

Transitioning to water sensitive cities Insights from six Australian cities

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Business Cooperative Research Centres Program

Transitioning to water sensitive cities

Insights from six Australian cities Water Sensitive City Visions and Transition Strategies (IRP1) IRP1 – 6 – 2020

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Publisher

Cooperative Research Centre for Water Sensitive Cities PO Box 8700 Monash University LPO Clayton, VIC 3800

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Date of publication: September 2020

An appropriate citation for this document is:

Hammer, K., Rogers, B.C., Gunn, A., Chesterfield, C. (2020). *Transitioning to water sensitive cities: insights from six Australian cities.* Melbourne, Australia: Cooperative Research Centre for Water Sensitive Cities.

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Acknowledgements

The findings in this report have resulted from an inspiring co-creation process involving hundreds of leading thinkers from around Australia. We thank the research participants for bringing their enthusiasm, creativity and strategic insight to the workshop processes. We are grateful for the advice and collective efforts by the local steering committees; their support was instrumental in shaping the local action research activities to significantly advance their city's water sensitive transition agenda. We thank the IRP1 national steering committee—Shelley Shepherd (WA), Greg Ingleton (SA), Phill Birtles (NSW), Warren Traves (QLD), Chris Manning (QLD), Elliot Stuart (VIC), Christine Grundy (VIC), Amy Lomax (QLD), Josh Evans (QLD), Lisa Currie (NSW), Jenny Stewart (VIC), Professor Chris Cocklin (James Cook University)—for their invaluable guidance and support throughout the project. Finally, we thank our research collaborators in the IRP1 team for their contributions throughout the project: Emma Church, Jo Lindsay, Kelly Fielding and Angela Dean.

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Executive summary

The Cooperative Research Centre for Water Sensitive Cities' (CRCWSC) first integrated research project (IRP1), Water Sensitive City Visions and Transition Strategies, aimed to deliver a suite of participatory methods and associated tools for guiding cities and towns to accelerate their water sensitive city (WSC) transitions. The project involved transdisciplinary action research, drawing on insights from the scientific field of sustainability transitions and working with city stakeholders to develop visions and transition strategies for six case studies across Australia: Perth, Adelaide, Bendigo, Sydney, Townsville, and the Gold Coast.

This report compares and contrasts these cities' unique experiences and relationships with water, articulates their collective future aspirations, and identifies the strategic priorities for Australian cities to establish the conditions that will drive and enable the transformations needed to achieve their WSC vision.

Australia's urban water story

A common story underpins the evolution of water management in different Australian cities as they have responded to national and international drivers, trends and events. It is important to understand this story and how it has shaped Australian water systems today, to identify opportunities for improvement going forward. Common drivers, trends and experiences exist across the six case study cities: Aboriginal connection to country, protecting public health, post-war investment and population boom, environmental focus, policy and economic reform, and a drying climate. More recently, ensuring ongoing resilience and liveability have been key drivers for water policy and practice, and have set the scene for implementing a more water sensitive approach.

Visions of Australian water sensitive cities

Water sensitive city visions were developed for each of the six case study cities through collaborative workshop processes involving diverse stakeholders. Despite varied biophysical and social conditions, cities articulated common themes about future water sensitive city aspirations for their city in 50 years:



Despite the common themes across both urban water stories and future visions, each city had its own drivers, character and priorities that shaped unique city narratives. Perth, for example, has continued to experience a drying climate, leading to investment in water efficiency and supply options, while aspiring to be Australia's leading waterwise (or water sensitive) city. Townsville, situated in the Dry Tropics of North Queensland and faced with cycles of extreme drought and flood, aims to embrace its dry tropical identity while enhancing liveability and protecting waterways and the Great Barrier Reef. Sydney aspires to achieve equity of water-related benefits across all parts of the city and to continue being an internationally recognised liveable city. The Gold Coast embraces the lifestyle benefits of water and aims to support the health of the canals and beaches for human health and recreation. Bendigo aspires to be a thriving inland city, supported by an empowered community and a strong connection to country. Adelaide, with a strong history and culture of innovation, seeks to embrace the local ephemeral creeks and to continue to ensure water underpins a strong economy.

Assessing water sensitive performance

The CRCWSC's Water Sensitive Cities Index (WSC Index; Rogers et al. 2020) was applied to each case study city to assess its current water management practices against seven goals of a water sensitive city. Thirty-four indicators were scored on a 1–5 rating scale through a collaborative workshop process. Figure A shows the average, minimum and maximum scored for each goal from the six cities:



Figure A: Average, minimum and maximum goal scores across the six case study cities

The 34 indicators of the WSC Index can also be mapped to the idealised city-states represented in the Urban Water Transitions Framework (Brown et al. 2009). Figure B shows the percentage attainment of each city-state according to the average scores across the six case study cities:



Figure B: Percentage attainment of each city-state according to the average scores across the six case study cities

Australian transition priorities

Transitioning towards a water sensitive city will require significant changes across the structures, cultures and practices of urban and water system planning, design, management, engagement and decision making. These changes are likely to happen over a long timeframe as new water sensitive practices supplant old unsustainable practices. The CRCWSC's Transition Dynamics Framework identifies six types of enabling factors that need to be present and sequentially built up, to successfully transition to a new practice. The Transition Dynamics Framework was applied to each case study city to assess the city's current enabling conditions and identify strategies for progressing its transition to more water sensitive practice. Based on this assessment, a number of common transition priorities were identified across the six case study cities.

Australian water sensitive city transition priorities

Champions

- Broad community mandate for pursuing WSCs
- Capacity of WSC champions to be influential
- Political support and buy-in for WSCs
- Communities empowered to be active water sensitive citizens

Platforms for connecting

- Strong informal relationships and networks among diverse stakeholders
- Governance frameworks
 that enable coordination
 and collaboration across
 organisations and sectors
- Opportunities for community and industry to collaborate and learn from each other
- Platforms for sharing data and knowledge to support learning and collaboration

Projects and applications

- Consolidation and sharing of lessons from existing WSC projects
- Explicit learning agenda and strategy to guide identification and implementation of trial and demonstration opportunities
- Trials of solutions for emerging WSC technologies, collaborative governance arrangements and community empowerment processes
- Large-scale demonstrations of established WSC solutions
- Evidence of maintenance and lifecycle costs of water sensitive systems
- Monitoring and evaluation to improve system design and performance

Tools (administrative)

- A compelling WSC vision and narrative grounded in community values
- Policies, plans and strategies that embed the WSC vision
- Organisational culture, systems and processes that enable and encourage WSC innovation
- Strong and aligned policy, legislation and regulation for WSC implementation
- System-wide standards, targets and programs of implementation to deliver WSCs
- Robust, inclusive and integrated decision frameworks and processes
- Cost-benefit-risk sharing frameworks
- Business cases for specific WSC benefits and approaches
- Business models for alternative water systems at different scales

Scientific and practical knowledge

- Insight on how to effectively incorporate Aboriginal knowledge and values
- Knowledge on local groundwater systems
- Solutions for effectively engaging with and empowering the community
- Exploration of the potential of emerging WSC technological innovations
- System-wide assessments and quantification of WSC benefits

Tools (practice)

- Tools to support data and knowledge sharing
- Integrated software platforms that support models to interface with each other
- Guidelines that capture and contextualise lessons from trials and demonstrations
- Next generation flood risk assessment frameworks and tools
- Efficient and effective operations and maintenance systems

Towards implementation

Record-breaking heat, drought, bushfires and floods across the country in recent years means Australia is in a unique position to trial new approaches to water management and to lead the way in creating water sensitive cities. A clear vision for Australian water sensitive cities is now emerging, providing a strong orienting force to guide action. To deliver the vision, leadership is needed at all levels, along with collaboration and innovation to support the sharing of knowledge, costs and benefits. Greater knowledge and organisational capacity to deliver water sensitive solutions is also essential for a successful transition.

The case study cities in this research have taken many significant implementation steps. As cities and towns all over Australia consider their own water sensitive city priorities and actions, we have the opportunity to learn from each other's successes and challenges. Together, we can accelerate Australia's water sensitive transition.



1. Introduction

1.1 What are water sensitive transitions?

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

A WSC incorporates 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 functions, 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 among the community as their sense of place and collective identity is nurtured through their connection with water.

Many cities and towns are starting to articulate aspirations represented by the WSC concept. Becoming a WSC 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 WSC. However, we now recognise that adaptations are needed to address key social and environmental vulnerabilities that result from conventional approaches, such as degraded waterways, uncertain and extreme rainfall patterns, and growing community expectations for improved liveability.

The Urban Water Transitions Framework (Brown, Keath and Wong 2009) depicted in Figure 1 is a heuristic tool developed to help cities understand their present water management orientation and define their short- and longterm sustainability goals. The framework identifies six distinct developmental states that cities may move through on their path towards increased water sensitivity. Most cities in the world would appear somewhere on this continuum, but a city's journey from a water supply city through to the aspirational WSC is not linear. Australian cities are typically somewhere between a drained city and a water cycle city, with observable features across all six of the city-states.

Becoming a WSC requires significant changes in policy and practice as the water servicing system moves through different city-states. A successful transition will therefore rely on commitment and alignment among many different people and organisations.

Developing a shared perspective of water today, a compelling vision for the future, and a framework to guide coherent strategic action is critical for establishing the understanding, motivation and capacity among stakeholders to drive their WSC transition.



