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Contents

1 Introduction 4

1.1 Project context 4

1.2 Project objectives and scope 5

1.3 Key project considerations 6

1.4 Key project stakeholders 6

2 Approach 8

2.1 Investigation of benchmarking and current performance 8

2.2 Development of draft options for WSUD Code amendment 8

2.3 Development of final options for WSUD Code amendment 8

3 Jurisdictional water saving initiatives and compliance review findings 9

3.1 National 9

3.2 New South Wales 10

3.3 Victoria 10

3.4 South Australia 11

3.5 Western Australia 12

3.6 Queensland 13

3.7 Tasmania 13

3.8 Northern Territory 13

4 ACT WSUD principles, benchmarking and calculator review findings 15

4.1 Canberra water use targets and the Waterways WSUD General Code 15

4.2 Key findings from ACT water use studies and reviews 15

4.3 Pre-2003 water consumption in the ACT and water savings calculators 16

5 ACT Waterways WSUD General Code amendment options 18

5.1 Initial water saving possibilities identified 18

5.2 Ease of implementation and potential barriers 19

5.3 Feedback from workshop participants on initial water saving option suggestions 20

5.4 Revised options for further investigation 21

6 Final proposed revisions to the ACT Waterways WSUD General Code 23

6.1 Modelling assumptions 25

6.2 Potable water savings 28

6.3 Calculator limitations 31

6.4 Recommendations for rainwater harvesting 31

7 City-wide potable water savings, cost estimates and implementation plan information 33

7.1 Option 1 – Change the minimum roof area connected to rainwater tanks to 75% 36

7.2 Option 2 – Rainwater harvesting and reuse for compact blocks (<250 m²) 40
7.3 Option 3 – Rainwater tank installation: certified plumbing connections, pumps and diverters 44
7.4 Option 4 – Rainwater tank maintenance: pumps and diverters replacement program 48
7.5 Option 5 – Include a maximum12L/min flow requirement for outdoor plumbing fixtures 52
7.6 Option 6 – Mandatory minimum 4-star WELS ratings for plumbing fixtures 56
7.7 Option 7 – Combination of options 5 and 6 (demand management) 60
7.8 Option 8 – Combination of options 1, 2, 3, 4 (source substitution) 64
7.9 Option 9 – Combination of options 3, 5 and 6 (plumbing certification focus) 68
7.10 Option 10 – All options combined 72

Figures

Figure 1. *Total Water consumption per capita for the ACT, Sydney and Melbourne* 4

Tables

Table 1. Savings achieved from demand management measures in the ACT (Fyfe et al., 2011) 15
Table 2. Water consumption in the ACT from the WSUD General Code, a UTS 2011 study (Fyfe et al., 2011) and the ACT water savings calculators 16
Table 3. Combinations of options in the ACT water savings calculators that will reduce mains water use by greater than 40% compared to an equivalent development constructed in 2003 17
Table 4. Modelled water savings arising from each of the options described above, and savings arising from scenarios of combinations of options 18
Table 5. Feedback from workshop participants on initial water saving option suggestions 20
Table 6. Revised options for potential water savings able to be driven through amendments to the WSUD General Code 21
Table 7. Revised options for potential water savings able to be driven through amendments to the WSUD General Code 22
Table 8. Summary of draft final water saving options and recommended changes to the existing WSUD code and other documents 23
Table 9. Modelling assumptions for each scenario/option. 25
Table 10. Assumptions – People per dwelling, and areas for roof, POS and planting for different block sizes 26
Table 11. Assumption for people per dwelling, POS and garden bed area for apartments 27
Table 12. Potable water savings for new houses (not including apartments) in ACT assuming 1,000 new stock each year (30 % compact, 50 % mid-sized and 20% large blocks). 29
Table 13. Potable water savings for new dwellings (apartments) in ACT assuming 1,000 new stock each year 30
Table 14. Functionality in calculator to vary household water usage 31
Table 15. Potable water savings from 2020 to 2060 and associated Net Present Cost for each option 33
Table 16. Costing assumptions 34

1 Introduction

1.1 Project context

In response to climate change and a growing population, the ACT Government is committed to reducing potable water use, increasing water quality and controlling storm water flows. In response to this commitment, the ACT Government adopted a Water Sensitive Urban Design (WSUD) approach encompassing the following principles:

- Reducing the demand for potable water through the proliferation of alternative water sources (rain, treated wastewater) and facilitating the use of water efficient fixtures and appliances
- Minimising the generation of wastewater
- Treating urban storm water and wastewater for re-use and/or release
- Using stormwater to improve environmental aesthetics and recreation

WSUD addresses city planning to optimise water use, flows and capture to protect the environment, community and future. As part of this approach, the ACT Water Sensitive Urban Design Code was established, with the aim to achieve a 40% reduction of water use on 2003 levels. As of 2018, the ACT Government had met this requirement; however, despite this success, the average yearly water use per person for ACT residents remains above the water consumption targets of other major cities such as Melbourne under their own WSUD aspirations. Figure 1 shows the ACT water usage per capita compared to Melbourne. Note that the ACT component covers all uses (residential, commercial and recreational facilities etc.) while the Melbourne targets are residential and commercial only. However as approximately 65% of the ACT use is residential (70 kilolitres per capita per annum), there is a challenge for the ACT to investigate industry best practice approaches to the aspirations of matching the water use levels of other cities.

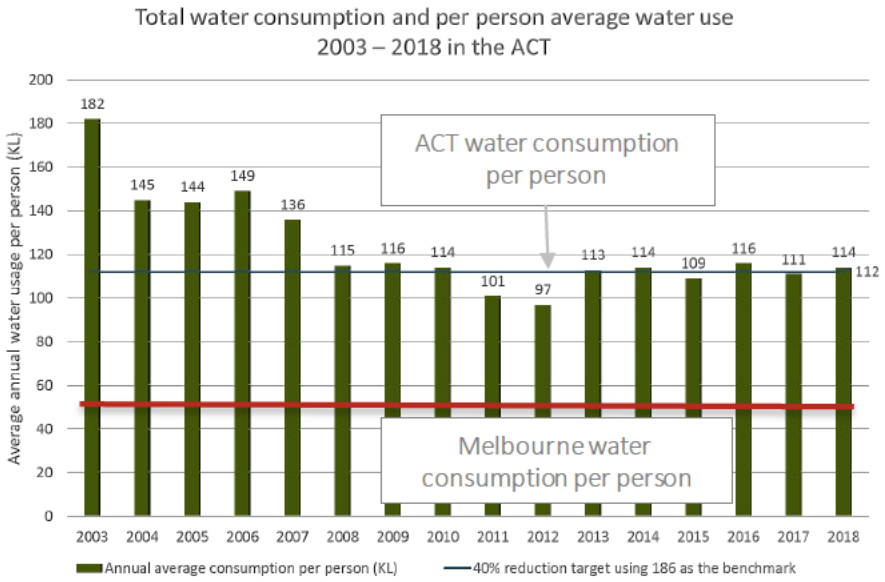

Figure 1. *Total Water consumption per capita for the ACT, Sydney and Melbourne*

Practices that the ACT could explore to bridge this gap include (but are not limited to):

- Application of enhanced water efficiency modelling tools – The ACT Government could undertake further investigations to ensure local environmental conditions are appropriately reflected in modelling tools used for the assessment of urban development on water use and water quality.

- Applying industry best practice to WSUD application technologies – Investigating new technology in anthropogenic and natural hydrological flow harvesting; new architectural design in land-use planning along with wastewater recycling and other sustainable technologies.
- Amending and Expanding the ACT's Permeant Water Conservation Measures to Reflect Industry Best Practice – Permanent water conservation measures that apply to the use of potable water were brought in to replace water restrictions. The intention of these measures is to avoid unnecessary water waste and save water for the future by encouraging a 'common sense' approach to water use. The measures primarily address how residents and business in the ACT can use water with respect to their gardens, lawns, pools, cars and cleaning. The ACT Government could work with the community to ascertain the best approach to conserving water.
- Exploring policy and financial incentives to promote WSUD – To increase potable water saved in the ACT region, it is important to maximise the ability of developers to contribute to water saving initiatives. In 2014, the ACT Government undertook community consultation regarding the Water Sensitive Urban Design Codes and received comment suggesting an offset scheme be in place to increase flexibility in how water sensitive urban design could be achieved in the region. For example, Melbourne Water's offset scheme allows developers that cannot meet water quality/flow targets (on site) to pay the equivalent of the unmet targets into a fund used to construct WSUD assets at a catchment scale. The lack of economic reward may act as a disincentive for those encouraged to install water saving technologies and, as such, the ACT Government could investigate the role of market-based incentives to drive the uptake of innovative solutions.

