



# The Cooperative Research Centre for Water Sensitive Cities

Impact to Date, Future Potential

25 March 2019



Building a better  
working world



Mr Ben Furmage  
Chief Financial and Operating Officer  
The Cooperative Research Centre for Water Sensitive Cities  
PO Box 8000, Monash University  
Clayton  
VIC 3800

25 March 2019

## The Cooperative Research Centre for Water Sensitive Cities – Impact to Date, Future Potential

Dear Ben,

In accordance with our Engagement Agreement dated 25 January 2019 (“Agreement”), Ernst & Young (“we” or “EY”) has been engaged by The CRC for Water Sensitive Cities (“you”, “The CRC for Water Sensitive Cities” or the “Client”) to provide an assessment of The CRC for Water Sensitive Cities’ impact and to identify opportunities for future impact (the “Services”) in relation to a proposed The CRC for Water Sensitive Cities’ transition planning activities (the “Project”).

The enclosed report (the “Report”) sets out the outcomes of our work. You should read the Report in its entirety. A reference to the report includes any part of the Report.

We appreciate the opportunity to work with The CRC for Water Sensitive Cities, and are delighted to provide you with this final Report. Our analysis indicates The CRC for Water Sensitive Cities is delivering significant impact and can lead the next big step towards sustainable, resilient, productive, liveable cities by building on this success while applying expertise across integrated city systems.

We also see how The CRC for Water Sensitive Cities’ philosophy of partnership and collaboration across sectors and countries means you are uniquely placed to shape the system-wide approaches needed to meet growing urban challenges facing our cities.

### Nature and scope of our work

The scope of our work, including the basis and limitations, are detailed in our Agreement and as follows:

- ▶ An impact assessment and quantification – using the CRC for Water Sensitive Cities’ 2015 impact assessment as a baseline, provide an analysis and quantification which estimates the impact The CRC for Water Sensitive Cities is expected to deliver for communities over a 15 year period.
- ▶ Identification of opportunities for future impact - based on our understanding of emerging trends in cities, as well as work with The CRC for Water Sensitive Cities on operationalising and implementing current research.

### Purpose of our Report and restrictions on its use

Please refer to a copy of the Agreement for the restrictions relating to the use of our Report. We understand that the deliverable by EY will be used for the purpose of supporting The CRC for Water Sensitive Cities in its transition planning activities (the “Purpose”).

This Report was prepared on the specific instructions of The CRC for Water Sensitive Cities solely for the Purpose and should not be used or relied upon for any other purpose.

This Report and its contents may not be quoted, referred to or shown to any other parties except as provided in the Agreement. We accept no responsibility or liability to any person other than to The CRC for Water Sensitive Cities or to such party to whom we have agreed in writing to accept a duty of care in respect of this Report, and accordingly if such other persons choose to rely upon any of the contents of this Report they do so at their own risk.

#### Limitations

Our work was completed on 25 March 2019. Therefore, our Report does not take account of events or circumstances arising after 25 March 2019 and we have no responsibility to update the Report for such events or circumstances.

In preparing this Report we have considered and relied upon information from a range of sources believed after due enquiry to be reliable and accurate. We have no reason to believe that any information supplied to us, or obtained from public sources, was false or that any material information has been withheld from us.

We do not imply and it should not be construed that we have verified any of the information provided to us, or that our enquiries could have identified any matter that a more extensive examination might disclose. However, we have evaluated the information provided to us by The CRC for Water Sensitive Cities as well as other parties through enquiry, analysis and review and nothing has come to our attention to indicate the information provided was materially mis-stated or would not afford reasonable grounds upon which to base our Report.

The work performed as part of our scope considers information provided to us and a number of combinations of input assumptions relating to future conditions, which may not necessarily represent actual or most likely future conditions. Additionally, modelling work performed as part of our scope inherently requires assumptions about future behaviours and market interactions, which may result in estimates that deviate from future conditions. There will usually be differences between estimated and actual results, because events and circumstances frequently do not occur as expected, and those differences may be material. We take no responsibility that the projected outcomes will be achieved, if any.

We highlight that our analysis and Report do not constitute investment advice or a recommendation to you on a future course of action. We provide no assurance that the scenarios we have modelled will be accepted by any relevant authority or third party.

Our conclusions are based, in part, on the assumptions stated and on information provided by The CRC for Water Sensitive Cities and other information sources used during the course of the engagement. The modelled outcomes are contingent on the collection of assumptions as agreed with The CRC for Water Sensitive Cities and no consideration of other market events, announcements or other changing circumstances are reflected in this Report. Neither Ernst & Young nor any member or employee thereof undertakes responsibility in any way whatsoever to any person in respect of errors in this Report arising from incorrect information provided by The CRC for Water Sensitive Cities or other information sources used.

This letter should be read in conjunction with our Report, which is attached.

Thank you for the opportunity to work on this project for you. Should you wish to discuss any aspect of this Report, please do not hesitate to contact me on 0407 875 803 or Stuart McCully on 0408 926 395.

Yours sincerely



Adam Fennessy

Partner

Advisory

## NOTICE

Ernst & Young was engaged on the instructions of The Cooperative Research Centre for Water Sensitive Cities (“The CRC for Water Sensitive Cities”) to assess the impact of the CRC for Water Sensitive Cities and identify opportunities for future impact (“Project”), in accordance with the contract dated 25 January 2019.

The results of Ernst & Young’s work, including the assumptions and qualifications made in preparing the report, are set out in Ernst & Young’s report dated 25 March 2019 (“Report”). The Report should be read in its entirety including the transmittal letter, the applicable scope of the work and any limitations. A reference to the Report includes any part of the Report. No further work has been undertaken by Ernst & Young since the date of the Report to update it.

Ernst & Young has prepared the Report for the benefit of The CRC for Water Sensitive Cities and has considered only the interests of The CRC for Water Sensitive Cities. Ernst & Young has not been engaged to act, and has not acted, as advisor to any other party. Accordingly, Ernst & Young makes no representations as to the appropriateness, accuracy or completeness of the Report for any other party’s purposes.

No reliance may be placed upon the Report or any of its contents by any party other than The CRC for Water Sensitive Cities (“Third Parties”). Any Third Party receiving a copy of the Report must make and rely on their own enquiries in relation to the issues to which the Report relates, the contents of the Report and all matters arising from or relating to or in any way connected with the Report or its contents.

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# Executive summary

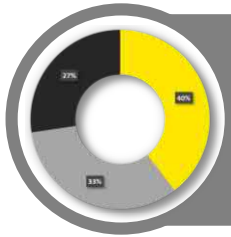


# The CRCWSC is delivering significant impact and can lead the next big step towards sustainable, resilient, productive, liveable cities by building on this success while applying expertise across integrated city systems



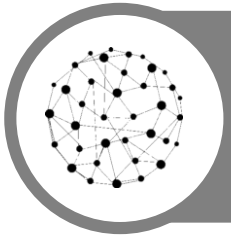
The CRC for Water Sensitive Cities and their partners play a critical role in supporting government, business, academia and communities in creating a future where cities, towns and regions are sustainable, resilient, productive and liveable.

- ▶ The CRCWSC is facilitating policy, strategy, relationships and integrated thinking across the lot, precinct and city scales.
- ▶ The CRCWSC has worked closely with government, water utilities, and the private sector to enable, pilot and prove the effectiveness of Water Sensitive City approaches.
- ▶ The CRCWSC's international partnerships are delivering direct economic benefits, opening up new markets for Australian businesses and de-risking innovative technologies and approaches.



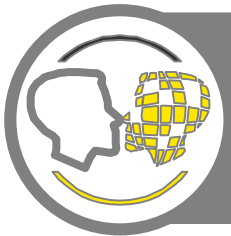
The CRCWSC has proven its worth by helping its partners deliver over \$600 million of economic, social and environmental value by building industry capability, developing supportive policy and regulatory frameworks and creating innovative technologies.

- ▶ The CRCWSC and the actions of its partners is estimated to deliver over \$600 million in economic, social and environmental impacts when assessed over a 15 year period using the Commonwealth Government's impact assessment tool. Comparing these benefits with the direct investment in the CRCWSC suggests a Benefit Cost Ratio of 6.18.
- ▶ This represents more than a 70% increase in impact since the 2015 impact assessment reviewed by the Commonwealth, using a consistent methodology.



With the importance of cities growing exponentially and rapidly changing technology and business models disrupting integrated city systems, there is an opportunity to extend the CRCWSC's role and unlock the enormous potential of systems thinking for sustainable development.

- ▶ Cities face challenges on an unprecedented scale – while working towards a sustainable, resilient, productive and liveable future, urbanisation is transforming the way billions of people live worldwide.
- ▶ There is an urgent need to rethink approaches to urban management, but current models and practices have not evolved to this new paradigm.
- ▶ Governments, developers, utilities and communities need to work together on system-wide solutions to these challenges.



To deliver exceptional value, a third tranche of CRCWSC research and adoption activities could focus on two key strategies – mainstreaming existing outputs to step up the impact of previous success; and achieving the next step change by contributing to the planning, delivery and operations of truly integrated and innovative city systems.

- ▶ Estimating the mainstreaming trajectory is challenging and highly uncertain. But given the current trend, anticipating a doubling or even a tripling of the annual impact that governments and markets can deliver with the support of the CRCWSC is not unreasonable.
- ▶ Looking beyond mainstreaming, should the CRCWSC and its partners take the next big step toward truly integrated urban systems planning, delivery and management across government and the private sector, this has the potential to unlock billions of dollars each year given the sheer scale of the infrastructure task.

# Contents

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“From global warming to homelessness, from debt crises to energy shortages, from insufficient water to outbreaks of disease, name any problem that concerns humanity and the city is the crucible where you will find it bubbling away”.

Geoffrey West,  
Santa Fe Institute

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# 1

The CRCWSC and its  
role in shaping the  
sustainable future of  
cities





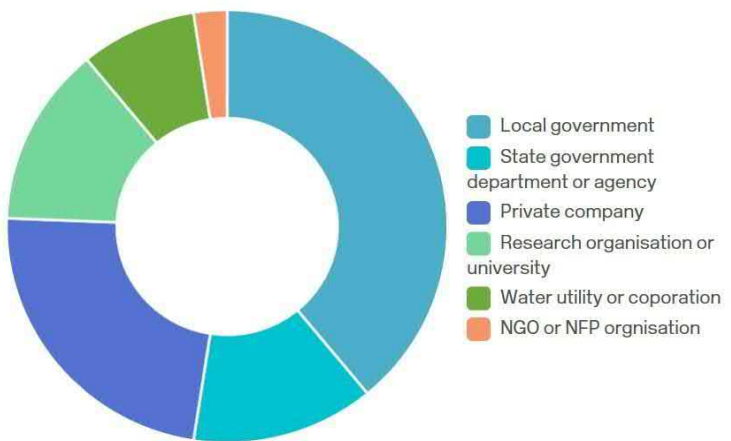
# The CRCWSC works with partners across Australia and internationally towards a future with cities, towns and regions that are sustainable, resilient, productive and liveable

- ▶ The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) is an Australian research centre that brings together many disciplines, world-renowned subject matter experts, and industry thought leaders who want to revolutionise urban water management in Australia and overseas.
- ▶ Their work integrates policy frameworks, research and business solutions, all of which need to be present and work in alignment with each other to drive real impact.
- ▶ The CRCWSC’s key partner sectors are government, business and academia, which enables them to take a holistic view of the challenges facing progress towards water sensitive urban management.
- ▶ The CRCWSC’s partner network extends to more than 80 organisations globally, with extensive access to expertise and potential for widespread influence.

## CRCWSC Essential Participants



## CRCWSC Partner Sectors



## Broader CRCWSC Collaboration

The CRCWSC also works with a range of Other Participants and SME Associated Partners. These organisations include universities, water utilities, government entities, and technology companies – in Australia and internationally.

(Source: The CRCWSC)

# The CRCWSC works with public and private partners on multiple fronts to support innovation at scale

The CRCWSC catalyses action over a range of scales and timeframes to provide an all encompassing enabling environment for innovation.