Cumulative Socio-Political Drivers

Service Delivery Functions

1.2 About this report

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) commenced its first integrated research project (IRP1) – *Water Sensitive City Visions and Transition Strategies* in response to the identified industry need for tailored guidance to drive and navigate WSC transitions. This project aimed to deliver a suite of participatory methods and associated tools for guiding cities and towns in accelerating their water sensitive transitions. The project involved transdisciplinary action research, drawing on insights from the scientific field of sustainability transitions and working with city stakeholders to develop visions and transition strategies for six case studies across Australia: Perth, Adelaide, Bendigo, Sydney, Townsville, and the Gold Coast.

The project also built on and integrated processes and tools developed in CRCWSC Tranche 1 research. Project A4.2 – *Mapping WSC Scenarios* developed the foundations of the process methodology refined in IRP1 through case studies in Perth and Elwood. Project A4.1 – *Society and Institutions* produced an early version of the Transition Dynamics Framework through empirical analysis of enabling factors in Melbourne's water sensitive urban design transition. Project 6.2 –*Developing a water sensitive cities assessment tool* developed the WSC Index and piloted its application in Perth. Project A2.3 – *Engaging Communities with WSCs* developed insights into strategies that will effectively promote water knowledge, build trust in water institutions and leverage community support for WSCs.

For each case study, the research involved a desktop review of local policies and plans, stakeholder interviews, a series of participatory workshops, and application of diagnostic tools to inform detailed analysis. An overview of the process is presented in Figure 2. A total of 274 leaders and strategic thinkers from across water, planning, environment, development, and other related sectors participated in the workshops from across 117 organisations. Across the Bendigo and Elwood case studies, 57 community members were also involved in the process.

This report marks the culmination of an immense engagement process which has provided substantial insights into the past, present and future of the Australian water sector. Details on each individual case study can be found in its Vision and Transition Strategy and companion full case report (see reference list). This report now aims to analyse and synthesise results across all six case studies to develop insights about the Australian water sector as a whole. It compares and contrasts unique city experiences and relationships with water, articulates the future outcomes that people collectively aspire to, and identifies how cities can overcome current barriers to drive the transformative change needed to achieve their WSC aspirations.



Figure 2: Water Sensitive Cities Transition Planning Process

2. Australia's urban water story

A common story underpins the evolution of management of water in different Australian cities as they have responded to national and international drivers, trends and events. European colonisation, world wars, the Gold Rush, and the Millennium Drought are just a few of the events that had significant impacts on Australians' relationship with water and how it is managed in cities and towns today. While in many instances cities share common drivers and trends, their local responses reflect their particular biophysical and socio-institutional contexts. This section walks through the story of water in Australia and the common influences that have shaped how water is managed today.

2.1 Common drivers, trends and experiences

Aboriginal connections

For many millennia, Aboriginal communities existed and thrived on the resources of their land and water environments. Local waterways and water bodies often defined their ways of life, from the Noongar people on the West coast relying on the wetlands and estuaries for food and other resources to the Wulgurukaba or 'canoe people' who resided on present day Palm and Magnetic Islands, basing their lives around the sea. The Dja Dja Wurrung people in Bendigo use the Chain of Ponds in what is now Bendigo Creek for animal and plant resources. A number of Aboriginal Dreamtime stories articulate how the natural water system came to be, such as the Rainbow Serpent carving out lakes, swamps and rivers and Tiddalik the frog filling them with water. No matter the location, First Nations Australians have always had a strong connection with water underpinned by both their creation stories and their harmonious relationship with natural environments. Because their stories are passed down from generation to generation, their connection to water and understanding of their local water cycle remains strong.

Servicing growing cities and public health

The arrival of Europeans in the late 1700s and early 1800s disrupted the harmonious relationship between people and nature. The harsh conditions and unfamiliar environments of the Australian landscape were not well understood by Europeans, who imposed European ways of life in this foreign land. Europeans recognised the plentiful resources available and began clearing land for agriculture, pastoralism and timber. Settlers began damming rivers and creeks for farming, disrupting the natural water systems. A number of conflicts between European settlers and local Indigenous communities arose over land, crops and livestock. These conflicts, coupled with the introduction of diseases such as smallpox and influenza, resulted in the loss of Aboriginal and European lives and the ultimate removal of Aboriginal groups from their native lands.

Colonies continued to grow, and thus needed reliable water supply systems to support the rise in population. Initial reliance on wells and springs soon turned to damming rivers for water storage. Higher numbers of people in settlements led to the need for waste collection and ultimately construction of sewerage systems to protect the public from diseases such as typhoid and cholera. What started out as small groups of people surviving on local water sources and features, guickly turned into colonies and towns that needed to modify water sources to meet the needs of more and more people. The modification of natural systems during this period (e.g. damming rivers, draining wetlands) have contributed significantly to some of the water quality and flooding problems of rivers around the country today. Outbreaks of Cryptosporidium and other water-borne diseases, and a general focus on public health, led to the creation of water boards (e.g. the Water Supply and Sewerage Board in Sydney) that could regulate water supply, sewerage and drainage services and, in turn, protect human health

Post-war investment and population boom

In the first half of the 20th century, World War I, the Great Depression, and World War II held back growth and investment. However the population boom post-World War II drove significant investment in water infrastructure, and public water utilities such as the Melbourne and Metropolitan Board of Works and Sydney Water Board grew large and powerful. Some examples of infrastructure investment include the Warragamba Dam to service Sydney, the Ross River Dam in Townsville, Lake Eppalock in Bendigo, the Hinze Dam and extensive canal systems in the Gold Coast, and the Mannum-to-Adelaide pipeline that connected Adelaide's water supply to the Murray–Darling Basin. As cities around the country rapidly grew, so did the water system infrastructure to support the increased demands.

During this period, suburban growth doubled the footprint of cities like Melbourne and pushed development into more marginal lands requiring more coordinated planning and investment in effective drainage networks. By the late 1970s, over 70 per cent of Australians were living in urban areas. This rapid urban development meant an increase in impervious surfaces (e.g. roads, footpaths and roofs), altering natural flow paths and increasing pollution in runoff. This alteration had significant impacts on downstream water quality and flows, degrading the health of once pristine rivers and waterways.

Environmental focus and community activism

Pollution of waterways and coasts from the poor treatment of sewage and urban stormwater generated increasing community concern in the 1960s and 1970s. Protests and campaigns for greater environmental protection led to increased regulation of industry, investment in 'backlog' sewering programs, and improvements in wastewater treatment. As an example, people in Melbourne began noticing the decline in water quality in the Yarra River and Port Phillip Bay, particularly after heavy rain events. The media brought attention to this issue, causing people to demand the government do something to address the poor water quality. A number of studies were commissioned in the 1990s (e.g. CRC for Freshwater Ecology's and CRC for Catchment Hydrology's Port Phillip Bay Environmental Study) to understand the science of the issue and identify possible solutions for improving water waterway health. The Victorian Environment Protection Authority was established to prevent and reduce negative impacts on the environment, including waterways, along with stormwater specific bodies like the state Stormwater Advisory Council. Water Sensitive Urban Design approaches were developed and trialled, demonstrating significant impact on improving water quality and flows; later, these became accepted as best practice across Melbourne. Other states experienced similar growing attention on waterway health.

Policy and economic reform

Australia, along with most western nations, embraced neoliberal economic policy reforms through the 1980s and 1990s. The water sector underwent significant change, with a focus on cost efficiency and commercialisation of services.

Many internal services of water utilities were outsourced or sold to the private sector. Pricing for services was set to recover costs and reflect usage. Policy, planning and regulatory functions were separated from service delivery organisations, which were increasingly corporatised and commercialised.

These reforms were implemented when Australian cities were experiencing relatively low rates of growth and the water sector had accumulated significant debt from infrastructure investments during the post-war growth period. System capacity commonly exceeded demand and attention shifted from capital investment to operational efficiency. These new drivers of change reflected a policy perspective that utilities were no longer about city building for growth and should instead focus on providing core services to customers.

Climate change and resource limits

From 1997 to 2010, many parts of Australia experienced the longest drought in the nation's history. This became known as the 'Millennium Drought' and it resulted in years of restrictions on water use. Water supply augmentations that had been thought decades away were rapidly reconsidered based on new planning assumptions and, out of the crisis, decisions were made to construct desalination plants in Perth, Sydney, Melbourne, Adelaide and South-East Queensland.

Ultimately, the drought ended before most of these desalination plants were commissioned. In some cities, this fuelled a community and political backlash against what was widely perceived as unnecessary, expensive and energyintensive water infrastructure. The policy response and almost exclusive investment in desalination raised questions about the management and apparent 'waste' of alternative water resources such as recycled water and stormwater. Only in Perth, which continued to face a drying climate, has desalination become a significant and broadly welcomed part of the water supply system.

The 'browning' of our cities and towns during the Millennium Drought coincided with a sustained period of population growth, particularly in Sydney, Melbourne and South-East Queensland. This helped to heighten awareness of the importance of water for enhancing the liveability of our cities – for example, through maintaining green spaces for recreation and protection from climate extremes. Widespread perceptions of mismanagement of the Millennium Drought crisis contributed to changes of government in the eastern states, along with a questioning of the policy and institutional settings in the water sector. A new policy direction emerged, shifting focus from economic efficiency to liveability and challenging the institutional status quo, particularly in the eastern capitals of Brisbane, Sydney and Melbourne.

Ensuring ongoing resilience and liveability

Australia's major urban centres are now reaching the limits of the environment in their regions to provide the resources and ecosystem services to support further growth. Climate change is reducing the capacity of the environment to meet even existing needs. Nowhere in Australia is this clearer than in Perth, where 70 per cent of the city's drinking water was once sourced from surface water catchments and today those catchments provide only around 10 per cent. The other 90 per cent now comes from desalination and groundwater.

