

URBAN WATER SUPPLY IN AUSTRALIA

A SNAPSHOT OF INSTITUTIONAL ARRANGEMENTS, SECURITY PLANNING AND OBJECTIVES

J Allan

ABSTRACT

This paper provides an updated summary of the current arrangements for urban water service delivery and security planning, for each state and territory in Australia. It touches on water resource management arrangements and provides references for key documents. It also reviews and summarises the levels of service objectives adopted for urban water security in each jurisdiction. Australia's blueprint for management of water is the *National Water Initiative*, established in 2004. In 2008, the *National Urban Water Planning Principles* were adopted, including a focus on the delivery of urban water supplies in accordance with agreed levels of service. The paper assesses urban water security planning and identifies opportunities for further development and improvement - for both policy makers and urban water planners. It finds that there is good progress towards definition of levels of service in some jurisdictions, but in most cases there is scope to add more detail. There is also a need to engage more directly with the community on the establishment of the levels of service, embracing a partnership approach and working towards agreed targets and outcomes.

Keywords: urban water security, levels of service objectives, water service provision, institutional arrangements, urban water planning principles

INTRODUCTION

Australia is the earth's driest inhabited continent, with highly variable rainfall and temperatures. Droughts and floods are an established feature of Australia's climate, as shown by the Millennium drought that hit south-eastern

Australia between 1997 and 2009 and the widespread flooding that followed in 2010/201 (South East Australia Climate Initiative, 2011). Both events had broad effects with the drought in particular impacting on the economic, environmental and social well-being of rural and urban communities (van Dijk et al., 2013). So how does a country like Australia aim to maintain urban water security?

In Australia, water is vested in governments that allow other parties to access and use water for a variety of purposes (Commonwealth of Australia et al., 2004). The National "blueprint" for management of water is the *National Water Initiative* (NWI), an intergovernmental agreement signed in 2004¹ between the Commonwealth of Australia and all state and territory governments (Commonwealth of Australia et al., 2004; Government of Western Australia, 2007; State of Tasmania, 2006).

In the last decade, a number of urban water sector reviews have been undertaken with a focus on enhancing water security strategies and opportunities for efficiency gains (National Water Commission, 2011b; PricewaterhouseCoopers, 2010; Productivity Commission, 2011) and more recently a broader review of emerging challenges and opportunities (Australian Water Association, 2017).

1. The State of Tasmania signed the agreement in 2005, followed by the Government of Western Australia in 2006, all other states and territories signed in 2004.

To some extent, these reviews provide a snapshot of arrangements in place at the time and reflect the changing nature of Australia's urban water sector. This paper provides an updated summary of the institutional arrangements for water service delivery, the broad regulatory regime and the urban water security planning arrangements in place in late 2017 for each state and territory in Australia. This is followed by a discussion of the levels of service (LOS) objectives for urban water security adopted in each jurisdiction and how these might be evolved in the future.

METHOD

An array of public material was reviewed to prepare this paper, including legislative and regulatory material, planning reports and documents, registers and website content. Material was reviewed across federal, state and territory jurisdictions. For the purposes of this paper, urban water security is taken to be synonymous with water supply reliability in urban environments - an approach discussed in more detail later in the paper. However, definition of urban water security is a complex subject and worthy of its own investigation and review

THE AUSTRALIAN NATIONAL VIEW

The National Water Initiative (NWI) has been described as a shared commitment by governments to increase the efficiency of Australia's water use, leading to greater certainty for investment and productivity, for rural and urban communities and for the environment (Department of Environment (Australia), 2010). The signatories agreed on actions to achieve a more cohesive national approach to the way Australia manages, plans for, measures, prices and trades water. Progress of the NWI was formally reviewed by the National Water Commission in 2007, 2009 and 2011. Responsibility for review now rests with the Productivity Commission with the next review due in late 2017.

