormwater assets
- planning and undertaking of community and industry stormwater pollution education campaigns.

BEST PRACTICE of stormwater offsets (Queensland and Victoria)

Stormwater offsets are contributions paid by developers to mitigate the impacts of stormwater pollution from urban development.[91] Melbourne Water operates stormwater quality offsets in a framework that includes development service schemes as described above. But in its most simplistic description, stormwater offset schemes occur where local councils take contributions from the developer and place the WSUD asset in another development site or location.[92] Stormwater offsets are an alternative mechanism whereby developers contribute funds towards regional assets that achieve similar outcomes of smaller devices.[93] Contribution schemes can have their advantages as the levy charged to the developer can be more cost effective than building and designing a WSUD asset. Stormwater offset schemes are controversial. Firstly there has been disparity between the levies charged and the real costs of not only building the asset but also managing it for the life of the development.[94] They also provide challenges for brownfield developments.[95]

The University of Queensland looked into the City of Ipswich's voluntary offset schemes.[96] The research found that in some instances, regional assets were difficult to implement because they are not financially viable because of land prices or site constraints. It also found that to correctly implement stormwater offsets it needed to be used in combination with other approaches including appropriate catchment management planning. The research concluded that the best cost benefit was working with the current infrastructure and assets.

91 Melbourne Water. (2014). *What are stormwater quality offsets?* retrieved from: <http://www.melbournewater.com.au/Planning-and-building/schemes/about/Pages/What-are-stormwater-quality-offsets.aspx>.
92 Wicks, M. (2013). *Local council stormwater offset schemes – do they really work?* Stormwater360 Australia, retrieved from: <http://stormwater360.com.au/local-council-stormwater-offset-schemes-do-they-really-work/>.
93 Patschke, S. & O'Neill, E. (2013), 'Off the hook? An examination of the appropriateness of stormwater offsets in South East Queensland' at the *8th International Water Sensitive Urban Design Conference 2013.*
94 Ibid.
95 Eadie, M. (2013). 'Stormwater quality offsets – the end or a new beginning for WSUD?' at the *8th International Water Sensitive Urban Design Conference 2013.*
96 Patschke, S. & O'Neill, E. (2013), 'Off the hook? An examination of the appropriateness of stormwater offsets in South East Queensland' at the *8th International Water Sensitive Urban Design Conference 2013.*

Findings

- The cost of routine maintenance of WSUD assets has become a significant issue in the Territory. The issue consists of a few components which ultimately come down to budgetary constraints and resources.
- TAMS is responsible for an increasing number of WSUD assets, placing a strain on budgets.
- There is a lack of funding to maintain WSUD assets due to other competing priorities.
- There are a range of mechanisms that have been employed in other jurisdictions to help fund stormwater infrastructure construction and maintenance, including levies and offset schemes.
- There is a need to look at alternative funding and management models for a sustainable WSUD network.

Recommendations

16.1) An overall cost benefit analysis be undertaken for funding models that take into account the whole-of-life costs of WSUD infrastructure.

16.2) Alternative funding and management models for WSUD infrastructure need to be investigated.

7. Discussion and analysis

Water Sensitive Urban Design has evolved from its early association with stormwater management to provide a broader framework for sustainable urban water management.[97] It seeks to integrate the interactions between the urban built form and the urban water cycle. Many centres are moving, or have moved, away from conventional stormwater management to a WSUD and IWCM environment. Integrated water cycle management, which focuses more on the social and environmental aspects of water management[98], recognises that every decision with water will influence the entire water cycle; the design aspect of IWCM is therefore more overarching and inclusive instead of focusing solely on reduction in water use.[99]

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

WSUD elements have beneficial impacts on water quality. Experts suggests that technologies already exist that are capable of mimicking the natural water cycle and reducing the downstream transport of stormwater pollutants through WSUD features.[100] By capturing stormwater at or near the source of runoff, WSUD should theoretically restore the critical components of natural flow regimes of ecosystems. The use of infiltration elements provides filtration of pollutants and WSUD has the potential to remediate both water quantity and water quality issues in streams. Incorporating WSUD into new developments can help prevent degradation of receiving waters. In existing dense inner-city areas with highly impervious basins, it is hard to provide breakages between impervious areas and receiving waters (e.g. pavements and open spaces), therefore it is suggested other mechanisms need to be investigated such as stormwater harvesting.