Conventional water systems, designed to meet singular objectives under a set of relatively narrow assumptions, may be vulnerable if conditions vary beyond the system's design capacity (e.g. in extreme drought or flood events). Australian cities are now recognising the need for more flexible, adaptive water systems, to be resilient to future uncertainties. Pressure from communities for cities to support healthy lifestyles is also increasing. Governments and water sector organisations are adopting policies and agendas to improve urban liveability, particularly around greening, cooling, improved amenity, equity, affordability and safety. Delivering these liveability outcomes will require new approaches by water institutions to work collaboratively with other sectors and non-traditional stakeholders who can help the sector diversify its service offering and shift from a city-servicing, efficiency-focused operating model to one that is cityshaping and focused on delivering liveability outcomes for people.



3. Visions of Australian water sensitive cities

3.1 Common themes

Water sensitive city visions were developed for each of the six case study cities through collaborative workshop processes involving diverse stakeholders. These cities ranged in scale, biophysical and social conditions, and institutional arrangements. People's relationships with water also varied in each city, and the local historical responses to drivers shaped how water is currently viewed and managed. Despite these contextual differences, cities articulated common themes about future water sensitive aspirations for their city in 50 years:



The following section elaborates on these aspirational outcomes to provide more detail on the emerging collective vision for future Australian water sensitive cities. Healthy, happy, and safe people

- Everyone has access to safe, secure and reliable drinking water and sanitation services
- People are protected from flooding and prepared for extreme climatic events
- People actively use their surrounding land and water environments for recreation, amenity and connecting to nature and each other
- Water in the environment supports both physical and mental health
- Flexible water services allow customers to have equity and choice

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Healthy, protected ecosystems

- Land and water environments are healthy, cherished and continually enhanced
- People understand the interconnectedness of land and water environments, and actively protect and enhance them
- Terrestrial habitats are healthy, connected and well-dispersed throughout urban areas
- Native flora and fauna are protected and thriving
- Catchments are healthy, protected and resilient to future uncertainties

Healthy, protected ecosystems

- Streets, parks and neighbourhoods are cool, green and comfortable for people to enjoy
- Water is integrated into the urban form, fostering a strong connection between people and place
- The urban environment supports recreation and connection to nature
- Networks of blue and green spaces are prevalent and accessible for everyone
- People enjoy spending time in well-designed public spaces that enhance social cohesion

Sustainable, efficient water systems

- Water comes from a diversity of sources and supplied fit for purpose
- All water, energy and chemical resources are used and recovered efficiently
- Water infrastructure is smart, adaptive and flexible across local and centralised scales
- Water infrastructure is multi-functional to deliver broad community benefits
- Water system decisions consider social, environmental, economic and technological costs, benefits and risks



Strong economies and water innovation

- Innovation is embraced in the water sector and facilitates business and employment opportunities
- Skills and practices needed to implement water sensitive approaches are continuously developed
- There are efficient and sustainable markets for water and energy
- Cities are desirable, liveable and attract investment from people and businesses

Empowered community stewardship

- People understand and appreciate the water cycle and their local catchment
- The community proactively cares for the environment and is committed to ongoing stewardship
- People understand future risks and uncertainty associated with climate change
- People actively and eagerly participate in water planning and decision making
- Water connects all people and cultures



Connection to country and Aboriginal values

- Traditional landowners are actively engaged in water planning and decision making and a strong partner in collaborative environmental stewardship
- Aboriginal water knowledge, values and ways of thinking are understood and embraced by all communities and form part of people's identify
- Culturally significant places are protected and considered places for ceremony

Collaborative, integrated governance

- Water governance is collaborative, integrated, adaptive and inclusive
- Community is empowered to participate in water planning and decision making through open and inclusive processes
- Community, government and sectoral leadership drives water sensitive practice
- Water decisions are made transparently and based on sound evidence and knowledge
- Water planning takes a systems approach, considering the whole catchment and all elements of the water cycle
- Collaboration across sectors, disciplines and levels of government is embedded in institutional culture, systems and processes

3.2 Unique narratives

While cities around Australia share many common aspirations, their differing contexts and responses to societal, climatic and environmental events have shaped their unique water systems and priorities. While some cities saw the end of the Millennium Drought with rain, others continued to experience a dry climate. Solutions such as desalination plants were welcomed in Perth, but were met with negative public reactions in other cities. Community connections to and knowledge of their local water systems varied with proximity of natural water features and different levels of information provided by water authorities, governments and the media. This section draws out some of the unique water stories and contexts for the six case study cities, explaining how these contexts have shaped their future water-related aspirations and priorities.

Perth

Perth has continued to experience a drying climate, even after the Millennium Drought lifted. The release of the State Water Strategy in 2003 unlocked an unprecedented investment in water efficiency, recycling, research and source investigation. The strategy initiated the construction of two major desalination plants, as well as investigations into the long-term sustainability of groundwater aquifers as water sources. Because of the rapid investment in desalination and use of private backyard groundwater bores, Perth residents were spared the extreme water restrictions that eastern states faced. Some research participants felt the lack of water restrictions had caused a disconnect between Perth residents and their local water system. The community generally supported the construction of desalination plants so they could continue to access reliable, cheap water supply. Today, Perth's water supply (scheme and self-supply) comprises 71 per cent groundwater, 22 per cent desalination, 6 per cent surface water and 1 per cent recycled water. Perth is now leading Australia in producing a climate-independent water supply that is resilient to its drying climate, the focus of the Water Corporation's 50 year plan Water Forever (Water Corporation, 2012).

Looking to the future, Perth aspires to foster greater stewardship of the water system among its diverse communities, building on the Noongar connection to land and water. It envisions community members who are engaged and informed, with a deep understanding of and connection to the water cycle. Perth aspires to use water management to protect and enhance iconic natural water features like the Swan and Canning Rivers, coastline, and groundwater aquifers. It aims to continuously deliver a secure and sustainable water supply for people both now and in the future, regardless of the impacts of climate change.



Figure 3: Diagram of Perth's four vision themes

Townsville

Townsville is situated in the Dry Tropics of North Queensland and adjacent to the world heritage listed Great Barrier Reef. The city has been shaped by its unique dry tropical climate and regular extreme weather events such as droughts, cyclones and floods. Its reputation as 'Brownsville' in the early 2000s and the desire to be a green, tropical city like neighbouring Cairns led to a dramatic increase in water usage for irrigating public and private open space. Water consumption rates are currently one of the highest in Australia, which research participants attributed to both the climatic conditions and the water allocation pricing structure. Dangerously low water levels in the Ross River Dam in 2017 drove national investment in a second pipeline to pump water from the Burdekin Dam, along with a program to reduce water consumption. Extreme monsoon conditions in 2019 then caused major flooding and dams to reach over 200 per cent capacity, creating unprecedented challenges for Townsville's water system.

The vision for Townsville as a future water sensitive city is centred on people embracing and being proud of their dry tropical identity and associated climatic extremes. It aspires to be an attractive, resilient city that manages water to enhance its surrounding ecosystems including the Great Barrier Reef and surrounding waterways, wetlands, coastline and land environments. It envisions itself as an international water innovation hub with a strong research presence and linkages with the Asia–Pacific region. Townsville wants to remain an attractive city with many eco-tourism opportunities for both local residents and visitors alike.

Sydney



Figure 4: Illustration of one of Townsville's vision themes on protecting the natural environment (Illustration by Travis Farley, TBD Communication Design)

Sydney, a metropolitan city of over 5 million people, was the largest of the six case study cities. While it has grown and evolved in a manner similar to other Australian cities. its size and associated complexities make it stand out as a case study. Sydney is recognised internationally for its beautiful harbour, beaches and coastline. Sydney now faces the challenge of ensuring equitable access to these areas of amenity as the city expands further west, as well as the need to create amenity for new development areas. In response to this challenge, the Greater Sydney Commission has articulated a vision for the three cities - the Eastern Harbour City, the Central River City, and the Western Parklands City. Sydney's water sensitive vision built on this three-city framework to articulate how water can contribute to amenity, lifestyle and identity in a way that is unique and appropriate to the different areas. The size of Sydney also creates a challenge of coordinating and aligning efforts to make Sydney more water sensitive. While there are currently many promising projects across Sydney that demonstrate innovative ways to achieve water sensitivity, they are typically led by individual councils or developers and are not aligned within a strategic framework. Greater Sydney is now faced with the challenge of coordinating and unifying efforts across the city through a collective leadership model that is appropriate for a city of its size.

Sydney aspires to be a beautiful, prosperous and resilient city with thriving communities, healthy ecosystems and cherished urban landscapes. In Sydney's water sensitive future, Aboriginal water knowledge, values and ways of thinking would form a unique part of people's local identity and sense of belonging. Water management would support liveability and amenity, which manifests uniquely in the eastern, central and western parts of the city. The eastern vision focuses on enhancing the harbour and coastline and ensuring accessibility; the central vision focuses on healthy and clean rivers that people value and enjoy; and the western vision is centred on water supporting green space and cool, comfortable urban parklands. Equity is foundational to Sydney's water vision: water-related amenity is accessible for all of Sydney's diverse communities and, because of its size, customers have flexibility and choice in water systems at different scales.