Lot scale

1

- The CRCWSC has worked with South East Water and property developer, Villawood, on the Aquarevo project which sets a new standard in household water efficiency, sewage and stormwater reuse and operational control through:
- ▶ Water in the landscape adding market value to the development
  - ▶ Integrating natural assets, smart technologies and real-time monitoring to significantly increase fit for purpose water use and avoid downstream investments
  - ▶ A new model for development can be delivered through public and private sector collaboration



Precinct scale

2

- Water Sensitive City approaches are delivering real economic benefits in Australia's largest urban renewal project at Fisherman's Bend.
- The CRCWSC has worked closely with government, water utilities and the private sector to see the adoption of innovative integrated servicing solutions that:
- ▶ Save precious drinking water in a rapidly growing city
  - ▶ Avoid significant downstream investment in drainage and sewerage infrastructure
  - ▶ Enhance local amenity and liveability and reduce urban heat island effects



City / state scale

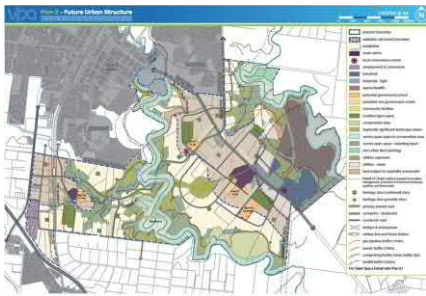
3

- The CRCWSC was a key technical advisor to the government in shaping its water policy which has integrated urban water management and water sensitive city principles at its core.
- ▶ Ongoing research and support has been provided to developing the regulations and planning controls needed to enable policy intent and proof of concept projects to become business as usual.
  - ▶ CRCWSC tools and guidelines, as well as close collaboration with capacity building organisations such as ClearWater, ensure industry has the skills and support needed to deliver policy and regulator intent and start to mainstream new WSC approaches.

# The CRCWSC is pioneering innovative and impactful water sensitive management practices in a range of other real world applications

## Urban Heat Island Effect

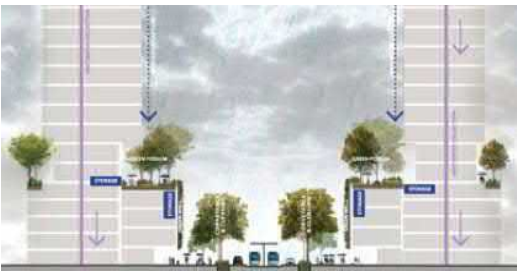
The CRCWSC is leading the first attempt of its kind to bring biophysical and economic modelling together to identify the economic benefits of urban greening in a greenfield residential setting in western Melbourne.



- ▶ A development of 11,800 houses (with 33,000 residents) in Melbourne's west
- ▶ Making use of **water sensitive urban design** would generate urban cooling benefits compared with standard practices
- ▶ The economic benefit just from these cooling benefits is estimated at **\$7.2 million**

## Fisherman's Bend

The Fisherman's Bend brownfield redevelopment in inner Melbourne, Victoria will occur over the next 40 years. The ideas have therefore been designed to be implementable from 2015, as well as remaining relevant in 2055 when new options are likely to change attitudes. CRCWSC inputs are influencing developments in policy, science and community aspects of the developments.



- ▶ 80,000 residents + 80,000 of transient population related to commercial activities
- ▶ 258 ha development
- ▶ Total Investment of **\$30 billion** in 5 precincts
- ▶ Water services cost **\$500 million**

## Bentley Regeneration Project

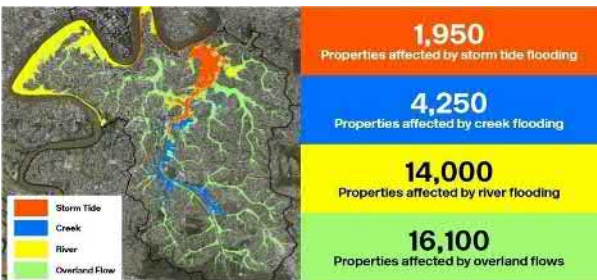
The Bentley Regeneration Project is a 25-hectare precinct approximately 8 km south-east of Perth CBD and 1.5 km north of the Canning River in the suburb of Bentley, Western Australia. CRCWSC inputs are being used in this project, which is WA's biggest infill development project and one of the most significant exemplars to meet a key driver of WA policy to establish a residential infill target of 47%.



- ▶ Seeking private-sector joint-venture partnership for **\$30 million** development
- ▶ Expected to **inject \$1.1 billion** over its construction cycle
- ▶ Key driver of WA policy to establish **infill target of 47%**

## Solutions for Norman Creek

The Norman Creek synthesis project highlights the potential mainstreaming of flood resilience tools and approaches developed by the CRCWSC. The management strategies developed in this project represent a potential scaling up of water sensitive urban design within the larger flood resilience response in the Brisbane area.



- ▶ 5 of the 12 suburbs included in the study are expecting significant population growth **within the next 10 years**, compounding flood sensitivity

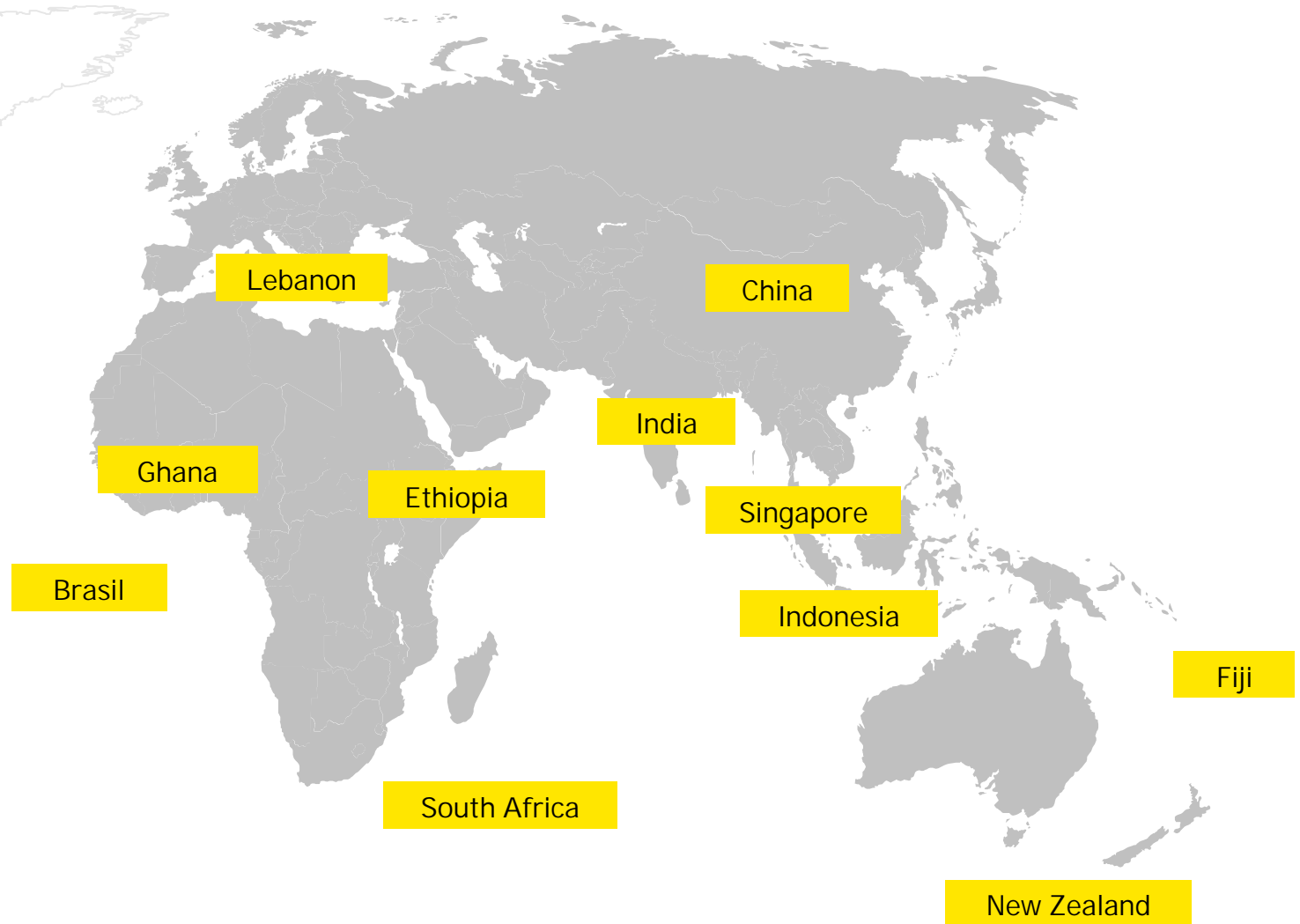
(Source: The CRCWSC)



## Further afield, the CRCWSC's international partnerships are delivering direct economic benefits for Australian research and businesses

### The CRCWSC's international engagement

- ▶ Water management is an international challenge which can benefit from international research collaborations. International collaboration in research offers higher productivity and has a greater impact.<sup>1</sup> The CRCWSC has worked with the International Water Association, the United Nations, World Bank and Asian Development Bank (ADB) demonstrating the value added by WSC principles and practices through application to a wide range of contexts and issues.
- ▶ International partners value the CRCWSC's experience and expertise and provide an income flow to the CRCWSC for further research and also opportunities for the CRCWSC to subcontract to Australian partners, giving them a direct channel to new markets. This delivers commercial benefit for the CRCWSC and its partners by generating income for Australia. This income stream is expected to grow to around \$5 million per annum by 2020/21.<sup>2</sup>



1. Jeong, Choi, Kim, (2014)  
2. The CRCWSC

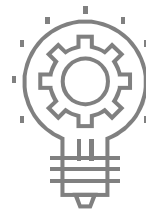
(Source: The CRCWSC)

## The CRCWSC's international engagement provides a testing ground for innovative approaches, de-risking these innovations and opening up export markets for Australian businesses

- ▶ The CRCWSC is leveraging global networks to make significant progress in innovative, market leading initiatives and is piloting these at scale.
- ▶ The CRCWSC have successfully applied water sensitive cities principles and practice to many global cities of varying climatic and institutional settings.
- ▶ This de-risks technologies and new approaches for Australian businesses and governments, who can then implement these innovative solutions at home with confidence.
- ▶ The CRCWSC and their partners' involvement at all steps of this process places Australian businesses at the forefront of new global markets, providing export and employment opportunities.

### Ideas have impacted

- ▶ Urban design master plans
- ▶ Green infrastructure designs
- ▶ Alternative water source networks
- ▶ Waterway and building designs
- ▶ High population density urban areas
- ▶ Governance arrangements
- ▶ Community engagement and water conservation campaign designs
- ▶ Business cases for water sensitive projects and programs



### Technologies



- ▶ Green infrastructure or technologies
- ▶ Alternative water supplies
- ▶ Amenity and urban greening
- ▶ Biofilters and rain gardens
- ▶ Living walls and green walls
- ▶ Wastewater recycling
- ▶ Resource recovery
- ▶ Vegetated systems and landscapes
- ▶ Flood management
- ▶ Water treatment
- ▶ Rainwater and stormwater harvesting

(Source: The CRCWSC)

The CRCWSC's partnership with the City of Kunshan shows the potential for applying research outputs on an expanded scale when the authorising environment and financing are in place

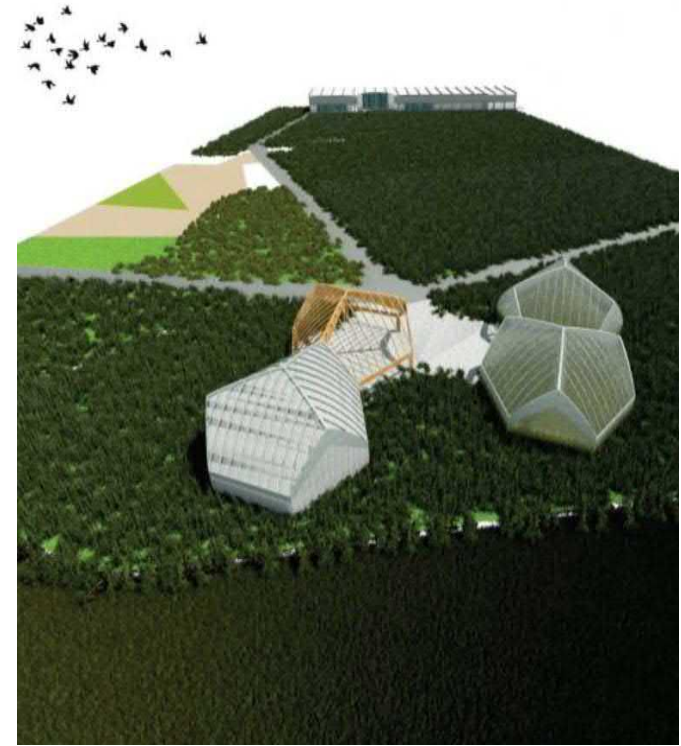


Forest Park Ecological Wetland

## Partnership with the City of Kunshan

The CRCWSC's partnership with the City of Kunshan together with the Victorian Government partnership with the State of Jiangsu have seen rapid application of Water Sensitive City principles at scale. Kunshan has already successfully implemented over 30 water sensitive projects in just 3 years through a highly productive partnership, with partners including the Kunshan City Bureau of Planning, KCID, Southeast University, E2DesignLab, and REALMStudio with further possibilities to include some of the more than 80 organisation partners of the CRCWSC.