Since the introduction of the WSUD Code in 2009, there has been an uptake of WSUD in the Territory due to the WSUD requirements in the general and development codes but also because of the industry initiatives taking place in the ACT. This review has considered 16 issues and proposed a number of actions and recommendations. The focus of this report was on the issues of WSUD, however it must be remembered that WSUD has social, environmental, and economic and climate change benefits. The intent of the WSUD Code is still valid. There is now an opportunity to revise the way the Territory deals with WSUD in particular with regard to climate change, population growth and environmental, social and economic factors.

The current nature of the WSUD Code and all WSUD requirements in the development codes and its relationship with the Territory Plan is a matter of concern. The codification of a guideline contradicts the standard of the Territory Plan as it is not set out with the usual rules and criteria. Furthermore the review has highlighted a need to revisit all WSUD principles and requirements in the development and precinct codes. It was identified that a Territory Plan amendment package is required. This would require a revision of the WSUD provisions of the Territory Plan, supported with a comprehensive WSUD Practice Guideline, a review of all WSUD requirements in the development and precinct codes and a review of the Water Use and Catchment Code. The review of design standards relating to WSUD and development guidelines would also help to support the Territory Plan amendment package.

97 Wong, T.H.F. (2006). An overview of water sensitive urban design practices in Australia. *Water Practice and Technology* 1(1), 1-8.
98 Sponsor, O. S. (2012). *Assessing Boroondara's Water Use and Stormwater Quality.* (Doctoral dissertation). Retrieved from: https://www.wpi.edu/Pubs/E-project/Available/E-project-022912-
99 Office of Water (2014), *Integrated Water Cycle Management*, Department of Primary Industries (NSW), retrieved from: <http://www.water.nsw.gov.au/Urban-water/Country-Towns-Program/Best-practice-management/Integrated-Water-Cycle-Management/default.aspx>.
100 Roy, A.H., Wenger, S.J., Fletcher, T.D., Walsh, C.J., Ladson, A.R., Shuster, W.D., Thurston, H.W., & Brown, R.R. (2008). Impediments and solutions to sustainable, watershed-scale urban stormwater management: Lessons from Australia and the United States. *Environmental Management*, 42(2), 344–359.

Australian and overseas WSUD examples have been considered in the report. There are a number of areas that the ACT is different to other jurisdictions in relation to WSUD. After looking at examples from across Australia and overseas, the Territory may want to consider a number of current plans and strategies in progressing WSUD into the future, including:

- A comprehensive WSUD Practice Guideline[101]
- A regional strategic stormwater management plan[102]
- Stormwater management treatment initiatives[103]
- Strategic flood planning management[104]
- Green infrastructure strategy[105]
- Other funding models and agreements for maintenance including maintenance agreements, development service schemes, stormwater management levies and stormwater offsets.[106]

Improving the way the Territory implements WSUD would be positively assessed in a TBL assessment because of the community, environment and economic benefits. An extensive literature review was conducted to assess the impacts of WSUD on the cost of housing. The literature could not find any substantial evidence to show that implementing WSUD in developments is increasing the housing cost and affordability. There were limited cost benefit analyses in relation to WSUD and housing affordability. It was difficult to conclude that WSUD was impacting on housing affordability based on the evidence gathered.

The current coordination and compliance of WSUD in the development and building phases identified internal administrative processes between ACT Government directorates and with developers and the building industry relating to WSUD and development need significant improvement. At the time of writing this report, a number of in-house discussions are being carried out. It is important that this report's findings be taken into account to further implement the recommendations. Improving WSUD administrative processes has benefits to the government and the community.

The review also looked at ways of expanding the acceptable WSUD measures to widen the choice of cost-effective interventions available to achieve WSUD targets, at different scales from on block to precinct and neighbourhood level to larger whole or part catchment approaches, while providing maximum flexibility to developers. It is strongly recommended that a comprehensive WSUD guideline and Territory Plan amendment be actioned to support this.

The report explored the various funding and maintenance arrangements occurring in other jurisdictions in the relation to the operation and maintenance of public WSUD infrastructure. An overall cost benefit analysis needs to be undertaken for funding models that takes into account the whole of life costs of WSUD infrastructure. It is also timely that reasonable maintenance requirements be identified, specified and integrated in the design of WSUD assets from the design phase onwards. This will also ensure that we meet our obligations with our agreement under the Basin Plan.