Figure 5: Graphic illustration of the vision for Sydney's Eastern Harbour City (Illustration by Lucy Klippan, Klipface)

Gold Coast

In the Gold Coast's early years, its beautiful beaches and pristine ocean waters attracted weekenders and holidaymakers from nearby Brisbane. What started as a few beach shacks gradually grew to Australia's sixth-largest city, typically characterised by high-rise, oceanfront buildings. The beaches, along with an extensive canal network left over from draining coastal wetlands for farming, represent the Gold Coast lifestyle. Residents of the Gold Coast are very connected to water for its recreation and amenity, which people enjoy through surfing, swimming, paddle boarding, sailing and other water sports. Since the Gold Coast is now growing to an international city of over 600,000 people, it will need to protect these natural water assets that are the defining feature of the Gold Cost lifestyle and identity.

The water sensitive vision for the Gold Coast involves protecting and enhancing water and land environments, and sustaining equitable access to these environments. It strives to protect and enhance its iconic water features, including the beaches, coastline and extensive canal network. It aspires to actively engage the Yugambeh people in water decision making and knowledge-sharing to promote stewardship of water and land environments. Innovation is embraced in the vision, contributing to the Gold Coast's diverse and sustainable economy. In 50 years, Bendigo aspires to be a thriving inland city, where water innovation supports happy and healthy people, cherished and healthy environments, and resilient water, energy and food systems. In their water vision, these outcomes would be enabled by inclusive governance arrangements, a culture of innovation, and a strong connection to country, guided by Dja Dja Wurrung knowledge and values. Bendigo aspires to continue to build its existing strong community connections to support ongoing stewardship.

Adelaide



Figure 6: Shared understanding of the Gold Coast's historical water story (Illustrations by Lisa Sorbie Martin as depicted in the Gold Coast Water Strategy)

Bendigo

Bendigo was the only inland city of the six case study cities. It developed around Bendigo Creek, once a chain of ponds significant to the local Dja Dja Wurrung people. From the time gold was discovered in 1851, Bendigo's natural landscape has been severely disturbed, with the creek being relocated to facilitate gold extraction and a large portion of native woodlands cleared to support mining activity. The extent of change caused the Dja Dja Wurrung people to rename the land 'upside down country'. Today, the Dja Dja Wurrung are a strong and active part of the community. Out of all of the case study cities, Bendigo saw the most direct impact of the mining industry. To support the population boom from the gold rush, water was diverted from the Coliban River to Bendigo through 70 km of channels. Mining also created significant challenges with the local groundwater systems, which needed to be pumped to make way for the mining activity and contain levels of arsenic and hydrogen sulphide. While Bendigo is still dealing with legacy issues, its rich history based on the establishment of a mining town continues to influence its character today.

Figure 7: Vision illustration depicting waterway biodiversity in Bendigo (Illustration by David McCubbin)

Water is an integral part of the Adelaide lifestyle, as seen through the connection to Gulf St Vincent, the extensive coastline, and ephemeral waterways. Cycles of drought and flood and associated responses from decision makers have characterised how water is managed in Adelaide today. The need to respond to these circumstances has led to a strong culture of innovation and adoption of emerging technologies and practices. This dates back to 1881 when Adelaide was the first city to implement flushing toilets, and continues through to more recent advancements such as the Mannum-to-Adelaide pipeline and implementation of water sensitive urban design, and it was the first city to implement aquifer storage and recovery (ASR). This culture of innovation and receptivity to new approaches puts Adelaide in a strong position to begin implementing solutions to emerging challenges such as urban heat.

Adelaide's 50-year WSC vision describes a community embracing the region's water story, the ephemeral creeks and the natural cycles of drought and flood. There is a strong emphasis on water underpinning a strong economy, and Adelaide being an affordable, vibrant and culturally rich city. Adelaide also strives to be a world leader in energy efficiency and carbon neutrality.



Figure 8: Vision illustration depicting diverse Adelaide stakeholders working together to achieve a water sensitive Adelaide (Illustration by Simon Kneebone)

For more detail on each city's water sensitive vision, refer to their individual WSC Vision and Transition Strategy reports (see reference list).

4. Assessing water sensitive performance

4.1 Water Sensitive Cities Index

Planning a city's transition to its WSC vision requires a detailed understanding of its current performance in relation to its aspirations. It is important to understand a city's current context, strengths and weaknesses to diagnose priority focus areas and to inform short- and medium-term action. Decision makers need targeted and tailored insight on where to focus efforts to overcome current barriers and improve overall water sensitive performance.

The CRCWSC's Water Sensitive Cities Index (WSC Index; Rogers et al., 2020) is a benchmarking tool designed for this purpose. It articulates seven WSC goals, which organise 34 indicators representing the major attributes of a WSC. These goals, presented in Figure 9, are both biophysical and socio-political in nature. The seven goals are unsurprisingly aligned with the Australian vision themes articulated in Section 3. The 34 indicators are also mapped to the idealised city-states represented in the Urban Water Transitions Framework (Figure 1) to provide a benchmarked city-state.



Figure 9: Seven goals of a water sensitive city

Goal 1 – Ensure good water sensitive governance refers to the need for integrated, collaborative, flexible governance arrangements to address the complex challenges associated with urban water management. It focuses on organisational leadership, capacity and resourcing to deliver water sensitive outcomes, and delivery of these outcomes in a transparent, equitable way.

Goal 2 – Increase community capital focuses on the ability of the general public to understand their role in delivering water sensitive outcomes. It assesses community understanding of and connection to water and water-related events, and whether they are able to actively participate in water stewardship. This goal also focuses on how well Indigenous groups are engaged in water planning and decision making, and what measures are being taken to incorporate Aboriginal knowledge and beliefs into water management.

Goal 3 – Achieve equity of essential services refers to the equitable delivery of the water system services of water supply, sanitation, flood protection, and amenity. It focuses on ensuring all people are safe and healthy, and that these services are delivered affordably.

Goal 4 – Improve productivity and resource efficiency focuses on improving efficiency and sustainability of resources within the water system. It ensures resources, including those beyond water (e.g. energy, nutrients, biosolids), are used efficiently, recovered and reused to promote long-term sustainability. This goal also emphasises the importance of the water sector contributing to business and commercial opportunities across other sectors to support the economic prosperity and productivity of the city.

Goal 5 – *Improve ecological health* highlights the importance of urban water management in maintaining or improving the health of surrounding natural ecosystems. These include both terrestrial and aquatic ecosystems, with a focus on health and quality of the ecosystem as well as biodiversity of flora and fauna.

Goal 6 – Ensure quality urban space focuses on delivering liveability outcomes associated with good urban design. It emphasises the importance of urban greening and incorporating water in the landscape for benefits such as urban cooling, social cohesion, mental health, and amenity. It also highlights the importance of water sensitive urban design and how elements of the urban form can best be integrated to provide water outcomes.

Goal 7 – Promote adaptive infrastructure focuses on delivering robust, intelligent and multi-functional water infrastructure. It outlines the need for water infrastructure at a range of scales that is flexible in delivering water services, depending on the use. It highlights the importance of a diverse water supply portfolio, and the need for infrastructure to support this. It also emphasises the importance of maintaining the infrastructure and capacity of people and organisations to do so.

4.2 Comparison of WSC Index scores

This section outlines the WSC Index benchmarking scores for each of the six case study cities. For each WSC Index goal, the cities' scores are explained, with elaboration on those that were high performing and those that had room for improvement.

Figure 10 represents the average (blue shaded area), maximum (outer dashed line) and minimum (inner dashed line) scored for each goal from the six cities. The smallest deviation from the average is seen for the goals *Achieve equity of essential services, Promote adaptive infrastructure, Ensure good water sensitive governance,* and *Ensure quality urban space.* This indicates that the six case study cities are performing relatively similarly across these goals. There is a high deviation from the average, however, in the goals *Increase community capital, Improve ecological health, and Improve productivity* and *resource efficiency.* This suggests that cities are performing quite differently across these areas, and that there is a significant opportunity to learn from each other in implementing actions to improve performance.

Table 1 outlines the goal scores for each of the six case study cities, along with the average across all six cities. The maximum score for each goal is highlighted in green.

Table 1: WSC Index goal scores for six case study cities (maximum score for each goal highlighted in green)



Figure 10: WSC Index footprint diagram depicting the minimum, maximum and average goal scores for the six case study cities

Cas (Dat	e study city te benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
1.	Ensure good water sensitive governance	2.4	2.9	2.8	2.6	2.4	2.8	2.7
2.	Increase community capital	2.3	2.1	3.0	2.7	2.8	2.8	2.6
3.	Achieve equity of essential services	3.9	3.8	4.0	3.9	3.9	4.0	3.9
4.	Improve productivity and resource efficiency	2.7	2.0	3.2	2.3	2.4	2.4	2.5
5.	Improve ecological health	3.0	2.5	2.8	2.6	3.1	2.0	2.7
6.	Ensure quality urban space	2.0	2.5	2.5	2.5	2.7	2.2	2.4
7.	Promote adaptive infrastructure	2.8	2.8	3.1	2.8	2.8	2.8	2.9

Figure 11 compares the cumulative goal scores for each city, with each colour depicting a different goal area. While Adelaide is leading by over one point, the other five cities are close behind, with each city's total within 1.5 points.



Figure 11: Cumulative bar graph of goal scores for each of the case study cities

4.3 Australia's benchmarked city-states

Figure 12 summarises the city-state benchmarking results for the average scores across the six case study cities. The results suggest that Australian cities and towns are typically somewhere between a Drained City and a Water Cycle City, with some observable features across all six of the city-states. On average, the six case study cities have fully achieved the Water Supply and Sewered City status, and are close to fully achieving Drained and Waterway City status (86 per cent and 90 per cent respectively). All of these cities are in a Water Cycle city transition phase with some elements of the Water Sensitive City (5 per cent) beginning to emerge.



