Benchmarking, Envisioning and Transition Planning for a Water Sensitive Adelaide: Final Case Report

CRCWSC Integrated Research Project 1:
WSC Visions and Transition Strategies

Business Cooperative Research Centres Programme

Benchmarking, Envisioning and Transition Planning for a Water Sensitive Adelaide: Final Case Report

Authors

Alex Gunn[1,3], Lara Werbeloff[2,3], Chris Chesterfield[3], Katie Hammer[1,3], Briony Rogers[1,3]

[1] Monash University
[2] Monash Sustainable Development Institute
[3] CRC for Water Sensitive Cities

Publisher

Cooperative Research Centre for Water Sensitive Cities
Level 1, 8 Scenic Blvd, Clayton Campus
Monash University
Clayton, VIC 3800

p. +61 3 9902 4985
e. admin@crcwsc.org.au
w. www.watersensitivecities.org.au

Date of publication: December 2017

An appropriate citation for this document is:

Gunn, A. W., Werbeloff, L., Chesterfield, C., Hammer, K., and Rogers, B.C. (2017). Benchmarking, Envisioning and Transition Planning for a Water Sensitive Adelaide: Final Case Report. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Acknowledgements

The authors thank the project participants for bringing their enthusiasm, creativity and strategic insight to the workshop series and for their input into the development of this report. We also acknowledge the significant input of the project's local steering committee in Adelaide.

The artist responsible for the illustrations in this report is Simon Kneebone (https://simonkneebone.com/). His contribution to this project is greatly appreciated.

Table of Contents

Glossary

CRCWSC	Cooperative Research Centre for Water Sensitive Cities
IRP1	CRCWSC Integrated Research Project 1 *Water Sensitive City Visions and Transition Strategies*
Transition	A fundamental shift in cultures, structures and practices as society changes from one pattern of socio-technological development to another usually more sustainable pattern
Transition Dynamics Framework	A framework that conceptualises how system-wide changes in practice (e.g. the transition to water sensitive practices) unfold over time, based on the establishment of key enabling factors: individual and organisational champions, platforms for connecting, science and knowledge, projects and applications, and tools and instruments
Urban form	The physical characteristics that make up the built environment, including urban density and size, parcels and buildings, public spaces, ecological assets and key services such as transport and drainage
Urban Water Transitions Framework	A framework that conceptualises different forms of urban water servicing as a city responds to evolving drivers: Water Supply City, Sewered City, Drained City, Waterways City, Water Cycle City, and Water Sensitive City
WSC	Water Sensitive City; a WSC provides water system services in a way that reflects an integrated approach to infrastructure, the built form, the environment, governance and community, in order to deliver outcomes that support the enduring sustainability, liveability, resilience and productivity for a place's community and ecosystems
WSUD	Water Sensitive Urban Design; an approach to the planning, design and maintenance of urban landscapes that will deliver WSCs through protecting and enhancing natural water systems and integrating the management of the total water cycle
WSC Index	A tool to benchmark and diagnose the water sensitive performance of a place (from the municipal to metropolitan scale), based on 34 indicators across seven goals: good water sensitive governance, community capital, equity of essential services, productivity and resource efficiency, ecosystem health, quality urban space, and adaptive infrastructure.

1. Introduction

1.1. Background

As cities and towns globally are grappling with the challenges of climate change and rapid urbanisation, practitioners, decision-makers and academics are recognising the importance of water in supporting urban liveability, sustainability and resilience for a city's long-term prosperity.

In Australia, the concept of the water sensitive city (WSC) is now widely used to represent an aspirational city-state, where water has a central role in shaping a city. In a water sensitive city, people can enjoy reliable water supplies, effective sanitation, protection from flooding, healthy ecosystems, cool green landscapes, efficient use of resources, and beautiful urban spaces that feature water and bring the community together.

A water sensitive city incorporates many innovative infrastructure, design and governance solutions. For example, water recycling at different scales, through wastewater recovery and stormwater harvesting, provides a diversity of water sources and improves the health of downstream rivers and creeks by reducing pollution and flow impacts. Water sensitive urban designs integrate nature-based infrastructure into the landscape to provide hydraulic and water treatment function, as well as amenity benefits such as an aesthetic environment and mitigation of urban heat island effects. Integrated and collaborative land use and water planning results in catchment-scale approaches to enhancing flood resilience and connecting areas of green and blue to create ecosystem and recreation corridors throughout the city footprint. Citizens are active in caring for water and the environment, and there is cohesion amongst the community as their sense of place and collective identity is nurtured through their connection with water.

Many places are starting to articulate aspirations represented by the water sensitive city concept. However, there is not yet an example of a water sensitive city in the world and becoming one is not easy. It requires a significant departure from the conventional mode of water servicing, which typically manages water as separate streams for water supply, wastewater and stormwater through large-scale, centralised infrastructure. These traditional water systems have given us critical benefits such as clean water, safe sanitation and effective drainage, and this mode of servicing is still an important part of a water sensitive city. However, we now recognise that adaptations are needed to address key social and environmental vulnerabilities such as degraded waterways, uncertain and extreme rainfall patterns and growing community expectations for improved liveability.

Significant changes in policy and practice are required for a city to achieve its water sensitive vision. Transitioning to a water sensitive city therefore requires commitment and alignment amongst many different people and organisations. Developing a shared perspective of water today, a vision for the future and a framework to guide coherent strategic action is critical for establishing the understanding, motivation and capacity amongst stakeholders to drive their water sensitive city transition.

1.2. About this report

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) was invited to develop a WSC vision and transition strategy for Adelaide, encompassing the Greater Adelaide region. This forms part of the *Water Sensitive City Visions and Transition Strategies* integrated research project (IRP1), which aims to deliver a suite of participatory methods and associated tools for guiding cities and towns in accelerating their water sensitive transitions.

Adelaide is one of five case studies conducted as part of the *Water Sensitive City Visions and Transition Strategies* project (along with Perth, Sydney, Townsville and Bendigo). The CRCWSC has also undertaken a similar project for Gold Coast outside the IRP1 project structure. As these cases are delivered, findings from across cities will be analysed to develop strategic insights about the agenda of transitioning to a water sensitive Australian cities more broadly.

This report presents the outcomes of the Adelaide case study, methodological details and full analyses that underpin the results:

Introduction and methodology	Section 1
The historical, contemporary and future water story for Adelaide	Section 2
Benchmark of Adelaide's current water sensitive performance	Section 3
A 50-year vision for Adelaide as a water sensitive city	Section 4
Assessment of Adelaide's current enabling conditions for transitioning	Section 5
Priority objectives and strategies for accelerating Adelaide's water sensitive city transition	Section 6

The report consolidates results of analysis by the project team and participant discussions, iterated over the course of three workshops and a series of pre-workshop interviews. Workshop images and anonymous participant quotes are included to highlight key activities and perspectives.

A companion report, "Vision and Transition Strategy for a Water Sensitive Adelaide", consolidates these outcomes into an executive summary that is intended for broad circulation.

Alongside the production of practical guidance for the Adelaide water sector contained in this report and its companion document, the engagement process overall has been valuable for strengthening relationships amongst stakeholders and building momentum and commitment for driving Adelaide's transition towards its envisioned water sensitive future.

1.3. Project methodology

The project approach is based on ongoing research by the CRCWSC[1] that aims to develop a suite of methods and tools for providing strategic guidance to cities and towns wanting to accelerate and build momentum for the transition towards their envisioned water sensitive future.

The project was conducted over a five-month period between March and July 2017, and involved desktop review by the project team, individual interviews with workshop participants, a series of three one-day workshops, and iterative synthesis and analysis across all the above sources of data to produce key elements of Adelaide's vision and transition strategy. Details of the individual activities are provided below.

The workshop designs and data analysis drew on theories and frameworks within transitions scholarship, an emerging body of research focused on understanding and navigating sustainability transitions. Within this field, the CRCWSC has developed two key benchmarking and diagnostic tools that were applied in this project: the Water Sensitive Cities Index and the Transition Dynamics Framework (as elaborated below).

Desktop review

The project team reviewed relevant literature, including SA Government policy documents relevant to the topic areas of the WSC Index, key SA Acts and regulations, department and agency websites, as well as published academic literature relevant to water policy in the Adelaide region. Key sources are listed in the References section.

[1] CRCWSC Integrated Research Project 1: Water sensitive city visions and transition strategies (https://watersensitivecities.org.au/content/project-irp1/)

Interviews

Pre-workshop interviews were conducted with practitioners across Adelaide's water, development, planning and environment sectors. Most interviews were conducted individually, though in some cases two individuals were interviewed together. A total of 26 people were interviewed. Interviews examined participants' understanding of Adelaide's water management issues, major challenges and opportunities, and professional and organisational culture, systems and processes. The interview questions were open-ended to allow for in-depth narratives about personal experiences and perceptions. Anonymous interview quotes are used throughout the report to illustrate key points. Perceptions expressed in the quotes should not be interpreted as representative of the views of the whole participant group, or of the authors.

Participatory workshops

The workshop series involved a diverse set of people from across Adelaide's water, planning and environment sectors (see Appendix A for a full list of participants). Participants were personally invited to ensure a rich mix of organisations, disciplines and perspectives.

The workshops were structured and designed to lead participants through an iterative series of discussions to understand the existing system conditions, develop shared aspirations for Adelaide's future, identify barriers to change, and understand strategic priorities. There were three full-day workshops between May and early July 2017.

The project team produced an interim report after each workshop that synthesised key outputs and incorporated subsequent analysis that drew on the desktop review and participant interviews, in addition to workshop discussions. At the subsequent workshop, participants were given the opportunity to refine and validate these outputs. Collectively, these outputs produced a strong narrative, clear strategic direction and a framework to create alignment and drive coherent action amongst stakeholders.

Specific information on each of the workshop topics is briefly presented below.

Workshop 1 - Understanding and benchmarking today

The first workshop, held on 8 May 2017, applied the WSC Index (Chesterfield et al. 2016), developed by the CRCWSC, to benchmark Adelaide's water sensitive performance and diagnose key areas of strength and weakness with respect to the seven goals of good governance, community capital, equity of essential services, productivity and resource efficiency, adaptive infrastructure, ecological health and quality urban space.

The WSC Index aims to:

- Provide a communication tool for describing key WSC attributes
- Articulate a shared set of goals of a WSC
- Provide a benchmark of a city's current water sensitive performance
- Measure progress and direction towards achieving WSC goals
- Assist decision-makers prioritise actions, define responsibility and foster accountability for water-related practices.

As well as being incorporated into the longer transition planning process (as it was in this project), the WSC Index can be applied as a standalone tool in a single one-day workshop. It has been co-developed with industry partners and its application relies on cross-organisational knowledge sharing and collaboration that strengthens broader industry relationships to deliver commitment to action.

The WSC Index application involved a full day workshop in which the 34 indicators across the 7 goal areas were scored on a 1-5 rating scale. Scoring was performed by participants individually using an interactive web-based tool, before a consensus score was determined by discussion and negotiation. There were 27 participants in the workshop drawn from State Government departments and

agencies, local government, professional and industry groups, and the private water industry. The results of benchmarking enabled comparisons against modelled representations of the “water sensitive city” or “water cycle city”, as well as to other cities that have participated in the WSC Index program.

Workshop 2 - Developing a narrative and future vision

In workshop 2 on 29 May 2017, participants were asked to consider the past and future drivers, industry trends and significant developments for Adelaide. The narrative of Adelaide’s historical and future developments created a deep appreciation of the contextual drivers and trends that have shaped and will continue to shape Adelaide. This led participants to consider why a water sensitive city transition is necessary and what a water sensitive city would need to deliver for Adelaide to continue to thrive.

Against this context, participants identified their vision for Adelaide in a 50-year timeframe. This comprised a suite of outcome statements that represent distinct but interconnected aspirations. The 50-year time frame was chosen to enable participants to think beyond today’s paradigms and constraints, since transformative change can occur over such a period.

Also at this workshop, participants were introduced to principles and frameworks emerging from transitions theory to provide them with a conceptual understanding of how transitions dynamically unfold and the types of strategic actions that have been shown to be valuable in enabling successful system transitions. Participants were also asked to discuss the challenges that could hinder the transition to the envisioned future for each of the seven goals of the WSC Index.

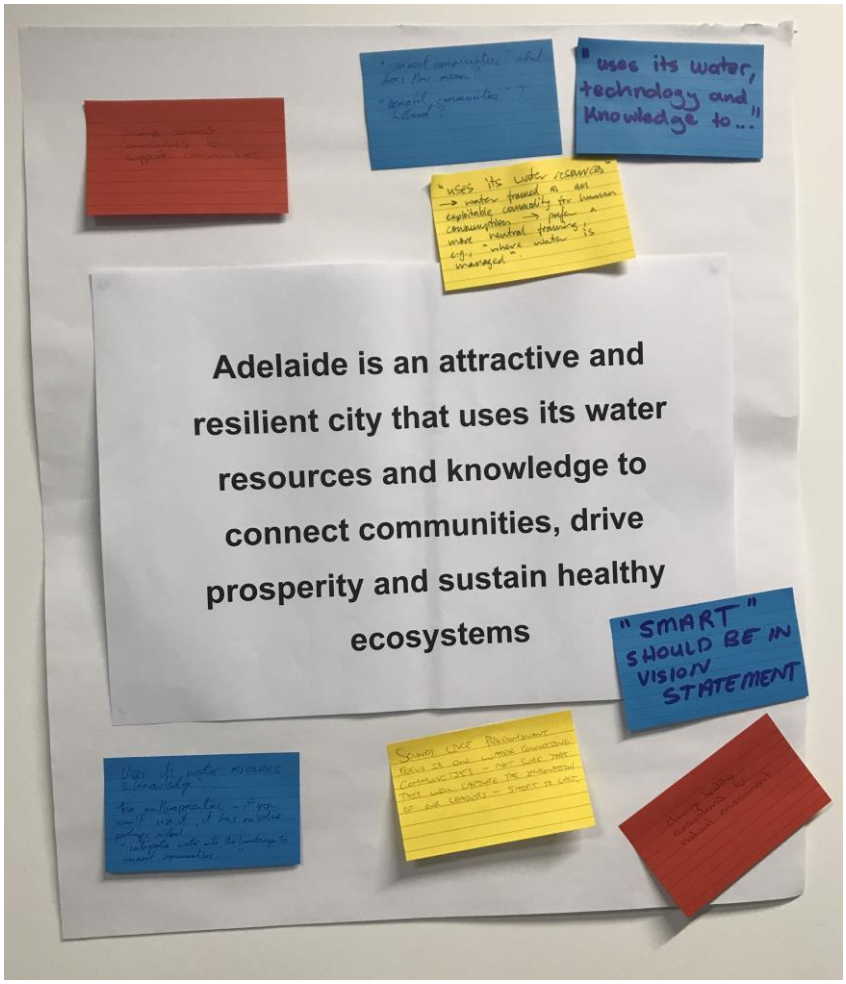


Figure 1. Participants’ comments on the text of the vision in workshop 3.

Workshop 3 - Reviewing strategic priorities for achieving the vision

This workshop, held on 3 July 2017, examined and refined the results of Adelaide's water story from workshop 2, describing in broad terms the changing focus of Adelaide's water sector. A draft vision was also presented and improved by participants. The workshop then sought to link the future vision with the current institutional settings and transition conditions using the Transition Dynamics Framework (Brown, Rogers & Werbeloff, 2016; Brown, Rogers & Werbeloff, 2017).

The Transition Dynamics Framework facilitates assessment of the current phase of transition towards more sustainable practices across five enabling factors: champions, platforms for connecting, knowledge, projects and applications, and tools and instruments. This analysis helps diagnose the critical barriers to achieving the vision, and the conditions that should be strengthened to promote transition progress over the short-to-medium term.

Key insights from this analysis were presented, in the form of priority objectives for each of the six headline vision statements. These were explored by participants within table groups. The results of these discussions have contributed to the amended priority objectives and strategies included in this Report.

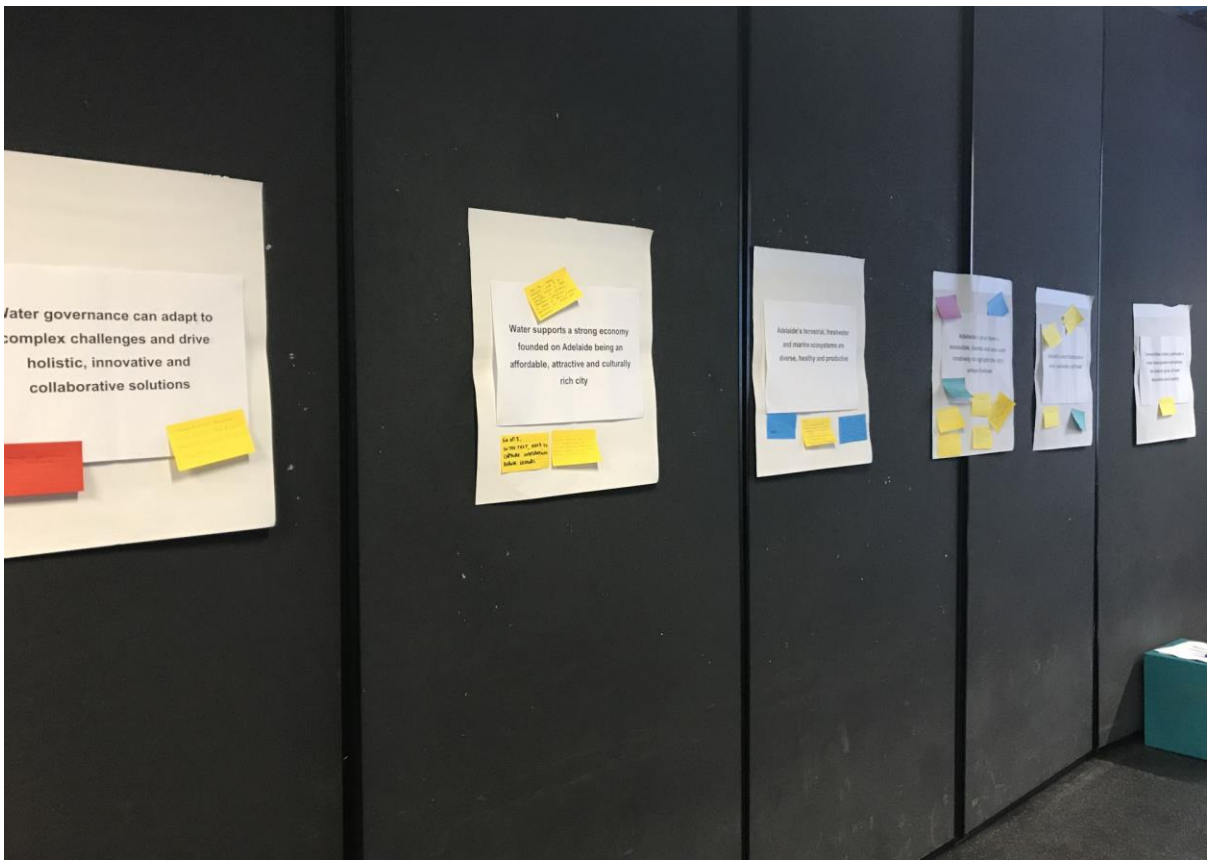


Figure 2. Participants' comments on some of the thematic vision statements.

2. Adelaide's water story

2.1. From the past to the present day

Participants identified events and trends for Adelaide across technical, environmental, governance, community and personal domains. These were collated on a large timeline on the wall (Figure 3). Group discussion then unpacked the storyline that emerged, analysing key periods and their drivers and impacts, and how the evolving water system enabled or were affected by the shifts observed. Post-workshop synthesis developed a visual representation (Figure 4) and narrative for these developments.

Figure 3. Timeline of Adelaide's historical water story created during Workshop 2 discussions

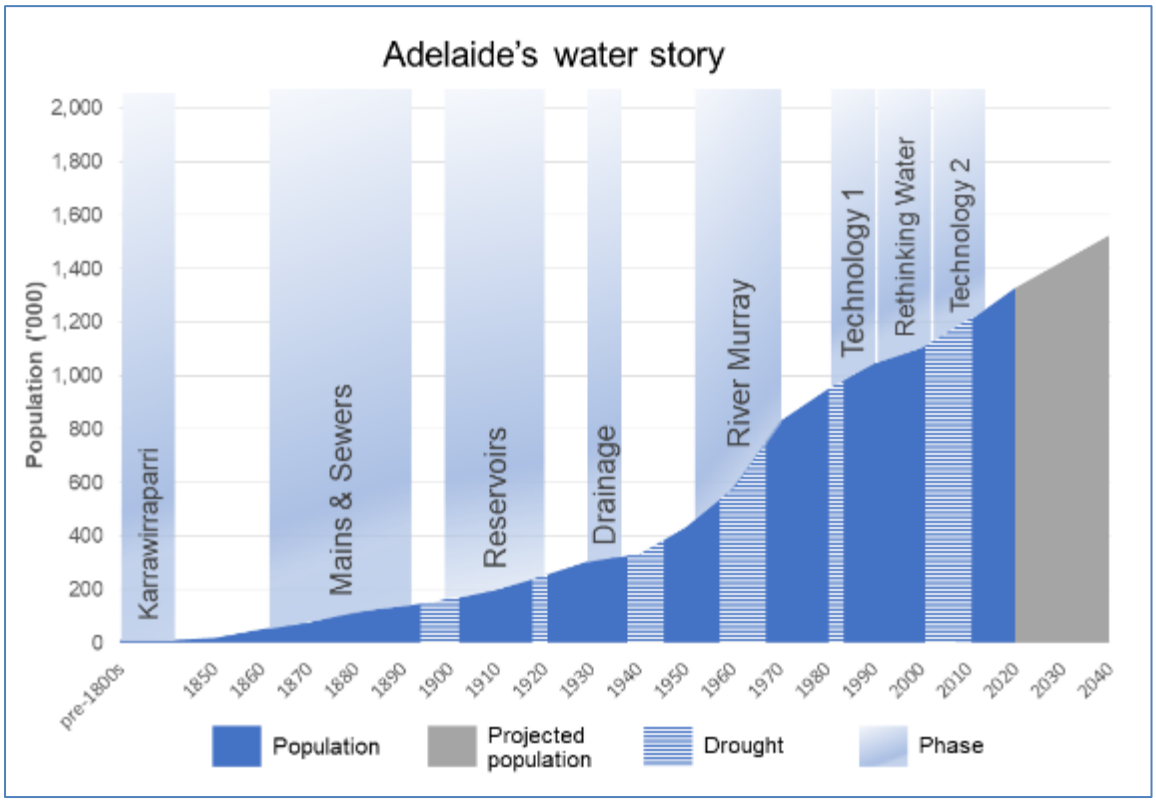


Figure 4. Synthesis of Adelaide's water history.

The collaborative development of Adelaide's water story up to the present day establishes a shared understanding of the trends that have shaped its current context and will influence its future. This provides a foundation for reflecting on the future for water in Adelaide, with its cycles of drought and flooding, and the importance of the city's water sensitive transition.