In 2008, the Council of Australian Governments (COAG) agreed to a work program including actions to adopt national urban water planning principles and establish and publish the LOS for metropolitan water supplies (Council of Australian Governments, 2008a). The *National Urban Water Planning Principles* (Council of Australian Governments, 2008b) were adopted shortly after to support sustainable and economically efficient planning and development of urban water and wastewater services, these are:

1. "Deliver urban water supplies in accordance with agreed levels of service.
2. Base urban water planning on the best information available at the time and invest in acquiring information on an ongoing basis to continually improve the knowledge base.
3. Adopt a partnership approach so that stakeholders are able to make an informed contribution to urban water planning, including consideration of the appropriate supply/demand balance.
4. Manage water in the urban context on a whole-of-water-cycle basis.
5. Consider the full portfolio of water supply and demand options.
6. Develop and manage urban water supplies within sustainable limits.
7. Use pricing and markets, where efficient and feasible, to help achieve planned urban water supply/demand balance.
8. Periodically review urban water plans."

Responsibility for compiling and disseminating water information across Australia lies with the Australian Bureau of Meteorology (BOM). BOM notes on its website, "Water security is a major challenge facing Australia. The need to accurately monitor, assess and forecast the availability, condition and use of water resources is vital."

The Australian Water Association (AWA), the national peak organisation for water professionals, consider it their role to promote the views of its members before decision-makers. In recent years, AWA has formally adopted water security as an advocacy platform. They have produced discussion papers that highlight issues and provide information to influence the way forward (www.awa.asn.au). AWA describes water security as, "the certainty the Australian community can have that its water needs will be met into the future on an economically, socially and environmentally sustainable basis". (Australian Water Association, 2016).

AUSTRALIAN STATES AND TERRITORIES

Consistent with the NWI, all Australian states and territories have embraced the imperative to manage water resources sustainably with clearly articulated environmental objectives and science-based decision making (National Water Commission, 2011a). Urban water security planning and decision-making occurs within this broader water resource management framework.

However, a water entitlement does not necessarily equate to a secure urban water supply (Priman, Casaril, & Rajakaruna, 2011). This is why effective planning for water security should be part of business-as-usual in all urban regions of Australia, underpinned by the *National Urban Water Planning Principles*.

Over a decade ago, the Water Services Association of Australia (WSAA) released the *“Framework for Urban Water Planning”* (Erlanger & Neal, 2005). It focussed on establishing service standards for urban water supply reliability, suggesting two sets of objectives: long-term LOS objectives, and others. The authors went on to describe the LOS objectives for a water supply system in terms of the desirable maximum frequency, duration and severity of water restrictions expected by the community, and the inclusion of other water quality and pressure objectives that can affect reliability of supply. This approach to establishing LOS for urban supplies has been broadly adopted, as follows:

- ▶ long term water supply system objectives articulated as frequency, severity and duration of restrictions have been evolving at different rates across the nation, these are discussed in more detail following
- ▶ drinking water quality is heavily regulated by various state entities in alignment with agreed national standards (*NHMRC & NHMMC, 2011*)
- ▶ the responsibility for delivered water pressure generally lies with local distribution service providers, with standards articulated through customer codes or contracts developed by the service providers in consultation with their communities.

Below is a summary by state and territory, of the institutional arrangements for water service delivery and urban water security planning.

AUSTRALIAN CAPITAL TERRITORY (ACT)

Institutional arrangements for water service delivery

Icon Water (previously ACT Energy and Water, ACTEW) provides drinking water and wastewater services to the ACT and some adjoining regions in NSW. They own and operate dams, water treatment plants and bulk water networks in the ACT and NSW, as well as water reticulation networks, sewage collection and treatment facilities in ACT. Icon Water sells bulk treated (potable) water to the Queanbeyan-Palerang Regional Council in NSW for distribution within their region. Icon Water is

owned by the ACT government.

Regulatory regime

The ACT’s water resources are managed by the Environment, Planning and Sustainable Development Directorate, a state agency. The Directorate has responsibility for high-level strategic water policy development, regulation of water resources, water quality monitoring and reporting, and plays a role in demand management. Water prices and access to water services are regulated by the Independent Competition and Regulatory Commission, an ACT owned entity. They also have responsibility for licensing utility services and ensuring compliance with licence conditions.