Figure 12: City-state benchmark for the average WSC Index goal scores

Across all six cities, water utilities have successfully provided safe and secure water supply and sewerage services through robust infrastructure systems, reliable delivery networks, and affordable services. This is evident in the average achievement of 100 per cent for both Water Supply and Sewered city-states.

The approach for drainage is generally more fragmented since responsibility often sits across both local councils and water authorities. This creates differences in levels of service across council areas, often leading to poor water quality outcomes and negative downstream impacts. There are also many instances of flash flooding within highly urbanised environments. Despite the fragmented drainage governance across Australia, the importance of drainage infrastructure in enabling liveability and supporting recreation and amenity is now being recognised. Programs and projects such as the Drainage for Liveability program in Perth and Bendigo's Reimagining Bendigo Creek are examples of organisations working together collaboratively to ensure broad liveability outcomes for the community, while also ensuring delivery of drainage objectives. Many cities also continue to develop in high flood risk areas without communicating that risk

to residents. For example, in Sydney, development in the Hawkesbury-Nepean flood zone could lead to catastrophic flood damages to residential areas if development is poorly planned or if the risks are not appropriately communicated to residents. In Perth, development in areas of high groundwater leads to issues with inundation. In Townsville, king tides coupled with high monsoonal flood risk leaves areas at high flood risk, especially in areas of high socioeconomic disadvantage. In response to these vulnerabilities, cities are pursuing flood risk mapping and strategies, including community response plans.

The case study cities achieved an average benchmark of 90 per cent for the Waterway City. This high score can be attributed to the focus on waterway and environmental health over the past several decades, and standards that have been implemented to protect natural assets. Community activism across Australia in the 1960s and 1970s (e.g. community protests at Bondi Beach) led to governments and water utilities investing heavily in connecting properties to sewerage networks and improving treatment plant performance. New environment protection agencies were established to regulate industry and monitor water quality. Waterways form a significant part of the open space network in the case study cities and there has been considerable investment by governments in environmental improvements and creating recreational access and connectivity. A strong research focus on stormwater led to a broad uptake of water sensitive urban design (WSUD), though it is not yet standard practice.

In working towards the Water Cycle City benchmark, the case study cities achieved an average score of 38 per cent. Total water cycle management, or integrated water management, has recently become a clear policy aspiration for Australian cities, particularly where growth in demand is limited by traditional resource availability and predicted climate change impacts. The concept of a circular economy is gaining traction, and the water sector is at the early stages of exploring how water management can improve holistic recovery, generation and reuse of other resources. Onground investment in recycled water schemes is evident in most cities, although it is almost entirely for non-potable purposes such as open space irrigation. Perth is the only case study city that has a major operating trial of indirect potable reuse through recycled water injection into a groundwater system that supplies drinking water to parts of the city. Stormwater harvesting is most advanced in Adelaide where aquifer storage is widely feasible.

The average score achieved for the Water Sensitive City benchmark was 5 per cent. Considerations for resilience, adaptability, equity and social inclusion are emerging in the conversation around water management in Australian cities. Communities are now beginning to be seen as partners rather than only consumers in water management. Cultural and spiritual considerations, including Aboriginal connections to and knowledge of water, are beginning to become more prevalent. While there is still work to be done across all Australian cities in achieving a WSC, there are many opportunities to be leveraged as cities continue their WSC transitions.



5. Australian transition priorities

5.1 Water sensitive city transitions

Transitioning towards a water sensitive city will require significant changes across the structures, cultures and practices of urban and water system planning, design, management, engagement and decision making. These changes are likely to happen over a long timeframe as new water sensitive practices supplant old unsustainable practices. Significant progress towards WSC status is unlikely without substantial changes in governance settings, which mostly still reflect water sector policy reforms of the 1990s that favour cost efficiency over broader liveability outcomes. A change in governance settings would create a more enabling environment to support the shift in culture, mindsets, capability and practices that is necessary to support the liveability of our rapidly growing cities.

Transitions theory is a body of interdisciplinary and transdisciplinary research that studies how transitional changes are driven and enabled over time.

CRCWSC research has drawn on this knowledge base to develop the Transition Dynamics Framework (Brown, Rogers and Werbeloff, 2016; Brown, Rogers and Werbeloff, 2017). This framework identifies six distinct phases of change during a city's water sensitive transition (Figure 13).

As a city moves through each phase sequentially, enabling conditions are established to support its trajectory towards its WSC vision and to avoid the risk of change pathways that reflect lock-in, backlash or system failure patterns (Figure 14).

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.



Figure 13: Six phases of change during the transition to a new practice (Brown et al. 2016)



Figure 14: Transition pathways: successful transition, lock-in, backlash and system breakdown (adapted from van de Brugge and Rotmans, 2007)

The CRCWSC's Transition Dynamics Framework sets out six types of enabling factors that need to be present throughout a transition: champions, platforms for connecting, administrative tools, science and knowledge, projects and applications, and practice tools. Together, these six factors create an enabling environment for a WSC transition and, mapped against the six transition phases, they create a matrix (Figure 15) for a deeper understanding of the pathways needed to support and drive a city's transition. The Transition Dynamics Framework provides a checklist of the factors that should be deliberately and sequentially built up to inform the prioritisation of strategies and actions. It was used as a diagnostic tool to assess the presence or absence of enabling factors as an indicator of progress towards more water sensitive practice across the six case study cities. The assessment in each city was informed by desktop review, participant interviews and workshop discussions that revealed insight about its enabling environment for water sensitive practices.

	Transition Phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
Desktop Preview	1. Issue emergence	lssue activists		lssue highlighted	lssue examined	
	2. Issue definition	Individual champions	Sharing concerns and ideas	Causes and impacts examined	Solutions explored	
Participant Review	3. Shared understanding & issue agreement	Connected champions	Developing a collective voice	Solutions developed	Solutions experimented with	Preliminary practical guidance
	4. Knowledge dissemination	Influential champions	Building broad support	Solutions advanced	Solutions demonstrated at scale	Refined guidance and early policy
Benchmarking discussion (WS1)	5. Policy and practice diffusion	Government agency champions	Expanding the community of practice	Capacity building	Widespread implementation and learing	Early regulation and targets
	6. Embedding new practice	Multi- stakeholder network	Guiding consistent application	Monitoring and evaluation	Standardisation and refinement	Comprehensive policy and regulation

Figure 15: Preliminary Transition Dynamics Framework (adapted from Brown et al., 2016; Brown et al., 2017; updated version forthcoming) with the three sources of evidence used for the assessment identified on the left.

5.2 Australian WSC transition progress

This section presents a synthesis of the transitions analysis for the six case study cities.

Figure 16 represents an overall assessment of Australian WSC transition progress, synthesised from the individual city diagnoses using the Transition Dynamics Framework. The assessment shows that while the cities are making

significant progress in some areas, there are still some areas of a WSC that need attention. The following section describes the enabling factors present in the case study cities and some of the key similarities and differences in critical enablers to achieve more water sensitive practice.

Transition Phase	Champions	Platforms for connecting	Knowledge	Projects and applications	Tools and instruments
1. Issue emergence	lssue activists		lssue highlighted	lssue examined	
2. Issue definition	Individual champions	Sharing concerns and ideas	Causes and impacts examined	Solutions explored	
3. Shared understanding & issue agreement	Connected champions	Developing a collective voice	Solutions developed	Solutions experimented with	Preliminary practical guidance
4. Knowledge dissemination	Influential champions	Building broad support	Solutions advanced	Solutions demonstrated at scale	Refined guidance and early policy
5. Policy and practice diffusion	Government agency champions	Expanding the community of practice	Capacity building	Widespread implementation and learing	Early regulation and targets
6. Embedding new practice	Multi- stakeholder network	Guiding consistent application	Monitoring and evaluation	Standardisation and refinement	Comprehensive policy and regulation

Green boxes indicate the enabling factor is fully present and regression into the previous phase is unlikely. Yellow boxes indicate some presence of the enabling factor, however they are vulnerable to regressing to the previous phase.

Red boxes indicate a complete absence of the enabling factor, and that progression is unlikely. Grey boxes indicate the enabling factor is not yet relevant due to absence of preceding enabling factor Each case study city had a strong presence of individual champions advocating for more water sensitive practices. This was demonstrated by people's commitment to participating in the IRP1 workshop series. In several case study cities, individual champions often lacked mechanisms to become connected or united around WSC objectives. While they strived to achieve liveability and sustainability outcomes, they were often faced with overcoming governance challenges and ingrained organisational silos. Some cities, however, had influential organisations and government agencies demonstrating leadership in water sensitive cities, creating a supportive enabling environment for individual champions to effect change. The Water Corporation and Department of Water and Environmental Regulation in Perth, for example, are strongly committed to achieving a waterwise city. The Victorian Department of Environment, Land, Water and Planning has provided strategic direction through an Integrated Water Management Framework and Forums.

Across the case study cities, platforms for connecting exist to help people share concerns and ideas about becoming more water sensitive. These include events and seminars run by industry networks such as the Australian Water Association and the Water Services Association of Australia, and state-based capacity building programs such as New WAterways, Water Sensitive SA, Splash Network, and Clearwater. Collaboration to achieve broad water sensitive outcomes generally occurs informally or on a project basis, relying on the goodwill and commitment of individual champions. Cities are just starting to see more formalised mechanisms for developing integrated solutions and disseminating these ideas to broad audiences. The Perth Water Sensitive Transition Network is an example of a platform for connecting water sensitive champions that gives credibility and legitimacy to their knowledge and perspectives. It has a collective voice around water sensitive issues and is now gaining traction and recognition among other sectors in Perth. Similarly, a number of key organisations and agencies in Bendigo have signed a Memorandum of Understanding as part of a joint effort to achieve a more sustainable water future for the Bendigo region, identifying a number of collaborative projects to focus their efforts on in the short term.