Significant ramifications for future water supply and management activities are to occur in the future. Water sensitive urban design has an important role to play in our commitment to the Basin Plan. It will continue to protect water quality in the ACT, to ensure we continue to protect the health of people in the ACT and down river, and to ensure there is no net decline on water quality in the Basin. Water sensitive urban design will help in ensuring Canberra remains a sustainable city.

101 Issue 1 Blacktown City Council Guideline example. Other best practice examples include Department of Environment, Water and Natural Resources (2013). Water sensitive urban design- Creating more liveable and water sensitive cities in South Australia, Government of South Australia: Adelaide; and Western Australian Planning Commission (2008). Better Urban Water Management, Department for Planning and Infrastructure (WA): Perth, retrieved from: <http://www.water.wa.gov.au/PublicationStore/first/82305.pdf>.
102 Issue 2 Blueprint2013 and Northern Tasmanian Stormwater Program examples. Other best practice examples include Water By Design, (2011). A business case for best practie urban stormwater management. Retrieved from South East Queensland Healthy Waterways Partnership website: http://waterbydesign.com.au/businesscase/.
103 Issue 10 Aurora Estate integrated approach and Issue 12 The Little Stringybark Creek Project.
104 Issue 6 Wagga Wagga City Council overland flooding and *Brisbane City Council Floodsmart Future Strategy* example.
105 Issue 7 City of Melbourne, City of Sydney and the European Union examples.
106 Issue 17.

Monitoring of the performance of individual interventions to protect water quality, such as WSUD assets, is far less systematic and sporadic. Data collected in this way is also not housed centrally and resides with a variety of custodians. This makes it difficult to draw any firm conclusions about the performance of WSUD assets against their modelled performance.

On opportunity exists with the recent announcement of the ACT Basin Priority Project, which has monitoring as a key first stage of the project. The Australian and ACT governments will be jointly investing in an ACT-wide water quality monitoring program that will build on existing monitoring to measure the effectiveness of the ACT in meeting water quality targets of flows out of the ACT into the Murrumbidgee River and the wider Murray–Darling Basin and to audit the effectiveness of water quality treatment processes, including WSUD assets. This will place the ACT in a position to be able to strategically select and site WSUD assets in the most effective locations to ensure the best water quality and quantity outcomes.

In moving forward with the findings and recommendations in this report, it is important that the ACT Government engages with the community on the outcome of this review. Any future changes to how WSUD is implemented in the Territory requires proactive community engagement that includes education and awareness and also requires positive liaison with industry and technical experts in WSUD practice. Building on and continuing community engagement is fundamental for the education and awareness of both government and stakeholders.

8. Where to from here?

The review considers a suite of issues and proposes a number of actions and recommendations. However these recommendations and actions can be grouped together as projects to ensure they are delivered to meet the ACT Government's commitment to inquire into and report on WSUD regulation in the ACT.

All priority projects must take into the consideration the information that the issues addressed and the recommendations in section 6.

Priority Project 1

EPD leads a revision of the water sensitive urban design provisions in the Territory Plan, supported by a practice guideline to provide for greater clarity and consistency in interpretation as well as to promote innovation and increase flexibility in meeting WSUD targets.

Combining the revision of codes and re-establishing the ACT WSUD guidelines would allow for a more flexible, outcome focus for WSUD. Revision of the WSUD Code and WSUD provisions in the development codes would also ensure that the WSUD is delivering appropriate environmental outcomes for the ACT.

Specific issue recommendations

Issue 1: Currency of the WSUD General Code and promoting innovation

1.1) Carry out a revision of the water sensitive urban design provisions in the Territory Plan, supported by a practice guideline.

1.2) The new practice guideline should be supported by a suite of community education and awareness tools.

Issue 3: Application of the Water Use and Catchment Code

3.1) Review the water use code and include catchment specific requirements for water quality flows etc. that accommodate land use changes and community and stakeholders expectations.

Issue 4: Estate Development Plan Guidelines

4.1) Review the WSUD component of the Estate Development Plan Guidelines to ensure they reflect best practice.

Issue 5: Expanding the range of acceptable on-site options for stormwater retention and detention

5.1) The rules and criteria for on-site retention and on-site detention be revisited as part of the Territory Plan amendment package.

5.2) The proposed new WSUD guideline should clearly articulate the best practice and contemporary design principles which will encourage cost effective innovation.

5.3) Investigate options of formulating requirements at different development scales, including at the neighbourhood scale.

Issue 6: The relationship of WSUD and climate change, including stormwater and flood management

6.1) Revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.