Urban water security planning

The *ACT Water Strategy 2014-2044* (ACT Government, 2014), was developed by the ACT Department of Environment and Planning. It describes the need for a sustainable water supply and clearly defines water security in terms of acceptable frequency of restrictions; it also acknowledges long term planning should consider the duration and severity of water restrictions. The Strategy notes that current security of “water storage” has been achieved through new infrastructure (as discussed below), with the strategy moving its focus to strengthening resilience. In 2007, in response to severe drought, Icon (ACTEW) reviewed water supply options for Canberra using six key planning variables including the cost of restrictions based on assumed duration, frequency and severity (ACTEW Corporation, 2009). Based on the reviews recommendations, Icon (ACTEW) completed two large “water security” projects in 2012 and 2013 - the Murrumbidgee to Googong Water Transfer and the Cotter Dam enlargement, respectively. Icon (ACTEW) also established the Tantangara Transfer that involves transferring high priority water purchased from the regulated Murrumbidgee River to the ACT via the snowy Mountains Scheme.



NEW SOUTH WALES (NSW) Institutional arrangements for water service delivery

WaterNSW is the state's major supplier of raw water, supplying water from 42 large dams, pipelines and the state's rivers to regional towns, irrigators, Sydney

Water and other licensed authorities, retail suppliers and councils. Two thirds of water used in NSW is supplied by WaterNSW.

Sydney Water supplies water, wastewater, recycled water and some stormwater services to almost five million people in Sydney, the Illawarra and the Blue Mountains. Sydney Water source their water from the dams managed by WaterNSW.

Hunter Water provides drinking water, wastewater, recycled water and some stormwater services to the Lower Hunter region of New South Wales and a small volume of bulk treated water to Midcoast Water customers. WaterNSW, Sydney Water and Hunter Water are all state owned corporations.

There are also 105 local water utilities in NSW responsible for providing water supply and sewerage services to non-metropolitan urban communities – provided by a range of local governments, water boards, electricity utilities and other public and private entities². The NSW government is current reviewing the institutional and regulatory arrangements for town water supply and sewerage services in country NSW.

Regulatory regime

The state's water resources are managed by the NSW Office of Water within the Department of Primary Industries and Water. They also provide oversight of water service providers. Economic regulation of entities, where applied, is provided by the state owned Independent Pricing and Regulatory Tribunal.

Urban water security planning

The NSW Metropolitan Water Directorate, a state agency, leads a whole-of-government approach to water planning for greater Sydney and the lower Hunter. The *2017 Metropolitan Water Plan* (Metropolitan Water

Directorate, 2017) for Sydney describes the LOS for urban water supplies in terms of security, robustness and reliability. Security is defined in terms of the frequency of running out of water (in storages), the frequency of water restrictions and the duration of water restrictions. The *Lower Hunter Water Plan* (Metropolitan Water Directorate, 2014) aims to ensure there is "enough water to supply the people and businesses of the region, as well as how we will respond to severe droughts". The NSW Government requires all local water utilities to prepare and implement a 30 year strategic business plan (SBP). The guidelines for the SBP (State of NSW, 2011) are heavily focussed on the achievement of agreed LOS for water and sewerage services defined in terms of a series of performance indicators. Restrictions during drought (frequency, severity and duration) form part of the objectives for availability of supply.

NORTHERN TERRITORY (NT) Institutional arrangements for water service delivery

In the Northern Territory, all water and wastewater services are provided by the Power and Water Corporation (Power and Water) or its subsidiary, Indigenous Essential Services. Both are owned by the Northern Territory government. Services are supplied to major population centres as well as minor and remote communities. There is provision for "on-supply" of water services from Power and Water, to end-users, by third parties.