- ▶ AUD\$240 million of capital works have already been directed to improving the water quality, flood protection, fit for purpose water reuse and liveability
- ▶ Currently embarking on an AUD\$1 billion project to open new pathways to market and partnerships
- ▶ Two further 'sponge' cities have been identified and discussions are commencing
- ▶ 2014 – present



Sponge City Innovation Park

(Source: <https://watersensitivecities.org.au/content/crc-water-sensitive-cities-support-jiangsu-province-ecological-sponge-city-initiative-china/>)

(Source: The CRCWSC)



# 2

The value created by  
the CRCWSC and its  
partners





# The CRCWSC and partners are expected to deliver over \$600 million of impact by building industry capability and capacity, developing policy and regulation, supporting new technologies and defining adoption pathways

## Overview

EY's impact assessment estimates benefit from the CRCWSC research programs, and work with partners, over a 15 year period and updates an assessment previously reviewed by the Commonwealth in 2015, thereby providing a consistent measure of progress and achievement. The research programs considered in the impact assessment are:

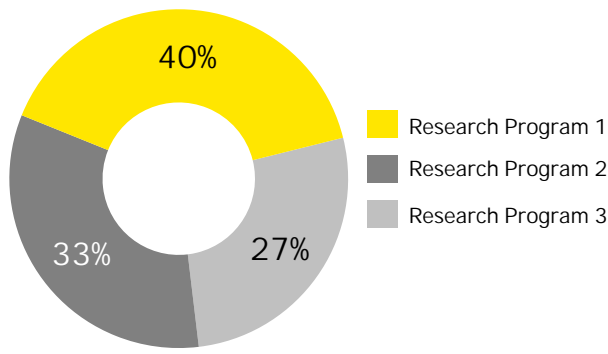
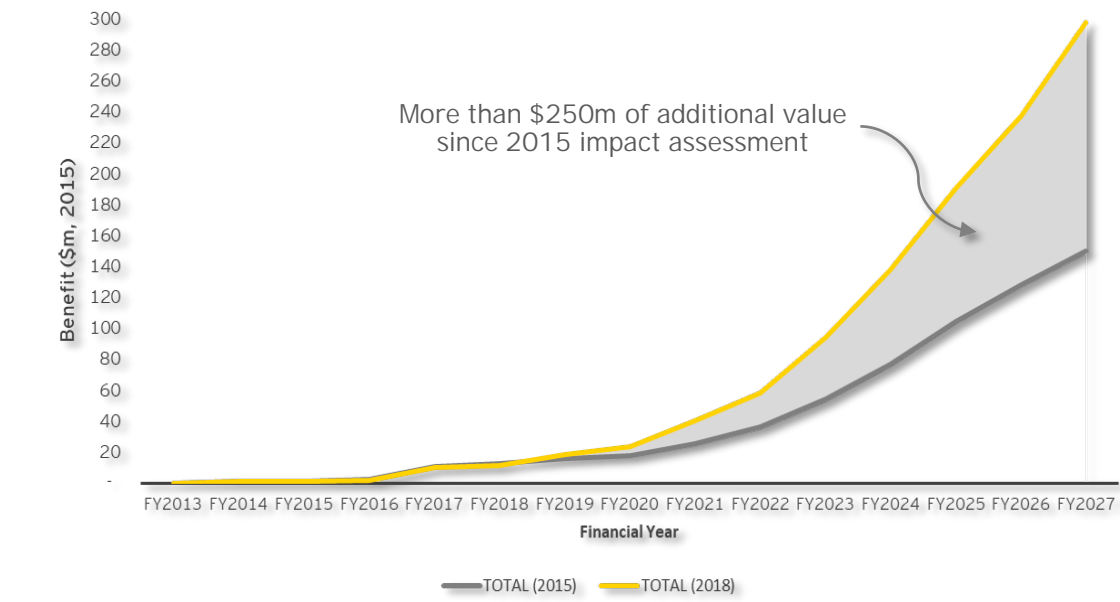
- 1 Research Program 1: Society  
Enhancing the capability and capacity of the water industry as a whole, delivering around \$240 million of value.
- 2 Research Program 2: Water Sensitive Urbanism  
Developing the policy and regulatory frameworks to support water sensitive urban planning and development, delivering around \$200 million of value.
- 3 Research Program 3: Future Technology  
Cutting edge research providing new technology to meet challenges faced by the water industry, delivering over \$160 million of value.
- 4 Research Program 4: Adoption Pathways  
A program for knowledge sharing which will enable the impact in the other programs (and therefore is not estimated to have its own impact).

The overall impact is estimated at over \$600 million, which represents an increase of more than 70% since the 2015 impact assessment, more than \$250 million of additional value.

The estimated Benefit Cost Ratio is 6.18, up from 3.74 in 2015.\*

The CRCWSC's successful delivery of research outputs is the main driver of increased value across all research programs, giving increasing confidence that estimated potential impacts will be achieved.

\*Benefits arise from both CRCWSC outputs directly and from partner actions in implementing changes - the cost calculations in this BCR consider costs of the CRCWSC only. This BCR therefore gives an estimate of the benefit delivered and unlocked by the CRCWSC relative to the cost of running the CRCWSC.



### Other impacts

The CRCWSC and partners are delivering value in addition to that formally measured in the impact assessment, including an estimated:

- ▶ Emerging research and tools delivering urban cooling benefits.
- ▶ Proven benefits of international projects.
- ▶ Benefits to other sectors. For example the potential application of the award winning purple phototropic bacteria to the agricultural sector.

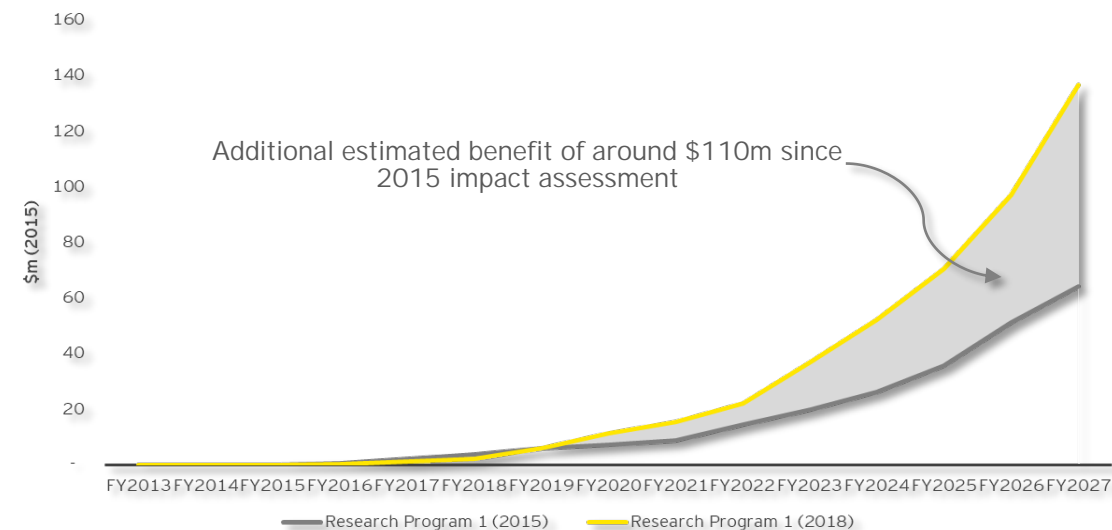
# CRCWSC outputs from Research Program 1 deliver infrastructure savings and build capacity in the Australian water industry, this program is delivering over \$240 million of value

## Activities

- ▶ Under Research Program 1, the CRCWSC develops toolkits, guidelines and methods to provide better information and decision making capacity within the Australian water industry.
- ▶ Since 2015, the CRCWSC has successfully delivered a number of outputs under this program, including cost benefit analysis guidelines for water sensitive practices, a behavioural assessment roadmap and guidelines for facilitating community acceptance, and reviews of current regulatory frameworks with associated recommendations. City Transition Strategies and the WSC Index also fall under this program.
- ▶ The CRCWSC also provides training workshops and continually engages with partners to embed these new practices in their business.
- ▶ This approach builds capability and capacity in the Australian water industry and enables CRCWSC research outputs to achieve their potential impact in the real world.

## Key impacts

- ▶ The largest benefit is related to the use of CRCWSC outputs to aid capital investment decisions, with an expected PV of around \$90m (impact 1.01).
- ▶ Water quality gain and remediation cost savings from CRCWSC outputs enabling more Water Sensitive Urban Design (WSUD) delivers an expected PV of around \$65m (impact 1.04).
- ▶ The CRCWSC's work influences existing WSUD dwellings to more fully realise the benefits of water quality gains and remediation cost savings (which are not currently being fully realised). The impact of this work has an expected PV of over \$30m (impact 1.07).



## Examples of Impact – Bannister Creek Living Stream

- ▶ CRCWSC tools and guidelines support the design, business case and delivery of a restoration project where benefits capitalised into local homes are found to be 2.5 times the cost of the project.
- ▶ These benefits are in addition to the value of improved water quality and biodiversity.
- ▶ When applied to the river restoration projects undertaken by CRCWSC participants, these additional benefits are significant. Melbourne Water's restoration activities alone is in excess of \$50m per year.



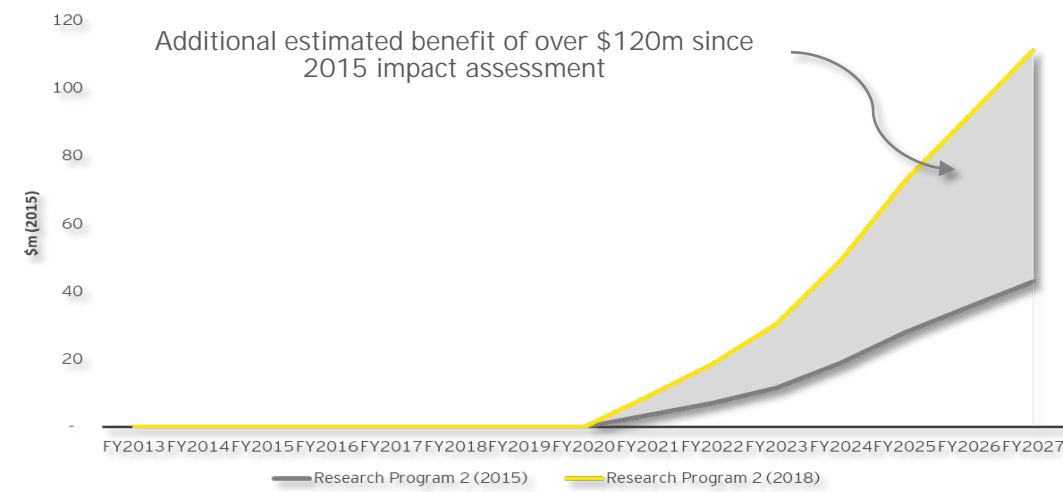
(Source: <https://watersensitivecities.org.au/solutions/case-studies/bannister-creek-living-stream/>)



In Research Program 2 the CRCWSC and partners inform policy and regulatory frameworks which provide an enabling environment and promotes real world impact, this program is delivering \$201 million of value

Activities

- ▶ Under Research Program 2, the CRCWSC develops planning tools, resource management guidelines and urban development and infill design principles to guide policy and regulatory frameworks which are required to enable the implementation of water sensitive practices.
- ▶ The CRCWSC takes a holistic approach to facilitating change by partnering with all levels of government to ensure that the full suite of policy and regulatory settings are taken into account, increasing the probability that water sensitive practices are used in real world applications.



