



CRC for
Water Sensitive Cities

Summary of Research Outputs

(Tranche 1, 2012/13 – 2016/17)

Draft for consultation purposes only



Australian Government
Department of Industry,
Innovation and Science

Business
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Centres Programme

Summary of Research Outputs (Tranche 1, 2012/13 – 2016/17)

Draft for consultation purposes only

Authors

Megan Farrelly ^{1,2} Briony Rogers ^{1,2} Fiona Chandler ^{2,3} Kim Markwell ⁴ Sally Boer ⁴

¹ Monash University, ² CRC for Water Sensitive Cities, ³ International WaterCentre, ⁴ E2Designlab

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Cooperative Research Centre for Water Sensitive Cities

Level 1, 8 Scenic Blvd, Clayton Campus
Monash University
Clayton, VIC 3800

p. +61 3 9902 4985

e. admin@crcwsc.org.au

w. www.watersensitivecities.org.au

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Introduction

Document purpose and audience

This document presents a summary of the research outputs delivered by the Cooperative Research Centre for Water Sensitive Cities (CRCWSC) during its first phase or tranche 1 from 2012/13 through to 2016/17 .

This summary has been developed to provide the CRCWSC participants and future end users, including government, water utility and industry groups with a quick guide of the key research outputs and how they relate to some of the key issues facing practitioners in delivering water sensitive city outcomes.

The intent of this summary is to communicate the extent of research undertaken in Tranche 1 and to help guide discussions on identifying the future research needs for the CRCWSC in its second tranche (Tranche 2) or stage of the research program.

Embracing the future.

We have world leading researchers, foresight and innovative culture to spearhead water sensitive cities into the future.

We bring together interdisciplinary research expertise and thought-leadership to equip the industry's best practitioners, policy makers and regulators to help innovate and develop liveable, resilient and sustainable cities around Australia and the world.

4 research programs = **38** research projects

Resulting in more than 130 research outputs.

85 participant organisations

More than **150** researchers and **64** PhD candidates from **7** universities, and **78** industry and government based organisations around Australia.

245 participant and stakeholder interactions hosted by CRCWSC since 2012

How to use the document

All of the completed and anticipated outputs associated with Tranche 1 research are included in this document. These are presented individually in summary tables throughout the document, with a short description of the output and the product type (training, guideline, literature, model etc.).

For ease of use, the 'Transition Pathways' framework has been used to group Tranche 1 research outputs into key themes to assist document users locate research outputs which are relevant and of interest to different end-user groups and contexts. The transition pathways framework identifies 3 key pathways along which change needs to be pursued if cities and regions are towards more water sensitive systems. These are:

1. On-ground practices = what gets done on the ground to deliver water sensitive city outcomes
2. Enabling structures = the broader social, political and economic framework in which urban water management takes place
3. Socio-political capital = support for pursuing the water sensitive city goals