Regulatory regime

The state's water resources are managed by the Department of Environment and Natural Resources. Water and sewerage supply services are regulated by the state owned Utilities Commission. The Commission's activities relate primarily to licensing, but include price and service standard monitoring functions, when requested.

Urban water security planning

Power and Water aim to ensure ongoing water security particularly in Darwin and Alice Springs (Power and Water Corporation, 2017), with a strong focus on water quality and public health. The *Darwin Region Water Supply Strategy* (Power and Water Corporation, 2013) clearly defines the LOS for the Darwin region in terms of the frequency, severity and duration of restrictions to be expected. The Strategy has a strong focus on drought response planning and "sustainability" of supply.

2. There is also some supply of water into NSW from Icon Water (ACT's water corporation).

QUEENSLAND

Institutional arrangements for water service delivery

In Queensland, bulk water supply assets are owned and operated by state government owned entities (SunWater, Seqwater, Gladstone Area Water Board and Mt Isa Water Board), private entities (such as mining companies) and local governments. Wastewater and stormwater are generally managed by local governments. In South East Queensland (SEQ), the state owned Seqwater manages an extensive portfolio of dams, weirs, water treatment plants, pipes and channels to supply treated water to local council owned distribution and retail entities, as well as raw water to industry and irrigators. Outside SEQ, the state owned SunWater owns and manages the majority of the raw water assets (dams, weirs, channels and some pipes), with local governments providing most of the urban water treatment, supply and distribution services.

Regulatory regime

The state's water resources are managed by the Department of Natural Resources and Mines. State government oversight of water service providers, including registration is undertaken by the Department of Energy and Water Supply. Economic oversight of entities, where applied, is provided by the state owned Queensland Competition Authority.

Urban water security planning

In Queensland, water service providers are responsible for water supply security (Queensland Government, 2017). Seqwater produces a regional water security program for SEQ, *Water for Life*, (Seqwater, 2015) based on prescribed LOS objectives. Outside of SEQ, the Department of Energy and Water Supply works with local governments and service providers to develop *Regional water supply security assessments*, on a town or community basis². Local councils and water service providers are encouraged to develop their own LOS objectives, in terms of the frequency, severity and duration of water restrictions that a community might experience.

SOUTH AUSTRALIA (SA)

Institutional arrangements for water service delivery

The state owned SA Water manages water services in South Australia including bulk and local water storage, treatment and supply, sewerage collection and treatment and some recycled water services. The state also takes an active role in the management of stormwater and

considers itself a leader in the harvesting and reuse of stormwater.

Regulatory regime

The state's water resources are managed by the Department of Environment, Water and Natural Resources. They also provide oversight of SA Water. Economic regulation is provided by the state owned Essential Services Commission of South Australia.

Urban water security planning

In 2009, the South Australian Government developed a forty year plan - *Water for Good* (Government of South Australia, 2009) to "provide the most secure water supply system in southern Australia". There is an explicit water security target given for Greater Adelaide in terms of frequency and severity of water restrictions and an inferred target for the entire state in terms of frequency and severity of restrictions. Supporting the plan, five *Regional Demand and Supply Statements* have been developed, as part of an ongoing program, with annual reporting arrangements also established. SA Water also plays a role in water planning through the development of water security plans to support capital and operating investment planning - integrated into the Regulatory Business Proposal submitted to the regulator each year. The plan for the Eyre Region was produced in 2008 (SA Water, 2008) prior to the release of *Water for Good*. No other plans have been released.

TASMANIA

Institutional arrangements for water service delivery

In Tasmania, TasWater has responsibility for water supply and sewerage services across the entire state. It is the only licenced water and sewage service provider in Tasmania. Its mandate is to source, store, treat and distribute water to customers, and collect, transport and treat sewage. TasWater is owned by 29 Tasmanian councils. The state owned Tasmanian Irrigation Pty Ltd develops and manages irrigation schemes, using public-private partnership arrangements. Stormwater management is undertaken by local governments.