Key impacts

- ▶ Transportation cost savings for Residents of infill developments facilitated by CRCWSC research outputs can benefit from transportation cost savings. This work is delivering and expected PV of over \$150m (impact 2.01).
- ▶ Infrastructure cost savings occur from infill developments facilitated by CRCWSC research outputs. This saving is calculated as the net result of higher dwelling construction costs being more than offset by savings in providing infrastructure compared with greenfield development. The CRCWSC can play a key role in enabling these developments by aligning incentives among all parties, as the higher dwelling construction cost may fall on one party while infrastructure savings are realised by another. This impact (impact 2.02) has an expected PV of over \$45m.

Examples of Impact – Fisherman’s Bend Drainage

- ▶ The CRCWSC played a key role in initiating the co-design process between the Fisherman’s Bend Taskforce, Melbourne Water, South East Water, City of Port Phillip, GHD, and City of Melbourne to develop a flood and drainage strategy for Fisherman’s Bend that combined distributed storage with traditional pipe and pump infrastructure.
- ▶ Work undertaken to date indicates that this hybrid approach may result in a greater than 20% cost saving compared with a traditional approach.
- ▶ The potential benefits from such a hybrid approach are significant given the need for infill development to accommodate future growth in major cities.

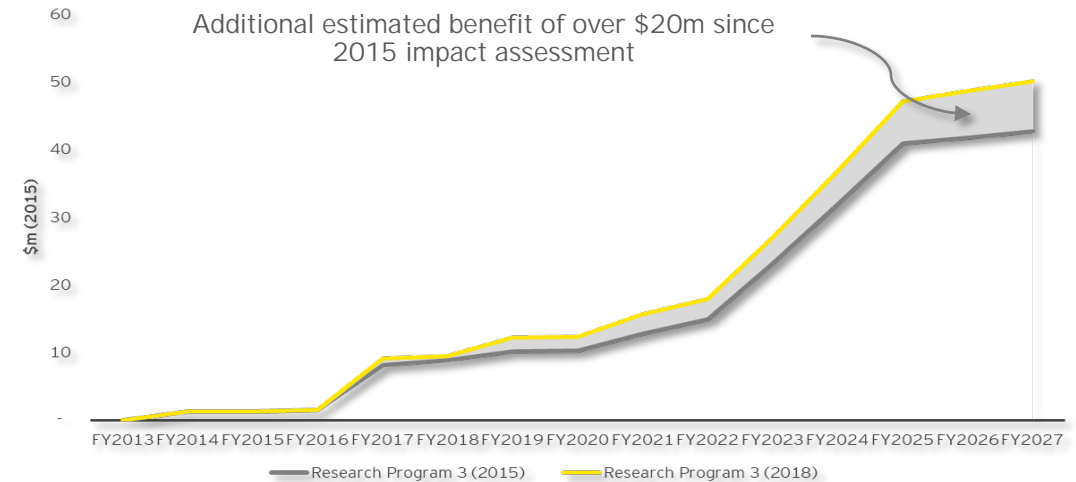


(Source: The CRCWSC)

In Research Program 3, the CRCWSC develops cutting edge smart technologies which optimise water systems, this program is delivering \$166 million of value

## Activities

- ▶ In Research Program 3, the CRCWSC develops novel technologies for urban water management, such as new technology for the treatment and reuse of multiple water sources, software and information technologies to enable more efficient use and management of water infrastructure, and smart technologies and control systems to optimise water systems.
- ▶ Outputs under this research program have continued to develop since 2015. For some impacts, use of new technologies has shown evidence of long term reductions in water demand and the probability of impact being realised has been increased as a result of this.
- ▶ In other areas, while research has progressed successfully a number of technologies are still at 'benchtop research' stage. In these cases, the updated impact assessment maintains a very conservative assumption that the probability of realising impact has not changed since 2015, despite the progress being achieved.



## Key impacts

- ▶ Utilities benefit from using the CRCWSC developed SeweX model which reduces their operational expenditure (operational expenditure of CRCWSC partner utilities is over \$900m per year, with an infrastructure depreciation cost base of over \$300m). This impact (impact 3.04) has an expected PV of around \$110m.
- ▶ Leakage reduction benefits of smart urban water systems being developed by the CRCWSC have an expected PV of over \$30m (impact 3.05).

## Examples of Impact – Water and Sewer Modelling

- ▶ The outputs of the CRCWSC and Water Corporation's trial of smart meters in Kalgoorlie Boulder provided an important foundation for the wider application of data science within Water Corporation and other utilities. This innovation is now also informing innovation in the rail sector.
- ▶ The CRCWSC's collaboration with the Advanced Water Management Centre has provided important insights into managing sewer corrosion and understanding the potential impact of water demand management on sewer operation. The integrated perspective of this research ensures demand management remains a critical tool for responding to drought.



(Source: <https://www.business.gov.au/assistance/cooperative-research-centres-programme/cooperative-research-centres-projects-crc-ps/current-crc-p-selection-round#crp6>)

# 3

Challenges facing  
future cities





# Cities face challenges on an unprecedented scale – while working towards a sustainable, resilient, productive and liveable future, urbanisation is transforming the way billions of people live worldwide

By 2050, more than two-thirds of the world’s people will live in cities. Rapid urbanization, aging infrastructure, quality of life, and safety and security are some of the most significant issues facing these cities of the future.

Cities are looking for solutions and initiatives to solve modern problems, and have become a convergence point for a range of new possibilities around mobility, energy, infrastructure and lifestyle experiences.

To thrive, the cities of tomorrow must be built around citizens’ ever-changing needs and be resilient to interoperability challenges and increasing global stresses and pressures.

With the market for the development of cities expected to reach US\$2 trillion by 2020, stakeholders from private and public sectors are building a better working world for citizens.<sup>3</sup>

Total global infrastructure needs have been estimated at US\$94 trillion between 2017 and 2040 with current trends indicating a gap of \$US15 trillion.<sup>4</sup>

Within 10 years there will be close to **500 cities** with a population of more than 1 million

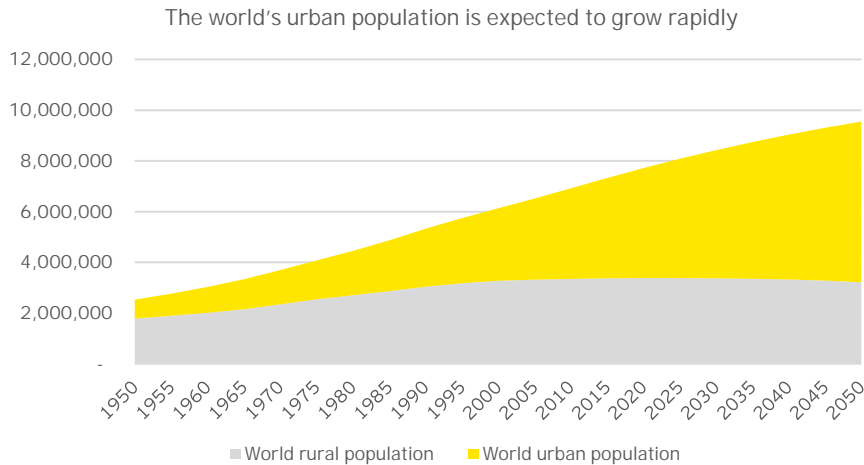
Source: OECD, Governing Cities

Cities will soon account for **90%** of the world’s population growth and **75%** of its energy consumption

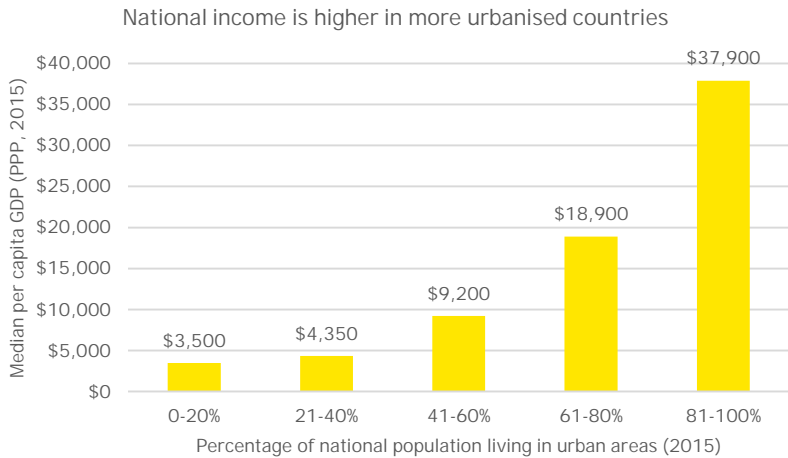
Source: un.org

Based on current trends the global infrastructure gap is estimated at a **US\$15 trillion** between 2017 and 2040

Source: G20 Global Infrastructure Outlook



Source: United Nations Population Division



Source: CIA World Factbook

3. EY, Citizen Today, Ransom’s notes (2014)  
4. G20 Global Infrastructure Outlook

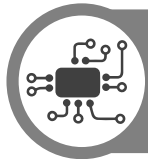
# Tomorrow's cities face enormous challenges that threaten the viability of economies, the quality of human life and the earth's ecology



## Demographic change

Fast growing capitals, shrinking regional cities and towns and aging populations are creating a unique set of challenges. These rapidly evolving communities also display rapidly changing values and expectations, including a strong desire for a sustainable future and an expectation of greater control of over decisions which affect them.<sup>5</sup>

All of Australia's states and territories experienced population growth between 2016 and 2017, with cities showing particularly large and rapid growth.<sup>6</sup> Net overseas migration is the main contributor to Australia's strong population growth, driving demographic change across multiple dimensions.<sup>7</sup>



## Technological disruption

Big data and digital transformation are disrupting business models, markets and economies and playing a greater role in urban management and the delivery of urban services. Digital transformation will add an estimated \$45 billion to Australia's GDP by 2021 and increase its growth rate by 0.5 per cent annually according to a new study released by Microsoft in partnership with IDC Asia/Pacific.<sup>8</sup> The Australia Trade and Investment Commission's report 'Australian Disruptive Technologies' states that between 2014 and 2020, the contribution of digital technologies to Australia's economy is forecast to grow 75 per cent to \$139 billion.<sup>9</sup>



## Environmental polycrisis

Climate change, ecological losses and the depletion of natural resources are increasing risks and shocks to cities and communities and threatening humanity's existence.<sup>10</sup> Australia is a country of weather extremes, but climate change is causing both the dry and wet extremes to intensify. In Australia, extreme storms and flash flooding will intensify more rapidly with the level of rain far higher than urban planners anticipated (e.g. Townsville is already experiencing this and has been in flood). At the same time, parts of Australia have been suffering one of the most intense droughts of the past century, with the Bureau of Meteorology stating Australia has been getting drier since July 2010 and rainfall deficiency has increased in both extent and severity country wide.<sup>11</sup> This is severely impacting rural and urban areas alike, through factors such as food production.



## Geographic polarisation

Within and between cities, communities are increasingly divided along geographic lines in terms of access to health, social and economic opportunities. Australia's geography makes us particularly sensitive to these challenges. Australia's overall population is small relative to its huge land size. Despite this, Australia is one of the most urbanised nations in the world, with 90% of the population living in just 0.22 per cent of the country's land area. As at the 2016 Census, more than two thirds of Australian's live in a capital city, with 40% of the population being the two largest cities of Sydney and Melbourne.<sup>12</sup>



## The 'great unbundling'

Dynamic global value chains continue to shift, creating new opportunities and threats for cities and the people and industries within them that underpin prosperity. Unbundling describes how the ubiquity of mobile devices, internet connectivity, consumer web technologies, social media and information access in the 21st century is affecting institutions by breaking up the packages they once offered, proving particular parts of them at a scale and cost unmatched by the old order. Within the water sector, the breaking down of the traditional water and sewerage supply chain is creating opportunities for disruptive and collaborative partnerships between government, the private sector and communities. The use of rainwater tanks for hot water supply, reducing usage of traditional mains supply (such as in the Aquarevo development) is an example of separating components of the water supply chain.