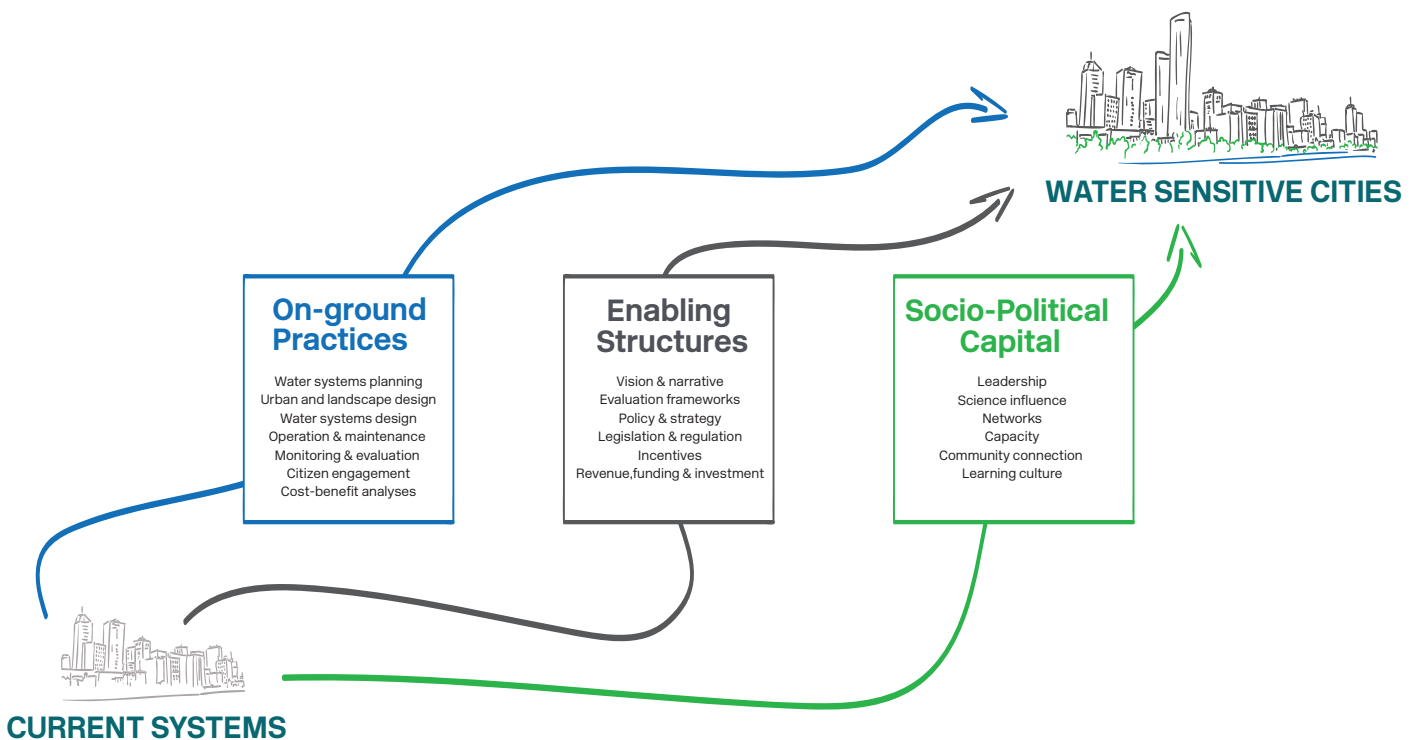


Figure 1 – Transition pathways

Not all elements identified in the transition pathways diagram have been explicitly addressed in Tranche 1 and therefore have no associated research outputs. These transition pathway elements are therefore not presented in this document. The following table shows the groupings of the research outputs summarised in this document.

There are also a number of Tranche 1 research outputs which can relate to more than one transition pathway element. In these cases, the research output is described under the most relevant transitions pathway element, and is also listed in italics under other categories.

1 On-Ground Practices	2 Enabling Structures	3 Socio-Political Capital
<ul style="list-style-type: none"> a. Water systems planning b. Urban and landscape design c. Water systems design d. Operation and maintenance e. Citizen engagement f. Cost benefit analyses 	<ul style="list-style-type: none"> a. Vision and narrative b. Evaluation frameworks c. Policy and strategy d. Legislation and regulation 	<ul style="list-style-type: none"> a. Science influence b. Capacity c. Community connection

1 On-ground practices

a. Water systems planning: Planning of urban water infrastructure

To enable the transition to water sensitive cities, water systems planning should be cross sectoral and highly integrated with urban planning. Uncertainty should be addressed through flexibility and contingency planning incorporates many future scenarios.

Why this is important

Planning of our water infrastructure to-date is often done in isolation of the broader planning of our urban environments and other social and built infrastructure.

Tranche 1 research

Projects were aimed at creating whole of landscape planning frameworks for water infrastructure which engage with urban planning and consider all options to identify resilient and diverse strategies which account for future uncertainties

Research activities summary

Overall, Tranche 1 research activities have:

- Assessed tools and frameworks used to inform water infrastructure planning
- Created guidance material and frameworks / models to inform collaborative planning processes

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Strategic assessment of water security for Perth, Melbourne and Brisbane (Catchment-scale landscape planning for water sensitive cities in an age of climate change - Project B1.2)	<ul style="list-style-type: none"> Assessment using the conceptual urban metabolism framework to determine the level of water security (floods and drought perspective) in Perth, Melbourne and Brisbane 				x				x
Urban water portfolio modelling for hedging supply risks (Economic modelling and analysis - Project A1)	<ul style="list-style-type: none"> An optimal urban water portfolio model that hedges against supply risks from all potential water assets, by taking into account uncertainties of water flows as well as differences in supply costs Economic algorithm to determine the optimal balance of three sources of water – desalination, reservoirs and stormwater harvesting Evidence of the economic value of stormwater harvesting as part of a portfolio of sources 				x			x	x
Web-based modelling platform to facilitate collaborative planning and decision-making processes (Social-technical modelling tools to examine urban water management scenarios - Project A4.3)	<ul style="list-style-type: none"> Provides interfaces with existing software tools, accesses cloud-computing capacity and allows multiple organisations to access common datasets, models and scenarios to facilitate collaboration 							x	x
Spatially interlinked database to describe a virtual urban environment (Social-technical modelling tools to examine urban water management scenarios - Project A4.3)	<ul style="list-style-type: none"> Database of spatially interlinked biophysical, infrastructural and socio-demographic data, including publicly available data (e.g. land use, BOM) 								
Guidance manual for participatory planning processes (Social-technical modelling tools to examine urban water management scenarios - Project A4.3)	<ul style="list-style-type: none"> Guidelines for facilitating participatory processes with community and professional stakeholders to guide WSC transition planning, drawing on envisioning and backcasting techniques 		x						
Guidance and recommendations on the development of effective and robust water management strategies (Social-technical modelling tools to examine urban water management scenarios - Project A4.3)	<ul style="list-style-type: none"> Advice on development and implementation of adaptation strategies based on review of case studies Key opportunities to link this with wastewater treatment models and receiving water modelling 	x							

1 On-Ground Practices

b. Urban and landscape design: Designing urban environments for water service delivery

To enable the transition to water sensitive cities, urban and landscape design should enable water service delivery to be an integral part of the built environment. Well connected green spaces and public areas should be fundamental in fulfilling important amenity and functional benefits and local aspirations should directly inform the design process.

Why this is important

Design of our water infrastructure to-date has been disconnected from the community's expectations that infrastructure should be aesthetically pleasing and provide enhanced ecological functioning. Concealing and separating water infrastructure from our built environments and landscapes disengages the community from these essential services and results in a loss of ecosystem services in our urban landscapes.

Tranche 1 research

Projects were aimed at building knowledge of how our urban water environments can be designed to be resilient to change, provide amenity, recreational and biodiversity values as well as treat urban water.