Regulatory regime

The state's water resources are managed by the Department of Primary Industries, Parks, Water and Environment. Licensing and oversight of water and sewerage infrastructure and service provision is undertaken by the state owned Tasmanian Economic Regulator (TER).

Urban water security planning

TasWater is currently developing its first long term strategic plan, underpinned by its financial plan and capital expenditure program (TasWater, 2017). The licence issued to TasWater by the TER contains no service standards or objectives, only a requirement to develop a management plan for compliance, asset management and emergency management (Tasmanian Economic Regulator, 2013).

VICTORIA

Institutional arrangements for water service delivery

The State of Victoria owns 19 water corporations that provide a range of services including management of bulk water storages and recreational areas; water supply, sewage and trade waste disposal services to urban customers; recycled water supply; rural water services and some waterways management. There are also 10 state owned catchment management authorities. Melbourne Water provides bulk water and bulk sewerage services to the three water corporations in the Melbourne metropolitan area (City West, South East and Yarra Valley Water). The remaining corporations provide water services to regional and rural Victorians.

Regulatory regime

The state's water resources are managed by the Department of Environment, Land, Water and Planning. They also provide oversight of the water service providers. Economic regulation of entities, where applied is provided by the Essential Services Commissions, a state agency.

Urban water security planning

The overarching water strategy for the state is *Water for Victoria* (State Government Victoria, 2016), which is a strategic plan for water resource management. The *Melbourne Water System Strategy* (Melbourne Water, 2017) outlines the key directions, opportunities and actions to ensure enough water is available in Melbourne for the next 50 years. It does not articulate LOS in terms of restrictions, but presents water management strategies based on the volume of water in storage - the "Water Supply Objective". This approach applies

to customers of City West, South East and Yarra Valley Water. The remaining water corporations that provide services to regional urban areas have developed individual *Urban Water Strategies* and *Drought Response Plans*, all with LOS objectives articulated using restrictions as the basis. The strategies all refer to the four levels of water restrictions that apply across the state. While the restrictions are uniform in definition, the application varies according to local by-laws and drought plans developed by each water corporation.

WESTERN AUSTRALIA (WA)

Institutional arrangements for water service delivery

The state government owned WA Water Corporation is the principal provider of water, wastewater and drainage services in Western Australia as well as providing bulk water for irrigation. The state also owns the Bunbury Water Corporation (Aqwest) and the Busselton Water Corporation which both provide drinking water to the communities in their service area. Other industry participants include local governments, private entities (such as mining companies) and community cooperatives.

Regulatory regime

The state's water resources are managed by the Department of Water. Oversight of licensed water service providers (for potable and non-potable water supplies, sewerage, irrigation and drainage services), including the issuing of licences is provided by the state owned Economic Regulation Authority.

Urban water security planning

The state government has released an extensive series of urban water planning documents over many years including guidelines, strategies, and drainage and water management plans. The Water Corporation has also produced a number of water planning documents for Perth and more broadly for Western Australia, including the 50 year plan *Water Forever: Towards Climate Resilience* (Water Corporation, 2009), *Water Forever - Drought proofing Perth* (Water Corporation, 2011) and *Water Forever - A 10 year plan for WA* (Water Corporation, 2012). The 50 year plan describes a general levels of security in terms of frequency for water restrictions but does not articulate the severity or duration. It also seeks to avoid "the imposition of more severe measures during summer periods". The security level underpins the design of the Integrated Water Supply Scheme - the water system that delivers water to Perth, the Goldfields and parts of south west WA.

DISCUSSION

Establishing clear frameworks and responsibilities for water resource management is a critical first step in moving towards effective urban water security planning. Despite the array of different arrangements for water service provision, responsibility for management of water resources is clearly established in all states and territories, and is consistently delegated to state departments. The responsibility for urban water security planning seems generally clear also, although it varies by region. However, the establishment of agreed levels of service (LOS), in accordance with the *National Urban Water Planning Principles*, has not consistently occurred.