5. EY (2016)

6. ABS (2018),

7. ABS (2018),

8. Microsoft Digital Transformation Study 2018

9. Austrade (2018),

10. IPCC (2018)

11. Bureau of Meteorology, Annual Climate Statement 2018

12. ABS 2016 Census data

# New research is also shedding light on the complex nature of cities and the influence water can have throughout multiple interactions

## Cities as complex adaptive systems

- ▶ There are multiple networked and interacting elements (with competing priorities and resource needs).
- ▶ Understanding parts does not convey an understanding of the whole.
- ▶ It is extremely hard to predict the outcome of events or interventions.
- ▶ 'Problems' are resistant to simplified analysis and resolution.
- ▶ Understanding and successfully working within integrated city systems is particularly important for Australia, a highly urbanised country, with more than two thirds of the population living in capital cities, and more than 40% in rapidly growing Sydney and Melbourne alone.<sup>13</sup>

## Water as an all pervasive element

- ▶ The influence of water can be felt throughout multiple elements and challenges.
- ▶ The 'water energy nexus' is an example of this. Water is used throughout the entire energy generation process, meaning our needs for both water and energy security are inextricably linked.<sup>14</sup> This thinking can also be extended to the role water plays in other infrastructure sectors, such as transport and waste management.
- ▶ Urban flooding cuts through all elements, with the potential to affect, property, transport, businesses and the urban realm as a whole. The risk of urban flooding is increasing due to factors outside (climate change) and within (urban design) our control.<sup>15</sup>
- ▶ Water's influence extends beyond purely physical infrastructure, playing a crucial role in the health of a city's inhabitants. This occurs not just through the provision of drinking water and safe sewerage systems, but also by keeping cities fed, greener, cooler and more liveable.<sup>16</sup>



13. ABS, 2016 Census data  
14. World Bank (2018)

15. The Conversation (2018)  
16. The CRCWSC (2017)



# There is an urgent need to rethink approaches to urban management, but current models and practices have not evolved to this new paradigm

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**Michael Mehaffy**

Centre for the  
Future of Places

Cities are complex, adaptive systems with their own characteristic dynamics and need to be dealt with as such. In that light we must re-assess our current systems of planning, building and managing cities—the laws, codes, standards, models, incentives, and disincentives that effectively make up the ‘operating system’ for urban growth.



**Productivity  
Commission**

National Water  
Reform: Inquiry  
Report

Future urban water management will have to provide water supply and sewerage services for rapidly growing cities and towns, while being efficient and affordable. Accompanying this will be expectations of improved urban amenity and liveability in a potentially drier climate.



**Michael Batty**

University College  
London

In many disciplines, the idea of ‘complexity’ as a coherent perspective for organising our knowledge has come to the fore. Cities... have not escaped this force, indeed in some respects they are in the vanguard of these developments.



**Luís Bettencourt**

Santa Fe Institute

There is no longer much of an excuse to ignore the many measurable properties of cities. Cities across the globe and through time are now more knowable like never before, across many of their dimensions: social, economic, infrastructural and spatial.



**United Nations**

World Water  
Development  
Report 2018

Nature based solutions for addressing water availability in urban settlements are also of great importance, given that the majority of the world’s population is now living in cities. Urban green infrastructure, including green buildings, is an emerging phenomenon that is establishing new benchmarks and technical standards that embrace many nature based solutions.



**Andrew McIntyre**

Asian Development  
Bank

We need to have a complete paradigm shift about how we look at urbanization and how we deal with cities. We need... a completely new, strategic, holistic approach to managing massive complexity and rapid change.

# How well communities, governments and businesses work together will determine how effectively cities transform to build a better working urban world

- ▶ Taking a whole-of-system approach to city planning and management by understanding community needs, technology and institutional networks will lead to improved diagnosis of urban problems, enable the development of coherent policies and plans to address them, and improve urban resilience. Moving from better plans to more resilient community outcomes will require new types of partnerships, governance, regulation and financing arrangements.
- ▶ For governments and businesses to collaborate successfully on smart, sustainable solutions to urban development, citizens and communities must be at the centre. Cities, after all, are the cumulative expression of their citizens and cannot grow and thrive without them.
- ▶ Governments and businesses will each have their own individual considerations, but in the pursuit of smart and resilient cities their common focus should be on delivering outcomes for the community which contains their citizens and customers.
- ▶ Citizens should feel part of a community which is connected to their city – through infrastructure and digital delivery, physical and social interaction, and emotional engagement.
- ▶ Establishing this community connection can be supported by giving citizens greater control over decisions which affect them. This requires a change in mindset – from viewing citizens as passive recipients of services to citizens being active partners in shaping and delivering the services they need.
- ▶ Greater citizen involvement can deliver more than just community perception of greater control, it can also lead to better and more innovative solutions to complex problems. An active community can help to manage bushfire risk more effectively, drive local place making, expand scientific research through citizen science, and much more.



Source: EY (2018) How can resilience thinking unlock the complexity of cities?

Only 29% of citizens think leaders can be trusted to make sound financial decisions

Only 31% of citizens think city leaders are prepared to listen to them

But...76% of citizens say they are interested in keeping up to date and having an opinion on how their city evolves

Source: EY (2016) How can you build a strong city pulse without taking the human pulse?



A range of factors can either enhance or limit the ability to meet these challenges – four key factors are

### Community centricity

Addressing system-wide challenges in a way that is driven by communities' needs and values.

To achieve this, governments, utilities and developers need to understand and empower the communities and customers they serve.

### Data driven predictive models and operations

Digital innovations are being used to solve complex information and coordination problems using smart systems which provide real time information to customers and communities and analytical tools which speed up and improve decision making by businesses, governments and regulators.

Technology is already enabling better integration of centralised and decentralised water supply systems as well as green and grey infrastructure.

### Rapid technological change

Recognising the potential for new technologies to change the way integrated city systems are managed and the ability to 'scale up' the use of technologies with proven effectiveness.

### Scarcity of capital

Allocating capital efficiently and sharing the burden appropriately – the cross sector benefits of system-wide thinking (e.g. the health, transport, and water benefits of urban green space and wetlands) mean that a number of parties benefit from an integrated approach.





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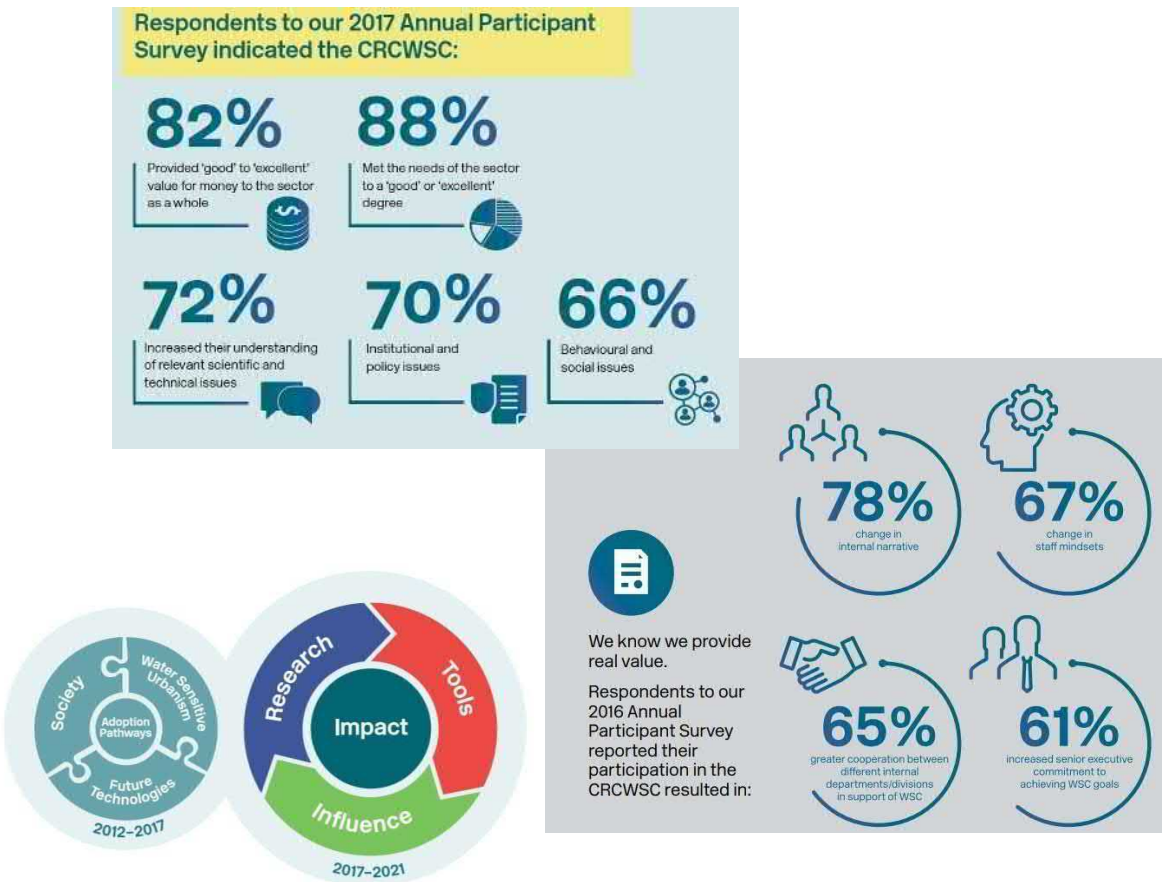
Future opportunities  
from continuing the  
CRCWSC



The CRCWSC’s philosophy of partnership and collaboration across sectors and countries means they are uniquely placed to shape the system-wide approaches needed to meet these complex challenges

- ▶ The CRCWSC has demonstrated its understanding of the role and perspective of each of their key partner sectors and focused their work effort on solutions which coordinate between these entities, align incentives and lead to collaborative outcomes to help increase resilience and improve management of cities. The CRCWSC has further leveraged this understanding through dedicated research which has progressed the science of collaboration.<sup>17</sup>
- ▶ As the CRCWSC’s work cuts across sectors, they can coordinate, provide information and make links between the community, government and businesses which allows them to significantly impact the cities system as a whole and build resilience into and across sectors.
- ▶ The global nature and massive scale of challenges presented by urbanisation, climate change and population growth mean that well coordinated action which effectively meets these challenges can open up the potential for substantial impact. The CRCWSC can deliver this impact by continuing to take a this system-wide view and further embedding practices based on their understanding of cities’ complex and dynamic nature.

The CRCWSC’s record of successful collaboration



17. Brown, Deletic and Wong (2015)

# The CRCWSC’s work in the water sector tackles challenges shared across integrated city systems, providing the foundation for expanding to a system-wide approach to deliver resilient and sustainable networks



Integrated city systems	Water	<p>The CRCWSC has worked extensively across the whole integrated service delivery pipeline in the water sector. This experience could provide value to other sectors.</p> <ul style="list-style-type: none"><li>▶ Initiatives across policy, regulatory and funding/financing frameworks which provide the enabling structures which unlock the rest of the service delivery pipeline.<sup>18</sup></li><li>▶ Planning, design and analytical advances which deliver innovations that enable efficient service delivery in increasingly densely populated and sustainable cities.<sup>19</sup></li><li>▶ Building socio-political capital through programs which enable active community participation in and acceptance of solutions such as distributed networks and innovative urban design.<sup>20</sup></li></ul>
	Energy	<p>The energy sector faces a number of challenges similar to or directly linked with the water industry. Water is directly involved in all stages of the traditional energy production pipeline.<sup>21</sup> The energy sector is also looking outside of traditional delivery methods to meet challenges posed by increasing population density placing pressure on existing systems and infrastructure while transitioning to a renewable future.<sup>22</sup> Distributed systems (such as rooftop solar and community generation) and community involvement are important aspects of the industry meeting these challenges and are closely aligned with existing CRCWSC expertise.</p>
	Transport	<p>Transport systems are influenced by urban design solutions in other elements of integrated city systems. Infill developments which give residents access to walking, cycling and existing (or even expanded) public transport networks can reduce the need for investment in infrastructure compared with an increasing urban sprawl scenario.<sup>23</sup> The CRCWSC’s work in the water sector, along with advances across other elements of integrated city systems are key to enabling these infill developments which are needed to manage increasing populations sustainably. Transport infrastructure also play a direct role in water management, with roads, pavements and gutters forming an important part of a city’s drainage system.</p>
	Waste	<p>The waste industry faces the dual challenges of reducing the environmental impacts of landfill while managing an ever increasing overall volume of waste driven by population and consumption growth.<sup>24</sup> In a context of increasing urbanisation, reductions in landfill tonnage are also required as the capacity in existing cities will be stretched by the increasing population while the same factor means there is no space for new sites. These multiple challenges can be partially addressed through innovative waste management approaches which have synergies with the water management sector and are aligned to CRCWSC initiatives such as green waste to energy.<sup>25</sup></p>
	Health	<p>The water management industry has been inextricably linked with public health since its inception, principally through the provision of safe drinking water and sewerage systems. Modern health challenges such as obesity, mental health and overall wellbeing can similarly benefit from thinking which takes a system-wide view. CRWSC work on urban design which leads to communities with access to green space and wetlands (which act as part of the water management system) can deliver positive public health outcomes by encouraging an active lifestyle, with its associated physical and mental health benefits as well as the broader wellbeing impacts of these public spaces.<sup>26</sup></p>

## Enabling actions

Across all sectors, there are key enablers without which these innovative system-wide approaches, designs, technologies etc. cannot deliver impact for the community. The CRCWSC’s work in these fields is therefore crucial to ‘unlock’ the value in all other programs. Key enablers include:

- ▶ Policy and regulatory settings - which are key to the pursuit of system-wide solutions, as these frameworks need to keep up with advances in their own particular area while also allowing for the increased integration across sectors.
- ▶ Funding and financing – with increasingly integrated service delivery, the costs and benefits of innovative programs may be dispersed among multiple players and incentives may be challenging to align. Achieving this alignment is vital – investment in solutions, no matter how beneficial, cannot proceed without the required funding.