Karrawirraparri

Before settlement by Europeans in the 1800s, the area now occupied by Greater Adelaide was home to the Kaurna tribe primarily, although lands at the periphery of Adelaide were also home to the Ngarrindgeri, Ngadjuri and Peramangk tribes. Pre-European settlement, River Torrens was known by its native Kaurna name, Tarndaparri. Around the river grew Karra, or red gum trees. This gave rise to another name for the river, Karrawirraparri, or 'Red gum forest river'. The river was also known by other names, such as Karrundo-ingga west of present-day North Adelaide, and Yertalla everywhere when in flood.

Mains & sewer construction

Early settlers were reportedly shocked that River Torrens ran dry in summer. This was a significant problem as up until the early 1860s, the Torrens was the primary water supply to Adelaide. By 1856, there were separate stormwater and sewer systems planned. By 1860, the first reticulated water reached Adelaide homes as a result of the completion of Gorge Weir and diversion to Thorndon Park Reservoir, and the construction of Kent Town Waterworks. The Hope Valley Reservoir was constructed in 1873. In 1881, Adelaide's "deep drainage network" of wastewater sewers was inaugurated. Adelaide was the first Australian city to gain a flush sewerage system. 1881 also saw the creation of Torrens Lake. Other decisions of this time have left a more problematic legacy, such as the decision in the 1850s to privatise waterways, so that many parts of creeks on the Adelaide plains are now integral parts of the stormwater drainage system, running through residents' backyards.

Reservoirs

Major droughts affected Adelaide in 1895-1903 and 1918-20. These droughts strained Adelaide's water supplies and led governments to search for new sources of water. By 1897, the Happy Valley Reservoir was completed to provide a storage capacity over four times that of Hope Valley. In 1902, the Barossa Reservoir was constructed to supply the northern Adelaide plains, and in 1918, the Millbrook Reservoir was completed. In 1938, the Mt Bold Reservoir was completed, which remains the largest of Adelaide's reservoirs to this day.

Drainage

Significant early legislation includes the *Waterworks Act 1856* (which led to the establishment of the Waterworks and Drainage Commission) and the *Sewerage Act 1929*. A major River Torrens flood in 1931 affected large areas of the eastern, southern and western suburbs. As a result, there was political drive to introduce legislation to establish new powers to manage stormwater flooding, and the *Metropolitan Drainage Act 1935* was enacted. This led to state investment in selected stormwater drainage works in areas subjected to flooding by River Torrens, Sturt River, and Keswick and Brown Hill Creeks. Another drainage management decision around this time was to give the River Torrens an artificial outlet to the sea – Breakout Creek was constructed in 1936.

River Murray connections

Post-World War II saw significant population growth in Adelaide, alongside some important infrastructure developments. The South Parra Reservoir, Adelaide's second-largest, was completed in 1958, and several other dams followed. However, it was the construction of the Mannum-to-Adelaide pipeline in the early 1950s that was the most significant development. This connected Adelaide's water supply to the Murray-Darling Basin for the first time. Another connection to the River Murray, the Murray Bridge to Onkaparinga Pipeline was completed in the early 1970s. Another major project in this period was the West Lakes land reclamation project.

Technological change, phase 1

Many Adelaide households in the 1970s and early 1980s drank rainwater rather than tap water, which tended to have a brown colour. With the late '70s and early '80s seeing the construction of several water treatment plants (beginning with Hope Valley Water Treatment Plant in 1977), drinking from rainwater tanks began to go out of fashion. Drought in 1982–83 prompted new approaches to water management. The Stop the Drip Campaign for water conservation debuted in the early 1980s. The mid-1980s also saw the City of Salisbury investigate a range of water sensitive urban design practices to manage water quality and stormwater flooding risk. In the 1990s, the City of Salisbury also began using Aquifer Storage and Recovery (ASR) to store treated stormwater over winter for summer irrigation of council reserves. Along with ASR trials in the adjacent City of Playford, this was likely the first use of ASR in an urban context in Australia. This was prompted by the latest research into Adelaide's geology showing Adelaide's natural advantages for ASR. In 1990, the Bolivar and McLaren Vale recycled wastewater schemes were developed.

Rethinking water

Significant attention was focused in the 1990s on national water reform and competition policy, which led to the Council of Australian Governments (COAG) National Water Initiative. Water resources began to be 'prescribed' to better manage their allocation; by the 2000s, nearly all of Adelaide's surface and groundwater resources were managed in this way. A growing desire for cleaner environments also influenced governance and development in Adelaide in the 1990s. The Environment Protection Act and Development Act were passed in the early 1990s. The Catchment Water Management Boards for the Torrens and Patawalonga catchments were created in 1995 following community anger about the condition of the Patawalonga Lake System (recognised at the time as one of the most polluted systems in the country). The 1998 Sydney water crisis (an outbreak of cryptosporidium and giardia) was another stimulus for increased protection of Adelaide's water catchments. Trash racks were installed along creeks from 1997. The Keep South Australia Beautiful (KESAB) campaign, as well as water quality education, was a feature of schools during the 1990s. Climate change became part of the agenda from 1992 following Australia's ratification of the United Nations Framework Convention on Climate Change. Around this time, Australia's first WSUD educator, Professor John Argue, was prominent in Adelaide.

"The Regent Gardens development, more than 20 years ago, one of the first aquifer recharge systems… would be much harder to do these days."

Technological change, phase 2

The Millennium Drought of 2001-09 put water security high on the government's agenda. In 2009, it was determined that a desalination plant would be constructed for Adelaide. The Glenelg to Adelaide Park Lands recycled wastewater project (GAP) was completed in 2010. 2010 also saw the first recycled treated sewage effluent ASR scheme. The North South Interconnection System, enabling a single integrated potable network for Adelaide, was completed in 2012. Much of this investment was

supported by a substantial influx of National Water Commission funding. There were also several stormwater reuse and ASR schemes constructed during this period through programmes such as Waterproofing the North, Waterproofing the South and Waterproofing the West. Many of these projects were foreshadowed by Water for Good, released in 2009, which sought to secure water supplies for Adelaide up to 2050 on a platform of decentralised and multi-source water supplies.

"The Goyder Institute and drought were the two things that helped the most. We've got better at innovation and risk than we used to be. We have some way to go in the innovation sense, but we do have quite a strong approach to innovation."

Adelaide experienced reduced amenity during the drought, with parklands being 'browned off' to save water. Households experienced severe water restrictions, which appear to have changed household and gardening technology and practices for the long-term. In addition to water efficiency measures, there has also been a focus in recent years on the issue of urban heat and its mitigation.

Other major policy releases in this period concerning water include the 30-Year Plan for Greater Adelaide, first released in 2010 and updated in May 2017, the Stormwater Management Agreement in 2006, which resulted in the formation of the Stormwater Management Authority, and the Adelaide Coastal Water Quality Improvement Plan (EPA, 2013), which advocated that the coast and marine environment be managed as part of a larger integrated catchment system. The SA WSUD policy, Water sensitive urban design – Creating more liveable and water sensitive cities in South Australia, was also released (DEWNR, 2013b).

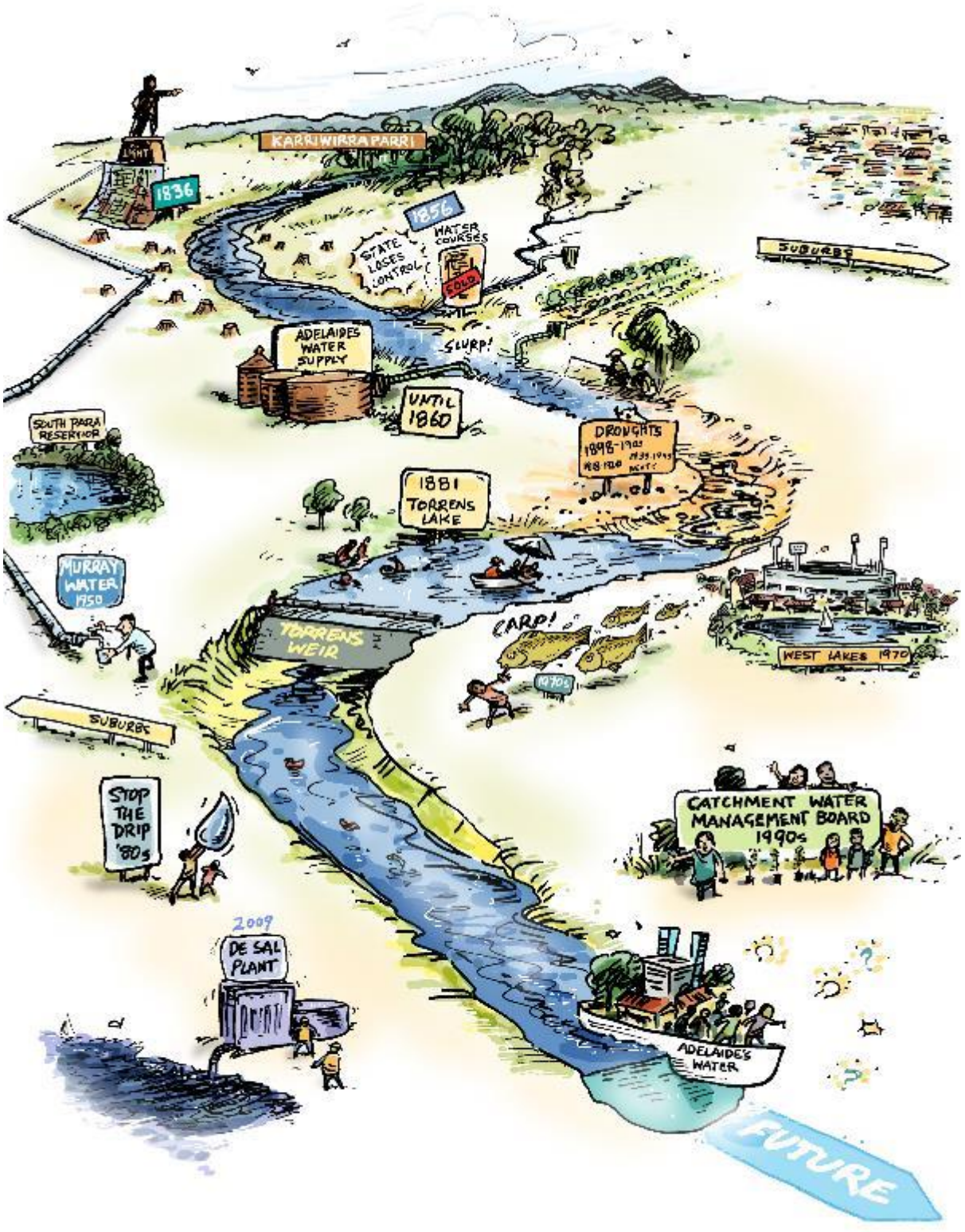


Figure 5. Adelaide's water story (illustration: Simon Kneebone).

2.2. Adelaide's current water system

The project iteratively analysed Adelaide's current system, drawing on workshop discussions as well as participant interviews and a review of secondary data. The social, historical, cultural, and biophysical conditions for Adelaide's water are presented here. The intent is to provide a snapshot of today's urban water management sector and highlight contextual elements that are particularly important for understanding Adelaide's water sensitive transition.

Supply, sewage and drainage

Adelaide has a hot Mediterranean climate, with mild, wet winters and hot, dry summers. It is the driest of the five Australian state capital cities and receives approximately half of the annual rainfall of Sydney or Brisbane. Adelaide's potable water supply is augmented by water from the Murray–Darling Basin due to low yields from local catchments compared to other major Australian cities. Average natural inflows are approximately 116 GL and average demand is approximately 145 GL. In years with lower than average inflows, the River Murray can supply 80% of Adelaide's water (SA Water, 2012). This reliance on geographically distant catchments is unusual for Australian capital cities (Blesing & Pelekani, 2015).

In broad terms, management responsibility for the three primary water services – water supply, sanitation and drainage – is split between SA Water and local government. SA Water is responsible for potable water supply and wastewater treatment for the state, and, with some exceptions, local government is responsible for stormwater management. This has held true until recently when local government has gained the technical and legal capacity to enter the water treatment and supply market. SA Water has similarly broadened its scope of operations in recent years (SA Water, 2016b).

"The [SA] government has a push for jobs, from old manufacturing to new manufacturing, and at some stage there will be water demand outstripping supply."

Long-term risks in the water system include water security and stormwater flooding. In terms of supply, metropolitan Adelaide has a relatively diversified system, which adds groundwater extraction (including aquifer storage and recovery), desalination, stormwater reuse, and wastewater reuse to supplies from the Murray-Darling Basin and the Mount Lofty Ranges catchment. Desalination, though not a popular solution in the community, was a significant source of potable water between 2012 and 2015. Currently, the potential economic benefits of growth in water-dependent industries are not as strong a driver as they can be for water recycling and other productivity enhancements. Increasing the productivity of Adelaide's water resources may be critical for future economic development, drought resilience and liveability. In the case of the latter, managing urban heat is considered a significant driver.

Adelaide is built on a natural floodplain, and many local government areas contain land vulnerable to flooding. The lead agency responsible for flood preparation, response and recovery is the Department of Environment, Water and Natural Resources (DEWNR), although councils have responsibility for protecting against flood hazards by, for example, managing stormwater drainage and as a relevant authority for planning assessment. Increasing infill development and projected higher peak rainfall intensity due to climate change has implications for existing drainage infrastructure in the long-term. During 2017, a Flood Reform Taskforce and its working groups was to have continued work to clarify responsibilities for management of watercourses, levee banks and other flood infrastructure, and to attend to the reform of development controls to explicitly reflect flood risk, among other recommendations (Burns, Adams, & Buckley, 2016).

Though the stormwater planning framework and institutions were considered to have effective leadership, there appears to be a shortfall in funding for major works. The capacity of the Stormwater Management Fund, which is currently about $5 million per year indexed to inflation, to provide for on-ground implementation was raised as a barrier by multiple participants.

Ecosystem health

One of largest drivers for water sensitive practices in Adelaide is the health of the marine environment. Gulf St Vincent has “extensive seagrass meadows, mangroves, and samphire or saltmarsh, as well as significant sandy and soft bottomed habitats and reef areas” (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2013, p. 29). However, many years of near-continuous inputs of nutrient-rich and turbid water have caused nutrient enrichment of coastal waters, growth of epiphytes, and effects on the seagrasses (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2013, p. 30). There has been over 5000 ha of seagrass loss, which the Adelaide Coastal Water Study attributed to increased nitrogen loads and, to a lesser extent, increased turbidity from sediment loads from stormwater, wastewater and industrial discharges (EPA, 2013).

“There was a lot of discussion about conserving water during drought, about treating water as a resource. But just because we’re not in a drought, it doesn’t mean we should ignore what happens to water once it leaves our property.”

There are few examples of open watercourses in Adelaide. Major rivers include the Gawler (including the North and South Para) in the far north, the Torrens in the centre and Onkaparinga River in the south. Recently, there have been trials to provide amenity and environmental flows for the Torrens, Onkaparinga and Para rivers, which has been seen to deliver tangible benefits. The Torrens amenity flow trial has reduced the number, onset, duration and severity of algal blooms, though they remain a hazard during the summer months (Adelaide City Council, 2016; Daniels & Good, 2015).

There are concerns that biodiversity in the region continues to decline as a result of pressure from urban growth. The Mount Lofty Ranges watershed is 90% private land (EPA, 2015). According to the Adelaide and Mount Lofty Ranges Natural Resources Management (AMLRNRM) Board, the key regional issues include the “fragmentation and degradation of native vegetation and landscapes, inappropriate fire regimes, unsustainable land management and resource use” (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2013, p. 24). Fragmented remnants of native vegetation survive on public land such as conservation reserves, as well as on the private lands of suburban, peri-urban and rural households (Bardsley et al., 2015). Unfortunately, peri-urban population growth has outpaced population development in other areas, often in areas with high conservation values such as in the Adelaide Hills. As a result of strict controls on clearing through the Native Vegetation Act (2003), in conjunction with the attraction of large trees in urban environment, “the urban forest now runs seamlessly into the remaining native forest remnants” (Bardsley et al., 2015, p. 159). This has, however, brought high bushfire risk to residential areas, and threatened catchment condition.

The most recent publication on the Central Adelaide Prescribed Water Area’s groundwater level and salinity status reported a trend of rising or stable groundwater levels across most of the region between 2010-11 and 2014-15 (Department of Environment Water and Natural Resources, 2015). However, about a quarter of wells, mainly near the coast, showed a trend of declining groundwater pressure levels.

Data indicated salinity was increasing in most monitoring wells, but was stable or decreasing in others. In 2015, salinity in the aquifer experiencing the bulk of extraction ranged from 815 to 4164 mg/L and five out of 18 monitored wells had salinities of more than 1500 mg/L (Department of Environment Water and Natural Resources, 2015).

Water governance

With the increased priority given to catchment health, water quality and urban ecology, among other functions, organisations beyond SA Water and local government have been given accountability for various aspects of water planning and management, including the EPA, NRM Boards, the Department of Environment, Water and Natural Resources (DEWNR), the Department of Planning, Transport and Infrastructure (DPTI), and the Stormwater Management Authority. Some degree of coordination is facilitated by bodies such as the Adelaide and Mount Lofty Ranges Natural Resources Management

(NRM) Board and the Stormwater Management Authority. The Stormwater Management Authority has an important function to support the stormwater management planning framework, which has the capacity to coordinate multi-council action. The metropolitan Adelaide region also supports several less formal networks to support water sensitive city initiatives. For example, the Goyder Institute, established in 2010, attracts senior policy input from State Government as well as research expertise from CSIRO and the three main universities in Adelaide. Although there are currently many champions to identify opportunities to leverage water-related benefits into other projects with connected agendas (such as health, recreation or urban renewal), there has been a tendency for inconsistency and a lack of strategic coordination.

"Project by project there's great collaboration between SA Water and councils."

Integrated urban water management for Greater Adelaide has been part of the South Australian Government's policy since at least 2005, having been key components of Water Proofing Adelaide – a thirst for change: 2005–2025, Water for Good, and the Stormwater Strategy (Department of Water, 2011; Office for Water Security, 2010). With major reforms to the planning system currently being rolled out, there is an important opportunity to put integrated water management into practice. This is considered important by participants as planning has generally focused on immediate priorities rather than long-term integrated outcomes, and water sensitive urban design implementation in particular has been affected by perceptions of high cost in comparison to traditional stormwater management.

Urban form

Adelaide has an enviable endowment of green space immediately surrounding the CBD. However, in the early planning of Adelaide, very little public land was set aside along watercourses. The River Torrens Linear Park and flood mitigation scheme was created through public land acquisitions in the 1970s and 80s, though much of the former private land had been protected from incompatible development. However, there remains a shortage of other linear green space. There are still believed to be opportunities for increasing green infrastructure, for example in disused parks and through more effective use of streetscapes, such as by reclaiming road.

Urban heat is perceived to be a major driver of investment in sustainable stormwater infrastructure, with strong links to community health and climate change adaptation. Three of Adelaide's five climate change adaptation regions, Resilient South, Adapt West and Adapting Northern Adelaide, have undertaken urban heat mapping to inform urban greening and water management strategies. The central business district is the hottest part of the Greater Adelaide area (Razzaghmanesh, Beecham, & Salemi, 2016). However, the air temperature in the Adelaide parklands is effectively cooler than the CBD by about 1.5°C at night, and 0.5°C during the day. With parkland irrigation, the cooling effect can be larger. In combination with the afternoon sea breeze in summer, the parklands may help reduce air temperatures in the CBD (Guan et al., 2013).

South Australian waterways are largely in private ownership due to pre-Federation settlement policies, which, in addition to complicating stormwater management, creates difficulty in planning linear parks around water courses. Nevertheless, there has been a prevalence of water sensitive urban design projects on public land. The maintenance of green infrastructure may in the future be challenged by the likelihood of future water shortages including from irrigation being rationed. This has in past had the support of community, who tend to have strong engagement with water conservation, but less so with the value of water in the urban environment.

Community

In a number of focus groups with Adelaide residents, Leonard, Walton and Farbotko (2015) found their participants to be very favourable to rainwater tanks and stormwater capture and storage as ways to access additional water and reducing stormwater flows to the coastal environment. Though concerned with the environmental impacts of desalination, it was viewed as an important safeguard against drought. Participants also preferred a centralised single pipe distribution system rather than a fit-for-purpose supply that separated potable and non-potable supply (2015, p. 1703).

A survey of Australian water literacy and attitudes (Fielding et al., 2015) indicated some differences between states, though the data did not distinguish regions within states (e.g. Adelaide within South Australia). It is likely that Adelaide residents have relatively high levels of knowledge about some aspects of water management, such as the factors that can negatively (e.g. fertilisers) or positively (e.g. actions within the home or garden) impact on water quality. Adelaide residents appear likely to have a better general understanding of how the water cycle works than the national average, though a smaller proportion than the national average would claim to have a clear understanding of the water cycle.

"Community don't know what a water sensitive city is, but want green space in their suburbs."

Local indigenous and cultural relationships to water are recognised in several strategies. Water for Good aimed to develop a partnerships approach to water policy implementation, with a focus on education programs. Relationship building was one of the guiding principles of the WSUD Policy (DEWNR, 2013b). Several programs and policies, including the AMLRNRM Plan and the EPA Catchment to Coast project have well-targeted engagement or capacity-building strategies. Nevertheless, engagement with the broader community about how to define Adelaide a water sensitive city is needed, and some key groups, such as mainstream developers, stormwater drainage engineers or public asset managers, need to be better engaged in planning and implementation.

2.3. Looking to the future

Participants were specifically asked about the implications of key drivers on water management in Adelaide, and what critical things a WSC needs to deliver for Adelaide to remain a great place in the future. Participants considered the critical drivers to be increasing resource (water, energy) scarcity, a changing climate and managing urban heat, the need for renewal of major trunk infrastructure, the availability of new technology, an ageing population, a more compact and attractive city, and the changing role of government and utilities.

Most of Adelaide's new residential development in recent years has occurred in established suburbs rather than at the fringes. This trend is expected to continue, not least due to the target of 85% infill development set by the 30-Year Plan for Greater Adelaide – 2017 Update (DPTI, 2017). If development intensifies and private residential space decreases, quality, multi-functional public open space will be of considerable importance for the community. In particular, green infrastructure will have a valuable role in the future because of its potential to support community health, sustainability and resilience. A key target for health and resilience measures may be Adelaide's significantly higher population of older residents.

Green infrastructure will be important for Adelaide if its climate warms as projected. For example, the average number of days exceeding 35°C may increase from 20 days in the period 1981–2010 to 26 days in 2030 and 32 days in 2090. Days of extreme heat, with temperatures exceeding 40°C, are forecast to increase from 3.7 days in the period 1981–2010 to 5.9 in 2030 and 9 in 2090 (CSIRO and Bureau of Meteorology, 2015). Adelaide along with Perth will experience the greatest increase in extreme heat days among Australian capital cities. Adelaide will need vegetation cover to better manage higher urban temperatures, but will need to do so with lower winter rainfall, with some years expected to receive nearly half the amount of winter rain compared to the present (CSIRO and Bureau of Meteorology, 2015). Therefore, it will need to use water in the urban landscape more productively and efficiently.

"Our challenge is look at water in a more holistic way to maximise its resource value."