Issue 8: Urban renewal and residential intensification

8.1) The new WSUD guidelines incorporate contemporary best practice principles that support the intent of the Canberra Spatial Plan and the ACT Planning Strategy and AP2 with regard to urban renewal and residential intensification.

8.2) The new WSUD guidelines to take into consideration the requirements of residential intensification and provide merit avenues to look at areas at a precinct-by-precinct basis.

Priority Project 2

EPD, TAMS CMTEDD work together to investigate alternative management and funding models for sustainable maintenance of WSUD assets, informed by a full cost-benefit analysis.

Competing budget priorities will continue to challenge TAMS as the managing agency for much WSUD infrastructure. There has been a significant growth in WSUD assets now in public management which presents a challenge to asset managers to maintain within current budget allocations. The current level of maintenance of assets is due to a lack of funding. However this lack of funding has other consequences that impact the whole lifecycle of a project. Firstly, a lack of resourcing means design advice from line areas is unable to be sought or, if sought, there is no policy or guideline to give weighting to this advice. Secondly, a lack of funding and resourcing has many implications including, but not limited to, an inability to maintain WSUD assets, incapacity to create policy frameworks and guidelines to assist maintenance crews in their ability to maintain these assets, and an incapability of asset management. Thirdly, ensuring design standards are up to date is unable to be carried out if there is no budget allocated to carry out these projects.

Specific issue recommendations

Issue 16: Funding inadequate for maintenance of WSUD assets and hence their performance targets cannot be met

16.1) An overall cost benefit analysis be undertaken for funding models that take into account the whole-of-life costs of WSUD infrastructure.

16.2) Alternative funding and management models for WSUD infrastructure need to be investigated.

Priority Project 3

The ACT Government will encourage WSUD approaches that maximise cost efficiency at the appropriate level (e.g. on-site versus sub-catchment) to minimise impacts on housing affordability in the ACT, as well as the maintenance burden.

It is clear that in new estate developments the management of stormwater and the protection of water quality are expected requirements of best practice development. The management of these issues is distributed between elements on individual blocks and those in the public domain. The size and complexity of WSUD assets depends on the characteristics of the estate or the redevelopment. Modelling is used to design WSUD assets in the public domain and assumes WSUD infrastructure like rainwater tanks are in place and performing detention and retention functions. Without these elements being in place the treatment train would be different and larger in the public domain. It was also observed that some developers invest more than is necessarily required in WSUD infrastructure, such as more elaborately planted swales, in order to enhance the amenity of their developments.

Specific issue recommendations

Issue 9: WSUD and housing affordability

9.1) The ACT Government will encourage WSUD approaches that maximise cost efficiency at the appropriate level (e.g. on-site versus sub-catchment) to minimise impacts on housing affordability in the ACT, as well as the maintenance burden.

Priority Project 4

EPD, subject to available funding, will lead development of a green infrastructure strategy for the ACT as a means of realising the social, economic and environmental values of our green assets including the integration of WSUD assets.

A green infrastructure strategy recognises in a holistic way the multiple benefits of the various components of WSUD, from the individual block scale to the catchment landscape scale in providing environmental, social and economic benefits to the community. Green infrastructure elements are woven through a catchment, from the smaller scale elements that are integrated into sites, such as infiltration beds, rain gardens, rainwater tanks and roof gardens to larger scale elements that span an entire catchment, such as playing fields, swales, large

water quality ponds and bio-retention basins. A green infrastructure strategy would recognise the combined contribution of all these elements and address them in terms of assets that require sustainable maintenance in order to continue to deliver their multiple services.

These services include water quality treatment, flood and climatic amelioration, micro-environment moderation, air quality improvement, recreational and aesthetic space as well as habitat improvement. Green infrastructure is also important in climate change adaptation, carbon sequestration and the urban heat island effect.
This project should also integrate and inform design standards for urban open space and related aspects.

Specific issue recommendations

Issue 6: The relationship of WSUD and climate change in particular to stormwater and flood management

6.1) Revisit and reframe the stormwater quantity and quality targets on a sub-catchment basis using data and capability generated by the ACT Basin Priority Project.

Issue 7: Green infrastructure strategy

7.1) The ACT Government develop a green infrastructure strategy, recognising the multiple and cross-sectoral benefits.

Priority Project 5

TAMS continues its review of design standards for urban WSUD and related infrastructure.