18. [https://watersensitivecities.org.au/content\\_type/resources/?fwp\\_pathways=enabling-structures](https://watersensitivecities.org.au/content_type/resources/?fwp_pathways=enabling-structures)

19. [https://watersensitivecities.org.au/content\\_type/resources/?fwp\\_pathways=on-ground-practices](https://watersensitivecities.org.au/content_type/resources/?fwp_pathways=on-ground-practices)

20. [https://watersensitivecities.org.au/content\\_type/resources/?fwp\\_pathways=socio-political-capital](https://watersensitivecities.org.au/content_type/resources/?fwp_pathways=socio-political-capital)

21. World Bank (2018)

22. Lilley et al (2012)

23. Tiwari, Cervero and Schipper (2011)

24. Department of the Environment and Energy (2017)

25. The CRCWSC (2018)

26. The CRCWSC (2017)



The CRCWSC can deliver exceptional value by working with their key partners across various sectors to mainstream approaches already proven at the pilot scale while taking the next step to develop system-wide solutions

The CRCWSC’s key partner sectors



Government

Policy and regulation provide the key enabling environment for dealing with challenges which cut across integrated city systems.



Developers

Affordable and sustainable housing is key to meeting the needs of growing urban populations and is inextricably linked with the use of and access to critical city infrastructure.



Utilities

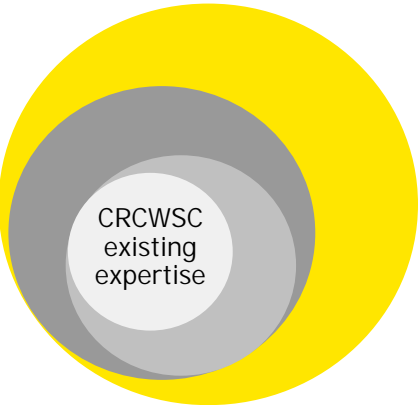
Utilities, across all sectors, play a vital role in providing infrastructure and services required to make cities sustainable, resilient, productive and liveable.



Community

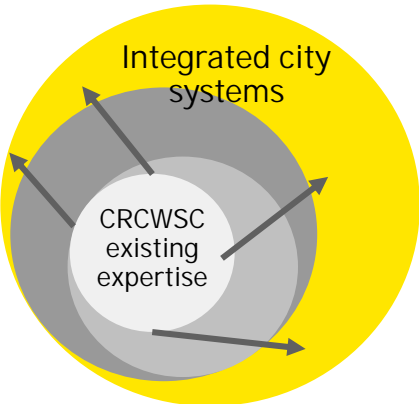
Cities are, in essence, a collection of citizens. The needs, values and actions of the community are the ultimate arbiter of success in future cities.

Mainstreaming existing approaches



The CRCWSC has proven successes working with partners across the full integrated service delivery pipeline to deliver water sensitive technologies and approaches at the pilot scale. Spreading these benefits throughout the whole economy by mainstreaming these successes has the potential to deliver substantial additional impact.

Expanding the CRCWSC’s focus throughout integrated city systems



The lessons learned and expertise developed by the CRCWSC so far have applications beyond the water sector. The hyper connected nature of cities means that the CRCWSC is uniquely placed to deliver value throughout integrated city systems.

# The CRCWSC's actions to mainstream existing expertise and to expand focus across integrated city systems can be targeted to respond to four key factors in meeting the challenges faced by future cities



## Community centricity

An example of the CRCWSC adding value within this theme is their collaboration across sectors helping governments, businesses and communities to understand each other better and develop community centric solutions in a partnership which sees citizens as active co-creators rather than passive recipients of services.

This approach opens up opportunities for community solutions in which the CRCWSC is a leading player, such as distributed systems in water and energy. This can deliver environmental benefits through uptake of recycled water and renewable energy generation (i.e. homes collecting their own water and generating their own electricity) while also increasing the capacity of existing infrastructure to serve growing urban populations.



## Rapid technological change

The CRCWSC have a history of spreading knowledge of technological capability so that this potential is seen by the partners. The CRCWSC has also worked with partners to put in place the governance, policy and regulatory settings, and industry capability to enable the adoption of innovative technologies at scale.

New technologies have the potential to make the previously impossible possible. The CRCWSC have a track record of supporting the development, piloting and de-risking of new technologies in the water sector and have developed the expertise to scale up the use of these innovation and also apply this knowledge more broadly across other elements of integrated city systems.<sup>27</sup>



## Data driven predictive models and operations

The CRCWSC has developed expertise in smart systems within the water industry and they understand the hyper connected nature of future cities. This factor may influence integrated management of manmade, natural and community assets or better decisions which reflect the integration of water, waste, energy and transport systems.

The CRCWSC can use their knowledge of cutting edge data techniques<sup>28</sup> to help governments and businesses to better understand and manage the links between integrated city systems as well as to understand, quantify and invest in the broader (system-wide) value of quality urban green space, healthy rivers and creeks and ecosystem services as a whole.



## Scarcity of capital

The CRCWSC have proven the value of collaboration. Projects with a range of beneficiaries have a range of possible funding and financing solutions, opening up the potential to create and mainstream usage of innovative financial instruments, partnerships and new markets.

The CRCWSC can use their understanding of perspectives across sectors to develop new financial tools (e.g. by leveraging learning from other sectors such as social impact bonds and community finance) which align incentives and risks such that beneficial projects which have previously not been considered bankable are unlocked by burden sharing across interested parties (which may include shared investments involving government, utilities, developers, insurers and residents).

27. <https://watersensitivecities.org.au/solutions/case-studies/aquarevo/>

28. <https://watersensitivecities.org.au/content/modelling-science-sewers-way-forward-urban-water-planners/>

Governments face increasing pressure to act on major challenges in health, infrastructure, affordability and environmental sustainability while also providing core services to rapidly growing urban populations

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Governments face a range of challenges which systems thinking and integrated solutions can help to solve.  
Key challenges include:

- ▶ City planning which reflects the integrated nature of city systems as well and meets the challenges of population growth and increasing urban density
- ▶ Increasing health costs driven by an ageing population, the obesity epidemic, and an increased focus on mental health
- ▶ Funding and delivery structures which encourage 'silos' and fail to reflect the hyper-connected nature of modern cities
- ▶ Infrastructure needs in the context of rapid population growth, urbanisation and an existing infrastructure gap
- ▶ Changing community expectations and values around sustainability, affordability and liveability
- ▶ Keeping policy and regulation up to date with rapid technological change

### The CRCWSC's Key Value Proposition for Government Partners

The CRCWSC's research can help governments at all levels by developing policy and regulatory frameworks which:

- ▶ Provide the enabling environment to achieve multiple policy goals through coordinated system-wide responses to complex challenges faced in health, housing, energy, transport and the environment.
- ▶ Are risk based and informed by the latest evidence and knowledge of cutting edge technology.
- ▶ Reflect the current expectations, values, and actions of the community.
- ▶ Unlock the potential of innovative solutions which reduce the burden on traditional infrastructure provision.



Developers need to meet the demands of rapidly growing urban populations in a way that reflects the changing values and expectations of customers, shareholders, and the wider community

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Developers have a range of stakeholders whose needs are changing at pace and face challenges which can be met by effective partnership across integrated service delivery pipelines. Key challenges include:

- ▶ Aligning the needs of shareholders and the community
- ▶ Changing customer/community expectations around affordable, liveable developments
- ▶ Regulatory uncertainty and the potential gaps between technological advancements available to developers and the policy or regulatory environment required to enable their use
- ▶ Access to capital for innovative projects which require partnerships with other sectors/government and deliver multiple benefits
- ▶ The complexity of infill developments which are required to house increasing urban populations but which could place increasing pressure on existing infrastructure
- ▶ Access to land which is developable, in desirable locations and can be connected to city systems

### The CRCWSC's Key Value Proposition for Developer Partners

The CRCWSC can help unlock development opportunities that would otherwise be prevented by:

- ▶ Enabling the infill developments required to deal with rapid urban population growth while minimising the need to upscale existing infrastructure.
- ▶ Continuing to reduce the lifecycle cost of hybrid green and grey infrastructure solutions and building industry capacity to deliver these solutions at scale.
- ▶ Continue to inform community desires and increase demand for affordable, liveable housing and precincts.
- ▶ Coordinating work across sectors and scales of development to provide a supportive and predictable legislative and regulatory environment.
- ▶ Developing innovative financial structures which reflect the spread of benefits being delivered and attract new potential sources of funding.

## Utilities need to build a smart, sustainable, affordable future with the support of the community while managing the context of increasing infrastructure needs and service demands

Utilities face pressure to provide services which are affordable and reliable while maintaining their 'social licence' by meeting customer and community expectations of sustainability. Systems thinking can help to deliver multiple outcomes and meet challenges which include:

- ▶ Aligning the needs of shareholders and the community (especially where utilities are publicly owned)
- ▶ Changing customer/community expectations, values and willingness to pay for sustainable services
- ▶ Access to capital and financing structures which reflect the system-wide benefits of investments in individual areas (e.g. in water sensitive residential developments which provide quality urban green space)
- ▶ Regulatory uncertainty, costs, constraints and the potential gaps between technological advancements available to utilities and the policy or regulatory environment required to enable their use
- ▶ Managing the nexus between water and the other sectors which make up integrated city systems (e.g. energy, transport, waste, health)
- ▶ Improving operational efficiency using smart/predictive systems and automated technology
- ▶ Managing cyber threats and customer data security concerns related to the use of smart systems

### The CRCWSC's Key Value Proposition for Utilities Partners

The CRCWSC can help utilities to achieve both environmental and fiscal sustainability by:

- ▶ Using smart systems and demand management to make more efficient use of existing and future water infrastructure assets – serving rapidly growing urban populations who are demanding sustainable services.
- ▶ Realising the value of these systems and approaches across the nexus points with other sectors.
- ▶ Coordinating work across sectors and scales of development to provide a supportive and predictable legislative and regulatory environment.
- ▶ Building opportunities for new forms of collaboration between public providers and community based utility service providers.
- ▶ Developing innovative financial structures which reflect the spread of benefits being delivered and attract new potential sources of funding.