1.2 Project objectives and scope

The Government's Environment, Planning and Sustainable Development Directorate (EPSDD) sought to investigate the potential water savings from a revision of the ACT Waterways Water Sensitive Urban Design General Code. The Code was last reviewed in 2014, but changes to the Code arising from recommendations of that report were only finalised in 2019.

The 2014 review focussed primarily on water quality outcomes. This project is investigating the feasibility of using the ACT Waterways Water Sensitive Urban Design General Code as a policy mechanism for reduction in mains water use. The objective of the project is to conduct a feasibility study investigating the quantum of potential water savings through revision of the Code.

Findings from the study will potentially inform an application to the Australian Government for funding under the Murray-Darling Basin Water Efficiency Program. One of the key elements of the Basin Plan is the recovery of an additional 450 GL per year through 'efficiency measures', which operate to decrease the quantity of water required for consumptive uses compared with the quantity required under benchmark conditions.

Some key points and conditions regarding efficiency measures projects under the MDBWI Program are shown below:

- Water recovered for the 450GL of efficiency measures must be done in a way that has neutral or positive social and economic impacts as defined in Section 7.17(2)(b) of the Basin Plan and pursue the environmental outcomes as set out in Schedule 5 of the Basin Plan.
- Every project must transfer an agreed volume of water to the Commonwealth. The Project Partner will be required to facilitate the transfer of the water entitlements agreed to be provided to the Commonwealth. This agreed water entitlement transfer must be no more than the Project's conservative or minimum technically feasible water savings.
- Additional water savings will be retained by the Participant.
- The minimum water saving to be transferred to the Commonwealth for an individual project is 100 ML of Eligible Water Rights.

- Project Partners with water rights but not entitlements can apply with water volumes and details about the water rights, and a proposed process for conversion to entitlements. This would be subject to agreement by the relevant water authority.
- The Department will offer a maximum project payment of 1.75 times the value of water entitlements being offered in return for funding from the Commonwealth for the project.

Current net water extraction in the ACT is significantly below the long-term average SDL, by between 15 and 20 GL/yr. The ACT government therefore has the opportunity to consider transfer of water entitlements to the Commonwealth in return for funding for water efficiency measures and related projects. In doing so, the volume of water entitlement transferred to the Commonwealth would in principle be recovered through reduced future growth in urban and non-urban water use.

1.3 Key project considerations

The WSUD general code and WSUD components of the Single Dwelling House Code are applicable to any land use that triggers a development approval. Investigations in this project of potential amendments to the WSUD code and WSUD components of the Single Dwelling House Code to improve water use efficiency focus on actions and requirements at the block level, not street or suburb level. There was also a need to consider what measures can be made mandatory without being overly onerous on the land development and construction industries.

Potential changes to community behaviour to reduce potable water use are being investigated and actioned through a separate ACT Government project.

A request for water use data was made by the ACT Government to Icon Water, and Alluvium provided input to the request to ensure it covered all potentially useful data for the project.

Case studies in Canberra and other jurisdictions were also considered with respect to WSUD code and policy:

- compliance through a range of approaches from education to active enforcement
- certification processes
- savings achieved

The ACT Government is keen to understand the level of confidence around modelled water savings. This comprises two areas of uncertainty; i) the level of certainty around the modelled water saving from a particularly WSUD code requirement and ii) the level of understanding and certainty around compliance with the code on the ground.

1.4 Key project stakeholders

A list of key project stakeholders is shown below. Representatives from these organisations are being contacted as part of the project investigations and invited to provide input and advice and participate in project workshops.

1. Suburban Land Agency
2. City Renewal Authority
3. Building inspectors (e.g. Master Builders Association)
4. EPSDD (Living infrastructure)
5. Housing affordability
6. Construction companies and groups
7. Developers (e.g. Airport Group, Riverview Group, Doma)

Primary stakeholder ACT Government contacts are shown below:

- Noreen Vu, Road Maintenance, TCCS (WSUD Code Review) - noreen.vu@act.gov.au 6205 0746
- Phil Prentice, Road Maintenance, TCCS (WSUD Code Review) - Philip.Prentice@act.gov.au 6205 4997
- Patrick Paynter, Principle Planner/Engineer, Infrastructure Planning, EPSDD (WSUD Code calculators) - Patrick.Paynter@act.gov.au 6207 2434
- Danswell Starrs, EPSDD (general water information) Danswell.Starrs@act.gov.au 6207 7032
- Nandhini Nagaratnam, EPSDD (Living Infrastructure Plan) Nandhini.Nagaratnam@act.gov.au 6207 7140
- Reuben Gaze, EPSDD (reactive compliance monitoring) Reuben.Gaze@act.gov.au 6207 6282
- Emma Humphreys, EPSDD (Sustainability/demand management programs in the ACT) - Emma.Humphreys@act.gov.au 6207 5532
- Chris Webb, Suburban Land Agency (Greenfield development) 6207 6824 chris.webb@act.gov.au
- Nicola Plunkett-Cole, City Renewal Authority (City Infill Development) 02 62076712 nicola.plunkett-cole@act.gov.au (back-up contact Cindy Cantamessa, Cindy.Cantamessa@act.gov.au)
- Rumana Jamaly, EPSDD (Development Applications) 6207 1830 rumana.jamaly@act.gov.aub
- Peter Rowed, Living Infrastructure Plan - Peter.Rowed@act.gov.au 6205 9669.

The following have been identified as potential industry and other contacts but haven't been briefed on this project:

- Peter Wright, Construction Control – Developer (pwright@ccontrol.com.au)
- Nick McDonald Crowley, Capital Estate Developments – Developer (n.mcdcrowley@capitalestate.com.au)
- Stephen Harding, Ginninderry – Developer (stephen.harding@ginninderry.com)

2 Approach

2.1 Investigation of benchmarking and current performance

All codes in the ACT that contained specific WSUD requirements were reviewed in order to determine water saving benchmarks used and water saving options proposed. Previous studies undertaken in the ACT on the application, uptake, current performance of water saving/substitution measures were also reviewed.

Water reduction targets used by other jurisdiction in Australia were reviewed and practices and interventions, including those around compliance monitoring, that appeared to be having the greatest impact were identified. Finally, the water saving calculators used in the ACT were investigated in detail to understand the formulas and assumptions used in the underlying models and estimate their likely impact on actual water consumption in new developments in the ACT. This included identifying baseline (pre 2003) water use per household and per capita.

Key stakeholders in the ACT Government were asked to provide responses, as appropriate and possible, to questions arising from these reviews.

2.2 Development of draft options for WSUD Code amendment

From the reviews, and responses to questions arising, including information on the likely and actual uptake and performance and effectiveness of water demand management or substitution measures, and compliance and monitoring approaches and trends in land development and building practices in the ACT and elsewhere, amendments to the ACT Waterways General WSUD Code that would potentially increase water savings were identified.

Mains water substitution and demand management options such as more water efficient fixtures and appliances, inclusion of rainwater harvesting on compact blocks, plumbing certification for rainwater tank installation were investigated. Likely savings were calculated at dwelling and city-wide scale using the existing ACT Single Residential water saving calculator. An ACT Government stakeholder workshop was held on the 28th of November at which findings from the reviews were presented, along with summaries of initial WSUD code amendment options identified, including modelled water savings. The workshop was attended by Chris Glennon (EPSDD Project Team), Miranda Gardner (EPSDD Project Team), Sarah Crisp (EPSDD Project Team), Reuben Gaze (EPSDD – reactive compliance monitoring), Nicola Plunkett-Cole (City Renewal Authority – City Infill Development), Rumana Jamaly (EPSDD – Development Applications), Philip Prentice (TCCS – Manager Dams), Guna Seelan (SLA), Nic Morgan (SLA), Greg Burghardt (SLA).