Though South Australia's economy is expected to restructure in response to a transition away from heavy manufacturing, WSC pathways favour the skills and technologies that will help South Australia shift its economy to knowledge-intensive activities and services, and high value food and beverage

production. These changes benefit from a move to a more compact city, for example in protecting land and water resources on the periphery of Adelaide to support agriculture. Changes in the use of water in the urban form may also provide conditions supportive of creative industries that drive growth in modern urban economies – through the presence of natural, cultural, and built amenities, well-regarded knowledge institutions, the density of economic activity, and the migration of talented people.

A new economy in which energy and water may be significantly more constrained will create new threats to prosperity, but also new opportunities. For example, food production is likely to need to decrease its reliance on climate-dependent water resources, and to increase its reliance on water efficient processes and water resources that are less impacted by rainfall. These changes can achieve a thriving post-carbon economy for South Australia.

3. Benchmarking Adelaide's water sensitive performance

3.1. WSC Index framework

Water servicing within cities has traditionally focused on meeting the basic needs of society through essential service provision. However, there is now a growing emphasis on the importance of water system services in enhancing a city's liveability, sustainability, productivity and resilience. These goals are partly what is meant by the water sensitive approach. Other concepts captured in this approach include integrated management of the whole water cycle, consideration of water systems as an integral part of the urban landscape, and engagement with citizens as active stewards of a city's water resources and environments (Wong & Brown, 2009).

Water sensitive cities strive to enhance biodiversity, encourage connected communities, and foster cultural significance. They also protect the health of waterways, reduce flood risk, and create multi-functional public green spaces. Ultimately, a water sensitive city recognises how water can both meet the basic needs of society and also contribute to the creation of connected, vibrant and liveable communities.

As cities seek to adopt this approach, they need to understand both its present status with regard to urban water management and define their short and long-term sustainability goals. An analytical tool has been developed specifically for this purpose: The Urban Water Transitions Framework (Brown, Keath & Wong, 2009) (Figure 6). The framework identifies six distinct developmental states that cities may move through on their path toward increased water sensitivity. Figure 7 describes each of the city-states in more detail. This understanding can help urban water strategists define the attributes of more sustainable cities and identify the capacity needs and institutional changes required for more sustainable water management.

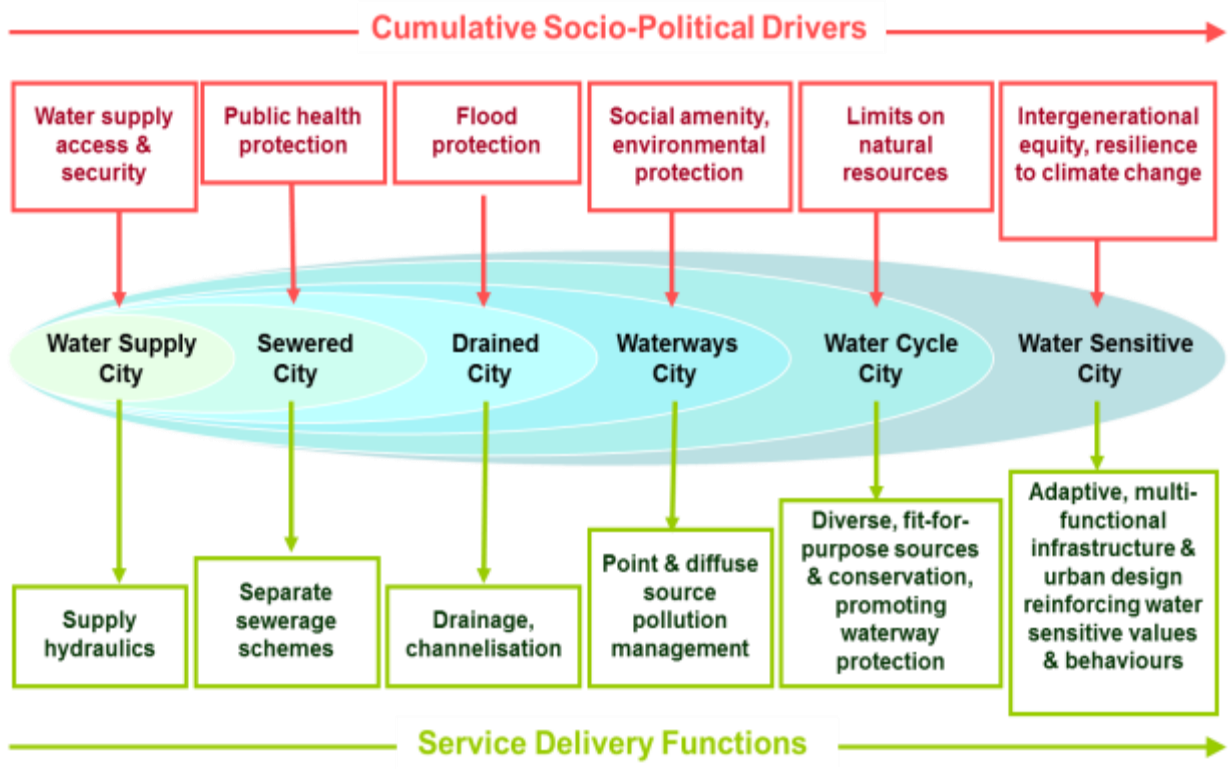


Figure 6. Urban Water Transitions Framework (Brown, Keath & Wong, 2009).

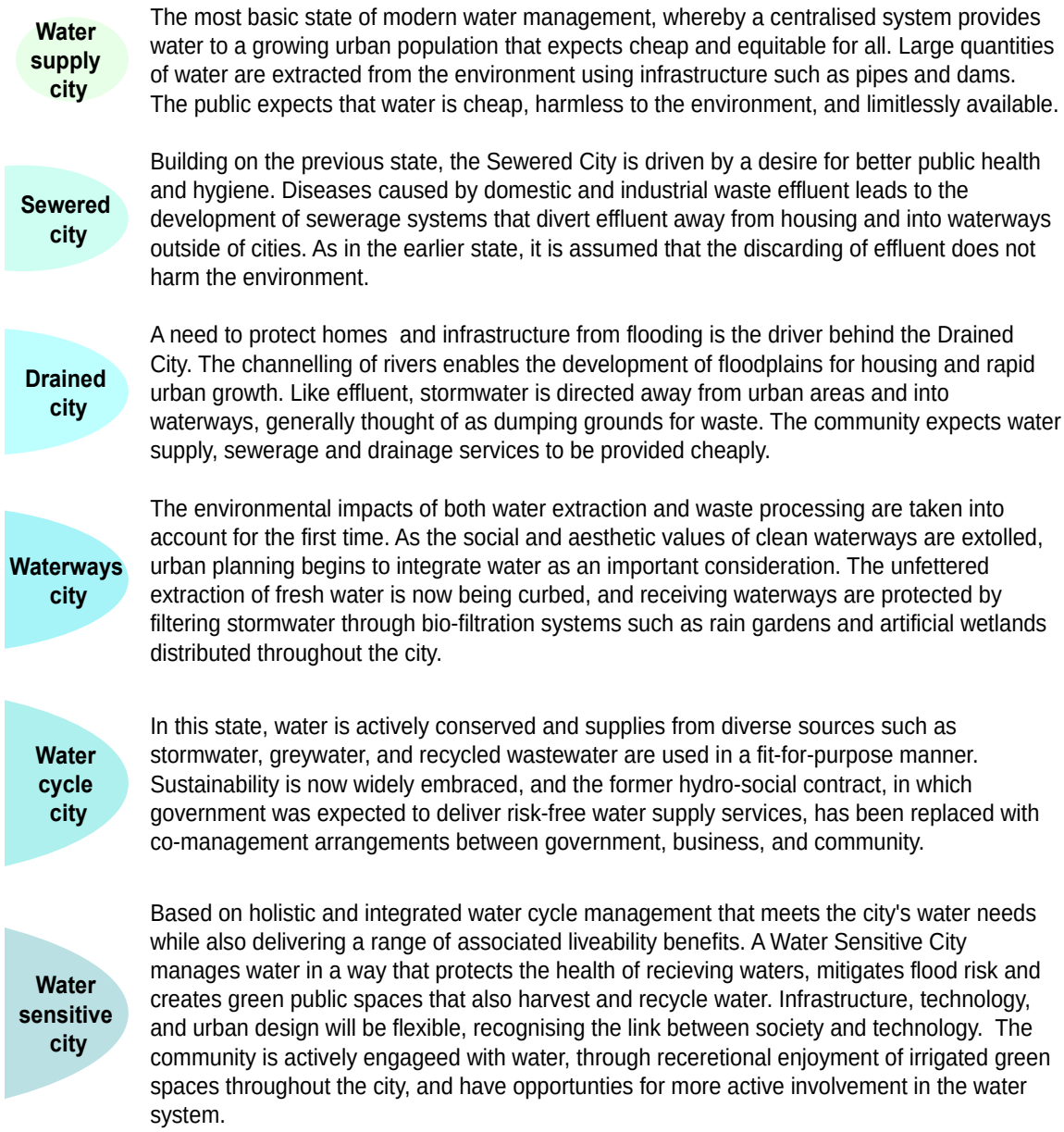


Figure 7. Descriptions of each state in the Urban Water Transitions Framework (Brown et al. 2016).

Planning Adelaide's transition to its WSC vision requires a detailed understanding of its current performance in relation to its aspirations. The CRCWSC's WSC Index is a benchmarking tool designed for this purpose. It articulates seven WSC goals, which organise 34 indicators representing the major attributes of a WSC (Figure 8). These indicators are also mapped to the idealised city-states represented in the Urban Water Transitions Framework to provide a benchmarked city-state.

While a city's local WSC vision may not emphasise all indicators of the WSC Index to the same degree, the tool enables diagnosis of key areas of strength and weakness. This insight can then inform the prioritisation of actions and it provides a framework for ongoing monitoring and evaluation of a city's water sensitive performance.

1. Ensure good water sensitive governance	2. Increase community capital	3. Achieve equity of essential services	4. Improve productivity and resource efficiency	5. Improve ecological health	6. Ensure quality urban space	7. Promote Adaptive infrastructure
1.1 Knowledge, skills and organisational capacity	2.1 Water literacy	3.1 Equitable access to safe and secure water supply	4.1 Benefits across other sectors because of water-related services	5.1 Healthy and biodiverse habitat	6.1 Activating connected urban green and blue space	7.1 Diverse fit-for-purpose water supply system
1.2 Water is key element in city planning and design	2.2 Connection with water	3.2 Equitable access to safe and reliable sanitation	4.2 Low GHG emissions in water sector	5.2 Surface water quality and flows	6.2 Urban elements functioning as part of the urban water system	7.2 Multi-functional water system infrastructure
1.3 Cross-sector institutional arrangements and processes	2.3 Shared ownership, management and responsibility of water assets	3.3 Equitable access to flood protection	4.3 Low end-user potable water demand	5.3 Groundwater quality and replenishment	6.3 Vegetation coverage	7.3 Integration and intelligent control
1.4 Public engagement, participation and transparency	2.4 Community preparedness and response to extreme events	3.4 Equitable and affordable access to amenity values of water-related assets	4.4 Water-related commercial and economic opportunities	5.4 Protect existing areas of high ecological value		7.4 Robust infrastructure
1.5 Leadership, long-term vision and commitment	2.5 Indigenous involvement in water planning		4.5 Maximised resource recovery			7.5 Infrastructure and ownership at multiple scales
1.6 Water resourcing and funding to deliver broad societal value						7.6 Adequate maintenance
1.7 Equitable representation of perspectives						

Figure 8. The 7 goals and 34 indicators of the WSC Index

3.2. Adelaide's WSC indicator scores

Table 1 provides the individual indicator scores for each goal and Figure 9 summarises the performance of Adelaide against the seven goals of a WSC and the benchmark of the idealised *Water Cycle City.*

Adelaide is well aligned to the Water Cycle City benchmark goals of *Achieve equity of essential services* and *Promote adaptive infrastructure*. A deficit in attaining key attributes of a Water Cycle City is most evident across the goals of *Improve ecological health*, *Ensure quality urban space*, and *Increase community capital*.

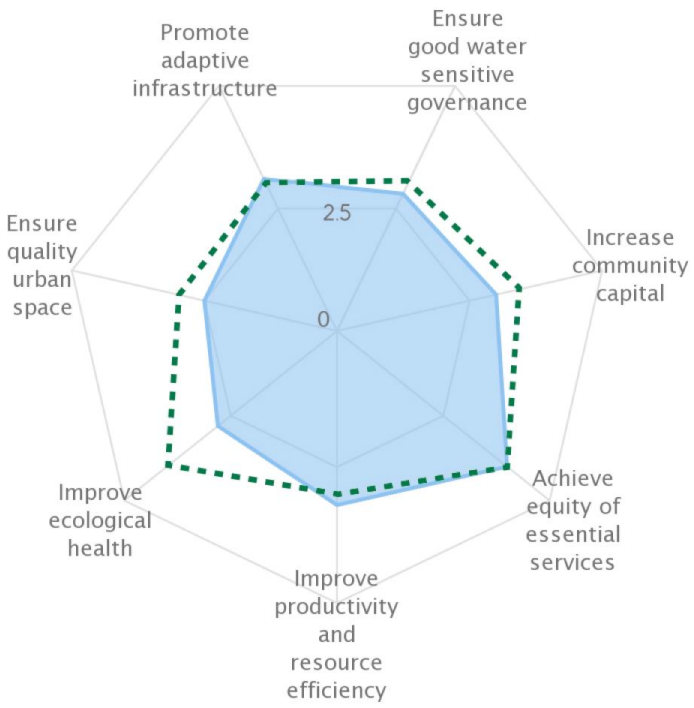


Figure 9. Adelaide's performance (blue area) compared to the water sensitive goals and the idealised *Water Cycle City* benchmark (dashed green line).

Table 1. WSC Index scores (Goals and Indicators) for Adelaide

	Score /5		Score /5
1. Ensure good water sensitive governance	**2.8**	**4. Improve productivity and resource efficiency**	**3.2**
1.1 Knowledge, skills and organisational capacity	2.5	4.1 Benefits across other sectors because of water-related services	3.5
1.2 Water is key element in city planning and design	2.5	4.2 Low GHG emission in water sector	2
1.3 Sound institutional arrangements and processes	3	4.3 Low end-user potable water demand	3
1.4 Public engagement, participation and transparency	3	4.4 Water-related commercial and economic opportunities	4
1.5 Leadership, long-term vision and commitment	3	4.5 Maximised resource recovery	3.5
1.6 Water resourcing and funding to deliver broad societal value	3	**5. Improve ecological health**	**2.8**
1.7 Equitable representation of perspectives	2.5	5.1 Healthy and biodiverse habitat	2
2. Increase community capital	**3**	5.2 Surface water quality and flows	2.5
2.1 Water literacy	3	5.3 Groundwater quality and replenishment	3
2.2 Connection with water	3.5	5.4 Protect existing areas of high ecological value	3.5
2.3 Shared ownership, management and responsibility for water assets	2.5	**6. Ensure quality urban space**	**2.5**
2.4 Community preparedness and response to extreme events	3	6.1 Activating connected urban green and blue space	3
2.5 Indigenous involvement in water planning	3	6.2 Urban elements functioning as part of the urban water system	2
3. Achieve equity of essential services	**4**	6.3 Vegetation coverage	2.5
3.1 Equitable access to safe and secure water supply	4.5	**7. Promote adaptive infrastructure**	**3.1**
3.2 Equitable access to safe and reliable sanitation	4	7.1 Diversify self-sufficient fit-for-purpose water supply	3.5
3.3 Equitable access to flood protection	3.5	7.2 Multi-functional water infrastructure	3
3.4 Equitable and affordable access to amenity values of water-related assets	4	7.3 Integration and intelligent control	2.5
		7.4 Robust infrastructure	3.5
		7.5 Infrastructure and ownership at multiple scales	3
		7.6 Adequate maintenance	3

3.3. Adelaide's benchmarked city-state

The WSC Index was applied by 27 participants during a full-day workshop. Each indicator was scored by individual polling, then group discussion of the results was conducted before a consensus score was agreed. During the discussion, justification for the agreed score was given, the score confidence (low, medium, high) was determined, and key sources of evidence were identified.

Figure 10 summarises the city-state benchmarking results for Adelaide. Percentage attainment for each city-state ranged from 100% as a Water Supply City and Sewered City through to 9% as a Water Sensitive City. This section summarises the key elements that contribute to the overall percentage attainment of each city-state.

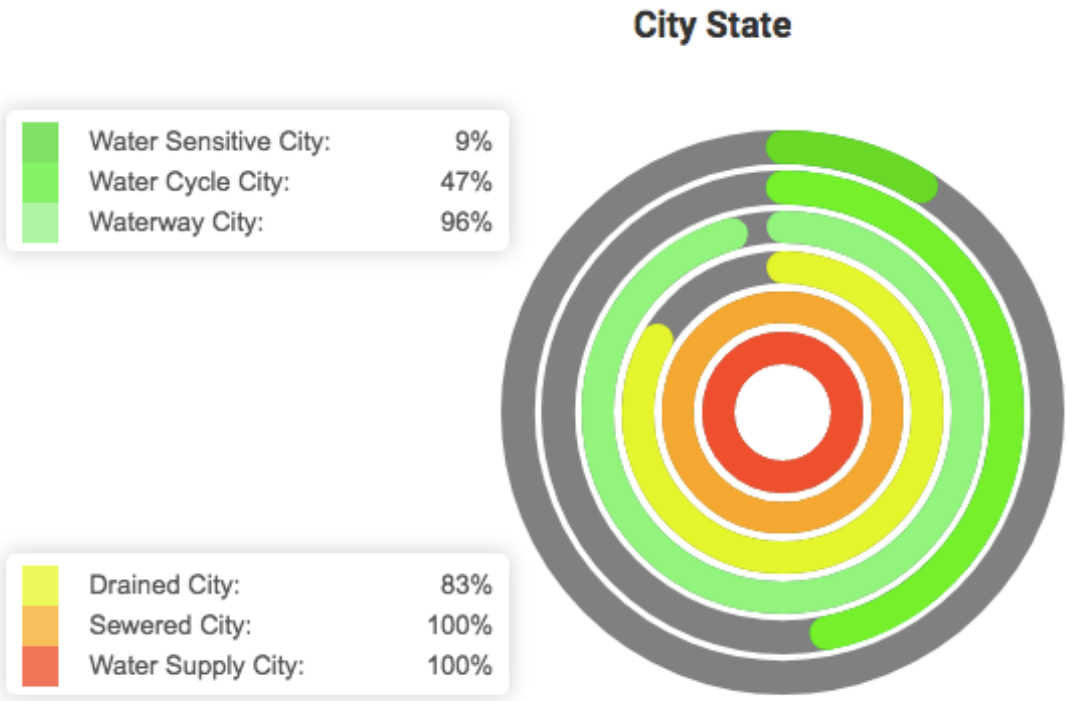


Figure 10. Summary of Adelaide's performance against the ideal measures for each city-state.

100% attainment of Water Supply City & Sewered City

Despite its dry climate, Adelaide is well regarded for water security and as such rated 100% as a Water Supply City. Measures to help ensure a safe and secure water supply for a growing population include an extensive network of water mains, water treatment plants and potable water sources such as reservoirs in the Mount Lofty Ranges catchments, the River Murray, and a desalination plant. This supply is managed centrally, provided at an affordable cost to end users and with very reliable public health outcomes. SA Water reported that 99.96% of metropolitan tests exceeded Australian Drinking Water Guideline (ADWG) parameters and testing also showed a 99.97% E. coli compliance for 2015-16 in metropolitan samples (SA Water, 2016a).

Similarly, nearly everyone in Adelaide – 1,133,000 residents according to a recent SA Water estimate – has access to safe and reliable sanitation (SA Water, 2016b). This meant Adelaide rated 100% as a Sewered City. The sewer system is linked to six wastewater treatment plants around Adelaide that treat wastewater to 'developed world standards' prior to release to the environment. Septic tanks systems are used in a few small communities in the Adelaide Hills.

83% attainment of Drained City

Adelaide rated 83% as a Drained City. The region has strong standards in place to protect homes and businesses from the impacts of flooding. This is considered to be the highest priority in land use planning with respect to water use and management. Most water courses have been piped or channelised to rapidly convey water out of urban areas.

Risk of extreme flooding events is generally well understood at the policy level across Adelaide. Emergency services are also well prepared with an all-hazards approach to emergency response. However, there are concerns about the effectiveness of household plans for extreme events. Though flood risk is limited to certain areas of Adelaide, this is considered the most significant gap in preparedness for vulnerable residents. Many residents are likely unaware they live in a floodplain because local flooding is relatively infrequent. Similarly, there is a general lack of awareness of the forecast impacts of future sea level rise. Several flood events in 2016 highlighted the vulnerability of the system to intense rainfall events.

To attain the Drained City, detention measures would need to be implemented throughout Adelaide's flood plains to reduce impacts associated with peak flood events.

96% attainment of Waterway City

Adelaide rated 96% as a Waterway City, reflecting well integrated and diverse water related assets. Significant investment continues to be directed at improving coastal integrity, waterway amenity and liveability values across Adelaide. Waterways and beaches are readily accessible.

The Adelaide community has a strong connection to water in the urban environment in an aesthetic sense. This is reflected in higher house prices closer to bodies of water and nearer the beach.

The delivery of broader societal value is a key driver of water infrastructure projects. There is a strong recognition of diffuse-source pollution and use of wetlands and other systems to manage it at the policy level across government. This has resulted in significant investment in WSUD and water security in the last 15 years. There are also industry guidelines and programmes in place to promote take-up of WSUD and build professional capacity.

47% attainment of Water Cycle City

Adelaide has shown considerable vision and innovation in water supply diversity. The current limits to traditional water supplies for a growing population and future economic development are understood. Non-potable water sources include groundwater extraction (including aquifer storage and recovery), stormwater reuse, wastewater reuse and rainwater tanks. There is increased decentralisation of stormwater capture, storage and distribution systems, though more can be done to integrate separate networks.

There has been considerable investment in the treatment of wastewater to limit the environmental impact on receiving waters, particularly in terms of the risk of eutrophication. However, stormwater remains an issue for the marine environment, and there is a need for more action to address diffuse source pollution to restore marine water quality. One of the constraints is the need to better integrate Water Cycle City objectives into the existing built form, to ensure there is sufficient open space in established urban areas to be able to treat stormwater. There are also areas that have low proportions of active green-blue space, and Adelaide has been recognised as having the lowest proportion of tree canopy cover among Australia's capitals.

Permanent water saving measures are in place. Following the Millennium Drought, uptake of demand management measures was common through the installation of water saving fittings, fixtures and appliances. Adelaide has one of the highest rainwater tank installed bases among Australian state capitals, though adoption of fit-for-purpose water use within the home (as opposed to the garden) needs more support, and there is potential that tank installations will plateau if there is not more supportive policy in place.

Participants believed there needs to be a more consistent approach to integrated water management through all relevant organisations, particularly in infrastructure provision. There is enthusiasm for integrated water management but a more coordinated approach across the urban form will promote innovation and adoption. However, there is a growing capacity and knowledge across larger organisations, and an interdisciplinary approach to water management is beginning to spread.