The six case study cities are fairly advanced in **knowledge** on some water sensitive outcomes, such as waterway health and improving water quality. Water sensitive urban design solutions have been developed, tested, and are now being rolled out as standard practice in many places across Australia. Technical solutions such as stormwater harvesting and reuse, managed aquifer recharge, and wastewater recycling have also been developed and are now facing implementation barriers. On the other hand, social solutions such as community empowerment, integrated governance, and engagement with Traditional Owners are earlier in their transition and beginning to be studied and developed.

There are a number of significant **projects and applications** across the six case study cities that showcase water sensitive practice. Some of these focus on greenfield and infill development (e.g. White Gum Valley in Perth, Central Park in Sydney) while others focus on collaboration to achieve social and environmental outcomes (e.g. Reimagining Bendigo Creek, Drainage for Liveability, Creek to Coral, Cooks River Alliance). However, for the broad range of water sensitive solutions, projects are generally implemented opportunistically and at a small scale. To scale up these demonstrations and begin to mainstream water sensitive practice, learning agendas should be embedded within these trials, to implant lessons from both failures and successes.

While many practical tools and administrative instruments exist to guide the implementation of water sensitive practices, they do not yet reflect the broad range of solutions needed to embed water sensitivity as mainstream. Many of the case study cities had supportive policy and strategic agendas (e.g. Greater Sydney Commission's District Plans, Victoria's IWM Framework, Perth's Waterwise Action Plan, and the Gold Coast's Water Strategy), however they are typically still developing the mechanisms needed for implementation. Supportive business cases, funding mechanisms, project management frameworks, and other tools and instruments for integrating water sensitive solutions across sectoral and disciplinary boundaries are just beginning to be explored. Water regulation also varies across cities - for example, Victoria has a relatively supportive regulatory environment while some other states face more significant regulatory barriers.

5.3 Common strategic priorities

The Transition Dynamics Framework analysis identified priority focus areas for the case study cities, based on which enabling factors were missing or not fully present. This diagnosis helped determine strategic advice for where cities should focus action and attention to build up the critical enabling conditions that would successfully progress their water sensitive transition. A suite of common transition priorities emerged across the six case study cities, and are outlined below according to the five types of enabling factor. Australian cities should broadly focus on developing the following strategic priorities, to advance their WSC transition:

Champions

- Broad community mandate for pursuing WSCs
- Capacity of WSC champions to be influential
- Political support and buy-in for WSCs
- Communities empowered to be active water sensitive citizens

Platforms for connecting

- Strong informal relationships and networks among diverse stakeholders
- Governance frameworks that enable coordination and collaboration across organisations and sectors
- Opportunities for community and industry to collaborate and learn from each other
- Platforms for sharing data and knowledge to support learning and collaboration

Scientific and practical knowledge

- Insight on how to effectively incorporate Aboriginal knowledge and values
- Knowledge on local groundwater systems
- Solutions for effectively engaging with and empowering the community
- Exploration of the potential of emerging WSC technological innovations
- System-wide assessments and quantification of WSC benefits

Projects and applications

- Consolidation and sharing of lessons from existing WSC projects
- Explicit learning agenda and strategy to guide identification and implementation of trial and demonstration opportunities
- Trials of solutions for emerging WSC technologies, collaborative governance arrangements and community empowerment processes
- Large-scale demonstrations of established WSC solutions
- Evidence of maintenance and lifecycle costs of water sensitive systems
- Monitoring and evaluation to improve system design and performance

Tools (administrative)

- A compelling WSC vision and narrative grounded in community values
- Policies, plans and strategies that embed the WSC vision
- Organisational culture, systems and processes that enable and encourage WSC innovation
- Strong and aligned policy, legislation and regulation for WSC implementation
- System-wide standards, targets and programs of implementation to deliver WSCs
- Robust, inclusive and integrated decision frameworks and processes
- Cost-benefit-risk sharing frameworks
- Business cases for specific WSC benefits and approaches
- Business models for alternative water systems at different scales

Tools (practice)

- Tools to support data and knowledge sharing
- Integrated software platforms that support models to interface with each other
- Guidelines that capture and contextualise lessons from trials and demonstrations
- Next generation flood risk
 assessment frameworks and
 tools
- Efficient and effective operations and maintenance systems

5.4 Towards implementation

Identifying priority focus areas in each case study city helped to show where organisations and stakeholders should focus action in the short- to medium-term. Since the completion of the IRP1 workshops, each city has taken steps to further understand and progress their specific focus areas. This section presents an overview of these steps and some examples of initiatives that have been undertaken.

Perth as a Waterwise City

Prior to the visioning workshops held in 2015, research participants spoke with frustration about fragmentation across the water, planning and development sectors. Creating a shared vision among a diverse range of stakeholders and a strategy for achieving it has been recognised as instrumental in generating alignment and commitment for water sensitive outcomes. The participants in the original workshop series have committed to continue meeting as Perth's Water Sensitive Transition Network, which has since expanded to ensure all of the necessary stakeholders are in the room. This groundswell of commitment has been influential within state agencies such as the Water Corporation and the Department of Water and Environmental Regulation (DWER). Water sensitive city policy agendas have since been established and are driving strategic action. For example, the Water Corporation has implemented a number of waterwise programs such as Waterwise Councils and Waterwise Schools. These have developed criteria for schools, businesses and organisations to work towards more waterwise practices. Perth's Waterwise Action Plan has recently been launched, focused on priorities for the next two years in the context of a 10year strategy; it commits to taking a more water sensitive approach and to monitoring the city's progress using the WSC Index.

Perth is also implementing significant on-ground demonstration projects that showcase the benefits of a WSC. The Drainage for Liveability program, led by Water Corporation and DWER, is a great example of collaborative governance to achieve liveability outcomes for the community. White Gum Valley is an innovative development that uses smart monitoring of on-lot water systems, a community groundwater bore, and an infiltration basin that doubles as a public park (CRCWSC, 2018). The Subiaco Wastewater Treatment Plant Strategic Water Resource Precinct is implementing a number of water sensitive initiatives as a result of a collaborative visioning process (CRCWSC, 2017).

Gold Coast Urban Water Strategy

The City of Gold Coast participated in the IRP1 project in 2017 to develop a transformative water vision and strategy. Findings from this process directly informed the development of the Gold Coast Water Strategy 2019–2024 (City of Gold Coast, 2019). The strategy articulates the City of Gold Coast's WSC vision and commits to using the WSC Index framework to monitor and track progress towards its vision. Community consultation revealed overwhelming support for the Water Strategy, and significantly more responses were received than Council consultation processes had ever achieved before. The development of the Water Strategy has created commitment from all areas of council to achieve a WSC and to actively track implementation of actions and progress towards its vision.

Victorian Integrated Water Management Forums

The Integrated Water Management Framework for Victoria (DELWP, 2017) outlines an integrated approach to water management and planning that aims to bring together government, the water sector and community. Integrated Water Management (IWM) Forums have been established for regions across both metropolitan Melbourne and regional Victoria to identify, prioritise and oversee the implementation of collaborative water opportunities. They have been designed to bring together all organisations with an interest in the water cycle to identify strategic direction statements for their region and specific projects for delivering these directions.

Cross-organisational commitment in Bendigo

Following the IRP1 action research process in Bendigo in 2018, stakeholders recognised the need to work together across organisational boundaries in order to implement Bendigo's WSC transition. A Memorandum of Understanding was signed between key organisations (Coliban Water, City of Greater Bendigo, Dja Dja Wurrung Clans Aboriginal Corporation, Department of Environment, Land, Water and Planning, and the North Central Catchment Management Authority) and supporting organisations (Department of Health and Human Services, Goulburn Murray Water and Regional Roads Victoria) which enables proactive and collaborative water management amongst the involved agencies, industry and community. These organisations now meet as a working group to drive Bendigo's water sensitive city transition, and to ensure actions are implemented where they cross organisational boundaries. This working

group recently released its first Annual Report that monitors progress and implementation of actions. In addition to the working group, a less formal network of champions (which includes other representatives such as consultants, developers, and community members) also meets to support a more water sensitive Bendigo.

The Reimagining Bendigo Creek Plan was released in June 2020 which sets out a vision to restore Bendigo Creek and its tributaries. It was developed through a collaborative process with government agencies, local residents and Dja Dja Wurrung community members, and represents a tangible and positive example in working towards Bendigo's WSC vision.

Recognition of need for whole of water cycle approach in Townsville

Townsville has experienced both severe drought and flooding in recent years, causing significant impacts on the local waterways and environment. Townsville City Council now recognises the need to redefine how it manages the whole water cycle to achieve a more water sensitive Townsville. As a result, a number of water sensitive projects were recently implemented or advanced. The IRP1 project helped pave the way for this implementation by providing the collaborative forum for stakeholders to discuss concerns and aspirations, and developing an ongoing partnership between Townsville City Council and the CRCWSC to support ongoing water sensitive city investigations. Some examples of these projects include the Smart Water Solution smart metering program and the Greening Townsville project, and they are currently exploring options for water quality offsets. Townsville is also progressing further work with the CRCWSC through IRP 3 - Guiding integrated urban and water planning, along with the Townsville integrated case study.