A summary of the LOS objectives for urban water security in Australia's capital cities is presented in Table 1. There is clear evidence of LOS objectives being developed in Adelaide, South East Queensland (including Brisbane), Australian Capital Territory (including Canberra), Darwin, Perth and Sydney, with varying degrees of sophistication. All these jurisdictions have used the WSAA approach to LOS and quantitatively described expected restrictions frequency. However, in most cases there is scope to add more detail particularly in regards to the severity and duration of restrictions that might be expected. Only SEQ and Darwin have provided quantitative details of all three components (frequency, severity and duration); with SEQ and Sydney further expanding the basic suite of measures to include the frequency that key water storages should empty. Darwin also provides an additional objective, to "not run out of water".

Notes: * PWCM = permanent water conservation measures = mandatory efficiency measures or "water wise" rules

The LOS approach taken in Melbourne is quite different to the WSAA approach adopted in other jurisdictions; it is also inconsistent with the approach adopted elsewhere in Victoria. The LOS for Melbourne are focused on water storage levels and provide only qualitative indications of

the frequency or severity of restrictions that might be experienced. The language is non-specific for example "when necessary"; and severity of restrictions ("severe" or "mild") does not align with the four defined levels. Outside Melbourne, quantitative restrictions-based LOS objectives have been developed by all the corporations servicing urban areas of regional Victoria. An example of the regional approach is presented Table 1 for the town of Ballarat. It is unclear why the approach adopted in Melbourne differs from elsewhere in Victoria and across the nation. In Tasmania, there is no evidence of any long term urban water planning or strategy development. Nor any discussion on the establishment of LOS for urban water supplies.

Although there is significant progress in developing LOS in Australia, it is questionable whether many can be called "agreed" LOS, as per the urban water planning principles. The adopted LOS summarised in Table 1 vary considerably. The frequency of restrictions range from one in ten, to one in one thousand years, and the severity ranging from permanent water saving rules to a 65% reduction in demand. It is not clear how the LOS were developed and why communities place such different values on water security, if that is in fact the case. There is evidence of broader stakeholder and community engagement in the development of long-term water plans and strategies (as presented in Table 1) and also for the general use of restrictions. However, there is limited evidence of the partnership approach and agreement to LOS. Notable exceptions include Darwin, where community attitude surveys informed planning and in Victoria's Central Highlands where community consultation resulted in modifications to LOS objectives for the Daylesford area (from 1 in 10 years, to 1 in 20 years for Stage 1 & 2 restrictions; aligned with Ballarat). However, nowhere is there evidence that any community has been presented with LOS alternatives and the accompanying advantages and disadvantages of the options. Such an approach would seem a reasonable progression from the solid foundations now established.



Table 1. Levels of service objectives for urban water security in Australian cities (as at August 2017)

Region	Levels of Service Objectives (LOS)			Additional service criteria	Engagement	Ref
	Max Frequency of restrictions (on average)	Severity or restrictions (demand reduction)	Duration of restrictions			
ACT (including Canberra and Queanbeyan)	1 in 20 years	10%-55% reduction	Unspecified	-	Some limited consultation planned.	(ACT Government, 2014)
	All other times	PWCM*	All other times			
(Greater) Adelaide	1 in 100 years	Not specified - Severe / Level 2+	Unspecified	-	No recent engagement reported.	(Government of South Australia, 2009)
	other times	PWCM*	All other times			
Darwin	1 in 20 years	10-35% reduction	12 months	The community will never run out of water.	Strategy informed by community attitudes survey (2006).	(Power and Water Corporation, 2013)
	1 in 100 years	65% reduction	Up to 2 years			
Hobart	No level of service objectives specified.				-	www.taswater.com.au
Melbourne	Base level of service is to keep water storage levels above 40% to avoid triggering severe water restrictions. Trigger mild restrictions when necessary. Restrictions Levels 1-4 summarised at www.water.vic.gov.au				Established community advisory groups inform planning.	(Melbourne Water, 2017)
	Permanent water saving rules are in place at all times. Voluntary water efficiency program currently in place (T155)					www.melbournwater.com.au
Perth and Goldfields	1 in 50 years	More than PWCM	Unspecified	-	Strong technical consultation.	(Water Corporation, 2009)
	All other times	PWCM*	All other times			
SEQ (including Brisbane)	Not more than 1 in 10 years	Medium level 140 L/p/d	< 1 year on average	Any of Wivenhoe, Hinze and Baroon Pocket Dam will run out of water < 1 in 10,000 years	Community feedback informed strategy. Strong technical consultation.	(Seqwater, 2015)
Sydney	1 in 10 years	Not specified	< 3% of time	Combined storages approach empty < 1 in 100,000 years	Community feedback sought on Wplan options and use of restrictions.	(Metropolitan Water Directorate, 2017)
	All other times	PWCM*	All other times			www.metrowater.nsw.gov.au
Regional Victoria – Ballarat	1 in 20 years	Stage 1 & 2	Unspecified	Lal Lal and White Swan Reservoirs will fall below 20% < 1 in 1,000 years	Extensive stakeholder consultation to develop plans and LOS.	(Central Highlands Water, 2017)
	1 in 1000 years	Stage 3 & 4	Unspecified			