2.3 Development of final options for WSUD Code amendment

The objectives of the ACT Government stakeholder workshop were to discuss key considerations associated with each option, identify potential barriers to implementation and understand the ease of incorporation into existing management approaches and arrangements. Options were rephrased or eliminated, and new possibilities identified, as a consequence of input from attendees at the workshop.

The revised options were distributed for comment to Peter Wright (Construction Control), Nick McDonald Crowley (Capital Estate Developments) and Stephen Harding (Riverview/Ginninderry) and presented to ACT Government stakeholders at a mini workshop on 17 January 2020. This mini-workshop was attended by Chris Glennon (EPSDD Project Team), Miranda Gardner (EPSDD Project Team), Rumana Jamaly (EPSDD – Development Applications), Emma Humphrys, Nandhini Nagaratnam, Stephanie Pret, Patrick Paynter and Lucinda Berri

Following these stakeholder engagements, the options for potential amendments to the ACT Waterways WSUD General Code were revised and refined and are described in greater detail in this report. Estimated potable water savings were calculated in greater detail, including the projected savings per annum over 40 years taking into account combinations of options and likely decays in water savings. The approximate cost of implementing each option, to government and to the building industry/residential building customers, was also estimated, and key considerations, risks and any secondary benefits documented (see Section 7).

3 Jurisdictional water saving initiatives and compliance review findings

The findings from the following review have been used to inform the suggested amendments to the code in Section 5.

3.1 National

Unless otherwise amended, the National Construction Code (NCC) 2016 Plumbing Code of Australia Volume Three – Part B1, states that the following minimum requirements must be met in all new buildings nationwide:

- A cistern or flushing valve used for the purpose of flushing a water closet pan must have a dual flushing mechanism that, when operated, discharges
    - for a 6/3 litre cistern—
        - not less than 5.5 litres and not more than 6.5 litres for a full flush; and
        - not less than 3.0 litres and not more than 3.5 litres for a reduced flush; and
    - for a 4.5/3 litre cistern—
        - not less than 4.3 litres and not more than 4.7 litres for a full flush; and
        - not less than 2.8 litres and not more than 3.2 litres for a reduced flush.
- The volume of water discharged to a flush urinal must not exceed 2.5 litres for each—
    - single urinal stall; or
    - 600 mm length of a continuous urinal wall, or part thereof.
- Automatic or set-cycle cisterns must not be installed.
- The outlet of a shower, basin, kitchen sink or laundry trough must have a maximum flow rate of not more than 9 litres per minute.

This is the equivalent of a 3-star WELS rating for toilets, tap fittings and fixtures, and a 2-star WELS rating for urinals.

With respect to water efficiency in residential buildings, we note the policy position of Housing Industry Australia (HIA) includes the following:

- Where regulation is necessary to achieve water efficiency in housing, HIA supports minimum necessary regulations being applied through the National Construction Code (NCC), the Plumbing Code of Australia (PCA) and associated standards referenced by the PCA.
- Any new water efficiency regulations must be developed according to the Council of Australian Governments' principles for best practice regulation.
- Building standards for water efficiency should not be incorporated into planning regulations. Any state-based regulations should be pursued through a variation to the NCC, justified through a detailed regulation impact assessment, and based on a proven difference due to geographical, geological or climatic conditions.
- HIA supports options and incentives to achieve improved water efficiency however, HIA does not support the mandatory provision of water tanks to residential buildings in metropolitan areas or a requirement for the tank to be connected to the house.
- Federal and State governments should provide appropriate support for the upgrading and development of new water infrastructure which will deliver additional water supply, is more water efficient in design and delivery, and reduces the demand on potable water supplies for non-potable uses.

- Federal and State governments should coordinate rebates to existing and new homeowners for the voluntary installation of improved hot water services, rainwater tanks and other alternative water saving technologies.

3.2 New South Wales

The Building and Sustainability Index (BASIX) scheme is the main State Environmental Protection Policy (SEPP) related to WSUD in NSW. For all new residential developments and redevelopments, the BASIX tool requires up to a 40% reduction in potable mains water use compared with an average NSW residential annual water consumption of 247.5 litres per person per day. The reduction target varies across NSW depending on location. In general, locations with higher annual rainfall (closer to the coast) are required to comply with a 40% reduction.

It is mandatory across NSW that a BASIX certificate is obtained and lodged with all development applications for a new home or alteration/additions to an existing home greater than $50,000 in value. This certificate is obtained following the completion of the BASIX assessment online tool.

A BASIX completion receipt is issued by a certifying agency following a final inspection, certifying that the project has been completed in accordance to the BASIX certificate. An occupancy certificate will not be issued until the BASIX completion receipt has be issued.

The BASIX Water Savings Monitoring for 2010-11 report has indicated that BASIX dwellings are achieving close to or are on the 40% reduction target.

The BASIX compliance audit report program report found that "for the majority of BASIX plan-marking elements, compliance standard can generally be described as fair to good". Plan-marking compliance was particularly high for rainwater tanks and water heaters.

3.3 Victoria

Under the Housing Design Guidelines 2018, requirements applied to the construction, redevelopment and design of new low-rise public housing dwellings include a minimum 3-star WELS rated shower head, tapware, faucets (for all mains pressure hot and cold-water systems) and a duel flush toilet.

Currently the Victorian Government has a rebate scheme (Victorian Energy Saver) in place, providing a discount or rebate to upgrade any existing inefficient (less than 3 stars) shower head to one of 3 stars or greater.

All new houses and apartments, all relocated homes and all alterations to existing homes in Victoria must meet the energy efficiency and water management requirements of the 6-star standard. According to the Victorian Building Authority, Victorian variations to the energy provisions of the Building Code of Australia require new Class 1 buildings (which include single dwellings) to either:

- install a rainwater tank that is connected all the sanitary flushing systems, or
- a solar water heater system.

When it comes to rainwater tanks, the 6-star standard says that tanks must:

- be able to receive rainfall from a minimum catchment area of 50m^2
- have a minimum capacity of 2000 litres

be connected to all toilets in the building for sanitary flushing

A cost benefit analysis performed by ACIL Tasmin found over a 10-year period that solar hot water heaters had a cost benefit ratio of 1.2 to 1.8 compared to 0.8 to 1.2 for rainwater tanks. It is suggested that this has driven more builders to opt to install a solar hot water system over that of a rainwater tank.

Victoria has a state-wide voluntary water consumption target of 155 Litres/person/day in place for mains water consumption.

Permanent water saving measures are in place in Victoria for outdoor use. These rules include:

- Water from a hand-held hose must not be used for any purpose (whether or not the use is subject to a permanent water saving rule) at any time unless the hose is fitted with a trigger nozzle and leak-free.
- A residential or commercial garden or lawn cannot be watered except with a hand-held hose, bucket or watering can at any time; and a watering system between the hours of 6 p.m. – 10 a.m. on any day.
- Water cannot be used to clean hard surfaces (including, driveways, paths, concrete, tiles, timber decking), except:
    - Where cleaning is required as a result of an accident, fire, health hazard, safety hazard or other emergency;
    - If staining to the surface has developed, and then only once a season;
    - In the course of construction or renovation,

  And then, only by means of:
    - A high-pressure water cleaning device; or
    - If such a device is not available, a hand-held hose or a bucket.

Between 2003 and 2008 a series of rebate programs, such as the Water Smart Gardens and Home Rebate Scheme, provided financial incentives for individuals to buy water-efficient appliances and a variety of household fixtures and products. Rebates could be received for the following:

- rainwater tanks
- dual-flush toilets
- water-efficient showerheads
- connecting a toilet to a rainwater tank
- installing a permanent greywater system
- hot water recirculators
- other small household goods that promote water efficiency (including garden mulch, shower and garden tap timers, tap flow reduction devices, compost bins).

The Water Smart Gardens and Home Rebate Scheme is estimated to have saved 2.4 GL/Year.

