CRCWSC Research Synthesis

Discussion Paper | CRC for Water Sensitive Cities

IDEAS FOR THE GREATER DARWIN REGION



CRC for Water Sensitive Cities



Australian Government Department of Industry, Innovation and Science Ideas for Greater Darwin Region

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Key benefits

Protecting Darwin Harbour for current and future generations.

Darwin is fortunate that its key environmental asset is healthy (NT EPA, 2014). Strategic investment now will protect this asset and avoid costly rehabilitation in the future. This requires management of discharges into the harbour such as treated waste water and diffuse runoff from urbanised areas of the catchment.

Providing water security to underpin a growing economy.

Darwin is growing and demand for water will increase as its population and economy grows. Water security can come through initiatives that:

- a. Increase the volume and reliability of centralised water supplies.
- b. Diversify the water resources portfolio to reduce dependence on any one source (particularly climate dependant sources such as rainfall fed dams).
- c. Harness the water that occurs in cities as a resource.
- d. Manage water usage as a cost-effective tool to balance supply and demand.

Maintaining Darwin's famed lifestyle as the city grows and the climate changes.

The Greater Darwin Region attracts people with its verdant city landscape, natural assets, recreation on the harbour and sense of community. Urban water management approaches that deliver multiple outcomes for the community will maintain this lifestyle into the future.



Research synthesis workshop for the Greater Darwin Region

A research synthesis workshop for the Greater Darwin region was held on 29 February to 2 March 2016. This workshop brought together CRC for Water Sensitive Cities (CRCWSC) researchers and local practitioners to identify ideas for Darwin's water future.

The workshop was attended by representatives from:

- Power and Water Corporation
- CRCWSC
- Bureau of Meteorology
- · Charles Darwin University
- City of Darwin
- City of Palmerston
- CSIRO
- Department of the Chief Minister
- Department of Health
- Department of Housing
- Department of Infrastructure
- · Department of Lands, Planning and Environment
- Department of Land Resource Management
- Department of Local Government and Community Services
- Department of Transport
- Department of Treasury and Finance
- Northern Territory Environment Protection Authority
- Northern Territory Planning Commission
- · Utilities Commission of the Northern Territory

This report presents the major ideas developed in this research synthesis workshop.



Figure 2. Darwin is a celebration of water's positive influence on cities, highlighted by its Harbour and green city landscapes.

The Greater Darwin Region

The Greater Darwin region includes the City of Darwin, City of Palmerston and Litchfield Council areas. It is home to approximately 135,000 people and is one the fastest growing regions in Australia.

The region sits within the catchment of Darwin Harbour, which is also its main natural asset. The Harbour is seven times larger than Sydney Harbour and "supports aquaculture, tourism, recreation and is home to a diverse range of plants and animals. A healthy harbour is also of great significance to local indigenous peoples" (LRM, 2015). While Darwin Harbour continues to have very good water quality and supports a healthy ecosystem, pollution from stormwater and licensed waste water discharge is a growing threat, particularly as more of its catchment becomes urbanised.

Water sensitive urban design has been trialled to better manage stormwater runoff but has largely been ineffective, with systems failing. Causes have included implementation as well as design problems, including application of systems that are not appropriate to the wet-dry tropics.

Challenge: Water quality in the Harbour remains good. Managing the impacts of continuing development in its catchment will require a coordinated approach.



Figure 3. Darwin Harbour Region Report Card 2015 (Fortune and Patterson, 2015)

Urban water management in Darwin

Like other Australian cities, Darwin's water supply is based on rainfall fed dams. It also faces similar pressures from population growth, climate change and ageing infrastructure.

The majority of Darwin's water comes from Darwin River Dam with security provided by the Howard East Borefields.

Urban water demand is very high and is continuing to grow faster than the population is growing. This demand is driven by outdoor water use aimed at maintaining a green urban landscape. The wet-dry tropical climate is characterised by highly seasonable rainfall, high year-round evaporation and high average temperatures. These factors influence urban water practices and behaviours.

Initiatives are already in place to enhance water security with a focus on water conservation in the short term and capital investments in supply augmentations in the longer term. Beyond 2025 potential options include new off-stream dams (Adelaide River), augmenting existing dams (Manton Dam), new sources (desalination) as well as investigating local alternative water solutions such as rainwater, greywater and recycled water (Power and Water Corporation 2013a).



Figure 4. Darwin Region's water supply system (Power and Water Corporation, 2013a)

Challenge: Providing water security, initially by addressing high water demand.

Darwin's community

Darwin has a diverse community comprised of Indigenous and multicultural groups, defence personnel, long term and seasonal residents and tourists.

Power and Water Corporation surveyed the community in 2005 and 2012. This showed the community was aware of, and supported, water conservation behaviour. It also suggested that more needs to be done to engage the broad demographic of the community. Where the community did not support water conservation it was based on assumptions about the security of rainfall in Darwin to meet their needs (Power and Water Corporation, 2013a).

Living Water Smart has been initiated to increase water conservation behaviours. It aims to reduce water use by 25 percent over five years.



Figure 5. Diversity is a hallmark of Darwin's community (Source: www.travelnt.com)

Challenge: The water narrative is disconnected from the sustainability narrative, even though both are embedded in the "Darwin lifestyle".