Research activities summary

Overall, Tranche 1 research activities have:

- Built evidence on how important water and green landscapes are in our urban environments
- Created guidance material and frameworks / models to inform the design of our urban areas to protect waterway and groundwater health and provide microclimate and amenity benefits.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
WATERWAY HEALTH									
Management guidelines for the repair of urban freshwaters (Planning, design and management to protect and restore receiving environments - Project B2.23)	<ul style="list-style-type: none"> A technical manual that presents a decision support framework to guide management decisions about how best to spend on-ground effort to achieve the desired ecological goals 		X						X
Conceptual models describing the key stressors to urban waterways (typologies) (Planning, design and management to protect and restore receiving environments - Project B2.23)	<ul style="list-style-type: none"> Diagrams illustrating how the key drivers of ecosystem health and function differ among physiographic regions and with characteristics of urban development and infrastructure 							X	
Set of indicators for assessing the ecological health of urban waterways (Planning, design and management to protect and restore receiving environments - Project B2.23)	<ul style="list-style-type: none"> A set of parameters that can be readily measured in urban freshwaters and can provide a rapid assessment of ecosystem health 								X
SHALLOW GROUNDWATER ENVIRONMENTS (2-4m)									
Understanding of the groundwater/surface water interactions in the Perth Coastal environment based on data assessment (Hydrology and nutrient transport processes - Project B2.4)	<ul style="list-style-type: none"> Background information to assist understanding of groundwater/surface water interactions in the Perth Coastal environment based on meta-analysis of urban water monitoring datasets 				X				
Data and knowledge gaps report for urban systems impacted by groundwater (Hydrology and nutrient transport processes - Project B2.4)	<ul style="list-style-type: none"> Identification of urban water data and knowledge gaps for urban systems impacted by groundwater to help define research activities to further develop and validate conceptual model of groundwater/surface water interaction 		X		X				

Research outputs	Description	Product type						
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database
GREEN SPACES AND GREEN INFRASTRUCTURE								
Integrated greenspace framework (Catchment-scale landscape planning for water sensitive cities in an age of climate change - Project B1.2)	<ul style="list-style-type: none"> Determination if current plans in the case study regions incorporate a formal greenspace framework that implicitly links the urban areas hydrologically and ecologically with their region For regions that do not have a formal greenspace framework, identification if there are elements within the existing plans that could be- readily adapted into a greenspace framework 				X			
Advice on the aesthetic design for raingardens based on landscape perceptions (Society and institutions - Project A4.1)	<ul style="list-style-type: none"> Report on landscape perceptions (drafted) and input into the adoption guidelines for biofilters 				X			
New green technologies performance (Integrated multi-functional urban water systems - Project C4.1)	<ul style="list-style-type: none"> Results from monitoring new technologies including living walls and green walls for greywater treatment and stormwater treatment 				X			
Advice on integrating WSUD in existing and new urban areas based on review of international and national case studies (Urban intensification and green infrastructure - Project D5.1)	<ul style="list-style-type: none"> The document will focus on integrated outcomes of WSUD within existing suburbs and new urban development (greenfield) from national and international best practice case studies of WSUD and its impact to urban development/ form The case studies will inform and be part of the design toolkit (due mid 2016) 				X	X		
Adoption guidelines for the design, maintenance and operation of new green technologies (Integrated multi-functional urban water systems - Project C4.1)	<ul style="list-style-type: none"> Design, maintenance and operational guidelines for green and living walls technologies 		X					

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
MICROCLIMATE									
Quantified benefits of water sensitive urban design and urban greening on the urban climate and urban heat mitigation at a range of scales (Green cities and microclimate - Project B3.1)	<ul style="list-style-type: none"> Empirical evidence of observational (including remote sensing) and climate modelling approaches to quantify the potential air temperature reductions and changes to human thermal comfort from the implementation of WSUD and urban greening 				X			X	
Evaluation of the benefits of improved urban climates on heat-health outcomes (Design of public realm to enhance urban microclimates - Project B3.2)	<ul style="list-style-type: none"> Documentation of the heat-health thresholds for Australian capital cities and the spatial variability in heat vulnerability throughout cities Determination of the effect on heat-health outcomes of urban heat mitigation (air temperature reductions) from WSUD and urban greening 				X				
Evaluation of the benefits of improved urban climates on Human Thermal Comfort (Green cities and microclimate - Project B3)	<ul style="list-style-type: none"> Documentation of the levels of Human Thermal Comfort in Australian Cities Determination of the effect of WSUD and urban greening on human thermal comfort (including air temperature, humidity, wind speed and mean radiant temperature) 				X				
Heat thresholds for Australian capital cities (Green cities and microclimate - Project B3)	<ul style="list-style-type: none"> Determination of climatic based thresholds (e.g. air temperature, apparent temperature) for Australian capital cities at which impacts on human health increase. These thresholds can act as a target for urban heat mitigation through WSUD and urban greening 				X				
Guidelines for the design of WSUD and urban greening for improved urban climate (Green cities and microclimate - Project B3)	<ul style="list-style-type: none"> Practical guidance on the design and placement of WSUD and urban greening interventions to maximise their effectiveness in improving urban climates based on observational research and the climate modelling research Design guidelines now being published 		X						



1 On-Ground Practices

c. Water systems design: Designing and implementing water service infrastructure

To enable the transition to water sensitive cities, water systems design should focus on designing at multiple scales to achieve multiple objectives and to deliver a range of benefits. Fit-for-purpose solutions should be widely used and synergies between different areas of the water cycle created and utilised.