3.4 South Australia

The Technical manual for water-sensitive urban design in Greater Adelaide, specifies that new houses and house extensions greater than 50 square metres are required to install an additional water supply, supplementary to mains water. This must be plumbed to a toilet, a hot water heater and/or all cold-water outlets in the laundry prior to the house being occupied. If a rainwater tank is used to satisfy this requirement, it must be no less than 1000 litres and must be additional to any other tanks required e.g. tanks for bushfire fighting purposes.

In 2003, permanent water conservation measures were introduced across South Australia, including the following restrictions:

- Public or private gardens, recreational areas, sports grounds or nurseries can be watered:
    - by hand (through a handheld hose, from a bucket or watering can)

- through a drip-feed irrigation system
- where the watering takes place through a sprinkler – after 5pm and before 10am on any day (or, when daylight saving is in force, after 6pm and before 10am).

- No hosing down of external paved areas with water at any time is permitted unless it is absolutely necessary to do so.
- Water must not be used to clean a motor vehicle or boat unless the water is applied:
  - from a bucket or watering can filled directly from a tap
  - by a high-pressure low volume water cleaner
  - from a handheld hose that is fitted with a trigger nozzle.
- Motor vehicles or boats can be cleaned at a commercial car wash or by means of an automatic washing system that recycles water. Boat motors may be flushed or rinsed after use.

The NCC amendments for South Australia require an energy efficiency assessment to be undertaken. This assessment includes a section on water heater efficiency, requiring all water heaters installed to be low emission and all connected shower outlets to be a minimum of a 3-star WELS rating or have a flow restrictor installed.

3.5 Western Australia

The Western Australia State Water Plan sets a state-wide consumption target of less than 100kL/person/year, reducing total residential use by 20% from 2001 levels. This consumption target is also replicated in the Better Urban Water Management (WAPC 2008) framework.

Permanent water efficiency measures (PWEMs) are in place to ensure best practice for the efficient use of outdoor water use.

- Scheme water users and domestic garden bores in Perth metropolitan and the South West (including Albany) between 1 September and 31 May each year watering permitted once per day two days a week for scheme water users and three days a week for domestic bore users before 9 am or after 6 pm.
- A permanent winter sprinkler ban applies to scheme and domestic garden bores in the Perth metropolitan area and some parts of the South West from 1 June to 31 August each year.
- Domestic garden bores in other regional areas in Western Australia can irrigate once every day before 9 am or after 6 pm. Scheme water users are restricted to watering once on the rostered day described in the Water Services Regulations 2013 before 9 am or after 6pm.

The 'National construction code – amendments for Western Australia' states the following:

- All tap fittings other than bath outlets and garden taps must be a minimum of 4 stars WELS rated
- All showerheads must be a minimum of 3 stars WELS rated
- All sanitary flushing systems must be a minimum of 4 stars WELS rated dual flush
- An outdoor private swimming pool or spa associated with a Class 1 building must be supplied with a cover, blanket or the like that
  a) is designed to reduce water evaporation
  b) is accredited under the Smart Approved Watermark Scheme governed by the Australian Water Association, the Irrigation Association of Australia, the Nursery and Garden Industry Australia and the Water Services Association of Australia.

- All internal heated water outlets (such as taps, showers and washing machine water supply fittings) must be connected to a heated water system or a re-circulating heated water system with pipes installed and insulated in accordance with AS/NZS 3500: Plumbing and Drainage, Part 4 Heated Water Services. The pipe from the heated water system or re-circulating heated water system to the furthest heated water outlet must not be more than 20 m in length or 2 litres of internal volume.

3.6 Queensland

With respect to building requirements, all class 1 and 2 buildings that are serviced by a water service provider, are required to install water efficient toilets and taps under the Queensland Development Code (QDC) (Part 4.0 Building Sustainability, MP 4.1) whereby:

- all shower roses have a minimum 3-star WELS rating.
- tapware for laundry tubs, kitchen sinks and basins have a minimum 3- star WELS rating, and
- all toilet cisterns:
    - have a dual flush function and be a minimum 4-star Water Efficiency Labelling and Standards rating
    - are compatible with the size of the toilet bowl to allow for proper functioning of the toilet.

The requirement to install water tanks in Queensland under MP4.2 of the QDC was revoked in 2013. Councils that are able to demonstrate that the targets under MP4.2 will deliver 'net benefit to the community' may opt in to reinstate the targets in their local government area.

All new and replacement garden irrigation systems in areas serviced by a water service provider must comply with the Efficient Irrigation Water Conservation Guideline. An efficient irrigation system must have the following features:

- a network of permanent piping connected to emitters which has been designed and installed to water a specific landscape area
- the maximum output capacity of each emitter within the irrigation system must not exceed 9 litres/min
- the irrigation system must be fitted with either:
    - a manual timer with a maximum range of two hours; or
    - an automated timer, used with a soil moisture sensor or rain sensor to prevent the system operating during rain or where the soil already holds adequate moisture to sustain plant growth
- where dripline is used it must be pressure-compensated and consist of permanent plastic tubing which has inline or internal emitters (inside the hose) spaced at regular intervals of at least 30 cm
- drippers may only be used for lawn irrigation where certified by a Certified Irrigation Professional
- the use of an efficient irrigation system must be in accordance with the operating requirements and watering times determined by the QWC (for SEQ) or by the local Council (for residents outside SEQ).

3.7 Tasmania

With the exception of requirements listed under the NCC, no further water efficiency requirements were found to be documented for Tasmania.

3.8 Northern Territory

With the exception of requirements listed under the NCC, no further water efficiency requirements were found to be documented for the Northern Territory.

In Kathrine compulsory water conservation measures have been implemented to reduce pressure on groundwater supplies. These measures include:

- Odd numbered properties can only water three days a week on Mondays, Wednesdays and Saturdays from 6pm to 8am.
- Even numbered properties can only water three days a week on Tuesdays, Thursdays and Sundays from 6pm to 8am.
- No watering on Fridays.
- No watering of hard surfaces such as concrete or paved driveways, footpaths, street gutters and road areas.

4 ACT WSUD principles, benchmarking and calculator review findings

4.1 Canberra water use targets and the Waterways WSUD General Code

The Waterways WSUD General Code in the ACT applies to all new development and redevelopments, including single residential dwellings, residential estates, multi-unit developments and commercial, institutional and industrial development. It specifies a water use target for the ACT that comprises a reduction in mains water consumption of 12% compared with pre-2003 levels by 2013 and 25% by 2023.

Actual water consumption per household in the ACT fell by approximately 33% between 2003 and 2010 (Fyfe et al.). In their 2018-19 annual report, Icon Water state that since November 2010, per capita water consumption in Canberra and Queanbeyan has consistently been 35 – 40 per cent below consumption levels experienced before the introduction of water restrictions in 2002.

To help maintain achievement of this target, the Waterways WSUD General Code requires that new developments show a minimum 40% reduction in potable water consumption compared to an equivalent development constructed in 2003. This target applies to commercial, institutional and industrial developments also. Typical solutions proposed in development applications for mains water reduction tend to focus on fixtures and fittings first, then rainwater tanks, then greywater. Estate-scale greywater solutions are basically not applied in the ACT owing to health concerns and licencing and operations and maintenance requirements.

While a minimum water efficiency rating for plumbing fixtures is not a requirement specified in the development codes (except Option A for compact blocks in the Single Dwelling Housing Development Code), the checklists to calculate mains water reduction requires a minimum 3-star rating to be included to achieve a 40% reduction. Most DA applications also include water efficient dishwashers and washing machines, but these appliances are mostly provided by the owners and there is no guarantee the appliances included in the checklist at development approval stage will be installed by the owners. There are currently no regulations in the ACT regarding the sale of water efficient fixtures (and appliances). However, there are few, if any, 2- or 1- star appliances on the market in the ACT.

There is currently no requirement in the ACT to separate washing machine and bathroom drainage from the remainder of the wastewater system in new houses. However, there is a requirement to separate water supply to toilets and washing machines. Certifiers are not required to check whether household plumbing, fixtures and appliances are compliant with the Waterways WSUD General Code (i.e. a 40% reduction in mains water use compared with an equivalent dwelling in 2003 is demonstrable).