Communities are trying to achieve their desire for a sustainable and liveable future while navigating challenges posed by living in the information age while relationships and demographics change around them

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Communities face challenges across multiple elements of wellbeing and liveability. Holistic approaches to policy, planning and service delivery which reflects the integrated nature of city systems can help to address multiple concerns, which include:

- ▶ Managing resources and maintaining water, food and energy security in the face of challenges such as climate change, increasing urban populations
- ▶ Community expectations of consultation and greater input/control over receiving personalised products, services, and delivery channels
- ▶ Living in the information age – making the most of the benefits such as improved decision making (e.g. smart meters/ transport apps) and digital services (e.g. mobile banking) while also managing challenges such as cyber bullying, fake news, or negative wellbeing impacts of social media
- ▶ Changing and community expectations and values around sustainability, affordability (e.g. housing) and liveability (e.g. traffic congestion, sedentary lifestyles, access to green space)
- ▶ Cyber threats and personal data security and privacy concerns
- ▶ Automated technologies affecting the labour market (e.g. robots replacing workers)
- ▶ Population growth, changing demographics and changing definitions of community (e.g. online and in person relationships)

### The CRCWSC's Key Value Proposition for Community Partners

The CRCWSC can help communities to live in cities which meet their needs and reflect their values by:

- ▶ Developing approaches which realise the potential for communities to take greater control over the sustainability, resilience, productivity and liveability of their cities and local communities – e.g. through distributed systems or community level infrastructure across sectors.
- ▶ Influencing the provision of public services to be geared towards citizens' lived experience, which occurs in cities as a connected whole.
- ▶ Developing solutions which support citizens to navigate the information age and changing demographics – e.g. by using smart systems to provide people with accurate and timely information.
- ▶ Working with all partners to deliver outcomes which reflect the community's desires for – among other things - healthy lives, access to transport, affordability and environmental stewardship.



## Given the scale of these challenges, the CRCWSC can deliver significant additional impact by 'mainstreaming' their existing outputs, which have already been proven in the pilot phase

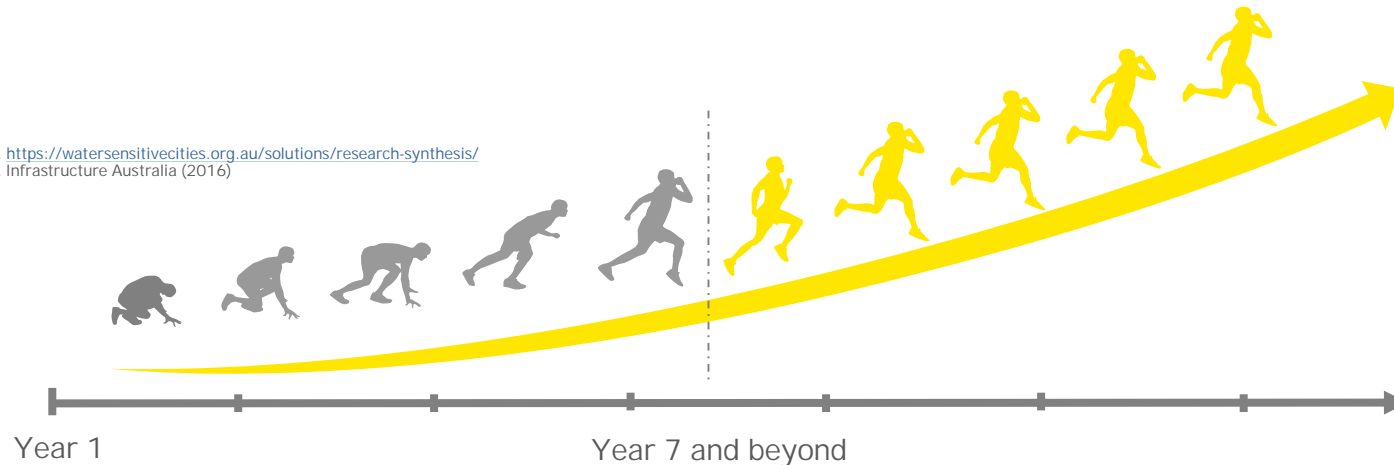
The CRCWSC has a history of successfully translating research into practical ideas with proven effectiveness and real world impacts covering areas such as:

- ▶ Urban design master plans
- ▶ Green infrastructure designs
- ▶ Alternative water source networks
- ▶ Waterway designs
- ▶ Building designs
- ▶ Governance arrangements
- ▶ Community engagement and water conservation campaign designs
- ▶ Business cases for water sensitive projects and programs.<sup>29</sup>

The impact assessment we have completed demonstrates how the CRCWSC and its partner organisations are expected to deliver around \$600m in economic, social and environmental value for Australian communities over 15 years to 2027.

While these impacts are large and far reaching, there is enormous additional value to be created by moving CRCWSC outputs from the pilot phase to the mainstream in key areas that are critical for delivering sustainable urban development as the populations of our major cities continue their significant projected growth.

29. <https://watersensitivecities.org.au/solutions/research-synthesis/>  
30. Infrastructure Australia (2016)



The CRCWSC and its partners are impacting varying proportions of the markets they operate in. In the case of water utilities, CRCWSC participants form a large proportion of the total market in Australia and the tools and approaches the CRCWSC has helped to develop and implement are being widely adopted. At the same time, the role of the CRCWSC in influencing the design and development of growing urban areas is still relatively immature, with opportunities for expansion. While case studies like Aquarevo in Australia and Sponge Cities in China prove the significant value that can be created, this represents a small proportion of the overall addressable market for urban development, where it is expected that around 500,000-700,000 new dwellings will be added to each of Australia's four largest cities over the next 15 years (and population trends indicating an ongoing need).<sup>30</sup>

While mainstreaming the approach to residential development in our major cities offers significant potential gains, influencing the entire value chain to fully embrace best practice approaches is challenging and a long term aspiration. Over the next 25 years it is more likely that a more modest share of the total market can be accessed.

To date we are seeing a rapid acceleration of the CRCWSC's influence as new tools, insights, technologies and capabilities are introduced. This is expected to continue until the end of the 15 year modelling period, with the annual impact expected to triple in the final 5 years of the model.

Estimating the mainstreaming trajectory beyond the current 15 year period is challenging and highly uncertain. But given the current trend, anticipating a doubling or even a tripling of the annual impact that governments and markets can deliver with the support of the CRCWSC is not unreasonable, in the context of the stated caveats.

The potential impact from expanding the CRCWSC’s role to tackle challenges across integrated city systems and service delivery pipelines is substantial, and synergies with existing work imply a short learning curve even in these new areas



The CRCWSC can play a crucial role, along with partners, in unlocking the massive potential value from taking a coordinated, system-wide approach to tackling challenges of this scale, which will potentially cost the Australian economy billions of dollars each year.

31. Kompas, Ha and Che (2018)  
32. Australian Institute of Health and Welfare (2017)  
33. RANZCP (2016)  
34. Infrastructure Australia (2016)

# 5

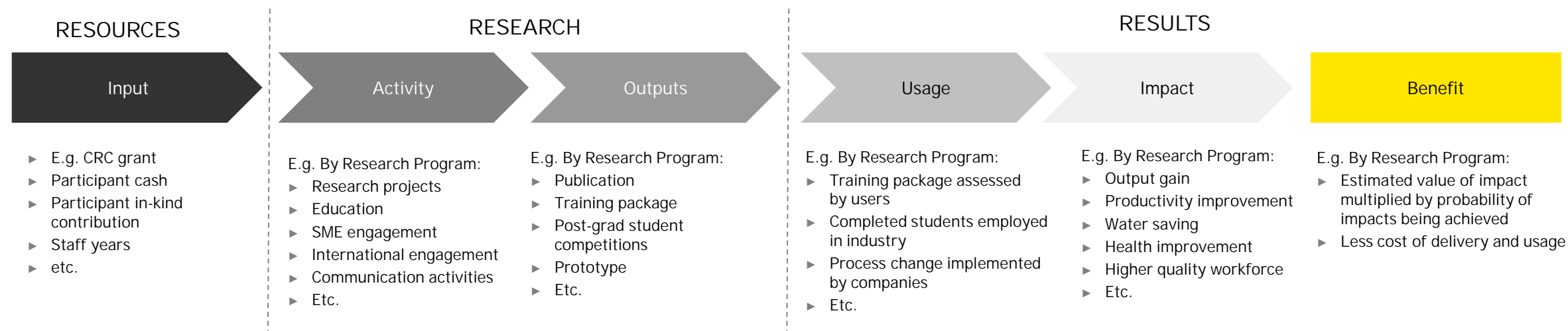
## Technical annex





# Methodology

- ▶ The Commonwealth Government’s CRC Impact Tool was used for the 2015 Impact Assessment and EY’s methodology follows this template.
- ▶ This methodology represents a process through which research outputs lead to economic impacts, through a series of steps which take account of uncertainty at each stage of the process. The robustness of the final results is improved by this approach, as a series of risks have been taken into account in the impact quantification process, these include the risks that:
  - ▶ Research outputs will not be successfully delivered
  - ▶ Given that the outputs are delivered they may not be applied by the intended users
  - ▶ Even if the outputs are successfully delivered and applied they may not deliver the expected impact.
- ▶ These risks are quantified using a series of probability estimates. These probabilities can be adjusted over time as these risks either materialise or are mitigated (e.g. outputs are actually delivered and therefore this risk is fully mitigated).
- ▶ The following figure outline the steps in this methodology.



Source: CRC Australia

# Additional impact assessment detail

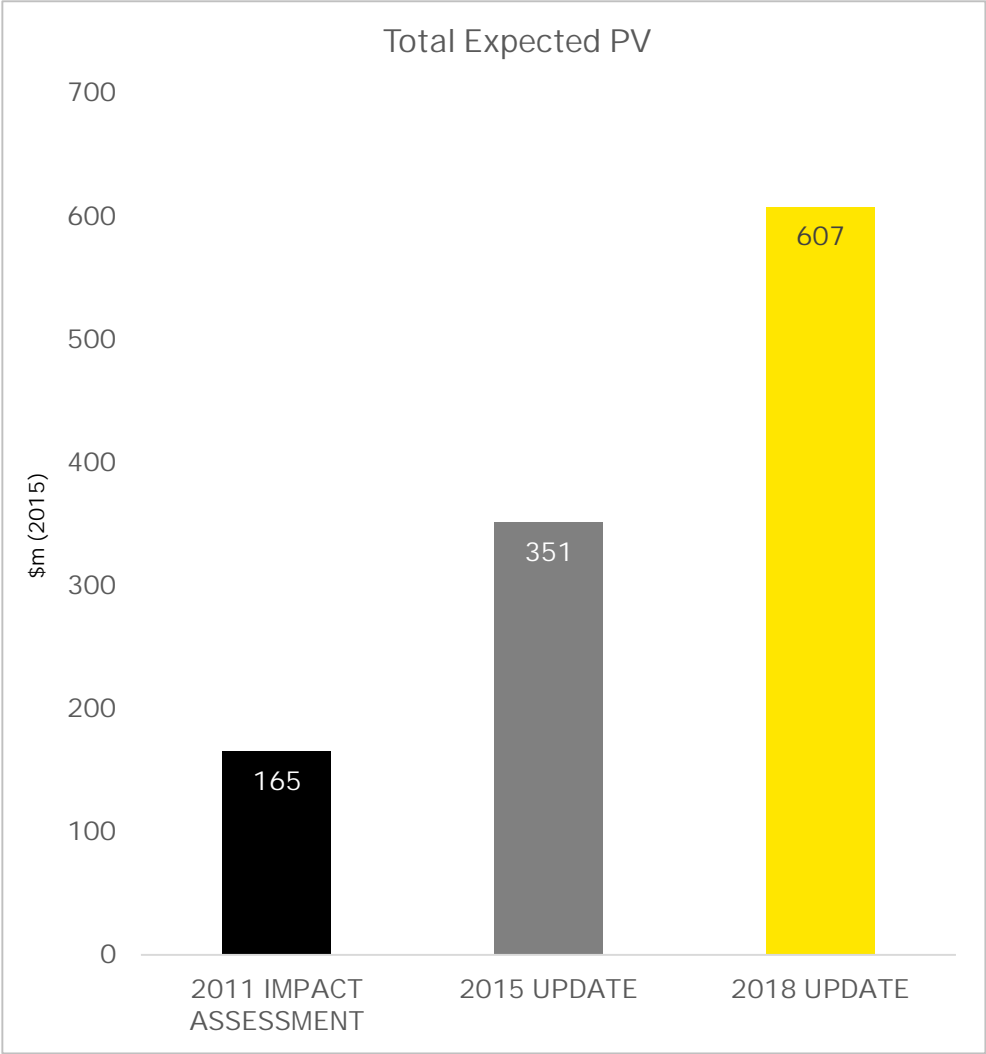
The previous impact assessment for the CRCWSC was completed by the CRCWSC in 2015. At this point in time, a number of research outputs were developing as expected and showed significant promise for the future. Results of the impact assessment reflected this by showing a substantial uplift in impact from the initial estimates in 2011 while still being tempered by a conservative assessment of the probability of these impacts being fully realised.