Why this is important

Australian towns and cities often attempt to address 21st century issues with 19th century technologies which are typically large scale and designed to deliver single objective solutions.

Tranche 1 research

Projects focused on the development of innovative urban water infrastructure which integrates the management of urban water systems, allows fit-for-purpose use of water and recovers resources embedded in urban water with the aim of maximising the multiple beneficial values of urban water.

Research activities summary

Overall, Tranche 1 research activities have:

- established evidence of the benefits and risks associated with new technologies (or green infrastructure)
- developed new water technologies and datasets with accompanying guidance material to support adoption.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type						
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database
POLLUTANTS								
Chemical and microbial characteristics of stormwater (Risk and health: understanding stormwater quality hazards - Project C1.2)	<ul style="list-style-type: none"> Characterisation of the chemical and microbial qualities of untreated stormwater 				X			
Prioritisation of human health risks associated with untreated stormwater (Risk and health: understanding stormwater quality hazards - Project C1.2)	<ul style="list-style-type: none"> Prioritisation of human health risks associated with chemical and microbial hazards in untreated stormwater 				X			
Description of the influence of catchment characteristics on untreated stormwater quality (Risk and health: understanding stormwater quality hazards - Project C1.2)	<ul style="list-style-type: none"> Advice on the influence of catchment characteristics on the chemical and microbial quality of untreated stormwater 	X			X			
Recommendations for undertaking risk assessment of untreated stormwater (Risk and health: understanding stormwater quality hazards - Project C1.2)	<ul style="list-style-type: none"> Recommendations for assessing risks associated with untreated stormwater including the role of chemical surrogates 	X						
Model to simulate micropollutant behaviour in WSUD systems (Sustainable technologies - Project C1.1)	<ul style="list-style-type: none"> Model to simulate the key treatment processes within stormwater biofilters/ wetlands and bio-chemical degradation. Coupled with MUSIC hydraulic model (insitu tested) 							X
Development of a new method to identify which microbial pollutants are present and viable in stormwater before and after treatment (Fit-for-purpose water production - Project C1.3)	<ul style="list-style-type: none"> Development and validation of a molecular-based method to determine microbial pollutants viability and risks to public health that combines next generation sequencing techniques with the chemical propodium monoazide - PMA Assessment of health risks using PMA method 					X	X	

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
SMART INFRASTRUCTURE									
Model to allow rapid analysis from smart meter datasets (Intelligent urban water systems - Project C5.1)	<ul style="list-style-type: none"> A novel algorithm that will enable rapid analysis of “big data” on water usage derived from smart meters – significant demand management tool 								X
Decision support tools for pumping optimisation with multiple water sources (Intelligent urban water systems - Project C5.1)	<ul style="list-style-type: none"> Decision support tools for multi-objective optimisation of pumping with multiple water sources 								X
RECYCLED WATER / WASTEWATER									
Literature review of current and novel treatment technologies for recycling water treatment identifying benefits and limitations of both (Fit-for-purpose water production - Project C1.3)	<ul style="list-style-type: none"> Examination of the benefits and limitations of existing and possible future systems for treatment of recycling water. Key factors considered include: installation and operating costs, energy consumption, scalability, maintenance requirements, environmental and other external benefits, novelty, etc. 				X				
Development and demonstration of novel urban wastewater resource recovery technologies (Resource recovery from wastewater - Project C2.1)	<ul style="list-style-type: none"> Proof-of-concept in novel resource recovery – potential for further development of commercial outputs. Demonstration site now secured with Queensland Urban Utilities 					X	X		
Development of novel treatment systems for reclaimed water (Fit-for-purpose water production - Project C1.3)	<ul style="list-style-type: none"> Low-cost and low-energy consuming filtration systems for treatment and reuse of reclaimed water 						X		
Guidelines for the use and application of novel wastewater treatment systems (Fit-for-purpose water production - Project C1.3)	<ul style="list-style-type: none"> Supporting technical information for novel treatment system 		X						

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
CENTRALISED & DECENTRALISED SYSTEM INTERACTIONS									
Characterisation of the interactions between centralised and decentralised water delivery systems (Managing interactions between decentralised and centralised water systems - Project C3.1)	<ul style="list-style-type: none"> Literature review/report on centralised and decentralised water delivery systems documenting the risk factors affecting a decentralised wastewater recycling schemes. 				X				
Recommendations for modelling and integration of decentralised systems (Managing interactions between decentralised and centralised water systems - Project C3.1)	<ul style="list-style-type: none"> Three models considered - Water distribution network model EPANet, SewerX, wastewater treatment plant (IWA's ASM, ADM) Case studies provided on the application of the linkages of the various models 	X				X			
Models to assess the impacts of changes in water use practice on downstream collection system (odour and corrosion, GHG emissions and sedimentation) (Managing interactions between decentralised and centralised water systems - Project C3.1)	<ul style="list-style-type: none"> Models (based on SewerX model) to describe the impacts of implementation of decentralised systems on centralised systems. The models will provide support minimising the impacts and optimising function of the sewer networks. Due late 2015 								X
Decision support platform to integrate models to assist decision making (Managing interactions between decentralised and centralised water systems - Project C3.1)	<ul style="list-style-type: none"> A platform for integrating the three models (Water distribution network model EPANet, SewerX, wastewater treatment plant - IWA's ASM, ADM) to aid decision making 								X
RISK									
Analytical framework for identifying risk perceptions (Society and institutions -Project A4.1)	<ul style="list-style-type: none"> Framework identifying personal and professional attributes that might influence perceived risk of alternative urban water systems and sources, in order to understand and anticipate possible risk perceptions 								X
Report on current risk perceptions of Australian urban water practitioners towards alternative urban water systems, technologies and sources (Society and institutions - Project A4.1)	<ul style="list-style-type: none"> Report drawing together conclusions from empirical study of risk perceptions of Australian urban water practitioners towards alternative urban water systems, technologies and sources, highlighting barriers to their implementation in the water sensitive city 				X				