Commercial and institutional developments don't appear to be proposing to use rainwater or greywater for indoor cooling purposes. However, large developments (e.g. estate developments) usually incorporate a 50% roof area connection to rainwater tanks as part of their plans.

4.2 Key findings from ACT water use studies and reviews

A UTS study of changes in water consumption in the ACT in 2010 found that demand management measures had achieved savings close to that anticipated by the ACT Government, with low variation amongst participants (Fyfe et al., 2011). Source substitution had also achieved savings but not as much as previously estimated and with high variation amongst participants.

Table 1. Savings achieved from demand management measures in the ACT (Fyfe et al., 2011)

	Average Savings (Litres/hh/day)	Confidence interval (Litres/hh/day)	Coefficient of Variation (%)
WaterSmart Homes			
WaterSmart Homes All	71	10	14%
WaterSmart Homes 1 Showerhead	60	14	23%
WaterSmart Homes > 1 Showerheads	81	14	17%

	Average Savings (Litres/hh/day)	Confidence interval (Litres/hh/day)	Coefficient of Variation (%)
Rainwater tanks Rebate			
All	46	16	35%
Indoor	74	38	51%
Outdoor	18	23	128%
Indoor and Outdoor	60	42	70%
Dual Flush Program			
Dual Flush All	86	27	31%
Dual Flush 6-L toilets	97	30	31%
Dual Flush 4.5-L toilets	41	58	141%
ToiletSmart			
ToiletSmart All	86	9	10%
ToiletSmart 1 toilet	84	10	12%
ToiletSmart > toilets	93	19	20%

4.3 Pre-2003 water consumption in the ACT and water savings calculators

When building, redeveloping or significantly extending a property in the ACT, the manner by which a 40% water efficiency target (reduction from pre-2003 water consumption levels in an equivalent development) will be met needs to be demonstrated. Calculators are provided to identify how the water efficiency target can be met for single residential dwellings, commercial developments and multi-unit developments. The calculators have been designed specifically for the Canberra region using local water usage statistics, rainfall data and watering requirements.

Table 2 shows the baseline (pre-2003) water consumption in the ACT specified in a) the WSUD General Code, b) a UTS study of changes in water consumption in the ACT (Fyfe et al., 2011) and c) the ACT online water savings calculators. Using the calculators, a 40% reduction from consumption pre 2003 equates to a usage of approximately 150 L/pp/day.

Table 2. Water consumption in the ACT from the WSUD General Code, a UTS 2011 study (Fyfe et al., 2011) and the ACT water savings calculators

		Baseline reference potable water consumption (pre-2003)		
		L/pp/day	KL/pp/year	L/hh/day
ACT Waterways WSUD General Code	Single dwelling	330	120	904
UTS 2011 study	Residential	328	120	900
ACT water savings calculator	Single dwelling	251	92	678

Using the ACT water savings calculators, reductions in mains water use of greater than 40% compared to an equivalent development constructed in 2003 can currently be achieved (in single dwellings) using the combinations of options shown in Table 3. It can be seen that if rainwater harvesting, 5-star fixtures and 3-star appliances were made mandatory in new developments, water savings from current levels of water use (around 150 L/pp/day based on the water savings calculator and assuming full compliance) would be around 25 L/pp/day reducing consumption to approximately 125 L/pp/day.

Table 3. Combinations of options in the ACT water savings calculators that will reduce mains water use by greater than 40% compared to an equivalent development constructed in 2003

	Mains water consumption	
	L/pp/day	% reduction compared to an equivalent development constructed in 2003
Baseline	253	
Shower head and appliance to 3 star + Rainwater harvesting (Toilet+Laundry)	148	42 %
All fixtures 4 star + Appliance 3 star + Rainwater harvesting (Toilet+Laundry)	137	46 %
All fixtures 4 star + Appliance 4 star + Rainwater harvesting (Toilet+Laundry)	131	48 %
All fixtures 5 star (toilet and showerhead) + Appliance 3 star + Rainwater harvesting (Toilet+Laundry)	127	50 %

5 ACT Waterways WSUD General Code amendment options

5.1 Initial water saving possibilities identified

Initial suggestions of ways in which water savings could be generated in residential developments additional to those currently mandated by the WSUD code are shown below:

1. Mandate that all Water efficient fixtures have a minimum 4-star WELS rating. Some jurisdictions/programs are implementing 4-stars fixtures successfully e.g. 40% of BASIX homes uses taps and fixtures 4 stars or higher

2. Mandate that all Water efficient fixtures have a minimum 5-star WELS rating. It is likely only a small proportion of new homes are implementing 5-star fixtures in other jurisdictions

3. Mandate that all water efficient appliances have a minimum 4-star WELS rating. Some jurisdictions/programs are implementing 4-star fixtures successfully e.g. 32% of BASIX homes have installed dishwasher 4 stars or higher

4. Only allow water efficient lawns (change from 1.3 to 0.8 L/sqm/day watering requirement). 'Certification' would be required by suitable experts (horticulture). Note that savings can be lost over time.

5. Mandate that outdoor taps have a minimum to 2-star WELS rating (flow rates from 20L/min to 12L/min)

6. Rainwater tank installation – Mandatory plumbing connection. Compliance certification by suitable experts would be required

7. Rainwater tank installation – Quality of pumps and diverters installation. Compliance certification by suitable experts would be required. Note that savings can be lost over time without effective maintenance

Modelled water savings arising from each of the options described above, confidence in the modelled estimates, and savings arising from combinations of options, are shown in Table 4.

Table 4. Modelled water savings arising from each of the options described above, and savings arising from scenarios of combinations of options

		Savings (potable water) per dwelling					
Water saving options		L/hh/day	KL/hh/year	Confidence	Scenario 1 KL/hh/year	Scenario 2 KL/hh/year	Scenario 3 KL/hh/year
Indoor plumbing fixtures	1 Mandate that all water efficient fixtures have a minimum 4-star WELS rating.	28	10.2	± 15%	X	X	X
	2 Mandate that all Water efficient fixtures have a minimum 5-star WELS rating	56	20.4	± 15%			
Appliances	3 Mandate that all water efficient appliances have a	18	6.7	± 15%	X	X	X

Water saving options			Savings (potable water) per dwelling					
			L/hh/day	KL/hh/year	Confidence	Scenario 1 KL/hh/year	Scenario 2 KL/hh/year	Scenario 3 KL/hh/year
		minimum 4-star WELS rating						
Landscaping	4	Only allow water efficient lawns	53	19.4	± 40% (GardenSmart program)			X
Outdoor plumbing fixtures	5	Mandate that outdoor taps have a minimum to 2-star WELS rating	81	29.6	± 15%	X	X	X
Rainwater tanks	6	Rainwater tank installation – Plumbing connection	22	8.1	± 15%		X	X
	7	Rainwater tank installation – Quality of pumps and diverters installation	24	8.6	± 15%		X	X
					Total	46.5 ± 6.9	63.2± 9.5	82.6± 17.2

5.2 Ease of implementation and potential barriers

The options identified above were presented and discussed at a stakeholder workshop in November 2019. The following key considerations were raised and discussed.

Water saving options			Key considerations presented and discussed
Indoor plumbing fixtures	1	Mandate that all water efficient fixtures have a minimum 4-star WELS rating.	• Fixtures availability in the market? • Effort required to switch to higher rating products? • Additional cost to developers / builders?
	2	Mandate that all water efficient fixtures have a minimum 5-star WELS rating	• Fixtures availability in the market? • Effort required to switch to higher rating products? • Additional cost to developers / builders? • Residents acceptance e.g. low flow rate?
Appliances	3	Mandate that all water efficient appliances have a minimum 4-star WELS rating	• Appliances availability in the market? • Effort required to switch to higher rating products? • Additional cost to developers / builders?
Landscaping	4	Only allow water efficient lawns	• Compliance becomes part of building / plumbing certification process? • Certification requires horticultural expertise? • Potential that lawns are replaced?
Outdoor plumbing fixtures	5	Mandate that outdoor taps have a minimum to 2-star WELS rating	• Fixtures availability in the market? • Effort required to switch to higher rating products? • Residents acceptance?
Rainwater tanks	6	Rainwater tank installation – Plumbing connection	• Compliance becomes part of building / plumbing certification process? • Additional cost to developers / builders?