CONCLUSIONS

This paper provides a snapshot of institutional arrangements, security planning approaches and LOS objectives for urban water management in each state and territory in Australia. National urban water planning principles have been developed and adopted, and many states and territories have established LOS for metropolitan water supplies. However, there are some significant gaps and considerable scope for further development. Work should continue to add detail to the LOS for urban water supply delivery, particularly in regards to the severity and duration of restrictions that might be expected. There is also a need to improve consultation and move towards LOS that are agreed with the community, rather than simply presented.

The partnership approach to establishing LOS is a core tenant of the urban water planning principles. Policy makers have a key role in setting the frameworks to drive the development of LOS objectives, be it through legislation, license conditions or other mechanisms. Urban water planners have a key role to engage with the community, to keep them informed and react to changing views over time. Work is then required to understand the relationship between service objectives and urban water security outcomes achieved.

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THE AUTHOR



Julie Allan (julieallan@tpg.com.au) is a chemical engineer with over 25 years of experience in the resources and water sectors. For the last 18 years Julie has worked in strategic planning and policy, and asset management within the South East Queensland water sector. Julie

developed her interest in urban water security planning during the Millennium Drought and is now pursuing her PhD in this field through the University of Queensland.

REFERENCES

- ACT Government. (2014). ACT Water Strategy 2014-44, Striking the Balance. Retrieved from www.environment.act.gov.au.
- ACTEW Corporation. (2009). 2009 Review of planning variables for water supply and demand assessment. Retrieved from www.iconwater.com.au
- Australian Water Association. (2016). Water Security for all Australians, Discussion Paper. Retrieved from www.awa.asn.au
- Australian Water Association. (2017). Emerging challenges and opportunities to secure our water future - discussion paper. Retrieved from St Leonards NSW: www.awa.asn.au
- Central Highlands Water. (2017). Urban Water Strategy 2017, A 50 year water outlook for our communities in the Central Highlands Region. Retrieved from www.chw.net.au/urban-water-strategy
- Commonwealth of Australia, Government of New South Wales, Government of Victoria, Government of Queensland, Government of South Australia, Government of the Australian Capital Territory, & Government of the Northern Territory. (2004). National Water Initiative - Intergovernmental Agreement. Retrieved from www.agriculture.gov.au.
- Council of Australian Governments. (2008a). COAG Work Program on Water - November 2008 - Agreed Actions.
- Council of Australian Governments. (2008b). National Urban Water Planning Principles. Retrieved from www.agriculture.gov.au
- Department of Environment (Australia). (2010). National Water Initiative Pricing Principles. Canberra: Australian Government Retrieved from www.agriculture.gov.au.
- Erlanger, P., & Neal, B. (2005). Framework for Urban Water Planning WSAA Occasional Paper No 14: WSAA.
- Government of South Australia. (2009). Water for Good. Adelaide, SA: Office for Water Security Retrieved from www.environment.sa.gov.au.
- Government of Western Australia. (2007). Western Australia's Implementation Plan for the National Water Initiative. Perth, WA: Department of Water Retrieved from www.water.wa.gov.au.
- Melbourne Water. (2017). Melbourne Water System Strategy. Victoria State Government Retrieved from www.melbournewater.com.au.
- Metropolitan Water Directorate. (2014). Lower Hunter Water Plan. NSW Government Retrieved from www.metrowater.nsw.gov.au.
- Metropolitan Water Directorate. (2017). 2017 Metropolitan Water Plan. Retrieved from www.metrowater.nsw.gov.au
- National Water Commission. (2011a). The National Water Initiative - securing Australia's water future, 2011 Assessment. Australian Government.
- National Water Commission. (2011b). Urban Water in Australia: Future Directions. Australian Government.
- NHMRC, & NHMMC. (2011). Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. Australian Government Retrieved from www.nhmrc.gov.au.
- Power and Water Corporation. (2013). Darwin Region Water Supply Strategy. Northern Territory Government Retrieved from www.powerwater.com.au.