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
FLOODING									
Methods for describing hydrological hazards (Building socio-technical flood resilience – spatio-temporal flood risk modelling - Project B4.1)	<ul style="list-style-type: none"> • Methods for describing concurrent hydrologic hazards developed in Denmark and to be tested in Australia 		X			X			
Flood risk modelling tool (Building socio-technical flood resilience – spatio-temporal flood risk modelling - Project B4.1)	<ul style="list-style-type: none"> • A flood risk modelling tool which integrates an economic valuation of physical assets threatened by these hydrological hazards • Method to be tested in Australia 								X
Module linking flood risk modelling tool with DANCE4Water (Building socio-technical flood resilience – spatio-temporal flood risk modelling - Project B4.1)	<ul style="list-style-type: none"> • A module that dynamically links the integrated flood risk modelling tool with the DANCE4Water platform (Dynamic Adaptation for enabling City Evolution for Water) 								X
Software tool to model flood management policies (Building socio-technical flood resilience – spatio-temporal flood risk modelling - Project B4.1)	<ul style="list-style-type: none"> • Model of a novel technique for modelling flood management policies developed in the Netherlands and to be tested in Australia 								X
Accounting tool, with user guide recommendations for flood management (Building socio-technical flood resilience – spatio-temporal flood risk modelling - Project B4.1)	<ul style="list-style-type: none"> • Accounting tool that supports the application of the flood risk management policy model in Australian cities 		X						

1 On-Ground Practices

e. Citizen engagement: Interacting and engaging with citizens in decision-making processes

To enable the transition to water sensitive cities, citizens should be treated as partners in decision-making and their meaningful involvement and empowerment be actively pursued.

Why this is important

A key challenge to urban water reform is the disconnection between the community and their water systems.

Tranche 1 research

Projects were aimed at creating advice and guidance on engaging the community successfully with their water systems to allow them to make informed decisions.

Research activities summary

Overall, Tranche 1 research activities have:

- developed advice on how to engage and influence the community in water decision-making including processes and terminology to use based on an understanding of how people make decisions.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

1 On-Ground Practices

f. Cost benefit analyses: Quantifying the costs and benefits of water services

To enable the transition to water sensitive cities, cost benefit analyses should consider and quantify externalities and non-market values of water services. Investments should be based on the highest value option that incorporates market and non-market benefits as well as citizen preferences.

Why this is important

Australian towns and cities often try to meet 21st century challenges by re-investing in 19th century strategies that are now recognised as economically and environmental inefficient and not in alignment with community values and expectations. Without the inclusion of environmental and social benefits into economic evaluation frameworks used in water-related decision making, it was difficult to change the status-quo.

Tranche 1 research

Research projects were aimed at building an understanding of the drivers behind water sensitive outcomes and their economic value to allow development of economic evaluation frameworks to help promote water sensitivity.

Research activities summary

Overall, Tranche 1 research activities have:

- enhanced our understanding of the economic value of water sensitive outcomes
- developed guidance and data to help the use of economic valuation frameworks in water-related decision making.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
<p>Preferences (willingness to pay) for attributes of stormwater management (Economic valuation - Project A1.1)</p>	<ul style="list-style-type: none"> High level messages of relative priorities people are willing to pay for across NSW and Vic Evidence of communities willingness to pay for stormwater management and the ecosystem services it provides 	x			x			x	
<p>Monetary and non-market values of water sensitive landscapes (Economic valuation - Project A1.1)</p>	<ul style="list-style-type: none"> Literature review collation of empirical evidence of monetary and non-market values of water sensitive landscapes / green spaces in a working paper 				x				
<p>Economic assessment of decentralised water supply system case studies (Valuation of economic, social and ecological costs and benefits - Project A1.2)</p>	<ul style="list-style-type: none"> Evidence of: <ol style="list-style-type: none"> private benefits from rainwater tank installations and subsequent application of a public-private benefit cost framework to evaluate policy responses and integrated project evaluation of local government water recycling scheme to use treated wastewater on parks, open spaces, schools and playing fields benefits Working paper on integrated economic assessment of selected water sensitive systems and technologies 				x	x		x	
<p>Economic assessment of WSUD technology case studies (Valuation of economic, social and ecological costs and benefits - Project A1.2)</p>	<ul style="list-style-type: none"> Evidence of economic benefits associated with: <ol style="list-style-type: none"> rain gardens a living stream project the amenity value, recreational value, and ecosystem value of two CRCWSC designed constructed wetlands (Melbourne and China). Working paper on integrated economic assessment of selected water sensitive systems and technologies 				x	x			