Water saving options		Key considerations presented and discussed
	7 Rainwater tank installation – Quality of pumps and diverters installation	• Products available in the market? • Effort required to switch product? • Compliance becomes part of building / plumbing certification process? • Additional cost to developers / builders? • Ongoing maintenance / compliance required?

5.3 Feedback from workshop participants on initial water saving option suggestions

Feedback from workshop participants on the initial water saving option suggestions presented is shown in Table 5.

Table 5. Feedback from workshop participants on initial water saving option suggestions

Water saving options		Workshop feedback
Indoor plumbing fixtures	1 Mandate that all water efficient fixtures have a minimum 4-star WELS rating.	Feasible except for showerhead which is only available as 3-star product. Requirement of certification at the same time as household plumbing certification recommended.
	2 All water efficient fixtures to minimum 5-star WELS rating	Possibly feasible, dependent on the availability and cost of products. Requirement of certification at the same time as household plumbing certification recommended.
Appliances	3 Water efficient appliances to minimum 4-star WELS rating	Easier to just increase the water use reduction target and let the calculators drive the changes than mandating the number of stars in the General Code. Most DA applicants include water efficient dishwashers and washing machines, but these appliances are mostly provided by the owners and there is no guarantee the appliances included in the checklist at development approval stage will be used by the owners.
Landscaping	4 Water efficient lawn (from 1.3 to 0.8 L/sqm/day)	Unlikely to be feasible or valuable as there would need to be legislative changes to require gardens to be certified and the chances of removal post inhabitation are relatively high
Outdoor plumbing fixtures	5 Outdoor tap to 2-star WELS rating (20L/min to 12L/min)	Feasible. Requirement of certification at the same time as household certification recommended
Rainwater tanks	6 Rainwater tank installation – Plumbing connection	Feasible. Requirement of certification at the same time as household certification recommended
	7 Rainwater tank installation – Quality of pumps and diverters installation	Feasible. Requirement of certification at the same time as household certification recommended. Ongoing maintenance checks suggested.

Workshop participants also suggested an additional option. Under the current ACT Waterways WSUD General Code, the minimum roof area required to be connected to a rainwater tank is 50%. It was proposed that this minimum roof area be increased to 100%, which would require the installation of charged line systems.

In addition, it was noted that for proposed single residential dwellings, water saving options were provided which, if implemented, would mean the dwelling would be deemed to have achieved the WSUD Code mains water use reduction target without having to actually demonstrate achievement of the target using the ACT water savings calculator.

5.4 Revised options for further investigation

Following feedback from workshop participants on the initial suggestions for water saving options able to be driven through amendment to the ACT Waterways WSUD General Code, the options were amended and refined. These revised options and their key considerations are shown in Table 6.

Table 6. Revised options for potential water savings able to be driven through amendments to the WSUD General Code

Revised water saving options			Key considerations
Rainwater collection	1	Change the minimum roof area connected to rainwater tanks to 100 %	Requires installation of charged line systems and potentially upsizing tank overflow pipe.
Rainwater tank certification	2	Rainwater tank installation – Certified plumbing connections, pumps and diverters	Compliance becomes part of building certification process
Rainwater tank maintenance	3	Rainwater tank inspection and maintenance including parts (pumps and diverters) replacement program	Significant ongoing monitoring, maintenance and administration funding required.
Outdoor plumbing fixtures	4	Include a maximum 12L/min flow requirement for outdoor plumbing fixtures	There doesn't appear to be much in terms of WELS rated outdoor plumbing fixtures on the market. However, it is simple to install a flow restrictor in outdoor taps at the time of installation. Residents acceptance of relatively low flow rate may be an issue, but 12L/min is actually still relatively high pressure. The saving is due to water currently being supplied at high pressure in the ACT (at least 20L/min and as high as ~120L/min in some areas).
Mandatory minimum 4-star WELS ratings	5	Minimum 4-star WELS ratings required for all fixtures (shower heads remain at 3-star).	Likely some increase in the cost and decrease in the availability of products but noting also that the ACT WSUD Guideline currently states the Territory requires a minimum 4-star WELS rating for appliances and fixtures.

These revised options and estimated associated water savings were presented to ACT Government stakeholders at a mini workshop in January 2020. Following the workshop, the options were again revised to those described in Table 7.

Table 7. Revised options for potential water savings able to be driven through amendments to the WSUD General Code

Revised water saving options			Key considerations
Rainwater collection	1	Change the minimum roof area connected to rainwater tanks to 75%	Requires installation of charged line systems.
Rainwater harvesting	2	Rainwater harvesting and reuse required for compact blocks	Compact blocks (<250 m²) to require rainwater harvesting for toilet, laundry and outdoor water use including irrigation.
Rainwater tank certification	3	Rainwater tank installation – Certified plumbing connections, pumps and diverters	Compliance becomes part of building certification process
Rainwater tank maintenance	4	Rainwater tank inspection and maintenance including parts (pumps and diverters) replacement program	Inspection and maintenance of rainwater tanks and parts proposed every 5 years
Outdoor plumbing fixtures	5	Include a maximum 12L/min flow requirement for outdoor plumbing fixtures	There doesn't appear to be much in terms of WELS rated outdoor plumbing fixtures on the market. However, it is simple to install a flow restrictor in outdoor taps at the time of installation. Residents acceptance of relatively low flow rate may be an issue, but 12L/min is actually still relatively high pressure. The saving is due to water currently being supplied at high pressure in the ACT (at least 20L/min and as high as ~120L/min in some areas).
Mandatory minimum 4-star WELS ratings	6	Minimum 4-star WELS ratings required for fixtures (shower heads remain at 3-star)	Likely some increase in the cost and decrease in the availability of products but noting also that the ACT WSUD Guideline currently states the Territory requires a minimum 4-star WELS rating for appliances and fixtures. In addition, an option for minimum 4-star WELS ratings for appliances (dishwasher and washing machine) in apartments will be investigated.

6 Final proposed revisions to the ACT Waterways WSUD General Code

Revised mains water saving option proposals and associated recommended changes to the existing WSUD code are summarised in Table 8. To help drive the uptake of any and all the options proposed in Table 8, we also recommend the ACT Government increase the mains water use reduction target and make water saving calculations mandatory for all new developments or redevelopments.

Under the current ACT Waterways WSUD General Code, each individual block must demonstrate compliance with the mains water use reduction target of 40% of pre-2003 levels of use in all new developments and redevelopments. For multi-unit residential, commercial, industrial and institutional developments, ACT water savings calculators must be used to demonstrate the target is being met. For single residential blocks however, options relating to rainwater use and greywater use are provided in the code that, if installed, are deemed to be equivalent to achieving the target. If one of these options is selected, there is no requirement to further demonstrate that the target is being met.

Given improvements in recent years in the efficiency ratings of household plumbing fixtures and appliances, the potential for inclusion of flow restrictors on outdoor plumbing fixtures, and the potential to increase roof water collection area requirements, an increase in the mains water use reduction target from 40% to 50% of pre-2003 levels in all new developments and redevelopments is considered feasible. An intermediary target, such as 45%, may be appropriate also.

For residential developments, we recommend also considering whether the new target should be stated in L/pp/day or KL/pp/year in new dwellings, based on the number of bedrooms, e.g. 1 bedroom = 1 people, 2 bedrooms = 2 people, 3 bedrooms = 2 people, 4 bedrooms = 3 people etc, or similar assumptions). A 50% reduction from pre-2003 use levels, for example, would be 124L/pp/day or 45KL/pp/year. This, however, would require restructuring the water savings calculator into a water use calculator, and would require new data and/or assumptions on actual water use in modern homes.

For commercial and institutional developments and redevelopments, any new target should remain stated as a percentage reduction in mains water use from pre-2003 levels (or some other appropriate period).