Water sensitive action in Adelaide

The close of the IRP1 workshop series in Adelaide saw momentum and commitment from a number of influential stakeholders in the water sector. A 'Water for a vibrant Adelaide' workshop was delivered and brought together stakeholders from across water, planning, development, open space management, and other areas to identify the challenges and opportunities for enhancing water services in South Australia. 'Cooler, greener Adelaide' was delivered as an industry forum to explore how councils, architects, developers and water service providers are transforming homes, streets and neighbourhoods with new technologies and designs that make the most of water. South Australia's reform of the natural resource management sector, plus the focus on national water reform from the Productivity Commission, have prompted renewed focus on water planning and management within the state. Councils such as the City of Adelaide, City of Unley, and City of Marion are also working to deliver the vision for Adelaide as a WSC, along with Water Sensitive SA which is driving a number of water sensitive urban design projects across the city. A particular focus area is the City of Salisbury, which is a case study for a number of other CRCWSC research projects.

6. Conclusion

Australia is a country that is defined by water - from the dry, harsh outback to the Great Barrier Reef and marine environments, ecologically significant waterways and wetlands, and beautiful coastlines that attract people from around the world. It is also a land of water extremes, consisting of extremely dry areas that receive little to no rain, and regions that face extreme flooding and cyclones. Our Indigenous people, plants and animals have learned to cope with these harsh environments, making them unique to any other place in the world. As the global climate changes and cities rapidly grow, these water-related extremes are only going to intensify. Australia in particular is seeing these changes already, with record-breaking heat, drought, bushfires and floods in recent years. These environmental urgencies put Australia in a unique position to trial new approaches to urban water management and to be a global leader in creating WSCs.

As future conditions remain uncertain, water challenges are becoming more complex and our traditional approaches to urban water management will not be sufficient to meet the health and wellbeing needs of people or the environment. But a clear vision for Australian WSCs is now emerging, providing a strong orienting force to guide action and change. Governments and organisations need to transform the structures, cultures and processes that were established for now outdated water management practices and are not suited to address contemporary, complex water challenges. Coupled with its climatic conditions, the fact that water remains a public good presents an opportunity for governments to demonstrate leadership and to deliver large-scale positive impact.

First, **leadership** in the water sector will need to become more distributed, bottom-up and adaptive. We can no longer rely solely on top-down models of leadership; to become a WSC, leadership must be demonstrated at all levels and from a range of perspectives and expertise. Citizens and First Nations communities should also play key roles in water leadership, influencing decisions about their local areas.

Better **collaboration** is needed to maximise opportunities, improve efficiency, and to deliver broad city outcomes through water management. Organisational structures will need to be designed to remove traditional silos and to encourage cross-fertilisation of ideas and knowledge. Collaboration also needs to occur across sectors (e.g. health, development, planning, energy, waste and transport) to better understand how water can enable broad city outcomes and how to best work together to implement integrated solutions. These sectors must first be brought into the conversation for them to realise the value and potential of a more water sensitive approach to city planning and design.

To become more water sensitive, cities will need to develop new solutions supported by a culture of **innovation** and experimentation. Innovation is needed across technical, design and social domains and should be underpinned by acceptance of a certain level of managed risk. Coupled with this, organisations will need to accept innovation failures and learn from them, rather than writing them off. Smallscale trials and demonstrations should be undertaken in the context of a learning agenda that contributes to a broader process of change and that ensures lessons are harnessed for future solution development. This will ensure trials are not done in isolation and that organisations can benefit from the experience.

Organisational and professional **capacity** to implement integrated, water sensitive solutions is also essential in ensuring a successful transition. While deep technical knowledge and experience are important, it is also important for people to understand linkages with other sectors and disciplines. Improving capacity will require continuous investment in professional development, along with dedicated activities such as seminars and training. Partnerships with universities and researchers will also be important as new research and solutions emerge.

Open and transparent data should support the sharing of **knowledge** and data across organisations, councils, cities and countries. There is huge potential to learn from the experiences of other places to accelerate water sensitive city transitions. To enable effective knowledge sharing, tools and platforms are needed that are interactive, useful and secure. All of these attributes are underpinned by the need for new research to address contemporary urban water challenges. Partnerships with universities and academics will become more important to ensure adoption of new tools, methods and practices.

Becoming a WSC is no easy feat – the challenges of a changing climate, rapid urbanisation, and entrenched organisational structures and processes often seem difficult to surpass. This report demonstrates that Australian cities are already taking strides to transform urban water management and become more water sensitive. Participants in each of the cities demonstrated strong motivation and commitment for undertaking collective action to achieve their shared water sensitive vision. Building on this momentum to transform organisational structures, processes and cultures will put Australian cities in strong positions to achieve their aspired water sensitive future.

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Appendix A: WSC Index indicator analyses

This section analyses the WSC Index results for the six case study cities for each specific goal area, with some insight into common themes or issues presented in the goals, which cities are doing well and why, and areas for improvement.

Goal 1: Ensure good water sensitive governance

Scores for Goal 1 were fairly consistent across the case study cities. Water is generally still governed through traditional arrangement silos that have become ingrained in governments and institutions. These arrangements serve cities well for delivering basic water services (water supply, sewerage and drainage), but new needs around liveability and social amenity are now emerging, which will require greater collaboration and integration across disciplines and sectors. Examples of collaborative partnerships are emerging around Australia, adopting innovative models of sharing costs and risks to achieve broad outcomes – for example, the WA Department of Water and Environmental Regulation (DWER) and the Water Corporation's joint Drainage for Liveability program.

Perth scored the highest for Goal 1 (2.9/5.0) mainly due to its leadership, long-term vision, and commitment to water sensitivity.

Table 2: Case study goal and indicator scores for Goal 1

Perth developed a shared WSC vision in 2015, which helped bring together diverse stakeholders to commit to shared outcomes for Perth. Since then, Perth has launched a government-wide action plan to become a Waterwise City by 2030, which encompasses all aspects of a WSC. The WA Water Corporation is also demonstrating significant leadership by implementing programs such as the Waterwise Councils, Waterwise Schools, and Waterwise Business programs that aim to encourage more sustainable water practices.

Sydney and Townsville scored lowest of the six cities for Ensure good water sensitive governance. Metropolitan Sydney is such a large and diverse city that most of its water sensitive projects are implemented ad hoc by individual champions and organisations. There is no citywide agency or framework that is driving collective water sensitive practice. To improve its score, Sydney's bottomup leadership would need to be coordinated and aligned to improve collaboration towards water sensitive outcomes. Townsville is the opposite of Sydney, with all water and urban planning functions sitting within Townsville City Council. Townsville now faces with the challenge of integrating internal departments and building capacity of staff to deliver integrated, water sensitive outcomes.

Case (Date	e study city e benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
1.	Ensure good water sensitive governance	2.4	2.9	2.8	2.6	2.4	2.8	2.7
1.1.	Knowledge, skills and organisational capacity	2.0	3.0	2.5	3.0	2.5	3.0	2.7
1.2.	Water is key element in city planning and design	2.0	3.0	2.5	2.5	2.5	2.5	2.5
1.3.	Cross-sector institutional arrangements and processes	2.0	3.0	3.0	2.0	2.0	2.5	2.4
1.4.	Public engagement, participation and transparency	2.5	2.5	3.0	3.0	2.0	3.0	2.7
1.5.	Leadership, long-term vision and commitment	2.5	4.0	3.0	3.0	3.0	3.0	3.1
1.6.	Water resourcing and funding to deliver broad societal value	2.5	3.0	3.0	3.0	2.5	3.0	2.8
1.7.	Equitable representation of perspectives	2.5	2.0	2.5	1.5	2.5	2.5	2.3

Goal 2: Increase community capital

Adelaide, Townsville and Bendigo all scored highly for Goal 2. Community consultation on water issues is done fairly well in all cities, but the adopted approach tends to view community as the end-user or consumer, and does not typically provide direct opportunity to incorporate citizen priorities and aspirations into strategic planning. The need for meaningful engagement that values citizens as active water partners and stewards has now been identified, and cities are beginning to experiment with innovative engagement methods. The score was highest for water literacy in Sydney, Adelaide and Bendigo, reflecting the education campaigns and severe water restrictions during the Millennium Drought. Many Bendigo residents are already actively engaged in environmental and sustainability issues, helping their understanding of the water system. The score for water literacy was low in Perth, where people were spared harsh restrictions due to investments in desalination, and education campaigns were not conducted to the extent they were elsewhere. Water literacy was also scored low in Townsville, reflecting their pricing system based on water allocation that reportedly makes people feel entitled

Table 3: Case study goal and indicator scores for Goal 2

to use their full allocation. Coupled with an extremely dry climate and desire for green, lush gardens, Townsville residents continue to have one of the highest potable water consumption rates in Australia. A strong component of community capital is also people's connections to water: Gold Coast and Townsville scored the highest due to people's lifestyles being centred on water activities (e.g. surfing, paddle boarding, boating).

The indicator that scored consistently lowest across all cities for this goal is indicator 2.5 *Indigenous involvement in water planning*, with four cities scoring below 2.5. Integrating Aboriginal knowledge and values into how water is used and managed is an emerging objective across Australia, and agencies are beginning to engage with local Indigenous groups to determine ways forward. Both Adelaide and Bendigo, however, scored 3.0/5.0 for that indicator. The Dja Dja Wurrung Traditional Owners have a particularly strong influence in Bendigo, and are often engaged on matters related to water and the environment.