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Cost-benefit analysis of nutrient emission case study in Western Australia's Southern River catchment (Economic incentives and instruments - Project A1.3)	<ul style="list-style-type: none"> Measurement of the rate at which emissions (nutrients) are changing - GIS analysis and database, hedonic analysis providing modelling results Links between land use change and fertiliser use (and surface / groundwater interactions) Assessment of the cost and benefits of different policies for reducing emissions including behaviour change among households, local authorities' policies and restrictions on developers to identify <ul style="list-style-type: none"> least / cost solution for Canning (treatments for public and private cost effective nutrient management plan 		X					X	
Salient method to improve non market evaluations with choice experiments (Economic valuation -Project A1.1)	<ul style="list-style-type: none"> Method available to improve non-market valuation with choice experiments (due late 2015) 							X	
Database of existing non-market values for WSUD (Valuation of economic, social and ecological costs and benefits - Project A1.2)	<ul style="list-style-type: none"> Evidence based on literature review of existing knowledge and indexing of values into a database 								X
Adaptation of UK green infrastructure online toolkit (Valuation of economic, social and ecological costs and benefits - Project A1.2)	<ul style="list-style-type: none"> The adaption of an existing UK-based online tool for evaluating green infrastructure nonmarket values 		X						
Guidelines for cost benefit assessments of water sensitive city projects (Valuation of economic, social and ecological costs and benefits - Project A1.2)	<ul style="list-style-type: none"> Guidelines (practical guide) for cost benefit analysis for water sensitive city projects i.e. on how to undertake the analysis 		X						

2 Enabling structures

a. **Vision and narrative: Aspirations of a city, how to get there and why they are important**

To enable the transition to water sensitive cities, the vision and narrative should feature a widely shared understanding of the role of water in a city which embraces all principles of water sensitivity in a locally contextualised way. The vision and narrative should also be embedded across sectors and linked to broader city aspirations.

Why this is important

Transformative change in the water sector towards water sensitive cities outcomes requires a clear vision supported by clear transitional strategies to support this change. Without this vision and transition strategy, change will be difficult.

Tranche 1 research

Research focused on facilitate collaborative workshops to help stakeholders develop visions and supporting transition strategies for Australian cities.

Research activities summary

Overall, Tranche 1 research activities have:

- Undertaken workshops and developed reports outlining long term future visions and supporting transition strategies for a number of Australian cities

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Guidance manual for facilitating participatory processes (Mapping water sensitive city scenarios - Project A4.2)	<ul style="list-style-type: none"> Focus on participatory processes with community and professional stakeholders to guide water sensitive city transition planning drawing on envisioning and backcasting techniques 		X						
<i>Report on Melbourne water sensitive city transition scenarios (Mapping water sensitive city scenarios - Project A4.2)</i>	<i>Report documenting transition scenarios for Melbourne, integrating community, practitioner and science perspectives (focus on suburb scale i.e. Elwood)</i>				X	X			
<i>Report on Perth water sensitive city transition scenarios (Mapping water sensitive city scenarios - Project A4.2)</i>	<i>Report documenting transition scenarios for Perth, integrating different stakeholder perspectives</i>				X	X			
<i>Report on Other cities water sensitive city transition scenarios (Mapping water sensitive city scenarios - Project A4.2)</i>	<i>Report documenting transition scenarios for Brisbane, integrating different stakeholder perspectives</i>				X	X			

2 Enabling structures

b. Evaluation frameworks: Instruments to facilitate coordination towards desired outcomes

To enable the transition to water sensitive cities, evaluation frameworks should be used and correspond with water sensitive city goals. They should be shared by different sectors and levels of government to promote coordination, set priorities and clarify responsibilities.

Why this is important

Water system and urban planning and design is typically undertaken in silos, making integrated water solutions difficult.

Tranche 1 research

Research focused on developing tools for the industry to use to assist in water sensitive city collaborative planning and design processes.

Research activities summary

Overall, Tranche 1 research activities have:

- developed a range of models and frameworks to assist in the collaborative planning and design of water sensitive cities
- demonstrated the use of these models through case study application
- developed capacity building training and guidelines to support the adoption of the models.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

2 Enabling structures

c. Policy and strategy: Policies and strategies that facilitate the delivery of desired outcomes

To enable the transition to water sensitive cities, policies and strategies should be coherently aligned to the water sensitive vision. They should coordinate effectively between sectors and levels of government and define how water sensitive goals should be achieved.

Why this is important

Policies which reinforce conventional water practices make it difficult to transition to new water sensitive systems.

Tranche 1 research

Research projects investigated different policies, strategies and governance structures to understand how these can hinder or support water sensitive city outcomes to develop recommendations and tools to guide future water sensitive city policy development and adaptation.

Research activities summary

Overall, Tranche 1 research activities have:

- built an understanding of the current policies, strategies and governance structures guiding water and environmental decisions
- developed recommendations and tools to guide water sensitive city policy development.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Comparison of formal vs. informal policy mechanisms for monitoring pollution and improving environmental outcomes (Economic incentives and instruments - Project A1.3)	<ul style="list-style-type: none"> Study on policy mechanisms comparing a formal regulatory mechanism with informal peer monitoring and social sanctions and examining its effectiveness in reducing pollution in waterways as compared to formal regulatory approaches 				X				
Case study reports of urban water policy development in Victoria, Queensland and Western Australia in relation to political dynamics and policy influence (Strategies for influencing the political dynamics of decision making - Project A3.3)	<ul style="list-style-type: none"> Reports of case study research based on interviews with advisors and decision makers (Victoria case study due end 2015, Queensland and Western Australia to be integrated in Science-Policy Manual due mid-2016) 	X			X	X			
New knowledge of urban water governance systems (both in Australian and beyond) (Better governance for complex decision making -Project A3.1)	<ul style="list-style-type: none"> Published review of current and recent governance and approaches and how they deal with complexity in the major cities in major cities based on literature and interviews 				X				
Policy framework inputs for stormwater management in areas with shallow water tables (Hydrology and nutrient transport processes in groundwater/surface water systems - Project B2.4)	<ul style="list-style-type: none"> Input to policy frameworks for management of stormwater in urban areas with a shallow water table (2 - 4 m below ground) 		X		X				
Preliminary report on the experience of key decision makers and stakeholders in the application of Water Sensitive Urban Design in the planning system (Statutory planning for WSUD - Project B5.1)	<ul style="list-style-type: none"> Short written report on experiences with WSUD in the planning system based on interviews with stakeholders 				X				
Comparative review and survey of statutory planning legislation, regulation and processes relevant to WSUD across five cities (Brisbane, Sydney, Melbourne, Adelaide and Perth) (Statutory planning for WSUD - Project B5.1)	<ul style="list-style-type: none"> Surveys used to scope purposes of literature review of planning policy and legislation relevant to WSUD (provides input into B5.1) 				X				

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Issues paper on the current application of WSUD and options for reform and draft recommended model of planning regulation for WSUD (Statutory planning for WSUD - Project B5.1)	<ul style="list-style-type: none"> Identification and assessment of key opportunities and constraints in planning systems relevant to the implementation of WSUD and integrated water management 				X				
Final report on the current application of WSUD and options for reform and recommended model of planning regulation and policy benchmarks for WSUD (Statutory planning for WSUD - Project B5.1)	<ul style="list-style-type: none"> The Final Report will identify best practice planning policies and standards for applying WSUD to developments of different planning scales 				X				
Literature reviews and industry notes on political dynamics, policy frameworks, tactics and strategies for researchers to influence policy (Strategies for influencing the political dynamics of decision making - Project A3.3)	<ul style="list-style-type: none"> A two-part published literature review, focusing on: <ol style="list-style-type: none"> (1) policy frameworks and theoretical aspects of political dynamics; and (2) tactics and strategies for influencing policy. Industry notes will summarise key aspects for simpler communication. 				X				
Growth scenarios report detailing methods for incorporating ecological and water science into statutory planning (Catchment-scale landscape planning for water sensitive cities in an age of climate change - Project B1.2)	<ul style="list-style-type: none"> Identification of possible reform to existing planning framework to underpin robustness in a water sensitive planning process Based on tests of the robustness of current planning framework under a series of growth scenarios 				X				
Assessment of planning policies under various growth scenarios for three case study city-regions (Catchment-scale landscape planning for water sensitive cities in an age of climate change - Project B1.2)	<ul style="list-style-type: none"> Documentation of initial policy 'test bed' model which allows planners/policy makers to test policy impacts under multiple plausible growth scenarios has been provided to end users from city regions. 				X				
Context-relevant recommendations of governance structures and strategies to support innovation and adaptability (Better governance for complex decision making - Project A3.1)	<ul style="list-style-type: none"> Recommendations to embed capacity for innovation and flexibility into urban water governance from review of international best practice and public sector reviews – for Australian cities and their contexts (based on case study reviews) 	X			X				

2 Enabling structures

d. Legislation and regulation: Legislative and regulative instruments that ensure and enable water sensitive practices

To enable the transition to water sensitive cities, legislation and regulation should promote water sensitive practices and be outcome oriented, flexible, and coordinated between sectors.

Why this is important

Legislation which is highly prescriptive and reinforces traditional water systems can hinder the adoption of new technologies and therefore constrain the use of water sensitive solutions rather than incentivise.

Tranche 1 research

The research focused on understanding the current legislative frameworks and how these help or hinder water sensitive city outcomes to enable to development of tools and guidance to inform future reform which factors in risk management..

Research activities summary

Overall, Tranche 1 research activities have:

- built an understanding of the existing legislation and regulations guiding water and environmental decisions
- developed models and frameworks for urban water reform and risk allocation with supporting guidelines for planners in the land use, environmental, landscape and natural resource management fields.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

3 Socio-Political Capital

b. Capacity: Knowledge, skills and experiences of practitioners

To enable the transition to water sensitive cities, practitioners' skills and knowledge should be cross-sectoral, multi-disciplinary and inter-organisational. Specialised skills and knowledge in core areas should be combined with a broad working knowledge of other relevant areas.

Why this is important

The transition to a water sensitive city requires practitioners to be knowledgeable across a number of different disciplines to drive the delivery of integrated solutions which look beyond the traditional urban water engineering solutions.

Tranche 1 research

Research focused on building an understanding of the current skills and knowledge in the industry to inform the development of targeted training and capacity development to support learning. The development of tools and case studies to show how this new learning can deliver water sensitive outcomes was also critical to inform this capacity building.