Table 8. Summary of draft final water saving options and recommended changes to the existing WSUD code and other documents

Water saving option		Recommended changes to existing Code(s) / Territory Plan
1	Change the minimum roof area connected to rainwater tanks from 50% to 75%	In the ACT Waterways WSUD General Code, amend the references in Section 2.4 to minimum roof area connected to rainwater tanks from 50% to 75% and remove references to roof areas in square metres. Also amend Appendix A to the WSUD General Code as required.
2	Include rainwater harvesting for compact residential blocks (<250 m^2)	In the ACT Waterways WSUD General Code, amend the references in Section 2.4 to include rainwater harvesting for compact residential blocks (<250 m^2) Also amend Appendix A to the WSUD General Code as required.
3	Rainwater tank installation – Certified plumbing connections, pumps and diverters	In the ACT Waterways WSUD General Code, include in Section 2.4 a requirement that all measures undertaken to meet the mains water use reduction target (indoor and outdoor plumbing fixtures and appliances, rainwater tanks and greywater systems) must be certified by a building inspector. In the Draft Variation to the Territory Plan No 354, include a note to this effect under Elements 1.1, 2.1 and 2.2. Include a note to this effect in the ACT Practice Guidelines for Water Sensitive Urban Design.

	Water saving option	Recommended changes to existing Code(s) / Territory Plan
		Include this requirement where necessary in other ACT planning documents and building regulations.
4	Rainwater tank maintenance – Pumps and diverters replacement program	In the ACT Waterways WSUD General Code, include in Section 2.4 that rainwater tank installations will be inspected by ACT government employees on an ad-hoc, ongoing basis, and that pumps and diverters can be replaced free of charge by government approved plumbing contractors, if the property owner is happy for this to occur. The code should indicate also that the property owner can have the equipment replaced by a plumber of their choice and claim the expense from the government.
5	Include a maximum 12L/min flow requirement for outdoor plumbing fixtures	In the ACT Waterways WSUD General Code, under Section 2.4 (p.24), **replace** *"Measures that can be considered for meeting these targets include:* • *mandatory 3-star rated (or better) plumbing fixtures;* • *use of rainwater tanks for garden watering, toilet flushing, and laundry uses; and* • *on-site greywater recycling."* **with** *"Measures that can be considered for meeting these targets include:* • *mandatory 3-star rated (or better) indoor plumbing fixtures;* • *mandatory 12L/min flow (or less) for outdoor plumbing fixtures;* • *use of rainwater tanks for garden watering, toilet flushing, and laundry uses; and* • *on-site greywater recycling"* Also amend Appendix A to the WSUD General Code as required. Amend the ACT water savings calculator to include outdoor taps.
6	Mandatory minimum 4-star WELS ratings required for plumbing fixtures (shower heads remain at 3-star)	In the ACT Waterways WSUD General Code, change Section 2.4 to state the mandatory requirement for 4-star rated (or better) plumbing fixtures. Also amend Appendix A to the WSUD General Code as required and the ACT water savings calculators.
7	Demand Management (combination of options 5 and 6 plus mandatory minimum 4-star WELS ratings for appliances in apartments)	As outlined in Option 5 and 6 above. In addition, in the ACT Waterways WSUD General Code, change Section 2.4 to state the mandatory requirement for 4-star rated (or better) appliances (dishwasher and washing machine) for apartments. Also amend Appendix A to the WSUD General Code as required and the ACT water savings calculators.
8	Source substitution (combination of options 1, 2, 3 and 4)	As outlined in Options 1, 2, 3 and 4 above. In the ACT Waterways WSUD General Code, amend the references in Section 2.4 to include minimum roof area connected to rainwater tanks of 75% for compact blocks WSUD General Code.
9	Plumbing certification (combination of options 3, 5 and 6)	As outlined in Options 3, 5 and 6
10	Combination of all options including mandatory minimum 4-star WELS ratings for appliances in apartments	As outlined above

6.1 Modelling assumptions

Modelling assumptions are outlined in Table 9, Table 10 and Table 11.

Table 9. Modelling assumptions for each scenario/option.

Scenario	Assumptions
Baseline	Based on development approach in 2003. Fixtures and appliance with a 1-star WELS rating except for toilet with a 3-star rating for all dwelling types (apartments and houses)
Business-As-Usual	Indoor fixtures and appliances have 3-star WELS rating for all dwelling types. Indoor water use assumption is based on assumptions in the calculator: • Compact blocks, mid-sized and large blocks: 3 people per dwelling (i.e. 4 bedrooms) • Apartment: 2 people per dwelling (i.e. 2 bedrooms) Rainwater harvesting is implemented for houses only not apartments. The preferred approach for source substitution is rainwater harvesting as opposed to greywater treatment and reuse. Rainwater tanks are installed on mid-sized and large blocks but not compact blocks. 80% rainwater tanks are adequately installed with a steady decay in tank performance over 20 years with 50 % receiving maintenance every 10 years and 50% not receiving any maintenance. Rainwater tanks that are not installed adequately do not produce any potable water savings from the time of installation. See Table 10 for roof, POS and planting areas for different block sizes including roof area that is harvested for rainwater harvesting.
Option 1: 75% Roof Water Collection	See Table 10 for roof area that is connected to rainwater tanks.
Option 2: Rainwater tank on compact blocks	Compact blocks include a 2KL tank for rainwater harvesting to meet toilet, laundry and outdoor water demand. For option 2, 50 % of the roof area on compact blocks is connected to rainwater tanks.
Option 3: Rainwater tank certified installation	95% of rainwater tanks are adequately installed, with a steady decay in tank performance with 50 % receiving maintenance every 10 years and 50 % not receiving any maintenance. Rainwater tanks that are not installed adequately do not produce any potable water savings from the time of installation.
Option 4: Rainwater tank maintenance / part replacement	95% of rainwater tanks are adequately installed, with a steady decay in tank performance over 20 years with 80% receiving inspection/maintenance every 5 years after installation (with part replacement allowed every 10 years per dwelling) and 20 % not receiving any maintenance or parts replacement. Rainwater tanks that are not installed adequately do not produce any potable water savings from the time of installation.
Option 5: Outdoor taps flow rate not exceeding 12L/min	Modelled as a 40% reduction in outdoor water use and 40% reduction in garden and lawn irrigation water use compared to BAU for all dwelling types. This option is only applicable for houses and not apartments

Scenario	Assumptions
Option 6: Mandatory minimum 4-star WELS ratings for plumbing fixtures (houses and apartments)	Minimum 4-star WELS ratings for indoor taps (not including shower head) and toilets. This applies to compact, mid-sized and large blocks as well as apartments. Given that the calculator does not have the functionality to determine savings from fixtures alone (savings from fixtures and appliances are lumped except for toilet), we have assumed only 50 % of savings is achieved in bathroom (as shower head remain at 3-star), laundry (as washing machines remain at 3-star) and kitchen (as dishwashers remain at 3-star) but 100% for toilets.
Option 7: Demand Management (combination of options 5 and 6 plus mandatory minimum 4-star WELS ratings for appliances in apartments)	As outlined in Option 5 and 6 above. Minimum 4-star WELS ratings for both fixtures and appliances (dishwasher and washing machine) in apartments is assumed. Given that the calculator does not have the functionality to determine savings from fixtures alone (savings from fixtures and appliances are lumped except for toilet), we have assumed 50 % of savings is achieved in bathroom (as shower heads remain at 3-star), but 100% for laundry, kitchen and toilet for apartments.
Option 8: Source substitution (combination of options 1, 2, 3 and 4)	This option is only applicable for houses. As outlined in Option 1, 2, 3 and 4 above. Compact blocks include a 2KL tank for rainwater harvesting to meet toilet, laundry and outdoor water demand with 75% of the roof area connected to rainwater tanks.
Option 9: Plumbing certification (combination of options 3, 5 and 6)	As outlined in Options 3, 5 and 6. Mandatory minimum 4-star WELS ratings for fixtures and appliances in apartments is included in this option.
Option 10: Combination of all options including mandatory minimum 4-star WELS ratings for appliances in apartments	As outlined above

Table 10. Assumptions – People per dwelling, and areas for roof, POS and planting for different block sizes

Assumption category	Compact block	Mid-sized block	Large block	Notes
# people per dwelling	3	3	3	
Block size	200 m²	375 m²	700 m²	
Private Open Space (POS)	80 m²	150 m²	370 m²	Based on minimum POS requirements in Single Dwellings Development code • 20% of the block area for compact blocks. • 40 % of the block area minus 50 m² for mid-sized blocks.