Since 2015, the CRCWSC has delivered on this promise, with many research outputs being successfully completed and having proved their effectiveness through activities with partners. The most recent results indicate this change. Assessments of the probability of delivering outputs have been lifted (as a number of outputs have been delivered) and assessments of the probability of these outputs delivering impact has also increased as the quality and effectiveness of outputs has improved over time. This leaves the CRCWSC on the cusp of being able to integrate improved knowledge and capability across industry and public sector partners by making these outputs part of mainstream usage.

Alongside the CRCWSC’s success in delivering outputs as planned, changes in the water industry and the projects being pursued using CRCWSC outputs have also driven increases in impact. For example, the number of cities with Water Sensitive City Transition Plans has doubled from three to six, rather than the progressing from three to four, as modelled in the previous impact assessment. Similarly, a number of parameters, such as the operational expenditure of water utilities, have been re-estimated using the latest data (a detailed description of these changes can be found in the attached technical annex).

Impacts of the CRCWSC represent benefits from separate research programs which represent different elements of progress towards water sensitive cities, all of which are required to drive effective change, these are:

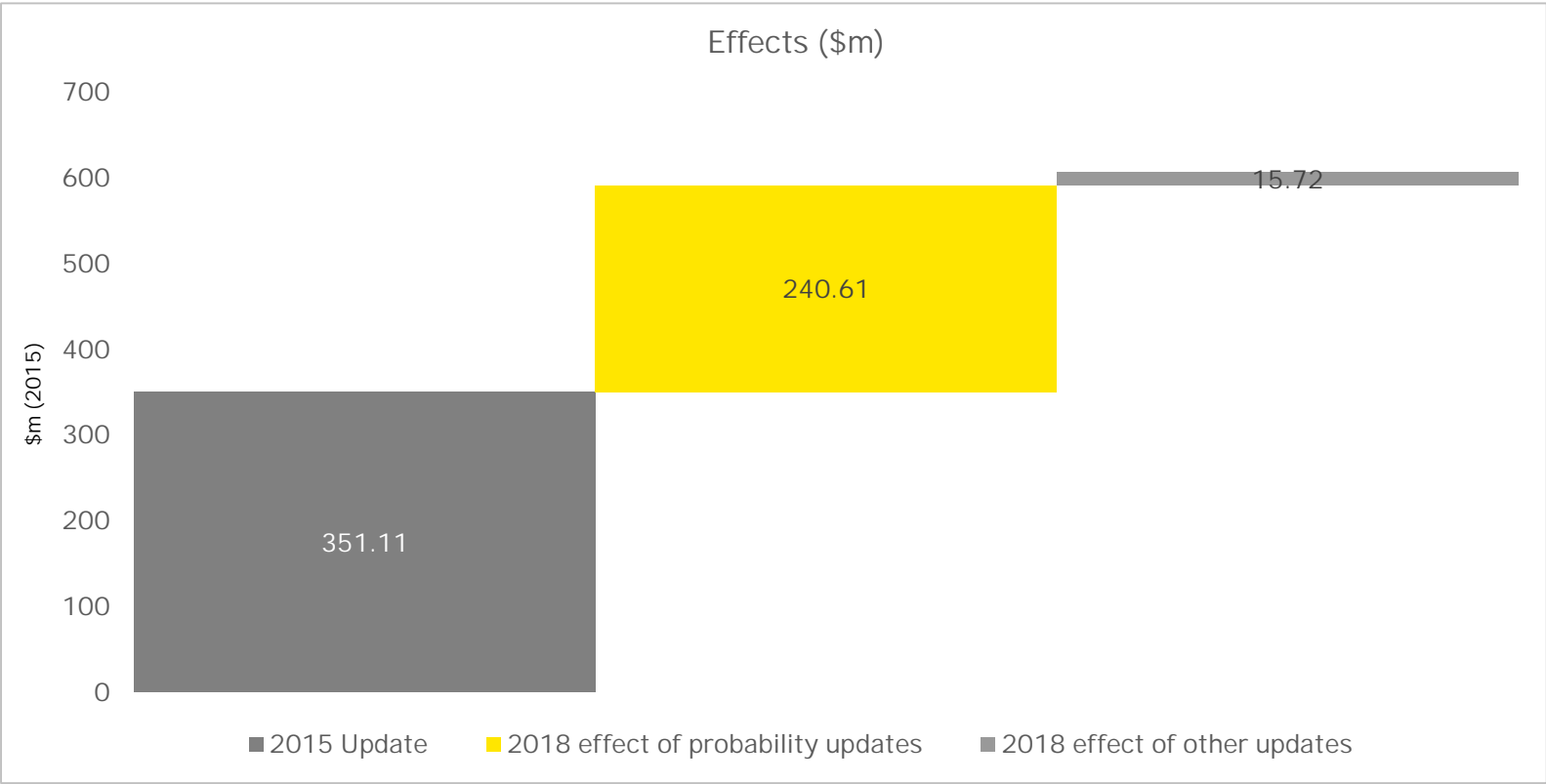
- 1 Research Program 1: Society – enhancing the capability and capacity of the water industry as a whole.
- 2 Research Program 2: Water Sensitive Urbanism – developing the policy and regulatory frameworks to support water sensitive urban planning and development.
- 3 Research Program 3: Future Technology – cutting edge research providing new technology to meet challenges faced by the water industry.
- 4 Research Program 4: Adoption Pathways – a program for knowledge sharing which will enable the impact in the other programs (and therefore is not estimated to have its own impact).



Present values calculated using a 5% discount rate and 2015 prices to remain consistent with the CRCWSC’s 2015 Impact assessment.

The CRCWSC has delivered on their promises by successfully completing and proving the effectiveness of a number of outputs – this is the primary driver of increased impact

- ▶ All of the individual changes in impacts since the 2015 assessment fall into one of two categories:
  - ▶ Changes driven by updating probabilities of outputs being delivered (as many have either been delivered or are further developed).
  - ▶ Changes related to other updates in parameters (many small individual updates to parameters driven by new estimates of the effect of CRCWSC outputs or more recent data providing updates to sources and assumptions).
- ▶ The chart on the right hand side shows the breakdown of the change in impact driven by these two categories.
- ▶ These results highlight that the main driver of increased impact is the CRCWSC fulfilling its promise by successfully delivering a number of outputs and working collaboratively with partner organisations to encourage the usage of those outputs.





## Increased impact in all measured research programs has resulted in increased Benefit Cost Ratios

The impact assessment tool used as a basis for this analysis includes a benefit cost calculator which compares the estimated cost of delivering each program with the estimated beneficial impact of the program and associated work with partners.

Benefit Cost Ratios (BCRs) provide an estimate of how many dollars of benefit are achieved for each dollar of cost. Benefits arise from both CRCWSC outputs directly and from partner actions in implementing changes – the cost calculations in this BCR consider costs of the CRCWSC only. This BCR therefore gives an estimate of the benefit delivered and unlocked by the CRCWSC relative to the cost of running the CRCWSC.

### Since the 2015 Impact assessment:

- ▶ BCRs in all research programs are estimated to have increased, along with the overall BCR.
- ▶ The largest increases in BCR are shown in Research Programs 1 and 2, which are most closely effected by the adoption of analytical and methodological tools which the CRCWSC has delivered and proven through a series of synthesis projects/case studies.

Research Program	BCR (2015 Impact Assessment)	BCR (2018 Impact Assessment)
Research Program 1	5.97	11.03
Research Program 2	2.87	7.42
Research Program 3	8.66	9.00
Research Program 4	-	-
TOTAL	3.74	6.18

## Assumptions for estimating impacts in Research Program 1 and Research Program 2

Impacts	Impact Summary	Key Assumptions/parameters	Usage Probability	Impact Probability
1.01	Better informed investment decisions using CRCWSC tools	Amount of investment influenced – rising from \$100m to \$3.5b per annum over time (from annual reports of CRCWSC partners) Effectiveness of CRCWSC tools – 20% saving (observed in Fisherman’s Bend Project)	70%	80%
1.02	Reduced administration and transactions cost of decision making for partners	Cost base of 6 cities with transition plans - \$289m per annum (from cities’ annual reports) Saving rate from CRCWSC tools – 3.75% growing to 7% in year 10	53%	60%
1.03	Increased uptake of WSUD delivering water savings enabled by CRCWSC outputs	Additional uptake of WSUD – growing from 1% in year 7 to 20% in year 15 Total number of dwellings built – 149,000 (ABS Cat. 8731.0) Water savings ML/1000 dwellings – 47.5 Value of water – Rising from \$1,500 to \$2,002 in year 7 (latest NPR data)	49%	60%
1.04	Water quality gains and remediation cost savings from WSUD dwellings enabled by CRCWSC outputs	Additional uptake of WSUD – growing from 1% in year 7 to 20% in year 15 Total number of dwellings built – 149,000 per annum (ABS Cat. 8731.0) Water savings ML/1000 dwellings – 47.5 Remediation cost saving - \$1,575 per dwelling	37%	60%
1.05	Better informed decision making in synthesis projects	Amount of investment influenced – rising from \$320,000 to \$4.2m per annum over time Effectiveness of CRCWSC tools – 20% saving (observed in Fisherman’s Bend Project)	95%	95%
1.06	Water quality gains and remediation cost savings from WSUD dwellings in synthesis projects delivered early	Number of dwellings impacted – 1,463 Remediation cost saving - \$1,575 per dwelling	95%	60%
1.07	Water quality gains and remediation cost savings from improving the effectiveness of existing WSUD dwellings	Number of dwellings impacted – 5,500 Remediation cost saving – \$787.5 per dwelling (existing WSUD dwellings assumed to only be realising half of potential gain).	37%	60%
2.01	Transportation cost savings from infill development enabled using CRCWSC outputs	Additional infill dwellings enabled – rising from 1,000 to 4,000 per annum Transportation cost saving per dwelling - \$20,925	24%	95%
2.02	Infrastructure cost savings from infill development enabled using CRCWSC outputs	Additional infill dwellings enabled – rising from 1,000 to 4,000 per annum Transportation cost saving per dwelling - \$21,387	24%	85%

## Assumptions for estimating impacts in Research Program 3

Impacts	Impact Summary	Key Assumptions/parameters	Usage Probability	Impact Probability
3.01	Reduced water supply generation cost from dwelling impacted by CRCWSC outputs	Number of dwellings impacted – rising from 2,000 per annum to 10,000 per annum Water saving per dwelling – 0.095 ML per annum Value of water – Rising from \$1,500 to \$2,002 in year 7 (latest NPR data)	56%	90%
3.02	Reduced net energy usage in wastewater plants using CRCWSC outputs	Energy production enabled per plant – 1.25m kWh Number of full scale plants – rising from 0.5 to 17 Energy cost savings \$0.2/kWh	38%	60%
3.03	Value of phosphorous production in wastewater plants enabled by CRCWSC outputs	Phosphorous production per plant – 27,500 kg per annum Number of full scale plants – rising from 0.5 to 17 Value of phosphorous – \$7/kg (\$5 commercial + \$2 saving)	38%	60%
3.04	OPEX and depreciation cost savings for utilities partners using CRCWSC outputs	Total OPEX impacted – \$984m (latest NPR data) % of network covered – rising from 5% to 80% OPEX saving – 20% Depreciation cost base – \$313m (latest NPR data) % depreciation savings – 10%	22%	90%
3.05	Water supply savings (leakage reduction) from using CRCWSC outputs	Leakage reduction enabled – rising from 317ML per annum to 6,330ML per annum Value of water – Rising from \$1,500 to \$2,002 in year 7 (latest NPR data)	60%	90%
3.06	Water supply savings (leakage reduction) observed in demonstration project	Leakage reduction enabled – 896ML per annum Value of water – Rising from \$1,500 to \$2,002 in year 7 (latest NPR data)	100%	100%



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