A principle of the Water Cycle City is co-management of the water system by government, business and the community. This necessitates broadening of participation in water management beyond traditional groups and disciplines. Currently, the SA Government has policy in place to improve gender equity, and there are recognised policies supporting engagement with indigenous groups. Progress has been made in broadening the representation of local government councillors and in some appointed boards. While several programmes to involve indigenous perspectives in water management have recently commenced or been piloted, indigenous engagement is not yet embedded in Adelaide's water governance. Public participation in water management, for example in managing water courses on private land, would also need to become more widespread.

9% attainment of Water Sensitive City

Adelaide rated 9% as a WSC, achievement of which is largely attributed to equity of essential services of water supply and sanitation. Both supply and sanitation services are accessible to everyone; they are safe, secure and affordable. Treated wastewater discharged to the environment is well managed.

Parts of Adelaide have well-connected urban green space with high canopy cover. Adelaide is also well-served by the central parklands. Legislation, regulations and policies are in place to protect areas of biodiversity significance, but there are concerns over their effectiveness.

To achieve a WSC, Adelaide will need to fulfil the multiple objectives of ecosystem protection and restoration, security of supply, flood control, public health, amenity, liveability and economic sustainability, among others. While Adelaide has begun to make strides towards a WSC, significant efforts are still needed in order to transition current water management practice to water sensitive practice.

4. The vision for a water sensitive Adelaide

Participants iteratively developed their vision for Adelaide as a water sensitive city over the course of two workshops. Brainstorming was initially structured around the seven goals of the WSC Index, with synthesis and refinement through subsequent discussions. Adelaide's WSC vision was consolidated into a set of six outcome statements, which distils the core ideas participants felt represent their long-term future aspirations. Each outcome statement is elaborated through text that provides a rich description of the future water sensitive Adelaide.

The 50-year water sensitive vision for Adelaide aims to orient and align the actions of stakeholders over the long-term. The aspirations of participants for their city's water future are expressed as a suite of outcome statements with accompanying rich descriptions. The timeframe enables people to stretch their ambitions beyond today's systems and constraints to reflect on the transformative change that is possible over such a period.

Adelaide is an attractive and resilient city that uses its diverse water resources and knowledge to drive prosperity, sustain healthy ecosystems, and connect communities

1. Adelaide's terrestrial, freshwater and marine ecosystems are diverse, healthy and productive
2. Adelaide's water infrastructure systems are smart, sustainable, and flexible
3. Adelaide's urban form is accessible, liveable and integrates water creatively to highlight Adelaide's unique features
4. Communities actively participate in water management and embrace the natural cycles of water abundance and scarcity
5. Water supports a strong economy underpinned by Adelaide being an affordable, vibrant and culturally rich city
6. Water governance can adapt to complex challenges and drive holistic, innovative and collaborative solutions

Figure 11. The vision of Adelaide as a WSC.

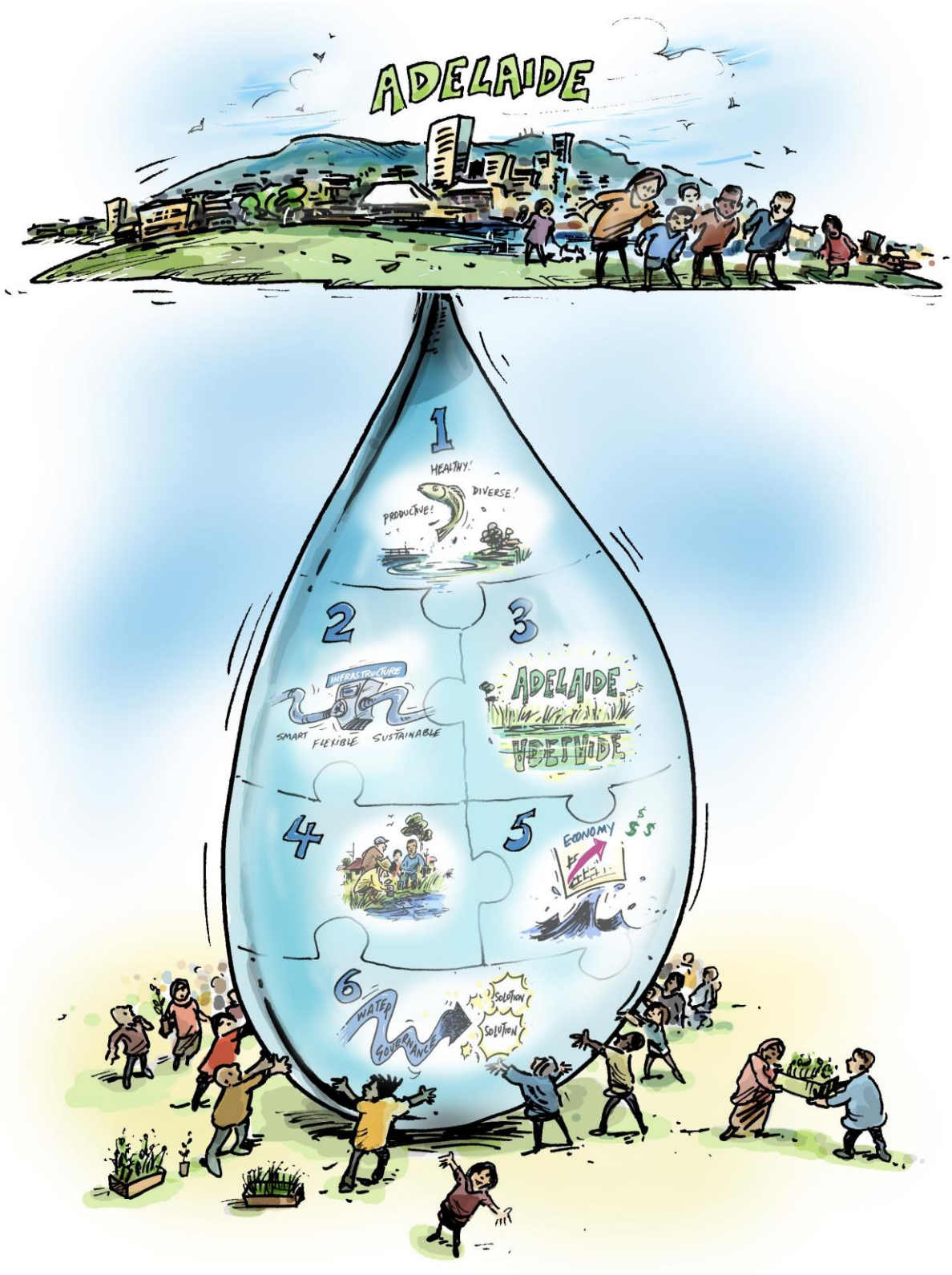


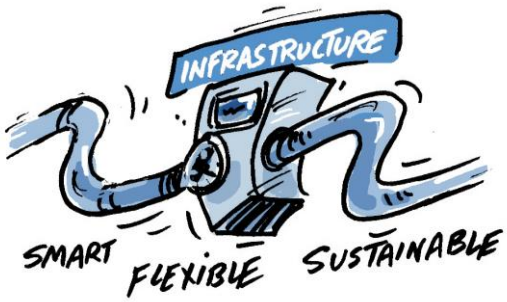
Figure 12. Adelaide vision illustrated (illustration: Simon Kneebone)

1. **Adelaide's terrestrial, freshwater and marine ecosystems are diverse, healthy and productive**

Waterways, coastal waters, wetlands and groundwater systems are sustainably managed and ecologically healthy. Adelaide is known for its iconic woodlands and network of ephemeral creeks. Seagrass habitats in the Gulf St Vincent have been restored to good health. Coastal and inland waters are safely enjoyed by the community year-round. In all but the driest summers, urban waterways are available for locals to swim. Pollution prevention and waste reduction are key drivers of management.

2. **Adelaide's water infrastructure systems are smart, sustainable, and flexible**

Adelaide has a sophisticated water system that ensures fit-for-purpose water is available wherever it is needed, there is no waste, and the city's overall energy efficiency is a critical element of management. For this outcome, water infrastructure makes extensive use of smart technology and is designed to fulfil multiple functions. Investment decisions are assessed to ensure they deliver social, economic and environmental benefits, and to be adaptable to new conditions and demands. Water management is carbon neutral and achieves full resource recovery. Ecosystem components such as flora, fauna, waterways, soils and topography are appropriately valued as part of water infrastructure. Intense rainfall occasionally causes flooding that affects some properties, but homes and businesses are safe and Adelaide responds effectively to disruption. Water services are priced equitably for residents irrespective of their location.



3. **Adelaide's urban form is accessible, liveable and integrates water creatively to highlight the city's unique features**

Adelaide's urban form supports multiple uses and functions that are linked by a celebration of water in the landscape. Public green spaces, including streetscapes, use water to keep the community cool, healthy and connected. There is accessible quality public green space throughout the region. Neighbourhoods are designed and serviced to support healthy communities with well-shaded streets that are walkable on hot days and for all ages. Canopy cover is maintained or increased across the urban area to reduce the urban heat island effect and achieve other goals. There is innovation in how roads and pavements are designed to increase infiltration and rebalance the urban water cycle. Green infrastructure is an integral part of the urban form and incorporates a range of native and exotic plants best suited to the conditions and intended outcomes. Semi-natural areas, such as linear

reserves along creeks and rivers, are a much-loved feature of the urban form, and provide opportunities for nature-based play, learning and connections to peri-urban conservation areas. Private open space provides enough room for aesthetic and kitchen gardens.

Figure 13. Leafy and cool streets (illustration: Simon Kneebone)

4. Communities actively participate in water management and embrace the natural cycles of water abundance and scarcity

Adelaide households and businesses are active participants in water management through choices made in the home as well as engagement in local, regional and state water planning processes. The community, including business, has a good understanding of the urban water cycle and how they influence water conservation and quality. The community also knows the importance of green infrastructure for urban liveability, such as its role in mitigating urban heat. Households are viewed as critical to stewardship of the water system, with important responsibilities for rainwater storage and water treatment. There are champions for WSC outcomes in every neighbourhood. The community has high understanding of natural cycles and associated risks. Information about the risk of flooding to property and services, and how to respond, is accessible to all residents.

5. Water supports a strong economy underpinned by Adelaide being an affordable, vibrant and culturally rich city

Adelaide is a desirable place to live and establish and conduct business. New residents as well as new investment are attracted to the city. Innovation is well supported, and there are efficient and sustainable markets for water and energy in which the value of resources is fully captured. There is demand for water that is fit-for-purpose, with strong competition in supply. The community understands the potential benefits and risks of new ideas in water management and are early adopters of new technologies. There is growth and export of water sensitive design skills and technology. Adelaide has a circular economy in food and agribusiness. Adelaide's highly regarded built and natural environment is at the core of a healthy tourism sector. Adelaide's growth in prosperity has been shared by all residents equitably to reinforce the city's strong social cohesion.

6. Water governance can adapt to complex challenges and drive holistic, innovative and collaborative solutions

Water resource planning is vertically and horizontally integrated, with organisations across different scales and sectors collaborating to deliver holistic and coordinated solutions. The regulatory framework for water encompasses all aspects of the urban water cycle (i.e. water capture, storage, distribution, use, disposal and treatment) in an integrated and flexible way. This framework promotes public and private sector innovation to create efficient and sustainable water solutions. The public is involved in planning and problem-solving processes through nation-leading approaches to open and transparent deliberation. This generates commitment to long-term water management goals beyond the electoral cycle. Adelaide's Traditional Owners have a stronger role in water management, both as a source of knowledge and as direct participants.

5. Transitioning to Adelaide's WSC vision

Participants explored Adelaide's progress in its WSC transition through interviews and workshop activities that examined the barriers to and enablers of change currently experienced. The project team analysed this data to give insight into whether Adelaide is early, midway or advanced in its transition towards specific aspects of its envisioned water sensitive future, which is important for understanding what should be given priority focus in the development of strategic actions.

5.1. Transition Dynamics Framework

Adelaide's transition towards its water sensitive city (WSC) vision will require significant changes across the structures, cultures and practices of urban and water system planning, design, management, engagement and decision-making. Transitions theory is a body of interdisciplinary research that studies how these changes are driven and enabled over time.

CRCWSC research has drawn on transitions theory to develop the Transition Dynamics Framework (Brown et al., 2016; Brown et al., 2017). This Framework identifies six distinct phases of change during a city's water sensitive transition (Figure 14). As a city moves through each phase sequentially, enabling conditions are established to support its trajectory towards its WSC vision and avoid the risk of change pathways that reflect lock-in, backlash or system failure patterns (Figure 15).

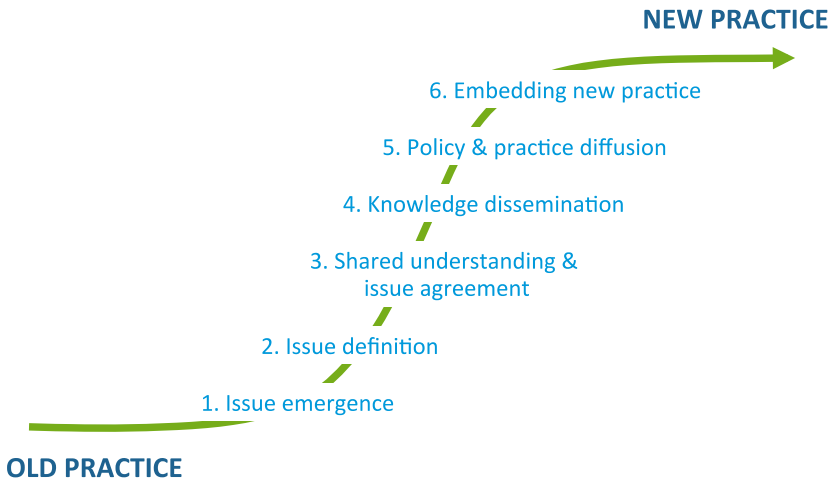


Figure 14. Six phases of change during the transition to a new practice.

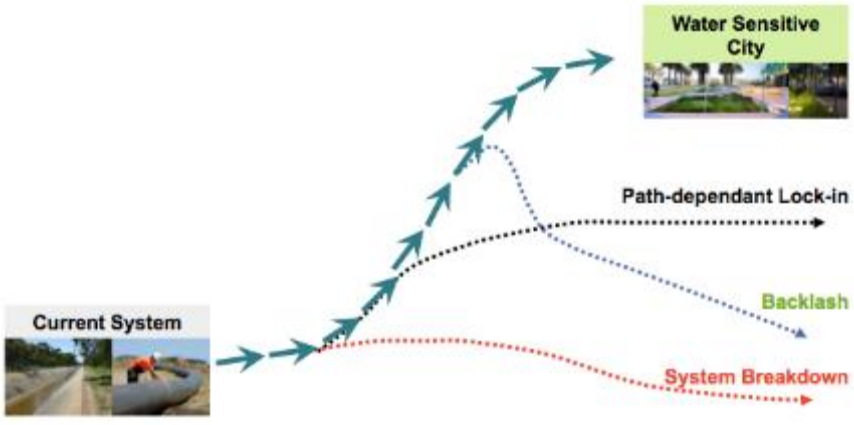


Figure 15. Transition pathways: Successful transition, lock-in, backlash and system breakdown.

Actions to orient and drive change towards a city's envisioned water sensitive future need to progressively establish these enabling conditions. Actions with the most impact during the early phases of transition will be different from those during the later phases. It is critical to identify a city's current phase of change to ensure that actions are prioritised according to the effectiveness they will have in accelerating the WSC transition.

The CRCWSC's Transition Dynamics Framework sets out five types of enabling factors that need to be present throughout a transition: champions, platforms for connection, science and knowledge, applications, and practical and administrative tools. Together, these five factors create an enabling environment for a WSC transition and, mapped against the six transition phases, they create a matrix (Figure 16) for a deeper understanding of the current transition phase for each vision outcome. A range of desktop and engagement activities provided data on Adelaide's enabling environment that was analysed using the Framework.

Transition phase	People and organisations	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue emergence	Issue activists		Issue highlighted	Issue examined	
2. Issue definition	Individual champions	Sharing concerns	Causes and impacts examined	Solutions explored	
3. Shared understanding & issue agreement	Connected champions	Sharing ideas	Solutions developed	Solutions experimented with	Preliminary practical guidance
4. Knowledge dissemination	Influential champions	Building support	Solutions advanced	Solutions demonstrated at scale	Early policy
5. Policy and practice diffusion	Organisational champions	Expanding the community of practice	Capacity building	Widespread implementation and learning	Formal practical guidance and early regulation
6. Embedding new practice	Multi-stakeholder networks	Guiding consistent application	Monitoring and evaluation	Standardisation and refinement	Comprehensive policy and regulation

Figure 16. Transition Dynamics Framework (adapted from Brown et al. 2016; Brown et al. 2017)

5.2. Priority objectives and strategies

Adelaide's WSC vision includes varied aspirations that are likely to require diverse implementation actions. Though the short-to-medium term objective is to fully achieve the Water Cycle City benchmark, the Transition Dynamics Framework gives insight into how this can be achieved for each vision outcome in more detail. This analysis is critical for ensuring Adelaide stakeholders pursue the most effective objectives, strategies and actions over the short-to medium term to accelerate Adelaide's WSC transition. This section discusses the enabling factors for each of the vision outcomes to derive strategic recommendations for advancing Adelaide's performance against relevant WSC Index indicators and therefore achieve the next phase of transition.

Vision outcome 1: Adelaide's terrestrial, freshwater and marine ecosystems are diverse, healthy and productive

Required changes in practice

Water system services can have serious negative impacts on ecological health, as well as play a critical role in protecting and enhancing ecosystem health and delivering ecosystem services for

people. Traditionally, water supply, sewerage and drainage systems have not considered ecological health objectives to be a primary concern, however in recent decades the removal of pollution from wastewater treatment plant discharges has become standard practice. The treatment of diffuse pollution in surface water and groundwater, and managing the hydraulic impacts of stormwater flows, is more challenging, however, and conventional water system services are not typically designed to address these objectives. For example, traditional drainage systems that aim to convey stormwater efficiently away from developed areas, typically through concrete-lined channels, have significant impacts on the health of the receiving waterways. In many jurisdictions, water resource management does not prioritise environmental flow objectives and natural water environments often become degraded as part of nearby urban development activities.

Improved ecological health therefore requires substantial shifts in water management practice. The characteristics, functions, conditions and values of ecosystems need to be better understood and respected, and controls are need to manage the impacts of urbanisation and pollution. Achieving these outcomes will require natural assets to be integrated into the water management system so their management can be adequately planned and resourced.

Current transition progress

Figure 17 shows Adelaide's current transition vision towards the vision outcome, "Adelaide's terrestrial, freshwater and marine ecosystems are diverse, healthy and productive". Adelaide is currently in Phase 3 and Phase 4 of its transition to practices aligned with this vision outcome. These correspond closely with the WSC Index indicators for the *Improve ecological health* goal. Due to more coordinated action and generally more effective safeguards, Adelaide is currently in Phase 4 for the protection of areas of high ecological value. For the other indicators of this goal, Adelaide is in Phase 3 of its transition. Areas of strategic priority for Adelaide are deepening and strengthening the network of champions for ecosystem health, and developing platforms for coordinated policy-making, implementation and evaluation.

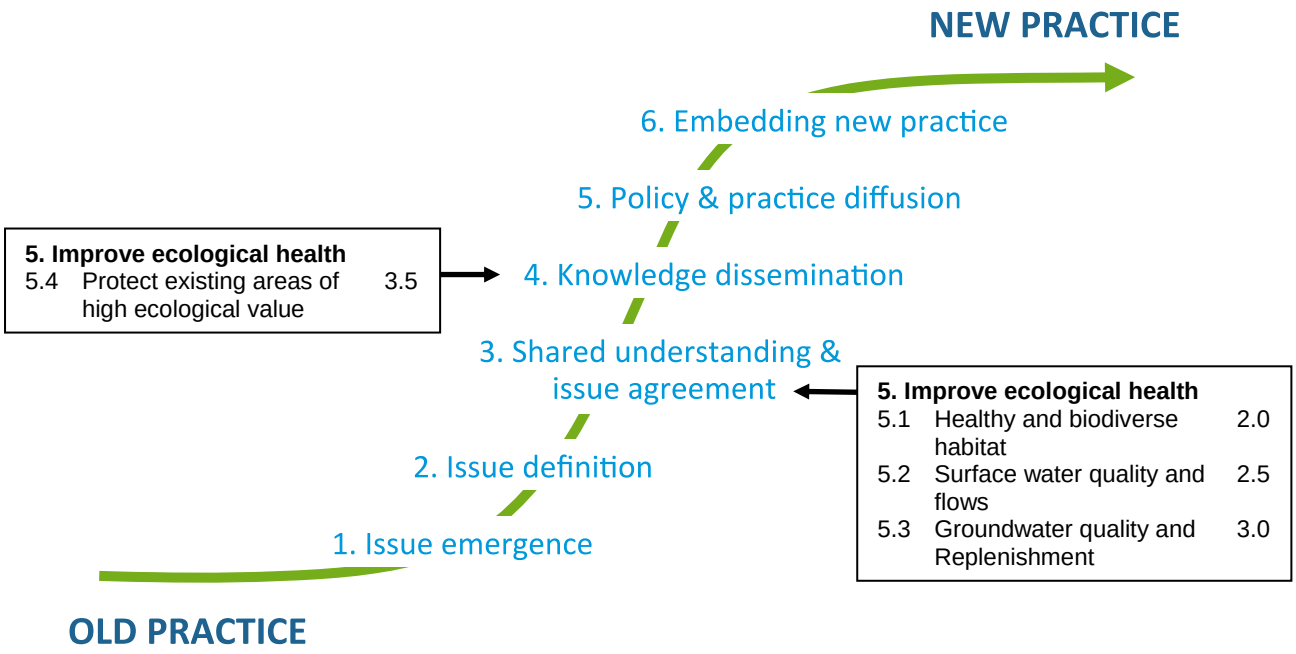


Figure 17. Transition phase for vision outcome 1.

Current enabling conditions

For Adelaide, the main concerns appear to be long-term biodiversity decline, in terms of native vegetation fragmentation and degradation, as a result of urban development, stormwater quality in fully urbanised areas, and the health of marine and coastal ecosystems. These threats are well understood by the scientific community and policy-makers. For example, though there are few examples of open water courses in Adelaide, the diversion of flows into these rivers for water supply purposes and the rise in the contribution of stormwater runoff has had significant impacts to their natural flow regimes and water quality. This has had well recognised effects on Gulf St Vincent ecological communities. There is regular monitoring of groundwater levels and salinity, though other aspects of groundwater quality are less well understood by policy-makers. For the broader community, however, there is a more pronounced gap in general awareness of these issues.

"There is varying opinion in how you would [manage water quality], but I don't think anyone is against [action] because they don't believe that water quality is an issue."

Evidence gathered during the project suggests that community knowledge of the interdependence of a range of urban and ecosystem functions, such as the links between hard urban surfaces and increased stormwater volume, and between stormwater and the health of the marine environment, needs to be raised. Without this knowledge, the solutions that address ecosystem benefits are unlikely to gain the support for implementation. Therefore, it is recommended that policy-makers across government and key agencies work towards **improving the community's understanding of the dependence of a wide range of community benefits on ecosystem health** (Strategy 1.1).