Research activities summary

Overall, Tranche 1 research activities have:

- built an understanding of the existing water sensitive city skills and knowledge across multiple stakeholder groups and identify opportunities for improvement
- developed tools to assist practitioners access and integrate multiple benefits of water sensitive cities
- developed training and guidelines to transfer new knowledge and build capacity for use of new tools such as the Water Sensitive Cities Toolkit.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Australian and international skills and knowledge needs assessment report (Strengthening educational programs to foster future water sensitive cities leaders - Project D4.1)	<ul style="list-style-type: none"> An assessment of the skills and knowledge needed to deliver water sensitive city outcomes across local government, state government, utilities and the private sector in Australia, The Netherlands and a selected set of Asian cities 				x				
A structured professional learning vision and set of recommendations for delivering water sensitive city outcomes (Strengthening educational programs to foster future water sensitive cities leaders - Project D4.1)	<ul style="list-style-type: none"> A report identifying and recommending opportunities for the CRCWSC to (i) invest in the development of new structured professional learning programs and courses (education and training) where gaps and sufficient demand exists and (ii) partner where existing provision or capacity exists to deliver on identified skills and knowledge needs 	x			x				
Masters level module on delivering Water Sensitive Cities (Strengthening educational programs to foster future water sensitive cities leaders - Project D4.1)	<ul style="list-style-type: none"> A professionally targeted high level module syllabus and teaching materials to introduce water sensitivity and how to deliver it through innovations in governance, technology and economics. 			x					
Set of structured professional learning programs and courses with paying participants (Strengthening educational programs to foster future water sensitive cities leaders - Project D4.1)	<ul style="list-style-type: none"> A set of structured professional learning programs and courses with paying participants delivered by a mixture of CRCWSC participants and external partners to effectively build capacity in water sensitive city outcome delivery 			x					
Updated blueprint Chapter: Research Adoption and Implementation (Officer) (Integration and demonstration through urban design - Project D1.1)	<ul style="list-style-type: none"> Revised and updated chapter in blueprint2015: stormwater management in a water sensitive city, describing the adoption, adaptation and implementation of research insights as part of Places Victoria's Officer development 				x	x			

Research outputs	Description	Product type							
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database	Model / framework
Case study applications of the Water Sensitive Cities Modelling Toolkit (Integration and demonstration through urban design - Project D1.1)	<ul style="list-style-type: none"> Documentation of application (testing and validation) of the Toolkit to specific locations 				x	x			
Seminars, reports, and site visits for demonstration projects (Integration and demonstration through urban design - Project D1.1)	<ul style="list-style-type: none"> Knowledge sharing seminars, presentations, reports and site visits focussed on CRCWSC research engagement, outcomes and insights for the Officer (Vic) and Marrickville (NSW) demonstration projects 			x		x			
<i>Engagement models for industry and stakeholders regarding design of WSUD</i>	<i>For details refer to: 1b Urban and landscape design: Designing urban environments for water service delivery</i>			x					
<i>Analytical framework for identifying risk perceptions</i>	<i>For details refer to: 1c Water systems design: Designing and implementing water service infrastructure</i>								
<i>Report on current risk perceptions of Australian urban water practitioners towards alternative urban water systems, technologies and sources</i>	<i>For details refer to: 1c Water systems design: Designing and implementing water service infrastructure</i>								
<i>Development and testing of capacity-building approaches for researchers to influence policy</i>	<i>For details refer to: 3a Science influence: The practices of science and its influence</i>								

3 Socio-Political Capital

c. Community connection: Citizens' attitude and appreciation of water and its role in the place they live

To enable the transition to water sensitive cities, citizens should be very knowledgeable about the water cycle and how the different elements of the system work together. They should be proud of their neighbourhood and water's role in the landscape, and welcome the opportunities to be engaged in managing and protecting it.

Why this is important

The disconnection between the community's water literacy, values and behaviors and the water systems supporting them was identified as a key challenge to urban water reform.

Tranche 1 research

Projects were aimed at building an understanding of the community norms and expectations in relation to water-use practices to allow potential behavioral pathways to be developed to reduce water footprints.

Research activities summary

Overall, Tranche 1 research activities have:

- enhanced our understanding of how our communities currently understand water issues and make water-related decisions.

See also 'On-Ground Practices - Citizen engagement' for more information related to research outcomes focused on how to engage with the community in the decision-making process.

The following table provides a more detailed summary of the research activities, providing a list of relevant research outputs and the types of products produced.

Research outputs	Description	Product type						
		Advice	Guidelines	Training	Literature	Case studies	Technology	Data / database
Report on the history of water use in Australia (Mapping water sensitive city scenarios - Project A2.1)	<ul style="list-style-type: none"> Book providing a historical analysis of water use in Australian households from 1788 – 2014 that identifies the social, physical, institutional, and cultural factors that have influenced water use during this period Description of cultures and contexts of water in three states 				x			
Report on Australian citizens water literacy (Engaging communities with water sensitive cities - Project A2.3)	<ul style="list-style-type: none"> Report comprising national survey outcomes of current levels of knowledge about key water issues amongst Australian citizens Report providing depth of understanding of literacy levels based on focus group analysis 				x			
Prioritised roadmap of household water behaviours for change (Accelerating transitions by influencing behaviour - Project A2.2)	<ul style="list-style-type: none"> Published database of water conservation and water quality behaviours Identification of priority water conservation and water quality behaviours and actions to target behaviours in campaigns 	x					x	
Data on the social norms for water conservation (Economic incentives and instruments -Project A1.3)	<ul style="list-style-type: none"> Analysed data on using social comparisons as a tool for water conservation from three randomised trials 						x	





CRC for
Water Sensitive Cities

Cooperative Research Centre for Water Sensitive Cities



Level 1, 8 Scenic Boulevard
Monash University
Clayton VIC 3800



info@crowsc.org.au



www.watersensitivecities.org.au