Case (Date	e study city e benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
2.	Increase community capital	2.3	2.1	3.0	2.7	2.8	2.8	2.6
2.1.	Water literacy	3.0	2.0	3.0	2.5	2.0	3.0	2.6
2.2.	Connection with water	3.0	2.0	3.5	4.5	4.0	3.0	3.3
2.3.	Shared ownership, management and responsibility of water assets	2.0	2.0	2.5	2.5	2.0	2.5	2.3
2.4.	Community preparedness and response to extreme events	2.0	2.0	3.0	3.0	4.0	2.5	2.8
2.5.	Indigenous involvement in water planning	1.5	2.5	3.0	1.0	2.0	3.0	2.2

Goal 3: Achieve equity of essential services

Goal 3 refers to the equitable delivery of the water system services of water supply, sanitation, flood protection, and amenity. It focuses on ensuring all people are safe and healthy, and that these services are delivered affordably. All cities scored relatively highly for Goal 3 (between 3.8– 4.0/5.0). Australian water utilities have successfully provided safe and secure water supply and sanitation services to all urban centres. While cities are generally protected from flooding, the responsibility for drainage services is often dispersed across local governments and thus proves to be more complex. This was the case for Sydney, which had the lowest score for equitable access to flood protection. The major point of difference in these goal scores is in equitable access to amenity values of water-related assets. Adelaide has many water-related assets that are highly accessible to residents, including wetlands, rivers and linear parks, coastline, and water sensitive urban design. Water is a defining feature of the Gold Coast and Townsville lifestyle, and people can easily access the canals, beaches and rivers for recreation and amenity purposes. In larger cities such as Sydney, this equitable access is more challenging when people need to travel much further and spend more money to reach areas of high water amenity (e.g. Sydney Harbour and beaches).

Table 4: Case study goal and indicator scores for Goal 3

Case (Date	e study city e benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
3.	Achieve equity of essential services	3.9	3.8	4.0	3.9	3.9	4.0	3.9
3.1.	Equitable access to safe and secure water supply	5.0	5.0	4.5	4.5	4.0	5.0	4.7
3.2.	Equitable access to safe and reliable sanitation	4.5	4.0	4.0	4.0	4.0	4.5	4.2
3.3	Equitable access to flood protection	3.0	4.0	3.5	3.5	3.5	4.0	3.6
3.4	Equitable and affordable access to amenity values of water-related assets	3.0	2.0	4.0	3.5	4.0	2.5	3.2

Goal 4: Improve productivity and resource efficiency

Adelaide scored highest for this goal (3.2/5.0), which can be attributed to its culture of innovation and trialling and adopting new sustainability technologies and solutions. The Adelaide water sector takes advantage of commercial and business opportunities, including with overseas markets. The indicator that consistently scores lowest for this goal is 4.2 Low GHG emissions in the water sector due to the energy intensity of Australian urban water systems. While Perth depends on desalination plants for much of its water supply, they offset their electricity with nearby wind farms. Townsville and Perth both scored lowest for indicator 4.3 *Low end-user potable water demand*, which aligns with their low scores for water literacy and poor understanding of impacts of excess water consumption (see indicator 2.1). Indicator 4.4 *Water-related economic and commercial opportunities* and Indicator 4.5 *Maximised resource recovery* both scored consistently low across all cities. These two areas are relatively new areas of interest for Australian water utilities and organisations and are being led by only a handful of innovative organisations or research partnerships.

Table 5: Case study goal and indicator scores for Goal 4

Case (Date	study city benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
4.	Improve productivity and resource efficiency	2.7	2.0	3.2	2.3	2.4	2.4	2.5
4.1.	Benefits across other sectors because of water-related services	2.5	3.0	3.5	2.0	3.0	3.0	2.8
4.2.	Low GHG emission in water sector	3.0	1.0	2.0	1.0	2.0	1.0	1.7
4.3.	Low end-user potable water demand	3.5	2.0	3.0	4.0	2.0	3.0	2.9
4.4.	Water-related economic and commercial opportunities	2.0	2.0	4.0	2.0	3.0	3.0	2.7
4.5.	Maximised resource recovery	2.5	2.0	3.5	2.5	2.0	2.0	2.4

Goal 5: Improve ecological health

Goal 5 highlights the importance of urban water management in maintaining or improving the health of surrounding natural ecosystems. These include both terrestrial and aquatic ecosystems, with a focus on health and quality of the ecosystem as well as biodiversity of flora and fauna. There was variability in scores for this goal, ranging from 2.0 to 3.1. Townsville scored highest (3.1/5.0), reflecting its strict water quality regulations due its proximity to the Great Barrier Reef; while these regulations generally have positive effects, there is still work to be done to improve urban runoff. Marine environments are also well protected. Bendigo scored the lowest for this goal due to the patchy urban habitats that offer little biodiversity value. The several creeks, in particular Bendigo Creek, that run through the urban area are highly degraded and often concrete-lined. There are now initiatives in place to rehabilitate Bendigo Creek and improve urban water quality.

There was often uncertainty for cities in scoring indicator 3.3 *Groundwater quality and replenishment* because in several of the case study cities, groundwater is not used as a water source and therefore not much is known about the system. This was not the case in Perth, where private groundwater bores are common but unmonitored, or Bendigo which has groundwater contamination issues (specifically arsenic) from legacy gold mines. Bendigo has the added challenge of rising groundwater due to the ceasing of mining activities, and the Victorian Government is now working with the community and local stakeholders to identify a long-term solution. Studies are being conducted in both of these cities to learn more about the current groundwater situations to inform future management.

Case study city (Date benchmarked)		Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
5. Improve e health	ecological	3.0	2.5	2.8	2.6	3.1	2.0	2.7
5.1. Healthy a habitats	nd biodiverse	2.0	2.0	2.0	2.0	30	2.0	2.2
5.2. Surface v and flows	vater quality	3.0	3.0	2.5	3.0	3.5	2.0	2.8
5.3. Groundwa and reple	ater quality nishment	3.0	2.0	3.0	2.0	2.0	2.0	2.3
5.4. Protect ex of high ec	kisting areas cological value	4.0	3.0	3.5	3.5	4.0	2.0	3.3

Table 6: Case study goal and indicator scores for Goal 5

Goal 6: Ensure quality urban space

Townsville scored the highest on goal 6 (2.7/5.0), largely due to the availability and connectivity of quality urban spaces. Its proximity to the beach and rivers means people can easily walk along The Strand, along Ross River, or up Castle Hill. Urban parks are kept irrigated to ensure they remain green for people to enjoy, and people actively use the green and blue spaces throughout the city. All cities scored fairly low on indicators 6.2 Urban elements functioning as part of the urban water system and 6.3 Vegetation coverage. There is currently much work being done on urban heat mapping, and developing and evaluating the benefits of design solutions such as street trees and urban greening to help mitigate urban heat. While there has been progress in this space, these solutions are often difficult to implement in cities due to lack of quantified supporting evidence and they are not yet being delivered as business as usual.

Table 7: Case study goal and indicator scores for Goal 6

WSUD is becoming more and more prominent across Australia, but there are still many new infill and greenfield developments being designed and constructed according to conventional design practices. The developments that are doing WSUD well are either being led by innovative developers or there are contextual requirements (e.g. presence of endangered species).

Case study city (Date benchmarked)		Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
6.	Ensure quality urban space	2.0	2.5	2.5	2.5	2.7	2.2	2.4
6.1.	Activating connected urban green and blue space	2.5	3.0	3.0	3.5	3.5	3.0	3.1
6.2	. Urban elements functioning as part of the urban water system	2.0	2.0	2.0	2.0	2.0	1.5	1.9
6.3	. Vegetation coverage	1.5	2.5	2.5	2.0	2.5	2.0	2.2

Goal 7: Promote adaptive infrastructure

All cities scored a 2.8–2.9/5.0 for Goal 7, except Adelaide which scored a 3.1/5.0. Australian water utilities typically have robust water supply and sewerage infrastructure systems that successfully deliver these services to residents. Drainage infrastructure is also fairly robust, but more prone to failures and overflows in cities with frequent and intense flooding events. When considering more integrated, decentralised and smart infrastructure systems, however, Australia is only beginning to experiment on the project scale. Many cities are implementing smart metering, and there are examples of precincts and developments that use innovative technology and infrastructure systems. Adelaide consistently scored on the higher end for each indicator in this goal, which reflects its culture for innovation and appetite to trial and implement new technologies and solutions.

While indicator 7.6 Adequate maintenance is generally high for water supply and sewerage infrastructure, the score was often brought down across cities when the maintenance of green infrastructure was considered. All six cities faced challenges of adequately maintaining green infrastructure (e.g. biofilters, rain gardens) due to lack of knowledge and capacity within the responsible organisations, often with poor asset handover arrangements.

Table 8: Case study goal and indicator scores for Goal 7

Case (Date	e study city e benchmarked)	Sydney (July 2017)	Perth (Feb 2016)	Adelaide (May 2017)	Gold Coast (Dec 2016)	Townsville (Nov 2017)	Bendigo (Oct 2017)	Average
7.	Promote adaptive infrastructure	2.8	2.8	3.1	2.8	2.8	2.8	2.9
7.1.	Diverse fit-for-purpose water supply	3.0	3.0	3.5	3.0	2.0	2.5	2.8
7.2.	Multi-functional water system infrastructure	2.5	3.0	3.0	3.0	3.0	3.0	2.9
7.3.	Integration and intelligent control	2.5	3.0	2.5	2.0	3.0	2.0	2.5
7.4.	Robust infrastructure	3.0	3.0	3.5	3.5	3.5	3.0	3.3
7.5.	Infrastructure and ownership at multiple scales	2.5	2.5	3.0	2.5	2.5	3.0	2.7
7.6.	Adequate maintenance	3.0	2.5	3.0	3.0	3.0	3.0	2.9



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