Participants consider there are champions present in many organisations who are advocating for specific ecosystem health outcomes, such as coastal protection solutions, seagrass replenishment, and waterway health. However, these champions are often competing with more influential interests, and they have not yet formed a united voice to advocate for holistic water management to deliver broad environmental outcomes. Several organisations have been given accountability for various aspects of ecosystem health, including the AMLRNRM Board, the DEWNR, the EPA, and local councils. The influence of these agencies collectively needs to increase beyond the environment sector.

One way champions could be supported is through enhanced coordination and collaboration between the various organisations with a stake in ecosystem health. The project revealed that some agencies work to improve collaboration in the delivery of programs or projects for ecosystem health outcomes, whether through advocacy or statutory mandate, with no single agency carrying this burden. Governance changes may not be necessary to establish this collaborative leadership, as it can be fostered through improved integration and a more holistic approach to ecosystem management at the decision-making level. This would promote cross-agency coordination and support the championing of a whole-system perspective. Key agencies should therefore work towards **developing and implementing a strategy for integrated ecosystem-based management decision-making** (Strategy 1.2).

"[A big driver will be] an increasing awareness of the values of waterways. Adelaide has pumped a lot of money into the Torrens Lake, and so that can be used as a vehicle to highlight stormwater quality issues. And there'll be growing desire to have good water quality through the Torrens."

There are many projects aimed at improving ecological health such as constructed wetlands, floating barriers, bird sanctuaries and Hills Face protection. The River Torrens amenity flow trial has significantly decreased the number and severity of algal blooms within Torrens Lake. While these projects are contributing to improved ecological health, they are seen by participants as isolated and not carried out with a system-wide approach. For example, the project to increase flow in the River Torrens to address water quality in Torrens Lake has not addressed the potential for water quality impacts on Gulf St Vincent at the river's outlet. Similarly, efforts at protecting biodiversity may not address landscape level changes such as long-term drying. Evidence also suggests that there is a lack of understanding among decision-makers about how WSUD can also deliver economic and

liveability benefits. These examples highlight the challenges facing government and industry in gaining support for new, innovative projects. It is recommended that key stakeholders seek to **trial and demonstrate innovative water system solutions that deliver multiple benefits, such as protecting areas of high ecological value and providing community health and wellbeing** (Strategy 1.3).

Tools and guidance around ecological health exist such as the EPA aquatic ecosystem report cards, environmental flow reports, tree removal controls and water quality targets. There are also strict controls on clearing native vegetation to protect areas of high ecological value. However, despite progress in recent years, the management of diffuse threats to water quality is an ongoing concern. There are currently no mandatory measures for the control of stormwater quality. In Adelaide's watershed, threats from failing on-site wastewater management require coordinated action. As a result, it is recommended that **improvements are made to the implementation of existing policies and programs for protecting ecosystem health through effective management of surface water, groundwater and wastewater, and protection of areas of high ecological value** (Strategy 1.4).

Recommended strategies

1.1	Improve the community's understanding of the dependence of a wide range of community benefits on ecosystem health to ensure community support for aligned water system solutions
1.2	Develop and implement a strategy for integrated ecosystem-based management decision-making
1.3	Trial and demonstrate innovative water system solutions that protect areas of high ecological value and deliver multiple benefits, such as community health and wellbeing
1.4	Improve implementation of existing policies and programs for protecting ecosystem health through effective management of surface water, groundwater and wastewater, and protection of areas of high ecological value

Vision outcome 2: Adelaide's water infrastructure is smart, sustainable, and flexible

Required changes in practice

The conventional mode of providing water system services typically delivers large-scale centralised infrastructures designed to meet singular objectives (e.g. water supply, sanitation, drainage) under a set of relatively narrow assumptions about parameters such as future rainfall, population and urbanisation patterns. The services provided by conventional water systems can therefore be vulnerable if conditions vary beyond the system's design capacity (e.g. in extreme drought or flood events). They require significant investment to install and adequately maintain separate infrastructure systems. With a focus on cost and risk minimisation and maximising efficiency within a narrow objective set, the opportunity to deliver broader benefits through multi-functional systems is not often a consideration. Furthermore, such approaches tend to allow limited customer choice about levels of service and pricing.

> *"We've done a pretty good job of becoming resilient to being a water-constrained environment, responding to droughts… In terms of water recycling, water reuse, some fantastic projects we've got going, ensuring we have reusable reliable supply. Lot more recognition of the value of green cities, urban heat island effects, we're doing relatively well in that space."*

Achieving Adelaide's water sensitive city vision will require a gradual transition to a more adaptive water servicing approach, involving greater integration of multi-functional systems, more diverse fit-for-purpose water resources, and greater customer choice of services and service levels. This goal

may require greater ability for individuals and businesses to provide infrastructure and services at property and precinct scales, which can be integrated with centralised systems through flexible regulation and intelligent control. The planning, design, management and maintenance practices to deliver such an approach will need to be highly collaborative, with systems and processes in place to enable the sharing of risks, costs, benefits, data and lessons between infrastructure providers and operators, including individual properties owners.

Current transition progress

Figure 18 shows Adelaide's current performance for the vision outcome, "Adelaide's water infrastructure is smart, sustainable, and flexible". Adelaide's relatively advanced implementation of fit-for-purpose water infrastructure for stormwater recycling, potable water demand management, and resource recovery suggests Phase 4 of transition for these WSC Index indicators. For other WSC Index indicators relevant to the vision outcome of smart, sustainable and flexible water infrastructure, there remains a need to establish shared understanding and recognition of the value of the desired practices, particularly at the residential and neighbourhood scales. This suggests that Adelaide is in Phase 3 of the transition to practices relevant to these indicators.

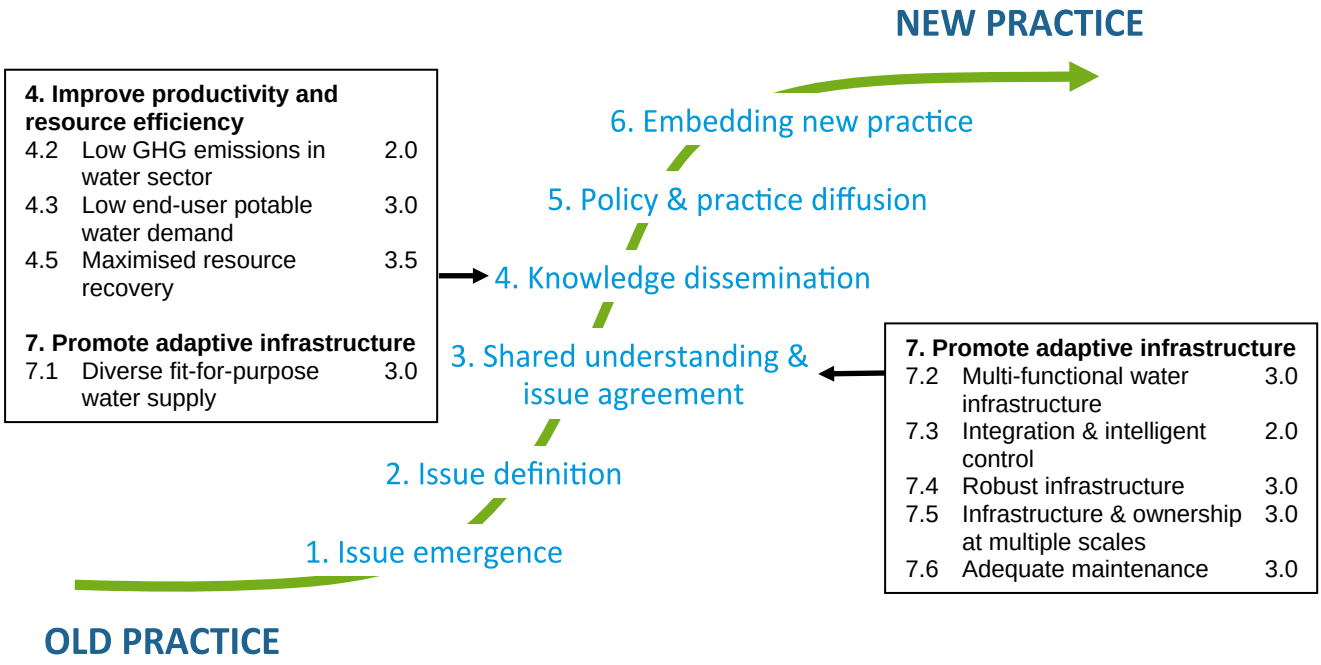


Figure 18. Transition phase for vision outcome 2.

Current enabling conditions

The water security crisis in 2006–09 prompted the industry to look to both centralised and decentralised supply solutions. Although centralised solutions proved to be favoured in practice during that period, there is ample knowledge in the industry about the capacity of decentralised urban water management to augment supply. Where there is uncertainty in Adelaide's water sector, it is usually about how to most effectively implement multi-objective infrastructure, rather than its potential value. An area where there is a need for more knowledge is in how to strategically use recycled water, particularly at the household scale.

"Water for Good was really successful for the first few years in that what it did was it set a foundation for things that can't then be changed back. On a number of levels. So the creation of the Water Industry Act, and ESCOSA and pricing, it took the opportunity to do some things that were fundamental, that needed to happen. It created targets for water recycling, it worked with the Greater Adelaide Plan. In a very short period of time, it did a lot to change our landscape to become a WSC."

Though the state was responsive to the need for regulatory reform to achieve many of these outcomes during the last drought, a more cost-constrained operating environment suggests that there would be less appetite for the type of regulatory approach necessary to promote multi-functional water infrastructure. Other approaches, such as industry incentives and advocacy for practice change, may need to be explored. To this end, there should be a detailed **evaluation of the evidence for the holistic economic benefits of multi-functional water-related infrastructure** (Strategy 2.1). At the same time, there needs to be wide support for these objectives, across all aspects of Adelaide's economy. Therefore, **a compelling narrative of the benefits of adaptive infrastructure in responding to system changes more rapidly and efficiently needs to be articulated and communicated** (Strategy 2.2). This will help build broad community and industry support and develop the capacity of champions to influence practice change.

In Adelaide, there is a sound awareness of the value of more adaptive and integrated water servicing approaches. There are champions for these approaches in the SA Government, SA Water, several councils, consulting practices and academic institutions who are driving stormwater recycling and implementing projects and demonstrations. There are good informal connections within industry, and it is easy to build links between stakeholders. However, there are organisations where champions still need to be developed, and overall the network needs to be strengthened, with its influence enhanced, to achieve the effective collaboration that is required. In addition, the potable water, wastewater and stormwater industries tend to be siloed. Individual organisations have their own goals and objectives and more needs to be done at an institutional level to achieve integration in planning and design. Some participants have also suggested there needs to be more support for collaboration by industry leaders. In response to these barriers, there should be concerted effort to **improve organisational culture, systems and processes for collaborative and integrated cross-sectoral water system management** (Strategy 2.3). This will support the sharing of learning from industry and the community and help build system resilience.

Adelaide's water sector has expertise in a variety of water resource efficiency methods, including aquifer storage and recovery and wastewater reuse. There is a willingness to experiment with innovative solutions. The Goyder Institute is a well-respected knowledge resource that has strong links to policy development. There are many good small-scale examples of multi-functional infrastructure such as wetlands, swales and raingardens, and these have been found to be relatively low maintenance. Participants also disclosed the willingness of Adelaide's water sector to adopt new processes or technologies. Past and recent examples include aquifer storage and recovery and urban heat management. However, there remain many organisations that have so far hesitated to adopt these approaches out of concern for their ongoing management costs. To overcome this barrier, it is recommended that a program be developed to support the **sharing of stormwater system management and asset maintenance capabilities between organisations** (Strategy 2.4). This would facilitate knowledge transfer and support a more flexible and responsive asset management system.

Recommended strategies

2.1	Evaluate evidence about the holistic economic benefits of multi-functional water-related infrastructure
2.2	Develop a compelling narrative of the benefits of adaptive infrastructure in responding to system changes more rapidly and efficiently
2.3	Improve organisational culture, systems and processes for collaborative and integrated cross-sectoral water system management to share learning and build system resilience
2.4	Improve stormwater system management and asset maintenance capabilities across organisational boundaries

Vision outcome 3: Adelaide's urban form is accessible, liveable and integrates water creatively to highlight Adelaide's unique features

Required changes in practices

The conventional approach to city planning and design typically considers water systems and built form separately. Urban planning and design processes tend to facilitate development and set basic requirements for open space: the provision of transport and housing tend to dominate as considerations, while water system services are an important but secondary consideration. Rarely is urban form considered an integral part of water service delivery in the conventional approach. The consequence of this separation is that liveability outcomes such as cool, healthy, and aesthetically pleasing urban environments are not optimised.

A central aspiration of Adelaide's vision of a water sensitive future is quality public open spaces that are green, blue, cool, accessible, and innovative. Achieving these outcomes will require the practices of water system planning and urban planning to be more integrated and collaborative so that standards and service outcomes that link to a broader vision of urban liveability and environmental health can be achieved.

Current transition progress

Adelaide's need to deepen its champions network, strengthen multi-sector collaboration, and see tangible application of the water sensitive design policies in current Development Plans suggests it is currently in Phase 3 for the WSC Index goal, *Ensure quality urban space,* associated with the vision aspirations for accessible, liveable and integrated urban form (Figure 19). Due to the priority attached to water in city planning and design and in providing amenity based on water-related assets, Adelaide is in Phase 4 for the relevant WSC Index indicators within the goals, *Ensure good water sensitive governance* and *Achieve equity of essential services*.

"I think people want an aesthetically pleasing place to live. That's first and foremost… Residents are willing to see investment going in [to avoid parched public open space]"

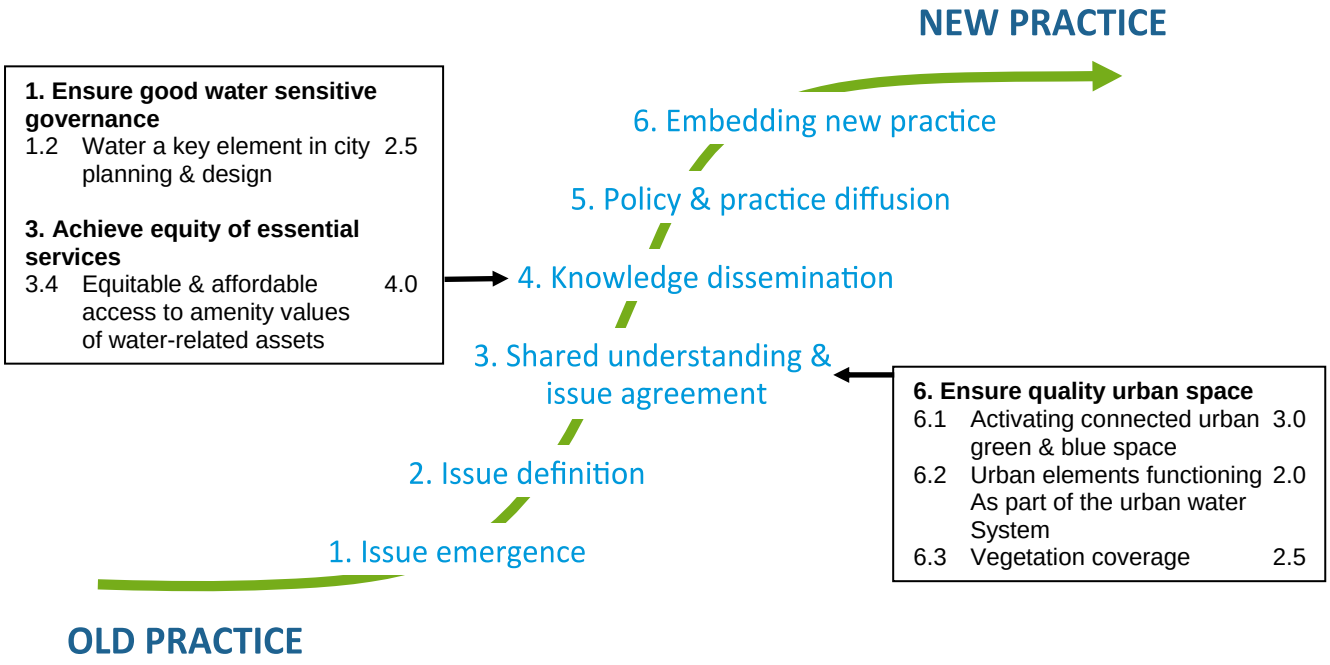


Figure 19. Current transition phase for vision outcome 3.

Current enabling conditions

The findings show that there are a number of champions in Adelaide that understand the importance of cross-sectoral integration to deliver efficient, sustainable and liveable urban form and green infrastructure. It can also be said that there is a general appreciation of the multiple benefits that urban spaces can provide through innovative and strategic water management approaches. However, the mechanisms to translate this understanding into effective cross-sector action are still relatively undeveloped, and more work is needed to build the economic case for multi-benefit urban form in the development sector and local government asset management, and to bridge the divide between academic thinking and water sensitive urban design and practice. As a result, the current approach to the design of urban spaces is generally single-objective, and land-use, water availability and water management are frequently considered separately. There is also a disconnect between the academic and policy sphere on the one hand and practice and implementation on the other. These issues are holding back the potential for more effective collaboration.

To overcome these barriers, effort must be directed towards cultivating greater senior management or political support for implementing WSUD in Adelaide's urban form. Policy should also have the rigour to support the implementation of the substance of WSUD. In the short-term it is recommended that a **compelling narrative of the economic, liveability and health benefits of water sensitive urban form in land use planning strategies be developed and communicated** (Strategy 3.1). In addition, **urban design solutions that integrate urban water management across the public and private realms** should continue to be trialled and demonstrated (Strategy 3.2). This will help provide evidence of the community benefits that can be delivered through innovative water sensitive urban designs, as well as lessons about the necessary conditions for their practical implementation.

There is confidence among participants that should a conducive economic and regulatory environment arise, there are individuals in Adelaide with the necessary knowledge to design innovative solutions. More work would need to be undertaken to ensure this knowledge is more widely held, including by more practitioners and the community more generally, to deliver solutions at scale. Participants felt that when capacity building programs have broadened their reach, industry capacity and technical skill will be better adapted to providing multi-functional solutions across the whole of Adelaide's urban form. A recommendation to achieve these outcomes is to **promote diverse stakeholder participation in collaborative urban development projects that feature water**

sensitive designs (Strategy 3.3). This would increase the capacity of the sector to deliver more accessible, cooler public and private open space solutions that are supported by water.

"The focus in Adelaide for stormwater harvesting schemes is much more about public open space. People do like having their nice green ovals. I know that there's a big push from some people that perhaps we've learnt from the drought that water restrictions are actually really a bad thing, because we lost green space, people paved over their gardens and put in air conditioners."

Overall, most areas of Adelaide have been enhanced by water-related assets. However, water-related assets are not as well implemented in lower socio-economic areas, and areas with higher water-related amenity attract a premium on property prices that exclude lower socio-economic status members of the community. It is therefore recommended that government **develop and implement a strategy for the provision of access to quality public green and blue space, based on community values** (Strategy 3.4). This would help ensure that the provision of access to quality urban spaces across Adelaide is a priority in decision-making.

Water sensitive urban design is promoted in planning policies guiding development, however, it is not viewed as a priority and not well implemented. There is a need for simple-to-use tools to facilitate the inclusion and assessment of water sensitive green infrastructure in small to medium developments to progress the transition. It is recommended that **water sensitive urban design and canopy cover be reinforced in land use planning policy and design standards** (Strategy 3.5). This will support healthier, cooler and more attractive outcomes to be more consistently delivered across the public and private realms, and in all development contexts.

Recommended strategies

3.1	Develop and communicate a compelling narrative of the economic, liveability and health benefits of water sensitive urban form in land use planning strategies
3.2	Trial and demonstrate urban design solutions that integrate urban water management across the public and private realms
3.3	Promote diverse stakeholder participation in collaborative urban development projects that feature water sensitive designs
3.4	Develop and implement a strategy for the provision of access to quality public green and blue space, based on community values
3.5	Improve policy and regulatory frameworks to incorporate water sensitive designs and canopy cover into land use planning policy and design standards

Vision outcome 4: Communities actively participate in water management and embrace the natural cycles of water abundance and scarcity

Required changes in practice

Conventional water servicing clearly defines the role for the community as customers who pay central utilities to provide water system services such as water supply, sanitation and drainage. This relatively simple transaction between provider and end-user has co-evolved with the single-objective large-scale centralised infrastructure that characterises most Australian water systems to date. As water systems become more complex to deal with changing community expectations and the challenges of climate change, population growth and urbanisation, this provider-customer relationship needs to evolve into a partnership where roles, such as service provider, are more amorphous.

These systemic drivers will see the way people interact with the urban water cycle change, for example by recognising and positively influencing the links between urban form in either the private or public realm, and water system services. The greater deployment of decentralised water systems has the capacity to alter markets, such as has been evident in the electricity industry, with opportunity for private landowners and businesses to become water providers as well as water users.

The community's knowledge of, connection with, and sense of responsibility for water as individuals and as part of the broader community will significantly influence Adelaide's transition towards its WSC vision. Fostering success will require community engagement practices to be meaningful and transparent, focused on empowering people to have the interest, capability and opportunity to be active partners in achieving water sensitive outcomes.

"A water sensitive city requires everyone to lean in."

Current transition progress

Figure 20 shows Adelaide's current transition phases for delivering the vision outcome "Communities actively participate in water management and embrace the natural cycles of water abundance and scarcity". Adelaide is currently in Phase 3 of its transition to deliver this vision outcome; there is a need to extend the community's involvement in water management and ensure it is actively engaged in the processes and practices that will achieve a water sensitive Adelaide. To achieve this, it is recommended that engagement on water issues is better coordinated both spatially and across different parts of the community. There is also considered to be untapped potential for the incorporation of indigenous knowledge in Adelaide's water management.

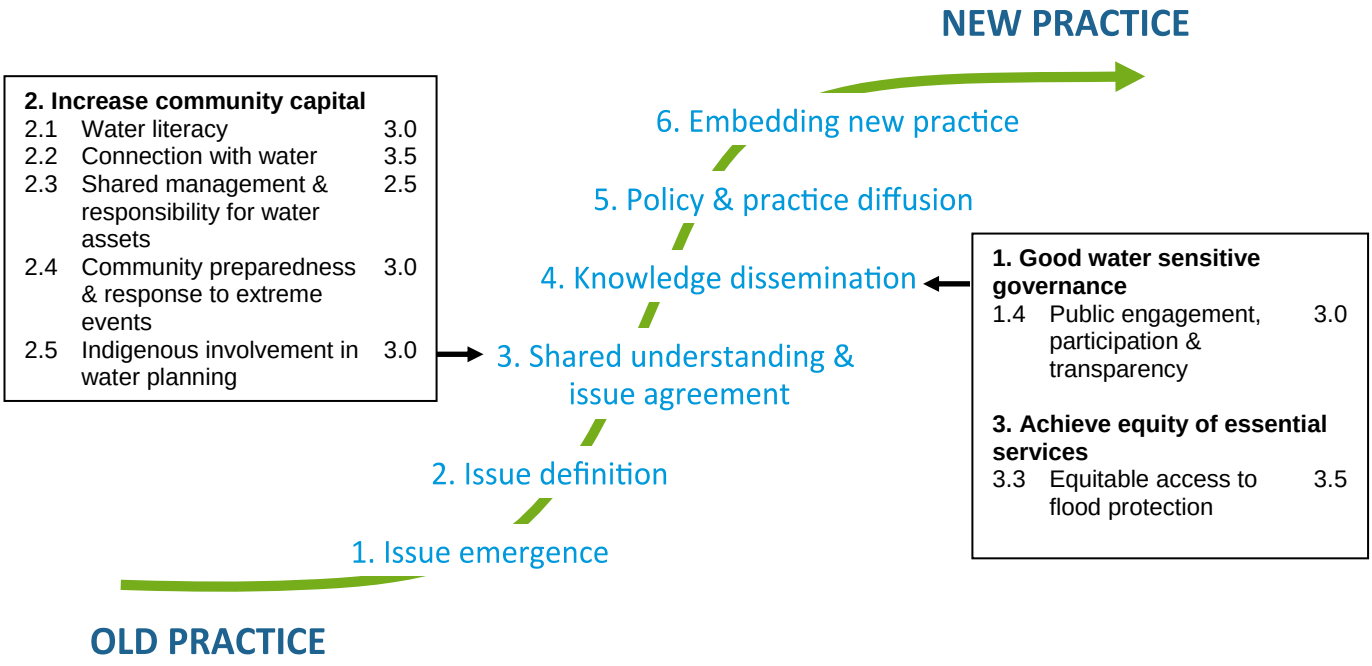


Figure 20. Transition phase for vision outcome 4.