There is a need to review and update the design standards for urban infrastructure. There is an opportunity to consider the merits and challenges associated with the development of WSUD asset specific design standards which could improve the consistency and reliability of WSUD assets in the ACT and identify these as different from other stormwater drainage infrastructure.

A review for design standards for urban infrastructure has commenced and the highest priority design standards are being addressed.

Other jurisdictions have adopted strategic approaches to stormwater management plans at a regional level which have helped to inform more specific guidelines that are applicable to the locality and jurisdiction. Adopting a similar concept will help inform the design standards to ensure they are trying to achieve the objectives and intent of WSUD rather than a process or obligation.

Specific issue recommendations

Issue 2: Design Standards for Urban Infrastructure

2.1) Review and update WSUD related design standards to reflect contemporary best practice in an ACT context.

Priority Project 6

EPD leads the development of a water quality and flows modelling and monitoring program, focusing on understanding the performance of WSUD assets against modelled results and building internal capacity within the ACT Government in modelling and monitoring.

The ACT Government has secured funding for the monitoring of six urban catchments. However the issue of lack of in-house stormwater modelling capabilities and limited access to related software, training and professional development is an issue.

Specific issue recommendations

Issue 11: Lack of in-house stormwater modelling skills and capacity

11.1) The ACT Government seek to establish a community of practice between government, industry and science around stormwater modelling and the application of WSUD in the Territory.

11.2) The ACT Government adopt the eWater MUSIC-link program and a guideline to the use of MUSIC and stormwater modelling in the ACT.

Issue 12: Water quality monitoring data to provide feedback loop for future designs, maintenance planning and operation of WSUD measures

12.1) The ACT Government continues to support the development and delivery of an appropriate water quality monitoring program with the assistance of the ACT Basin Priority Project to assess the behaviour of catchments and the performance of individual WSUD assets and as part of treatment trains.

12.2) EPD convene an annual review workshop on water quality data with key stakeholders to assess the outcomes of monitoring data and recommend directions for further work.

Priority Project 7

EPD, through the ACT Environment Protection Authority, review the Environment Protection Guidelines for Construction and Land Development in the ACT (2011) and continue to work with the construction industry to improve their performance in erosion and sediment control during the building construction phase. EPD also investigate building certifiers to ensure compliance with site management requirements, including erosion and sediment control.

Specific issue recommendations

Recommendations for Issue 15: Regulation and compliance on erosion and sedimentation

15.1) Environment Protection Regulations to be amended to include offences for non-compliance with approved erosion and sediment control on sites subject to an Environment Protection Agreement.

15.2) Investigate requiring building certifiers to ensure compliance with site management requirement, including erosion and sediment control.

Priority Project 8

CMTEDD leads the development of a guideline to inform the effective transfer of ACT Government owned WSUD infrastructure from construction to management.

The handover processes for assets during the development and construction phase is currently being reviewed between various key stakeholders such as CMTEDD, LDA, EPD and TAMS. There is opportunity to consider a staged handover policy framework for different assets to guide developers and government asset owners and managers through the land and construction phases of development. This will help processes within government and private developers and consequently the community to ensure WSUD measures are appropriately protected, managed and implemented to ensure their sustainable viability. Clarification of the staging of development will promote better economic and environmental outcomes, reducing the cost of development and ensuring the appropriate performance of WSUD infrastructure.

Specific issue recommendations

Issue 10: Selection of the most appropriate stormwater treatment measures

10.1) The ACT Government develops a handbook to guide staged development and handover processes.

Issue 13: Soil stabilisation techniques in developments

13.1) Review Environment Protection Guidelines for Construction and Land Development in the ACT (2011) to strengthen the way erosion and sediment control is staged.

13.2) The Planning and Development Forum be used as a stakeholder consultation to engage with the building industry on effective soil stabilisation.

13.3) The new guidelines should require erosion and sediment control measures are to be established during either the capital works or estate development phase by civil contractors and left in place for the house construction phase until house construction is largely complete (up to 85% development as a guideline).

Issue 14: Handover and responsibility of erosion and sediment control mechanisms

14.1) As stated above, the ACT Government develop a handbook to guide staged handover processes. It is to deal with:

- Erosion and sediment control between the land and construction phase and the building and development phase.
- Consider the siting of temporary erosion and sediment control ponds in open space or areas that do not need to be developed immediately.

14.2) The option be explored that developers undertake GPT clean-out during the building development stage until 85% of the catchment area is built.