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- Power and Water Corporation. (2017). Statement of Corporate Intent 2017-18. Northern Territory Government Retrieved from www.powerwater.com.au.
- PricewaterhouseCoopers. (2010). Infrastructure Australia: Review of Urban Water Security Strategies. Retrieved from infrastructureaustralia.gov.au
- Priman, R., Casaril, C., & Rajakaruna, J. (2011). Biting the Bullet - Urban Water Security Planning within a water entitlements framework. Paper presented at the OzWater 11, Adelaide.
- Productivity Commission. (2011). Australia's Urban Water Sector - Overview and Recommendations. Canberra, Australia: Australian Government Retrieved from www.pc.gov.au.
- Queensland Government. (2017). Queensland bulk water opportunities statement. Brisbane: Queensland Government Retrieved from www.dews.qld.gov.au.
- SA Water. (2008). Meeting Future Demand - SA Water's Long Term Plan for Eyre Region. Government of South Australia Retrieved from www.sawater.com.au.
- Seqwater. (2015). Water for Life: SEQ's Water Security Program. Retrieved from www.seqwater.com.au/
- South East Australia Climate Initiative. (2011). The Millennium Drought and 2010/11 Floods. Retrieved from www.seaci.org/index.html
- State Government Victoria. (2016). Water for Victoria, Water Plan. Melbourne: State Government Victoria Retrieved from www.water.vic.gov.au.
- State of NSW. (2011). NSW Water and Sewerage Strategic Business Planning Guidelines. Sydney: NSW Government Retrieved from www.water.nsw.gov.au.
- State of Tasmania. (2006). Implementation Plan for the National Water Initiative Tasmania. Hobart: Department of Primary Industries and Water Retrieved from dpiw.tas.gov.au.
- Tasmanian Economic Regulator. (2013). Water and Sewerage Licence issued to Tasmanian Water and Sewerage Corporation Pty Ltd. State of Tasmania Retrieved from www.energyregulator.tas.gov.au.
- TasWater. (2017). Corporate Plan 2018-2020. Retrieved from www.taswater.com.au/
- van Dijk, A., Beck, H., Crosbie, R., de Jeu, R., Liu, Y., Podger, G., Viney, N. (2013). The Millennium Drought in southeast Australia (2001-2009): Natural and human causes and implications for water resources, ecosystems, economy, and society. *Water Resources Research*, 49(2), 1040-1057. doi:10.1002/wrcr.20123
- Water Corporation. (2009). Water Forever: Towards Climate Resilience. Retrieved from Perth: www.watercorporation.com.au
- Water Corporation. (2011). Water Forever: Drought-Proofing Perth. Retrieved from Perth: www.watercorporation.com.au
- Water Corporation. (2012). Water Forever: A 10 Year Plan for Western Australia. Retrieved from www.watercorporation.com.au