Current enabling conditions

All participants believed that the community had a strong connection to water conservation, largely due to the impact of the Millennium Drought. Water in the landscape is generally valued by the community, which is evident in the broad acceptance of investment in fit-for-purpose water supply and distribution systems for public open space. On the other hand, some dimensions of water management are less well understood by the community. For example, the risk that stormwater flooding from extreme rainfall, defined as a minimum 1-in-50-year rainfall event, may adversely affect some properties in some areas is generally well-understood by planners, but the community is considered less aware. This is thought to be the result of the infrequency that such events occur, and

their relatively minor impact across the Adelaide area. As a consequence, property owners in areas at risk of flooding have limited preparedness. Another example with low community awareness is the benefit of using rainwater or recycled water in homes.

Nationally, the SA Government has been at the forefront of using new forms of public participation to engage communities in policy processes, with citizen juries, deliberative forums and crowd-sourcing being among the techniques demonstrated successfully. Recent policy topics subjected to these processes include cyclists' safety, nuclear waste storage, and neighbourhood improvements. However, some participants felt that engagement by government and non-government organisations on water issues has fallen since the end of the Millennium Drought. Although the water sector has been slower to take up these new approaches to engagement and transparency, examples such as the finalisation of the Brown Hill and Keswick Creeks Stormwater Management Plan and engagement on the Adelaide International Bird Sanctuary management plan show that progress is being made.

"[Converts to water sensitive urban design] are remarkably willing to share and volunteer our time."

There are several isolated efforts to develop community capital for WSC practices. These include the EPA's Rain Garden 500 project, and AMLRNRM Board's urban water education program and NRM Plan consultation process. Engagement of Aboriginal nations of Adelaide is not as extensive as the engagement efforts for areas of the River Murray. Overall, there is a need to strengthen Adelaide's institutional engagement capacity appropriate to the scale of community impact by ensuring local engagement is more consistently effective and solutions implemented across the region deliver large-scale changes in community capital.

For water literacy in Adelaide, there is a need to increase the community's awareness of the role that green infrastructure plays in the urban water cycle to promote local champions to act. To fill gaps in community water literacy and overcome what has in the past been an ad hoc and uncoordinated approach to awareness-raising, it is recommended that **collaboration within and between organisations to improve engagement strategies be promoted** (Strategy 4.1). In addition, **knowledge about the barriers to increasing Aboriginal involvement in water management needs to be developed** (Strategy 4.2).

"During the drought there was a water conservation mindset. However, the corollary, one of the perverse outcomes of water conservation measures was this focus on one single objective, that we must aim for water conservation at all costs. So, 'what's that useless bit of green space doing at the end of our street, let's turn off the irrigation because that's a waste of water'. So the concept of water as a resource which we can use to achieve other things was lost."

The general lack of awareness of the urban water cycle adversely affects the demand for WSUD in new and renovated homes, and also in the willingness to assume maintenance responsibility for water assets such as waterways on private land, water tanks and septic tanks. There have been planning policies available to councils to encourage water sensitive practices in residential development, but all policies except those relevant to flood risk management have been discretionary. Historical policies resulted in many urban ephemeral waterways falling into private property, and there are few instruments in place to promote good environmental stewardship practices. There is a need to promote effective, affordable projects that have the potential for significant learning in the community and widespread adoption. It is therefore imperative that strategies be developed to **lift the community's understanding of their role as partners in driving long-term system transformations towards Adelaide as a water sensitive city** (Strategy 4.3). Allied to this, agencies should seek to **trial and demonstrate community engagement approaches that connect people with water and empower community as partners in delivering WSC outcomes** (Strategy 4.4).

There are process currently underway to clarify responsibilities for management of watercourses, levee banks and other flood infrastructure, and to attend to the reform of development controls to explicitly reflect flood risk. However, while these governance issues are being resolved, it is important that households are made aware of the potential for flooding to impact on their property, and of

available solutions to mitigate harm, respond to future flooding emergencies, and to rebound from flood events. A key step is to **improve the community's understanding of flood risk and the potential social and biophysical flood resilience solutions** (Strategy 4.5).

. ***Recommended strategies***

4.1	Promote collaboration within and between organisations to find better approaches to improving the community's understanding of the urban water cycle
4.2	Develop new knowledge about the barriers to increasing Aboriginal involvement in water management
4.3	Improve the community's understanding of their role as partners in driving long-term system transformations towards Adelaide as a water sensitive city
4.4	Trial and demonstrate community engagement approaches that aim to connect people with water and empower community as partners in delivering WSC outcomes
4.5	Improve the community's understanding of flood risk and the potential social and biophysical flood resilience solutions

Vision outcome 5: Water supports a strong economy underpinned by Adelaide being an affordable, vibrant and culturally rich city

Required changes in practice

Traditional water system services are designed to meet singular objectives (e.g. water supply, sanitation, drainage) that have prioritised cost efficiency over broad community value and tended to externalise environmental costs. In response to changing community perceptions, the water industry is beginning to explore and experiment with strategies to realise economic benefits in other sectors, such as health, recreation and tourism. To progress towards Adelaide's water sensitive city vision, water system services could be designed as regenerative or 'net-positive' to take advantage of the synergies and connections between water, energy, food and land resources. The potential for commercial opportunities from such a change in Adelaide's water management practice is significant, both in the community value that can be created through regenerated resources and greater environmental health, and the business that can be attracted to Adelaide as a leading international city in water system innovations.

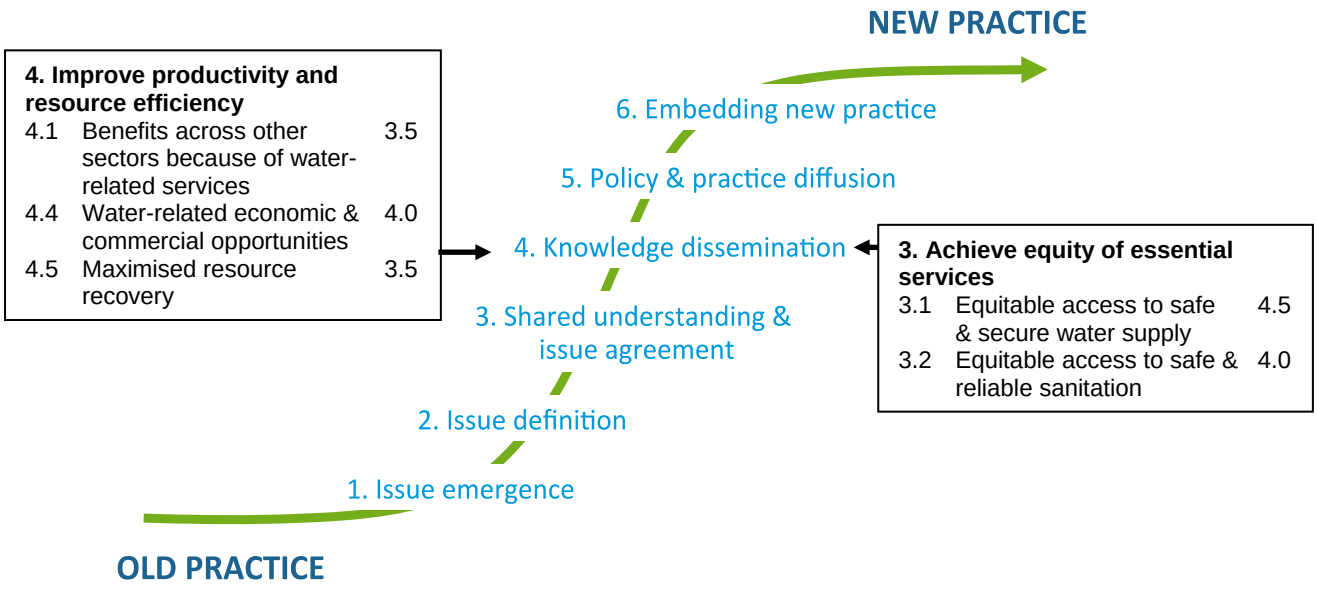


Figure 21. Transition phase for vision outcome 5.

Current transition progress

Adelaide has made significant headway in recent years to improve the productivity of available water resources and to reduce demand for potable water. There are strong connections between champions in the water sector and water-dependent industries such as agriculture to coordinate new opportunities to grow Adelaide's economy. However, some sectors, notably the residential development sector, are less well integrated and therefore opportunities at the residential scale are harder to pursue. Adelaide is currently in Phase 4 of its transition to practices that support a strong economy (Figure 21)**.**

Current enabling conditions

Champions such as the Water Industry Alliance and Water Sensitive SA advocate for water-supported outcomes that enhance economic prosperity for Adelaide and recognise the need for collaboration and innovation. SA Water champions the required practices and leads many demonstration projects in this space. While the water sector is leading the promotion of water sensitive solutions, other sectors are still some way from recognising their economic value. As a result, there is not yet broad support for the transformative restructuring involved.

It is also recognised that a more cohesive policy environment is needed. For example, in many policies with a non-water sector focus, such as energy, links to water efficiency and productivity could be more explicitly drawn. In the urban development space, individual councils' pursuit of policy measures to deliver more water efficiency or productive re-use in new development is considered to be undermined by the drive for a consistent metro-wide regulatory environment. To address these challenges, the government should **develop and communicate a compelling narrative about the water sector's potential to deliver broader economic prosperity through benefits such as more efficient resource use, cross-sectoral value, and preparing for future threats to prosperity** (Strategy 5.1). This narrative would be expected to show the water sector's potential to deliver broader economic growth in diverse strategic and policy initiatives.

"I can't think of any projects that have fallen over purely on the grounds [that they used new approaches]."

There are effective collaborative platforms between elements of the private sector and SA Water in waste management and the deployment of smart infrastructure. Mechanisms such as the *Water Industry Act 2012* have the potential to foster collaboration between actors in the water sector. For example, there is ample scope for joint ventures between local governments to capture, treat and distribute stormwater. This has generated several stormwater distribution networks, and it would not take much additional investment to integrate these schemes across the majority of the Adelaide metropolitan area. Another area where there may be opportunities in coming years is in collaboration between the water sector and non-water sector agencies to achieve shared objectives. Productive relationships may be developed with health and community services and development industry collaborations. These have only recently begun to be pursued.

"We're quite forward in realising that this [high-end food production] is part of our future prosperity, 'we cannot afford to waste this resource we need to use it because it's going to result in jobs and growth'."

Alongside the connections being built with non-water sector agencies, there are also strengthening relationships between the industry and research organisations. The Goyder Institute, which is a well-respected knowledge generator that has strong links to policy development, has been significant in this area. In the water sector, participants considered there to be sound knowledge on the technical side of implementation. Where there are gaps, they are likely in the linking of investment in water productivity and efficiency projects with economy-wide costs and benefits. Going forward, water-

related resourcing and funding decisions will need to be backed by an appropriate understanding of the wider societal benefits of integrated water practices. It is important that organisations critical to the water sensitive Adelaide agenda **improve systems and processes to incorporate the economic co-benefits and allied commercial opportunities from water investment in budget processes and strategic decision-making** (Strategy 5.2).

"One of the areas to drive innovation is government policy, and we have to work more closely with water industry itself."

Water use productivity in the state is regarded as generally higher than the Australian average, and there are many projects in Adelaide demonstrating productivity and resource efficiency. Wastewater treatment plants are recycling water and other resources at a large scale, and Adelaide is also leading the nation in stormwater harvesting. SA Water is leading the distribution of recycled wastewater for agriculture. However, wastewater recycling and stormwater capture and distribution have favoured larger, centralised infrastructure due to the economies of scale, and small-scale, decentralised facilities may enable greater resource capture and fit-for-purpose use. Increased productive use of stormwater at-source remains an important objective. More organisations need to be supported to contribute to innovation and commercialisation. In the short-term there is a need to **trial and demonstrate adaptive, multi-functional and integrated water system solutions in different housing densities, neighbourhood forms and system scales** (Strategy 5.3). Since significant progress has been made in demonstrating effectiveness at the larger scale of operation, trials and demonstrations of stormwater reuse and small-scale recycled water schemes need to be included, particularly at the household or enterprise scale. These demonstrations will contribute evidence of the productivity, resource efficiency and resilience benefits that can be harnessed through innovative water systems, and provide lessons about the conditions supporting their practical implementation.

Recommended strategies

5.1	Develop and communicate a compelling narrative about the water sector's potential to deliver broader economic prosperity
5.2	Improve organisational culture, systems and processes to incorporate the economic co-benefits and allied commercial opportunities from water investment in budget processes and strategic decision-making
5.3	Trial and demonstrate adaptive, multi-functional and integrated water system solutions in different housing densities, neighbourhood forms and system scales (beyond stormwater quality treatment and large-scale recycled water schemes)

Vision outcome 6: Water governance can adapt to complex challenges and drive holistic, innovative and collaborative solutions

Required changes in practice

Governance arrangements to deliver urban water system services have been evolving over more than a century in response to the community's growing needs for safe and reliable potable water supply, sewage treatment and removal, and stormwater drainage. Typical urban water governance structures and processes for conventional water systems include large centralised institutions with responsibilities for policy, planning, delivery and regulation of single-objective water system services. In the face of pressures from climate change, population growth and urbanisation, the community's expectations for outcomes delivered by the water system are evolving further, and now reflect a broader agenda for water to support a city's liveability and resilience. This shift is becoming well recognised in water policy in jurisdictions around Australia.

Traditional water governance arrangements may therefore need to continue to evolve to deliver outcomes that meet the community growing expectations for significant aspects of water servicing. Delivering healthy and liveable urban environments that are supported by resilient and sustainable

water system services will require governance structures, processes and capacities that enable and drive integrated, long-term, cross-sector and inclusive planning and design decisions.

Current transition progress

Figure 22 shows Adelaide's current progress for the vision outcome, "Water governance can adapt to complex challenges and drive holistic, innovative and collaborative solutions". Significant strides have been made in the last ten years to transform Adelaide's water governance. Broad consensus has been reached over the importance of leadership and capacity-building, public engagement, and an integrated policy framework. As a result, Adelaide is now in Phase 4 of its transition to practices aligned to good water sensitive governance. Progress is still required to build broad multi-sector commitment towards the vision of a water sensitive Adelaide, and some practices, particularly early engagement with communities and formal cross-sector integration, need attention in coming years.

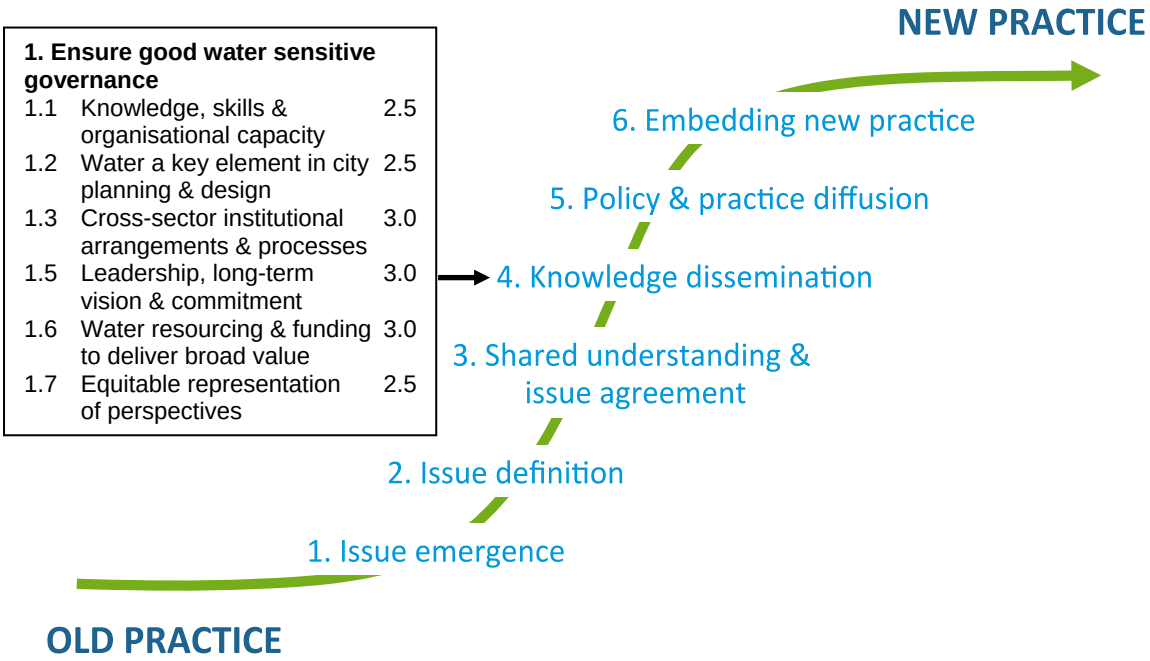


Figure 22. Transition phase for vision outcome 6.

Current enabling conditions

An analysis of the Adelaide context suggests that WSC champions are dispersed through a relatively large number of organisations. These champions tend to be linked by an informal network that supports knowledge exchange and project delivery. At the senior leadership level, there is some commitment to water sensitive outcomes, although it is somewhat isolated; generally, WSC champions are not in senior leadership positions. As a result, the water sensitive agenda, and the resources committed to support it, suffer from a lack of prioritisation when considering public and particularly private sector activity overall. Though there is progress in promoting water leadership, it remains important for Adelaide's water sector to continue to increase the influence of its champions, and to promote integration, particularly at the local government level.

"We all need to be pushing the same principles [of a water sensitive city]… We can all buy into the vision when it doesn't affect us. [Decision-makers] need to understand how their agenda can be enhanced by buying into this vision."

The project found there are several institutional arrangements that are effective in driving inter-agency coordination. This is particularly evident in the development approvals process and some flagship policies. There are well-regarded tools in place for increased collaboration, such as the *Working Together* policy guide and prescribed consultation processes in resource management or planning legislation. The *Change @ South Australia* initiative is designed to grow a collaborative culture within government departments. There have been good recent examples of inter-organisational collaboration. For example, the 30-Year Plan for Greater Adelaide is well-integrated and involved substantial engagement with the community and other stakeholders. Nevertheless, in some critical areas, notably budgeting decisions and implementation, the promotion of WSC principles and collaboration needs to be further developed. It is therefore important to expand the influence of WSC champions and to recruit champions from disciplines and sectors generally considered to be at the periphery of the water sector, such as those in the finance, health and community services disciplines. To address these needs, government should promote **a compelling narrative about the value of a water sensitive Adelaide across diverse planning and strategic initiatives** (Strategy 6.1).

Although Adelaide can generally look to a positive record of strategic water sector coordination, the project revealed some critical areas that need review. Coordination at the operational level in transport and urban development projects was one area highlighted during the project. This has often resulted in a misalignment of top-level directions and the on-ground delivery of water-related projects, frequently leading to conventional water solutions when water sensitive solutions could be expected. The most significant area for improvement identified, however, was stormwater management. The evidence suggests that there is substantial scope to achieve more coordinated and integrated stormwater management at the local level. To begin to overcome the barriers to more integrated stormwater planning and management, it is recommended that **the roles and responsibilities of key actors in stormwater management be clarified** (Strategy 6.2). This would be expected to increase collaboration across stakeholders and promote a more responsive asset management approach.

When considering governance relationships between organisations, rather than between organisations and the community, Adelaide's water sector has been more successful. In this sense, the commitment of organisational champions has helped identify opportunities for collaboration to leverage the benefits into other projects with related agendas, such as health, recreation or urban renewal. The next stage in Adelaide's transition will need to see this project-by-project approach mature into a more coordinated and integrated process that is less reliant on the influence of individual champions. Therefore, more **opportunities for stronger integration of the water sector with other portfolios should be sought** (Strategy 6.3). Integration should target economic, planning, environment and infrastructure agencies, and local government as a priority. This will help ensure that there is effective coordination within inter-agency networks, and collaboration by relevant stakeholders in projects. It can also be expected to reinforce WSC principles in regulation governing urban or infrastructure development.

Recommended strategies

6.1	Develop and communicate a compelling narrative about the value of a water sensitive Adelaide across diverse planning and strategic initiatives
6.2	Improve organisational systems and processes to clarify the roles and responsibilities of key actors in stormwater management
6.3	Identify and pursue opportunities for stronger integration of the water sector with other portfolios including economic, planning, environment and infrastructure, and with local government

6. Strategies to drive Adelaide's WSC transition

The transition dynamics analysis in Section 5 informed the development of priority objectives and strategies that need to be pursued to accelerate Adelaide's transition towards its water sensitive vision. This section presents the suite of priority strategies, organised according to the broader objective (rather than by vision outcome). This representation highlights the convergence of strategic objectives between different vision outcomes.

This section aims to guide the development of actions to achieve the vision.