Assumption category	Compact block	Mid-sized block	Large block	Notes
				• 60 % of the block area minus 50 m² for large blocks The POS has been increased by 40 m² and 50 m² for compact and mid-sized blocks respectively to match typical developments as measured using aerial imagery.
Planting area	24 m²	68 m²	167 m²	Although the planting area requirement in Single Dwelling code is a minimum 50 % of minimum POS area, we have assumed planting area is 30 %, 45 % and 45 % of POS for compact, mid-sized and large blocks to match typical developments as measured using aerial imagery.
Lawn	0 m²	34 m²	83 m²	Based on formula in calculator which assumes 50% of planting area is lawn
Garden bed	24 m²	34 m²	83 m²	Based on formula in calculator which assumes 50% of planting area is garden bed
House, garage / carport and driveway footprint	120 m²	225 m²	330 m²	Difference between Block and POS size
House roof area	120 m²	200 m²	280 m²	Not including Garage/Carport
Roof area connected to rainwater tanks (BAU)	60 m²	100 m²	140 m²	50 % of roof area
Roof area connected to rainwater tanks (Option 2, 8, 10)	90 m²	150 m²	210 m²	75 % of roof area

Indoor and outdoor water savings calculation assumptions for apartments are outlined in Table 11.

Table 11. Assumption for people per dwelling, POS and garden bed area for apartments

Apartment area	150 m²
Indoor area	100 m²
Number of bedrooms/people per dwelling	2/2
Private Open Space (POS)	50 m²
Garden bed	25 m²

Water savings decay

In terms of water savings decay into the future, the following assumptions have been made:

- There is no water savings decay for fixtures, appliances and flow restrictors on outdoor taps
- Water savings from rainwater tank reduces over time due primarily to wear and tear of pumps and diverters but also due to clogging of inlets and sedimentation.
    - If no maintenance is provided, the modelling assumes a steady decay in performance (and in potable water savings) over 20 years after which rainwater tanks become ineffective (no water savings). The duration of 20 years is based on the typical operating life of pumps and diverters.
    - When maintenance is provided under Business-As-Usual, the modelling assumes that this occurs every 10 years when tank effectiveness has reduced to 50% and becomes a maintenance trigger. Maintenance restores tank effectiveness to 100%.
    - When an inspection/maintenance and parts replacement program is provided by ACT Government under Option 4, 8 and 10, the modelling assumes that maintenance occurs every 5 years when tank effectiveness has reduced to 75%. Maintenance restores tank effectiveness to 100%. Part replacement is assumed to occur every 10 years per dwelling.

6.2 Potable water savings

Estimated potable water savings per 1,000 new houses in ML/year are shown for each option, and for combinations of options in Table 12. Similarly, estimated potable water savings per 1,000 new apartments in ML/year are shown in Table 13.

Table 12. Potable water savings for new houses (not including apartments) in ACT assuming 1,000 new stock each year (30 % compact, 50 % mid-sized and 20% large blocks).

	Potable Water Use/Savings – ML/year					Uncertainty
	2020	**2030**	**2040**	**2050**	**2060**	
Baseline	206	2262	4318	6375	8226	
Business-As-Usual	124	1420	2777	4162	5412	
Reduction compared to baseline	40%	37%	36%	35%	34%	
Option 1 – Change the minimum roof area connected to rainwater tanks to 75%	119	1385	2722	4091	5326	
Potable water savings relative to BAU (ML/year)	**4**	**35**	**56**	**72**	**85**	**± 30 %**
Potable Water savings relative to Baseline (%)	42%	39%	37%	36%	35%	
Option 2 – Rainwater tanks to be implemented on compact blocks	117	1363	2688	4047	5274	
Potable water savings relative to BAU (ML/year)	**7**	**57**	**90**	**116**	**138**	**± 30 %**
Potable Water savings relative to Baseline (%)	43%	40%	38%	37%	36%	
Option 3 – Rainwater tank installation: certified plumbing connections, pumps and diverters	113	1308	2561	3841	4996	
Potable water savings relative to BAU (ML/year)	**10**	**112**	**216**	**321**	**416**	**± 15 %**
Potable Water savings relative to Baseline (%)	45%	42%	41%	40%	39%	
Option 4 – Rainwater tank maintenance: pumps and diverters replacement program	119	1381	2716	4083	5317	
Potable water savings relative to BAU (ML/year)	**5**	**39**	**62**	**80**	**95**	**± 30 %**
Potable Water savings relative to Baseline (%)	42%	39%	37%	36%	35%	
Option 5 – Include a maximum12L/min flow requirement for outdoor plumbing fixtures	119	1348	2605	3876	5022	
Potable water savings relative to BAU (ML/year)	**5**	**72**	**172**	**286**	**390**	**± 15 %**
Potable Water savings relative to Baseline (%)	42%	40%	40%	39%	39%	
Option 6 – Mandatory minimum 4-star WELS ratings for plumbing fixtures	111	1280	2509	3765	4898	
Potable water savings relative to BAU (ML/year)	**13**	**140**	**268**	**398**	**514**	**± 15 %**
Potable Water savings relative to Baseline (%)	46%	43%	42%	41%	40%	
Option 7 – Combination of options 5 and 6 (Demand management)	101	1167	2292	3442	4480	
Potable water savings relative to BAU (ML/year)	**23**	**253**	**486**	**720**	**931**	**± 15 %**
Potable Water savings relative to Baseline (%)	51%	48%	47%	46%	46%	
Option 8 – Combination of options 1, 2, 3, 4 (Source substitution)	104	1204	2348	3512	4562	
Potable water savings relative to BAU (ML/year)	**19**	**216**	**429**	**651**	**849**	**± 30 %**

	Potable Water Use/Savings – ML/year					Uncertainty
	2020	2030	2040	2050	2060	
Potable Water savings relative to Baseline (%)	49%	47%	46%	45%	45%	
Option 9 – Combination of options 3, 5 and 6 (Quality fixtures and installations)	96	1130	2233	3366	4390	
Potable water savings relative to BAU (ML/year)	**27**	**290**	**545**	**796**	**1022**	**± 15 %**
Potable Water savings relative to Baseline (%)	53%	50%	48%	47%	47%	
Option 10 – All options combined	83	968	1894	2838	3692	
Potable water savings relative to BAU (ML/year)	**41**	**452**	**884**	**1324**	**1720**	**± 20 %**
Potable Water savings relative to Baseline (%)	60%	57%	56%	55%	55%	

Table 13. Potable water savings for new dwellings (apartments) in ACT assuming 1,000 new stock each year

	Potable Water Use/Savings – ML/year					Uncertainty
	2020	2030	2040	2050	2060	
Baseline	126	1385	2644	3904	5037	
Business-As-Usual	87	960	1832	2704	3489	
Reduction compared to baseline	31%	31%	31%	31%	31%	
Option 1 – Mandatory minimum 4-star WELS ratings for plumbing fixtures	78	861	1644	2427	3132	
Potable water savings relative to BAU (ML/year)	**9**	**98**	**188**	**277**	**358**	**± 15 %**
Potable Water savings relative to Baseline (%)	38%	38%	38%	38%	38%	
Option 2 – Mandatory minimum 4-star WELS ratings for appliances	84	927	1771	2614	3373	
Potable water savings relative to BAU (ML/year)	**3**	**32**	**61**	**91**	**117**	**± 15 %**
Potable Water savings relative to Baseline (%)	33%	33%	33%	33%	33%	
Option 3 – Mandatory minimum 4-star WELS ratings for plumbing fixtures and appliances (option 1+2)	73	803	1533	2263	2920	
Potable water savings relative to BAU (ML/year)	**14**	**157**	**299**	**441**	**569**	**± 15 %**
Potable Water savings relative to Baseline (%)	42%	42%	42%	42%	42%	