Table 2. Strategies to increase awareness and understanding

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban form	Community	Economy	Governance
Examine and evaluate evidence	2.1	About the holistic economic benefits of multi-functional water-related infrastructure	A business case demonstrates the value of multi-functional infrastructure in delivering water system services		■				
Develop new knowledge	4.2	About the barriers and potential solutions to increasing the involvement of Aboriginal people in water management	Knowledge informs the development of effective governance arrangements for involving Traditional Owners as partners in water management and for enhancing and protecting Aboriginal cultural associations with water systems				■		

Table 3. Strategies to harness leadership and community support

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban Form	Community	Economy	Governance
Develop and communicate a compelling narrative	2.2	Of the benefits of adaptive infrastructure in responding to system changes more rapidly and efficiently	The authorising environment acknowledges the need and supports solutions for adaptive infrastructure to ensure water system services are resilient		■				
	3.1	Of the economic, liveability and health benefits of water sensitive urban form	The authorising environment supports the development and implementation of land use planning policies and strategies that drive the adoption of water sensitive designs			■	■		
	5.1	About the water sector's potential to deliver broader economic prosperity through benefits such as more efficient resource use, cross-sectoral value, and preparing for future threats to prosperity	The authorising environment recognises the water sector's potential to create economic value through more efficient resource use			■		■	
	6.1	About the value of Adelaide's water sensitive future across diverse planning and strategic initiatives	The authorising environment supports solutions and outcomes that are needed to deliver on Adelaide's water sensitive city vision			■	■		■
Improve the community's understanding	1.1	Of the dependence of a wide range of benefits they value on ecosystem health	Communities endorse and advocate for water system solutions that aim to improve ecosystem health	■		■			
	4.3	Of their role as partners in driving long-term system transformations towards Adelaide's water sensitive city vision	Citizens are motivated to actively engage in water-related community dialogue, governance processes and local-scale adaptations to the water system		■	■	■		■
	4.5	Of flood risk and the potential social and biophysical flood resilience solutions	Households are aware of the flood risk of their property, support the implementation of flood resilience solutions, and are prepared and capable of responding effectively to flood events.			■	■		

Table 4. Strategies to establish an integrated and systematic approach

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban Form	Community	Economy	Governance
Develop and implement a coherent and comprehensive strategy	1.2	For integrated ecosystem-based management decision-making	Management decisions take into account different elements of ecosystems in a holistic and integrated way	■					
	3.4	For the provision of access to quality public green and blue space, based on community values	Land use and infrastructure planning processes ensure that providing people across Adelaide with access to quality urban spaces is a priority in decision-making			■	■		
	6.3	For stronger integration of the water sector with other portfolios including economic, planning, environment and infrastructure, and with local government, linking data, management and tools	There is effective coordination within inter-agency networks, and collaboration by relevant stakeholders in projects						■

Table 5. Strategies to test potential new solutions in real world settings

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban Form	Community	Economy	Governance
Trial and demonstrate	1.3	Innovative water system solutions that protect areas of high ecological value and deliver multiple benefits, such as community health and wellbeing	Evidence of the community and ecosystem benefits that can be delivered through innovative water system solutions and lessons about the necessary conditions for their practical implementation	■			■		
	3.2	Innovative urban designs that integrate water management across the public and private realm	Evidence of the community benefits that can be delivered through innovative water sensitive urban designs and lessons about the necessary conditions for their practical implementation			■			
	4.4	Community engagement approaches that aim to connect people with water and empower community as partners in delivering WSC outcomes	Evidence of the sustained value of community engagement and empowerment approaches and lessons about the necessary conditions for their practical implementation				■		
	5.3	Adaptive, multi-functional, integrated and intelligent water system solutions in different housing densities, neighbourhood forms and system scales (beyond stormwater quality treatment and large-scale recycled water schemes)	Evidence of the productivity, resource efficiency and resilience benefits that can be harnessed through innovative water systems and lessons about the necessary conditions for their practical implementation		■	■		■	

Table 6. Strategies to enable and encourage people to collaborate and innovate

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban Form	Community	Economy	Governance
Improve organisational culture, systems and processes	2.3	For collaborative and integrated cross-sectoral water system management	Water management planning between organisations is well integrated and collaborative		■				
	3.3	To promote participation in collaborative urban development projects that feature water sensitive designs	There is increased capacity in the sector to deliver more accessible, cooler public and private open space solutions that are supported by water			■			
	4.1	To promote collaboration within and between organisations to enhance community engagement	The sector has a strategic and consistent approach for engaging with the community about water, regardless of organisational boundaries				■		
	5.2	To incorporate the economic co-benefits and allied commercial opportunities from water investment in budget processes and strategic decision-making	Water-related resourcing and funding recognises the wider societal benefits, and budgeting that supports integrated water practices is appropriately prioritised					■	
	6.2	To clarify roles and responsibilities of key stakeholders involved in stormwater management	Systems and processes for stormwater management are comprehensive, transparent and collaborative	■	■				■

Table 7. Strategies to improve implementation of existing policies

Strategy	Focus		Rationale	Vision Outcomes					
				Ecosystems	Infrastructure	Urban Form	Community	Economy	Governance
Improve implementation of existing policies and programs	1.4	For protecting ecosystem health through effective management of surface water, groundwater and wastewater, and protection of areas of high ecological value	There is better coordination across governments, industry and the community, strong compliance levers and effective asset management systems to deliver ecosystem health protection	■					
	2.4	For stormwater system management and asset maintenance across organisational boundaries	Increased collaboration across stakeholders and a more responsive asset management approach		■				
Improve policy and regulatory frameworks	3.5	To incorporate water sensitive designs and canopy cover into land use planning policy and design standards	Elements of the urban form that support healthier, cooler and more attractive outcomes are consistently applied across the public and private realm, and in all development contexts	■		■			

7. Conclusion

Adelaide's water history since European settlement has experienced cycles of drought, flood, and reaction from decision-makers. Now, with a much greater knowledge of the state's climatic variability, there is an opportunity to take proactive steps to preserve and enhance Adelaide's liveability, productivity, resilience and sustainability – the outcomes of a water sensitive approach to water system planning, design and management.

This report marks the culmination of a process in part to define what a water sensitive city means for Adelaide. In doing so, water sensitive city champions from across Adelaide's water sector were engaged to create a 50-year vision of a water sensitive Adelaide. This process has also attempted to structure and make sense of the change processes that will be required to achieve this vision. To this end, it has benchmarked Adelaide's current performance using two tools recently developed by the CRCWSC. The insights that these tools have generated show the progress that Adelaide has already made towards its vision, and the considerable change still required.

The outputs of this project are varied and include:

- Adelaide's historical, contemporary and future water story.
- The benchmark of Adelaide's current water sensitive performance using the WSC Index, highlighting the goals that need focus to achieve the water cycle city benchmark. For Adelaide, the most significant improvement is needed for ecological health, urban form and community capital.
- A 50 year vision for Adelaide as a water sensitive city, describing Adelaide is an attractive and resilient city that uses its diverse water resources and knowledge to drive prosperity, sustain healthy ecosystems, and connect communities.
- An assessment of Adelaide's enabling conditions for the transition towards its vision, using the Transition Dynamics Framework to indicate the presence of enabling conditions and its current transition phase for each vision outcome.
- Short to medium-term strategies for accelerating Adelaide's water sensitive city transition by addressing the identified priority objectives of: increasing awareness and understanding, harnessing leadership and community support, establishing an integrated and systemic approach, testing potential new solutions in real world settings, enabling and encouraging people to collaborate and innovate, and driving tangible actions that will achieve key water sensitive outcomes.

These outputs provide a framework for strategic action across the many stakeholder organisations that will need to work in a collaborative and coherent manner to facilitate Adelaide's transition to a water sensitive city.

Reflecting on the broader lessons from this Adelaide case study, it is evident that the champions that took part in the process have a common purpose. The core elements of the vision had unanimous approval, with all acknowledging that water will be central to Adelaide's resilience, prosperity, healthy ecosystems and community wellbeing. However, it is no coincidence that the preeminent attribute of Adelaide's long-term vision is that Adelaide is an attractive city. This demonstrates understandable pride in Adelaide as it is today, as well as a shared concern over the potential that a warming and drying climate will threaten the affordability and amenity that Adelaide has built through sound planning practices for the time. That these practices are likely to be insufficient to respond to the needs of Adelaide's long-term vision is a critical contention of this report, one supported by the participants engaged during its development.

It is encouraging that WSC champions have an awareness of the evolving practices required to achieve the WSC vision. There is also receptivity to the types of solutions needed, such as at-source stormwater capture and reuse, integrated water and urban services planning, multi-functional water

infrastructure, and community participation in water management. It is clear, though, that the implementation of these solutions is where Adelaide's WSC stakeholders need to focus their efforts.

One of the critical outputs of this project has been to analyse more closely the institutional conditions that need to be nurtured to advance Adelaide's WSC transition. The analysis of enabling factors revealed important insights such as the need to broaden and strengthen the network of WSC champions, particularly in the finance and development sectors and in local government. There is a need to raise the level of collaboration in WSC networks to reinforce the integration between sectors and jurisdictions, and to make integration more systematic rather than reliant on personal networks. The capacity to engage the community in water management, and for the community to make informed contributions to water planning, needs the coordinated strategic activities of a broad array of organisations working towards WSC outcomes. Perhaps most importantly, the benefits of a WSC need to be appreciated and embraced throughout the Adelaide community to authorise the changes required. This is the reason this report recommends that a compelling narrative of the value of Adelaide's water sensitive future be developed to give stakeholders, decision-makers and the community focus and clarity around their priorities and aspirations.

Finally, the authors would like to thank the participants for their enthusiasm and openness during this project. With their continued commitment to a water sensitive future, Adelaide has a solid foundation to achieve its vision.

8. References

Adelaide and Mount Lofty Ranges NRM Board. (2013). Adelaide and Mount Lofty Ranges Natural Resources Management Plan (Vol. Volume 1). Adelaide and Mount Lofty Ranges Natural Resources Management Board, Adelaide, SA.

Adelaide City Council. (2016). Torrens River Water Quality - Upstream and Downstream from Lake Torrens. Retrieved April 19, 2017, from https://data.sa.gov.au/data/dataset/river-torrens-water-quality-upstream-and-downstream-from-lake

Alluvium and Kate Black Consulting. (2012). A Business Case for a Water Sensitive Urban Design Capacity Building Program for South Australia, (December).

Arbon, N., Thyer, M., MacDonald, D. H., Beverley, K. and Lambert, M. (2014). Understanding and Predicting Household Water Use for Adelaide, (14). Retrieved from http://www.goyderinstitute.org/uploads/OWRM_Household_Water_Use_Final.pdf

ArborCarbon. (2016). Airborne Thermal Imagery and Analysis 2016: Resilient South.

Australian Bureau of Statistics. (2011). Household Water Consumption and Conservation Actions.

Australian Bureau of Statistics. (2013). Environmental Issues: Water use and Conservation, Mar 2013. Retrieved May 18, 2017, from http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4602.0.55.003main+features4Mar 2013

Australian Bureau of Statistics. (2016). Water Account, Australia, 2014-15. Retrieved April 18, 2017, from http://www.abs.gov.au/ausstats/abs@.nsf/Latestproducts/4610.0Main Features32014-15?opendocument&tabname=Summary&prodno=4610.0&issue=2014-15&num=&view=

Australian Government. (2013). Water Proofing the West – Stage 1: Fact Sheet.

Bardsley, D. K., Weber, D., Robinson, G. M., Moskwa, E. and Bardsley, A. M. (2015). Wildfire risk, biodiversity and peri-urban planning in the Mt Lofty Ranges, South Australia. Applied Geography, 63, 155–165. http://doi.org/10.1016/j.apgeog.2015.06.012

Bettini, Y., Brown, R. R. and de Haan, F. J. (2015). Exploring institutional adaptive capacity in practice: Examining water governance adaptation in Australia. Ecology and Society, 20(1).

Brown, R., Keath, N. and Wong, T. (2009). Urban water management in cities: historical, current and future regimes. Water Science and Technology: A Journal of the International Association on Water Pollution Research, 59(5), 847–55.

Brown, R.R., Rogers, B.C. and Werbeloff, L. (2016). Moving toward Water Sensitive Cities: A guidance manual for strategists and policy makers. Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

Brown, R.R., Rogers, B.C. and Werbeloff, L. (2017). A framework to guide transitions to water sensitive cities. Chapter 9 in Moore, T., de Haan, F.J., Horne, R. & Gleeson, B. (Eds) Urban Sustainability Transitions: Australian Cases – International Perspectives. Springer, Japan.

Chesterfield, C., Rogers, B.C., Beck, L., Brown, R.R., Dunn, G., de Haan, F.J., Lloyd, S., Urich, C. and Wong, T (2016). A Water Sensitive Cities Index to support transitions to more liveable, sustainable, resilient and productive cities. Proceedings for Singapore International Water Week, Singapore 11-14 July 2016.

City of Mitcham. (2017). Adapting to a Changing Climate. Retrieved April 28, 2017, from http://www.mitchamcouncil.sa.gov.au/adaptingtoachangingclimate

City of Salisbury. (n.d.). Stormwater Harvesting and Utilisation in the City of Salisbury. Retrieved April 24, 2017, from http://www.salisbury.sa.gov.au/files/4a8cc3d6-9068-4806-a049-9e85010fae2e/parafieldstormwaterharvest.pdf

CSIRO and Bureau of Meteorology (2015). Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report, CSIRO and Bureau of Meteorology, Australia

Daniels, C. B. and Good, K. (2015). Building resilience to natural, climate and anthropocentric change in the Adelaide and Mount Lofty Ranges region: a natural resources management board perspective. Transactions of the Royal Society of South Australia, 139(1), 83–96. http://doi.org/10.1080/03721426.2015.1035218

DCSI (2015). Disability Access and Inclusion Plan 2014-2018. Retrieved May 18, 2017, from http://www.dcsi.sa.gov.au/services/disability-sa/disability-access-and-inclusion-plans/disability-access-and-inclusion-plans-2014-to-2018

DCSI (2016). Aboriginal Employment Strategy Communities for all: Opportunities for everyone. Department of Communities and Social Inclusion, Adelaide, SA.

DCSI (2017). LGBTIQ Inclusion Strategy. Retrieved May 18, 2017, from http://www.dcsi.sa.gov.au/about-us/key-strategies-and-plans

Department of Water (2011). Stormwater Strategy. Adelaide, SA.

DEWNR (2013a). Water for Good Annual Report 2012. Department of Environment, Water and Natural Resources, Adelaide, SA.

DEWNR (2013b). Water sensitive urban design – creating more liveable and water sensitive cities in South Australia. Department of Environment, Water and Natural Resources, Adelaide, SA.

DEWNR (2015). Central Adelaide PWA T1 aquifer: 2015 Groundwater level and salinity status report. Department of Environment, Water and Natural Resources, Adelaide, SA.

DPTI (2017). The 30-Year Plan for Greater Adelaide – 2017 Update, Department of Planning, Transport and Infrastructure, Adelaide, SA

EPA (2013). Adelaide Coastal Water Quality Improvement Plan (ACWQIP). Environment Protection Authority South Australia.

EPA (2015). Mount Lofty Ranges. Retrieved 25 October, 2017, from http://www.epa.sa.gov.au/environmental_info/water_quality/programs/mount_lofty_ranges

EPA (2016). Adelaide and Mount Lofty Ranges NRM Regional Summary 2015 Aquatic Ecosystem Condition Report. Environment Protection Authority South Australia.

Fielding, K., Karnadewi, F., Newton, F. and Mitchell, E. (2015). A National Survey of Australians' Water Literacy and Water-related Attitudes, Cooperative Research Centre for Water Sensitive Cities, Melbourne.

Guan, H., Bennett, J., Ewenz, C., Benger, S., Zhu, S., Clay, R. and Soebarto, V. (2013). Characterisation , Interpretation and Implications of the Adelaide Urban Heat Island. Journal of the American Planning Association.

Jacobs, B., Mikhailovich, N. and Delaney, C. (2014). Benchmarking Australia's Urban Tree Canopy: An i-Tree Assessment.

Jeff Tate Consulting. (2012). Report on Councils and Stormwater Harvesting.

Jeff Tate Consulting (2013). Stormwater Narrative.

Leonard, R., Walton, A. and Farbotko, C. (2015). Using the Concept of Common Pool Resources to Understand Community Perceptions of Diverse Water Sources in Adelaide, South Australia. Water Resources Management, 29(5), 1697–1711.

Leonard, R., Walton, A., Koth, B., Green, M., Spinks, A., Myers, B, Malkin, S., Mankad, A, Chacko, P., Sharma, A. and Pezzaniti, D. (2014). Community Acceptance of Water Sensitive Urban Design : Six Case Studies. Goyder Institute for Water Research Technical Report Series No.14/3, Adelaide, SA.

Maheepala, S., Dandy, G., Marchi, A., Mirza, F., Wu, W., Daly, R., Hewa, G, Neumann, L., Maier, H., He, Y. and Thomas, S. (2014). A Decision Support Framework for identifying optimal water supply portfolios: Metropolitan Adelaide Case Study. 10.13140/RG.2.1.4820.4009

Office for Water Security. (2010). Water for good: a plan to ensure water future to 2050. Adelaide, SA. Retrieved from http://www.environment.sa.gov.au/about-us/our-plans

Razzaghmanesh, M., Beecham, S. and Salemi, T. (2016). The role of green roofs in mitigating Urban Heat Island effects in the metropolitan area of Adelaide, South Australia. Urban Forestry and Urban Greening, 15, 89–102.

Rijke, J., Farrelly, M., Brown, R. and Zevenbergen, C. (2013). Configuring transformative governance to enhance resilient urban water systems. Environmental Science and Policy, 25(ii), 62–72.

SA Water. (2012). South Australian Water Corporation Annual Report. Adelaide, SA.

SA Water. (2016a). Drinking Water Quality Report: 2015-2016. Adelaide, SA. Retrieved from http://www.portlandoregon.gov/water/article/244813

SA Water. (2016b). South Australian Water Corporation Annual Report. Retrieved from www.sccportal.org

Sharma, A., Pezzaniti, D., Myers, B., Cook, S., Tjandraatmadja, G., Chacko, P., Chavoshi, S., Kemp, D., Leonard, R., Koth, B. and Walton, A. (2016). Water Sensitive Urban Design: An Investigation of Current Systems, Implementation Drivers, Community Perceptions and Potential to Supplement Urban Water Services. Water, 8(7), 272.

Snehota, M., Jelinkova, V., Sobotkova, M., Sacha, J., Vontobel, P. and Hovind, J. (2015). Water Resources Research, 1359–1371.

Wong, T. H. F. and Brown, R. R. (2009). The water sensitive city: Principles for practice. Water Science & Technology, 60(3), 673–682.

Appendix A. Participants

Workshop Facilitators		
Lara Werbeloff	Monash Sustainable Development Institute	Manager Strategic Initiatives
Chris Chesterfield	CRCWSC	Director Strategic Engagement
Alex Gunn	CRCWSC, Monash University	Researcher
Katie Hammer	CRCWSC, Monash University	Researcher, IRP1 Project Manager
Briony Rogers	CRCWSC, Monash University	IRP1 Project Leader
Lindsey Beck	Foundry	CRCWSC Industry Partner (WSC Index)

Workshop Attendees[2]		
Alex Ward	Department of Environment, Water and Natural Resources	Green Infrastructure project officer
Alison Collins	Department of Planning, Transport and Infrastructure	Unit Manager, Regional Planning
Andrew King	City of West Torrens	Chairperson, Stormwater SA
Angus Simpson	University of Adelaide	Professor, School of Civil, Environmental and Mining Engineering
Belinda Dohring	City of Adelaide	
Ben Bruce	Department of Environment, Water and Natural Resources	Director, Water Group
Ben Murphy	Department of Planning, Transport and Infrastructure	
Ben Willsmore	Australian Institute of Landscape Architects (SA)	President
Brett Shuttleworth	Southfront	Senior Engineer - WSUD and Project Delivery
Chrissie Bloss	Department of Environment, Water and Natural Resources	Manager, Flood Management Unit
Daryl Day	ICE WaRM	Managing Director
Elsie Mann	MWH Global consulting	Consultant – Strategic Engineering
Grant Dalwood	Nursery & Garden Industry SA	Chief Executive
Graeme Hopkins	Fifth Creek Studio	Principal
Greg Ingleton	SA Water	Manager, Environmental Opportunities
Kym Pryde	Planning Institute of Australia (SA)	President
Martin Allen	Department of Environment, Water and Natural Resources	Principal Policy Officer
Mellissa Bradley	Water Sensitive SA	Program Manager, Water Sensitive SA
Michelle Irvine	SA Water	
Nadine Kilsby	Department of Environment, Water and Natural Resources	Senior Water Projects Officer, Natural Resources AMLR
Paul Smith	City of Adelaide	Senior Officer, City Design and Transport
Peter Pfennig	EPA	Manager Water Strategy Group
Rachel Barrett	Water Industry Alliance	CEO
Ruth Ward	EPA	Senior Environment Protection Officer
Sam Phillips	AMLR NRM Board	Water Projects Engineer
Sheryn Pitman	South Australian Museum	Programme Manager, Inspiring South Australia
Simon Thompson	Local Government Association	Senior Policy Officer

[2] Not all participants attended all of the workshops.

Steve Morton	Department of Environment, Water and Natural Resources	Manager Urban Water, Economics and Water Security
Steven Gatti	Department of Environment, Water and Natural Resources	Manager Water Projects, Natural Resources AMLR
Wally Iasiello	IPWEA	Board member

Interviewees (where not workshop participants)		
Baden Myers	University of South Australia	Research Fellow
Jennifer Slocombe	Department of Planning, Transport and Infrastructure	Environmental Policy Officer
Joe La Spina	W&G Engineers	Senior Consultant
John Devine	City of Unley	General Manager City Development
Richard Stranger	Renewal SA	Director, Urban Design
Robin Allison	DesignFlow	Director
Stephen Smith	Renewal SA	Senior Planner
Stephen Smith	Local Government Association of South Australia	Director Policy

Appendix B. WSC Index Result Details

A full day workshop was held at SA Water, 250 Victoria Square, on 8 May 2017. Participants represented a range of stakeholders from across Adelaide's water, planning, development and environment sectors. A three-step method for scoring each indicator was used:

1. Live polling to gauge individual participants' perspectives on the score for the indicator in question,
2. Interactive discussion to uncover evidence and justification to inform the indicator's score, and
3. Reach consensus amongst the participants on the score to be assigned.

The live polling used a bespoke web-based tool that participants accessed through their mobile devices to score 1-5. The collective results were then showed in real-time. These results were discussed, with evidence identified (e.g. policy documents, organisational materials, expert views, etc.) before reaching consensus on a given rating and level of confidence.

A summary of the status of the indicators that need to be higher for Adelaide to achieve the Water Cycle City benchmark are provided here.

Goal 5: Improve ecological health (Score: 2.8/5)

Indicator 5.1: Healthy and biodiverse habitats (Score: 2/5)

A strong legislative framework is in place to promote healthy and biodiverse habitats, supported by policies and institutions. With the increased aesthetic appeal of large trees in residential areas, stands of remnant native forest on public land are integrated well into the urban environment in the southern and eastern suburbs of Greater Adelaide (Bardsley et al., 2015).

However, biodiversity in the Greater Adelaide region, which is home to a national biodiversity hotspot, faces ongoing threats in the form of fragmentation and degradation, from unsustainable land management (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2013; Bardsley et al., 2015).

Workshop participants considered that there are isolated pockets of (terrestrial) biodiversity, but overall, Greater Adelaide needs more connectivity between areas of biodiversity to develop habitat. Furthermore, Adelaide has few waterways with year-round flows, and a large proportion of waterways are piped or channelised and on private land. Workshop participants considered that habitat restoration will need to consider these smaller streams to supplement the progress made with the Torrens, Onkaparinga and Para Rivers.

Indicator 5.2: Surface water quality and flows (Score: 2.5/5)

Coastal and marine habitats near Greater Adelaide include extensive seagrass meadows, mangroves, and samphire or saltmarsh, as well as reef areas. However, many years of near-continuous inputs of nutrient rich and turbid water have caused nutrient enrichment of coastal waters, growth of epiphytes, and detrimental effects on the seagrasses (Adelaide and Mount Lofty Ranges Natural Resources Management Board, 2013, p. 30). While improved wastewater treatment has mitigated some impact on seagrass habitat, stormwater quality and volume remains a high risk to ecosystem values in the marine environment.

Recently, there have been trials of providing amenity and environmental flows for the Torrens, Onkaparinga and Para rivers, which has been seen to deliver tangible benefits. The Torrens amenity flow trial has reduced the number, onset, duration and severity of algal blooms, though they remain a hazard during the summer months (Adelaide City Council, 2016; Daniels & Good, 2015).

Workshop participants believed the lack of water quality in stormwater flows was the main determinant of the current score. Although there was some action taken to address runoff quality prior

to discharge, including gross pollutant traps and wetlands around Greater Adelaide, a higher score will require more attention to the urban form; there is currently insufficient open space in established urban areas to treat runoff adequately.

Goal 6: Ensure quality urban space (Score: 2.5/5)

Indicator 6.2: Urban elements functioning as part of the urban water system (Score: 2/5)

There is some integration of urban elements with the water system. It is estimated that Greater Adelaide contains 450-500 examples of water sensitive urban design. There are high-level targets for harvesting stormwater in place, with interim targets having been exceeded by 2013 (DEWNR, 2013). Funding for small scale modifications to the urban form exists, such as the EPA's Rain Garden 500 program, but it is not ongoing and has yet to achieve results for a fair proportion of the region.

Urban heat management is part of the planning agenda, and there have been several attempts to quantify the scale of the problem (e.g. ArborCarbon, 2016; Guan et al., 2013; Razzaghmanesh et al., 2016). To date, however, there are few examples of local mitigation of urban heat except in the case of trials. Nevertheless, urban heat is perceived to be a major driver of investment in sustainable stormwater infrastructure, with strong links to community health and climate change adaptation. Resilient South, an initiative of the Cities of Onkaparinga, Holdfast Bay, Marion and Mitcham, received funding from the State Government for urban heat island mapping in the south (City of Mitcham, 2017, para. 17).

Adelaide has good wastewater reuse and stormwater harvesting practices when compared to other cities. However, this implementation is weighted towards large-scale infrastructure projects and masterplanned greenfield developments with favourable local conditions (i.e. aquifer storage).

Smaller-scale implementation in urban infill areas is much less prevalent in the built form. What would take this score higher is increased application of water sensitive urban design to structural features of the built form (such as increasing permeability and use of green roofs and walls).

Indicator 6.3: Vegetation coverage (Score: 2.5/5)

Across the 19 municipalities in Greater Adelaide, the average tree cover is about 20% (Jacobs, Mikhailovich, & Delaney, 2014). This places Adelaide's score between 2 and 3. There is significant local variation, however, as Mitcham and Adelaide Hills each have over 40% tree cover, but six of the municipalities (in the north and west of the city) are under 15%.

The State Government has proposed a policy to increase tree canopy by 20% by 2045, encouraging more trees in the private and public realm to create cool, shady and walkable neighbourhoods. There are several champions in positions of influence in the State Government and agencies who are seeking to institutionalise the target. The current focus is on achieving complementary health outcomes (e.g. Health, Wellbeing and Inclusion policy theme within the 30-year Plan for Greater Adelaide.

Workshop participants were concerned that there has been a net loss of trees since the Millennium Drought. They believed that vegetation coverage is not a priority for some councils. In addition, there are concerns over the quality of vegetation cover, that new developments are not getting coverage, and that established trees are not sufficiently protected by the planning system.

Goal 2: Increase community capital (Score: 3/5)

Indicator 2.2: Shared ownership, management and responsibility for water assets (Score: 2.5/5)

Where residential developments in Adelaide include prominent water sensitive urban design elements, residents appear to have a strong sense of ownership of the elements (Leonard et al., 2014). Focus groups with Adelaide residents have found that the community is generally very favourable to water sensitive urban design features and rainwater tanks (Leonard et al., 2015). Since 2006, there has been a requirement for new homes and home extensions to have a rainwater tank

connected to a toilet, a cold water laundry outlet, or a hot water service (Leonard et al., 2014, p. 5). The proportion of households in Adelaide with a rainwater tank installed was 44% in 2013, the second highest among Australian capital cities, which averaged 28% (Australian Bureau of Statistics, 2013). However, between 2007 and 2013, there was no change in the proportion for Adelaide households, whereas Sydney, Melbourne and Brisbane saw significant increases in household tank usage.

Workshop participants thought that there needed to be greater coordination to drive local water management solutions, though they were not completely ad hoc based on the existence of policies and regulations mandating adoption of some features (e.g. rainwater tanks) in new development. Participants also viewed the community's role in maintenance was not strong, most notably in the case of septic tanks. Although septic tanks are not common in Greater Adelaide, they are a substantial source of pollution in some catchments. In addition, water courses on private land are the responsibility of the landowner, but proactive management is ad hoc.

Goal 1: Water Sensitive Governance (Score 2.8/5)

Indicator 1.1: Knowledge, skills and organisational capacity (Score: 2.5/5)

There is considerable technical knowledge and engineering skill to achieve the Water Cycle City within Greater Adelaide. However, knowledge and capacity gaps may include the financial, such as for the development of strong business cases or obtaining an operations and maintenance budget for WSUD features, and the operational, as there may be a general lack of knowledge of water sensitive urban design maintenance requirements (Sharma et al., 2016). Knowledge and capacity for water sensitive management is also understood to be unevenly distributed among relevant organisations.

The indicator fell short of a score of 3 primarily because of the perception that there was insufficient influence of disciplinary skills outside of engineering, despite there being a growing spread of integrated water-related skills and knowledge across larger organisations. While there was evidence of integrated planning, there needed to be stronger links to urban planning and urban ecology disciplines. There is also a lack of consistency among water-related organisations, particularly in infrastructure provision: some are dominated by a traditional engineering orientation, whereas others are more innovative and active in employing integrated water management skills.

A related view was that planners and engineers at the local government level were highly influential in key decision-making, for example in budgeting and implementation, with very little input from other disciplines. Overall, participants thought that there still needs to be increased interdisciplinarity and innovation in smaller organisations.

Indicator 1.2: Water is a key element of city planning and design (Score: 2.5/5)

There are numerous examples of policy supporting sustainable water management and WSUD. However, there are concerns over the degree of planning coordination between organisations in addition to the degree of applied integration.

In terms of coordination, there is a view that there is enthusiasm for integrated water management (IWM), but a lack of coordination means that there is a struggle to progress adoption of WSUD and other practices consistent with IWM planning. There is no single organisational leader to define IWM planning and coordinate other actors.

Also affecting the application of IWM planning policy is the fact that many policies, particularly in the land use planning system, are non-mandatory. The significant exception to this is policy designed to mitigate the effects of flooding on a property. One of the recent reforms to the planning and design code is the potential to populate policy requirements for development approvals in a more informed way depending on the local context. This should require decision-makers to detail their justification for non-compliance with WSUD policies in development approvals.

Overall, there were strong arguments for a score of 2 and also a score of 3. The lack of monitoring and evaluation of planning was the key argument against a score greater than 3. Consensus on the score of 2.5 was not reached, but it was supported by a majority of participants.

Indicator 1.7: Equitable representation of perspectives (Score: 2.5/5)

While there is equity policy in place, participants considered there to be a low degree of representation of disadvantage or marginalised groups in water governance. Policies are in place to improve gender equity, and there are recognised policies supporting engagement with indigenous groups. A number of strategies are in place to support inclusion and access for disabled communities (DCSI, 2015), LGBTIQ communities (DCSI, 2017), and Aboriginal communities (DCSI, 2016). The State Government has guidelines in place to support departments to ensure that their services cater for all community members and to assess whether their policies, processes and culture support access and inclusion.

Though progress was believed to have been made in broadening the representation of women in local government and in some appointed boards, participants considered that few positions of power are held by marginalised or disadvantaged representatives. Increasing the representation of marginalised or disadvantaged groups would increase the score to 3.

Goal 7: Promote Adaptive Infrastructure (Score 3.1/5)

Indicator 7.3: Integration and intelligent control (Score: 2.5/5)

There are some examples of integrated and intelligent monitoring and control systems, such as control of barrages at the mouth of the Patawalonga to release water ahead of significant rainfall events within the Keswick, Brown Hill and Sturt catchments. Similarly, there is intelligent control of sewage systems to also mitigate risks from flooding.

Similarly, there has been detailed research and modelling of future demand scenarios to support water supply optimisation (Maheepala et al., 2014). At the operational level, data is monitored in real-time to support supply decision-making. This is undertaken to minimise supply costs (e.g. pumping from River Murray) with respect to live demand data. Water supply is also responsive to other parameters. For example, storage in decentralised systems is augmented in advance of forecast storms with the potential to cause power loss that would disrupt central supplies.

However, it is relatively rare for intelligent controls to be in place for smaller scale systems, and the whole urban water system is not controlled in an integrated way. There is also a lack of sophisticated scenario modelling for adaptive management. Workshop participants considered the controls to be largely passive systems rather than dynamic systems with the potential to optimise outcomes across multiple objectives and address a range of hazards.

Water Sensitive Outcomes and Practices

The WSC Index can filter results based on WSC Outcomes and WSC Practices. This method of analysis is still in development and will be enhanced as more cities are analysed using the tool.

WSC Outcomes

Water sensitive city outcomes assess the performance of the urban water system against the delivery of resilience, liveability, sustainability and productivity.

Resilience in this context is defined as the capacity to maintain water system services under acute or chronic disturbances, through adaptation or recovery. Sustainability is the capacity of water system services to deliver benefits for current and future generations. Liveability is the capacity of the water system to deliver a high quality of life for communities (such as thermal comfort, aesthetics, amenity, connection to place, etc.). Productivity is the capacity of the water system services to generate economic value.

The ratings from each indicator can contribute to one or more of these outcomes. For example, improving the rating for the indicator ‘diversify self-sufficient fit-for-purpose water supply’ related to provision of alternative water supplies would improve both resilience and sustainability outcomes.

The results shown in Figure 23 indicate how Adelaide scores against the expected Outcomes for the Water Cycle City. Productivity outcomes scores a 3.2 from a possible 5, which is consistent with the score likely for the Water Cycle City. As the graph indicates, improvements could be directed at actions to deliver enhanced Liveability and Sustainability outcomes for the community. The results of Liveability and Sustainability Outcomes have been influenced by the comparatively lower scores in the *Improve ecological health* and *Ensure quality urban space* indicators.

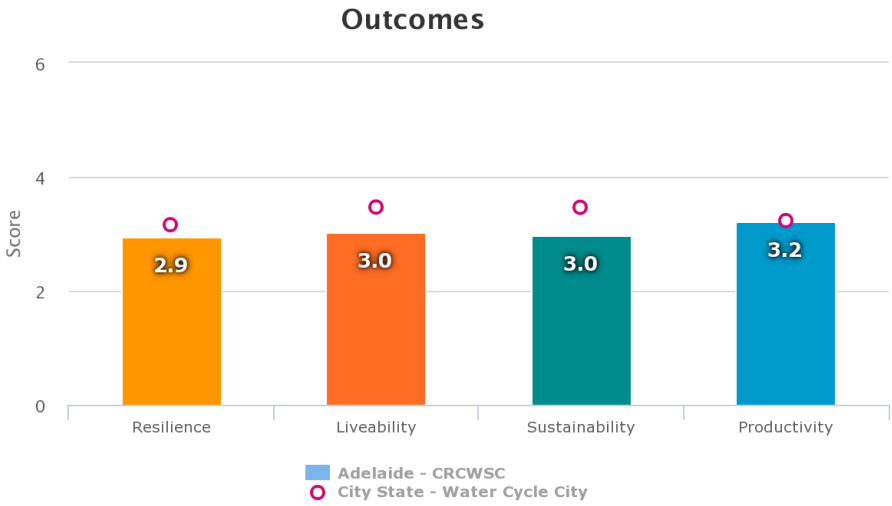


Figure 23. Adelaide WSC Index indicator scores represented by the WSC Outcomes of Resilience, Liveability, Sustainability and Productivity and compared with the ideal Water Cycle City.

Appendix C. Transition Dynamics Framework analysis

The Transition Dynamics Framework (TDF) is a tool developed by the CRCWSC to diagnose the current presence of enabling conditions in a system as it shifts from an old practice to a new, water sensitive practice.

Brown et al. (2016) provides details on the conceptual basis of the tool. In short, as a city moves through the phases of a transition, enabling conditions are established to support its trajectory towards its water sensitive city vision and avoid the risk of change pathways that reflect lock-in, backlash or system failure patterns. Actions to orient and drive change towards a city's envisioned water sensitive future need to progressively establish these enabling conditions. Actions with the most impact during the early transition phases will be different from those during the later transition phases. It is therefore critical to identify a city's current phase of change to ensure that actions are prioritised according to the effectiveness they will have in accelerating the water sensitive city transition.

The TDF was applied for Adelaide to each WSC Index goal to analyse what enabling conditions are currently fully present, present to some degree, and absent. The results are represented by a simple colour code:

Colour code		Indicators are fully present; regression unlikely
		Some presence of indicators; vulnerable to regression
		Absence of indicators; progression unlikely
		Not yet a consideration as preceding conditions not fulfilled

The TDF results provide insight into the enabling conditions that should be established as a priority. This leads to the formulation of priority objectives that should be pursued through enabling actions to efficiently advance further progress.

This section presents Adelaide's TDF results for each WSC Index goal, with a brief list of key evidence supporting the colour code. Where a specific indicator was considered at a significantly different transition phase, an indicator-specific TDF matrix was developed. The evidence that supports the colour coding of the matrix is more fully described in the respective in Section 5. This evidence is organised by the vision outcome rather than WSC Index goal, whereby the goals and in some cases individual indicators were allocated to the vision theme they best reflect.

Goal 1: Ensure good water sensitive governance

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions**	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Informal connections but these need to be more coordinated and include more seniority. Local councils provide a good collaborative model	**Developing a collective voice** AILA, CRC, SA Water, Cabinet taskforce developing voice. Working groups are present but ad-hoc	**Solutions developed**	**Solutions experimented with** Green Infrastructure Project – interagency collaboration, not yet embedded in policy. Projects are ad-hoc, no monitoring, evaluation or learning agenda	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** Champions not senior enough to influence	**Building broad support** Beginning to expand to other disciplines	**Solutions advanced** Know what the solutions are for some parts of the cycle, missing community engagement	**Significant demonstrations of solutions**	**Refined guidance and early policy** Urban Design Guidelines, implementation and coordination is ad-hoc, Better Together policy
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets** Planning and Design Code merit policy – meet 60-70% to get development approval, 30 year plan, Community Engagement Charter for planning, strong policies for gender equity and Aboriginal engagement, not as strong outside of government, legislated gender equity
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 2: Increase community capital

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions**	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** NRM Urban Engagement Team, Living smart program, some councils	**Developing a collective voice** Water Sensitive SA, CRCWSC	**Solutions developed** SA Water doing community engagement projects, need funding	**Solutions experimented with** SA Water doing community engagement projects, Kaurna wetland, Greening the East project	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** SA Water, Water Sensitive SA, more coordination needed	**Building broad support** Not yet broad support	**Solutions advanced**	**Significant demonstrations of solutions**	**Refined guidance and early policy** Local water management solutions (rainwater tanks and septic tanks) in policy, indigenous involvement in policy but limited implementation
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 3: Achieve equity of essential services

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions**	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Profile of issues not helpful to developing network	**Developing a collective voice** In-principle support for issues, but new practices have not been explored by many	**Solutions developed**	**Solutions experimented with** Wetlands and other assets available to the public. Lack of water-related assets in disadvantaged areas	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** Few championing issues with influence	**Building broad support** Reliance on established platforms, but issues not a priority	**Solutions advanced** Have technical knowledge on alternate sources, not much on enhancing consumer choice	**Significant demonstrations of solutions**	**Refined guidance and early policy** Need for regulatory frameworks supporting consumer choice
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 4: Improve productivity and resource efficiency

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions**	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Includes Water industry alliance, Water Sensitive SA, CRCWSC, Goyder, and there are some champions in DEWNR	**Developing a collective voice**	**Solutions developed** Need knowledge on how to quantify costs and benefits for other sectors	**Solutions experimented with** WWTP recycle water (Glenelg pipeline), but fewer small-scale developments. Stormwater resources OK but not much biogas, biosolids, heat, nutrients etc. Desal. emissions offset by renewables, but SA water 2nd highest energy user	**Preliminary practical guidance** Planning development infrastructure and design guidelines to be released in next 3-5 years
4. Knowledge Dissemination	**Influential champions** Water industry alliance, Water Sensitive SA, CRCWSC, Goyder	**Building broad support** Water Industry Alliance – collaborations, need to expand beyond just water sector	**Solutions advanced** Hard to justify individual business cases - need knowledge on how to quantify costs and benefits for other sectors	**Significant demonstrations of solutions** Good examples but coming from small no. of organisations	**Refined guidance and early policy** Carbon Neutral Adelaide, policy helping but incidental, not a driver
5. Policy & Practice Diffusion	**Government agency champions** SA Water – agricultural and wastewater	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 5: Improve ecosystem health (Indicators 5.1 Healthy and biodiverse habitat, 5.2 Surface water, 5.3 Groundwater quality and replenishment)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions** Some individual champions present	**Sharing concerns and ideas** Stormwater SA, NRM board	**Causes and impacts examined** Lots of data on habitat health, ecological health	**Solutions explored** Pockets of healthy habitat, wetlands, floating barriers, hills face protection, bird sanctuary, Happy Valley	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Champions focus on individual interests and are not connected, not influential	**Developing a collective voice** Champions have not developed a common purpose, more stakeholders need to be brought under the tent	**Solutions developed** Coastal protection solutions, wastewater solutions, monitoring ecological health, need to address urban runoff, groundwater mapping	**Solutions experimented with** Missing societal understanding	**Preliminary practical guidance** EPA aquatic ecosystem report cards
4. Knowledge Dissemination	**Influential champions**	**Building broad support**	**Solutions advanced**	**Significant demonstrations of solutions** Projects are isolated	**Refined guidance and early policy** WSUD policy has water quality targets, but not mandatory
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 5: Improve ecosystem health (Indicator 5.4 Protecting areas of high ecological value)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions** Some individual champions present	**Sharing concerns and ideas** Stormwater SA, NRM board	**Causes and impacts examined** Maps of threatened species	**Solutions explored** Pockets of healthy habitat, wetlands, floating barriers, hills face protection, bird sanctuary, Happy Valley	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions**	**Developing a collective voice**	**Solutions developed**	**Solutions experimented with**	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** Numerous champions in community	**Building broad support** Broad acceptance of value and protection measures	**Solutions advanced**	**Significant demonstrations of solutions**	**Refined guidance and early policy**
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building** Good quality mapping of significant value areas, acceptance of protection measures needed	**Widespread implementation and learning** Programs need to build on achievements and iterate more frequently	**Early regulation and targets** EPBC Act, Recovery plan, NRM Act, Adelaide Mt Lofty Ranges. Legislation exists for protecting areas of ecological value, but there are loopholes, and breaches not well enforced
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 6: Ensure quality urban space (Indicator 6.3 Vegetation Coverage)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted** Chris Daniels study – Adelaide one of worst for QUS	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions** e.g. Daniel Bennett, Stephen Forbes, Chris Daniels (publicly visible)	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Individual champions, though there needs to be stronger linkages and coordination	**Developing a collective voice** Industries are talking more to try and raise profile of the issue and to leverage good outcomes from individual champions. Starting to bring in health, planning, and engineering	**Solutions developed**	**Solutions experimented with**	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions**	**Building broad support**	**Solutions advanced**	**Significant demonstrations of solutions**	**Refined guidance and early policy** WSUD policy, veg coverage policy
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 6: Ensure quality urban space (Indicator 6.1 Activating connected urban green and blue space and Indicator 6.2 Urban elements functioning as part of the urban water system)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted** Chris Daniels study – Adelaide one of worst for quality urban space	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions**	**Sharing concerns and ideas**	**Causes and impacts examined** Data on accessibility and connectivity is available, but missing community values around blue/green space	**Solutions explored** Linear parks, high density heat mapping	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** There needs to be more senior or influential support for implementing WSUD	**Developing a collective voice**	**Solutions developed** Capacity to deliver solutions believed to be present	**Solutions experimented with** Some examples of projects with integrated WSUD, economic benefits are not fully demonstrated.	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions**	**Building broad support**	**Solutions advanced**	**Significant demonstrations of solutions**	**Refined guidance and early policy** WSUD policy, veg coverage policy
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**

Goal 7: Promote adaptive infrastructure (Indicators 7.2 Multi-functional water system infrastructure, 7.3 Integration and Intelligent control, 7.4 Robust infrastructures, 7.5 Ownership at multiple scales, 7.6 Maintenance)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions** Greg Ingleton, Andrew King, NGOs	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Certain councils	**Developing a collective voice** Knowledge needs to be better communicated beyond water sector, silos broken down	**Solutions developed** Alternate supply options but ad-hoc, multi-functionality not embedded in design, potable water system robust but not stormwater systems, green infrastructure causes maintenance concerns	**Solutions experimented with** Secondary supply networks, Eastern region alliance injecting water into aquifer for public open space; projects isolated and some still not incorporating WSUD	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** No high profile or political champion	**Building broad support**	**Solutions advanced**	**Significant demonstrations of solutions**	**Refined guidance and early policy** WSUD in policy but not mandatory; high-level policy (e.g. Water for Good, 30 year plan) is progressive
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Goal 7: Promote adaptive infrastructure (Indicator 7.1 Diverse fit for purpose water supply systems)

Transition phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue Emergence	**Issue activists**	**N/A**	**Issue highlighted**	**Issue examined**	**N/A**
2. Issue Definition	**Individual champions** Some high-profile champions in SA Water, councils, NGOs.	**Sharing concerns and ideas**	**Causes and impacts examined**	**Solutions explored**	**N/A**
3. Shared Understanding & Issue Agreement	**Connected champions** Some councils, but not the majority, have champions	**Developing a collective voice** Knowledge not communicated well beyond water sector, DEWNR missing cohesive narrative and in silos. Water Sensitive SA,	**Solutions developed** Alternate supply options but ad-hoc and isolated	**Solutions experimented with** Secondary supply networks, Eastern region alliance injecting water into aquifer for public open space irrigation	**Preliminary practical guidance**
4. Knowledge Dissemination	**Influential champions** No high profile or political champion,	**Building broad support**	**Solutions advanced** Stormwater harvesting at scale, but a need for network integration. Missing knowledge around demand and where to strategically use alternate water sources	**Significant demonstrations of solutions**	**Refined guidance and early policy** WSUD in policy but not mandatory; high-level policy (e.g. Water for Good, 30 year plan) is progressive
5. Policy & Practice Diffusion	**Government agency champions**	**Expanding the community of practice**	**Capacity building**	**Widespread implementation and learning**	**Early regulation and targets**
6. Embedding New Practice	**Multi-stakeholder networks**	**Guiding consistent application**	**Monitoring and evaluation**	**Standardisation and refinement**	**Comprehensive policy and regulation**

Cooperative Research Centre for Water Sensitive Cities

Level 1, 8 Scenic Boulevard
Monash University
Clayton VIC 3800

info@crcwsc.org.au

www.watersensitivecities.org.au