What is a Water Sensitive City?

The Urban Water Management Transitions framework (Brown et al., 2009) describes six states that cities progress through as community needs evolve.



Figure 6. The Urban Water Management Transitions Framework (Adapted from Water for Victoria, State of Victoria)

Ferguson et al (2014) describes these states. The first three represent the historical developments of water services in response to the need to provide clean and reliable water supplies, a desire for better public health and the protection from flooding. In these states water services are provided through large, centralised and largely hidden systems managed on the community's behalf by utilities.

The next three states move beyond existence needs to improve the ecological health of waterways and to diversify water resources to address pressures on traditional sources arising from climate change.

The *Water sensitive city* state provides a new urban design paradigm in which water improves the amenity of the city (in addition to the benefits of the preceding states). It delivers biodiversity, public green space, healthy waterways, connected communities, water security and cultural significance that all enhance liveability.

Cities that are rapidly developing and redeveloping have an opportunity to 'leap-frog' directly to a water sensitive city state instead of evolving water infrastructure and institutions sequentially through the preceding city states.

Challenge: A water sensitive city requires a reorientation of existing urban water approaches to include both centralised and decentralised institutions and infrastructure.

Darwin as a Water Sensitive City

The *Balanced Environment Strategy* (NT Government, 2016) supports a liveable city approach. A water sensitive Darwin can be a practical demonstration of this by addressing three important determinants of Darwin's future, and addressing them in an integrated way.

Water security

Water will come from a number of sources to diversify the water resource portfolio. This substantially reduces risks associated with a changing climate while also allowing new resources to be created within the city itself to increase the efficiency of the combined water/sewerage/ drainage system.

Water security will come from a mix of supply and demand solutions, with the overall impact being greater resilience to a changing climate, capacity to meet a growing demand and improved sustainability.

Harbour

Stormwater runoff will be managed through a mixture of good urban design, technologies to treat water and converting stormwater from a nuisance into a resource used to maintain the green landscape of Darwin. Protecting the Harbour will become a clear and unambiguous goal for agencies and community alike, and success in achieving this will be celebrated.

Lifestyle

Water will continue to play a key role in supporting the social, cultural and environmental values of Darwin's community. Water and 'green infrastructure' such as parks and trees define the urban landscape, provide cooler areas to escape to on hot days and encourage outdoor recreation across a network of high quality open spaces. A healthy Harbour supports a range of recreational and economic activities and will be a tangible manifestation of community participation in planning for new water services.



Figure 7. The drivers for a water sensitive Darwin

Developing ideas for Darwin

The research synthesis workshop focused on four design questions to address the challenges and opportunities for Darwin.

Challenges:

- Water quality in the Harbour remains good. Managing the impacts of continuing development in its catchment will require a coordinated approach.
- Providing water security, initially by addressing high water demand.
- The water narrative is disconnected from the sustainability narrative, even though both are embedded in the "Darwin lifestyle".
- A water sensitive city requires a reorientation of existing urban water approaches to include both centralised and decentralised institutions and infrastructure.

Design questions:

- How can growth in water supplies protect Darwin's environment and lifestyle?
- How can we change residents' water use habits and behaviours?
- How can we adapt water sensitive urban design to the wet-dry tropics?
- · How can we promote collaboration to reorient urban water approaches?

How can the expansion of water resources protect Darwin's environment and lifestyle?

Reliable water is essential to the health and functioning of both cities and our environment. Often this results in a trade off in which water security becomes a hierarchy of needs and values. An alternative paradigm views the development of water resources as an opportunity to improve environmental sustainability and climate resilience. This can be achieved by employing the notion of a 'city as a catchment' when updating long term water infrastructure plans.

Research and investigation insights

Research shows that:

- 1. A water sensitive city can minimise the need to draw water from outside the urban catchment by considering water within the city as a potential resource the principle of a city as a catchment. By adopting an integrated approach to the planning, design and use of this water, new decentralsied water supply schemes can be developed to diversify the city's water source options.
- 2. A portfolio of different water supply sources has a lower risk adjusted cost than a single source. It follows that diversifying the sources of water supply in a city is an effective strategy to manage risks such as climate change. The research suggests that while conventional sources such as dams will continue to dominate the supply portfolios for cities, stormwater and waste water reuse can play a much larger role.
- 3. The characteristics of stormwater as a resource are well understood. This can inform catchment management and treatment design to ensure reliable water supplies. Stormwater provides a substitute for drinking water in outdoor uses such as irrigation and indoor uses such as toilet flushing.
- 4. Designs have been developed and piloted for local scale, passive systems that can produce and treat stormwater and greywater for reuse. These systems can be viable alternatives where there are constraints on centralised systems.
- 5. The community has shown a willingness-to-pay to avoid water restrictions and to adopt solutions such as rainwater tanks in drought affected cities.
- 6. Wastewater treatment plants can produce multiple resource streams water, energy and nutrients that provide an economic return and reduce the volumes of treated wastewater returned to the environment.

Observations show that:

- 1. Darwin's water supply system relies on climate dependant sources. Factors such as high evaporation and the reliability of wet season rains are significant risk factors.
- 2. Demand already exceeds yield of this system. Through demand management, *Living Water Smart* is dampening demand until the next source of water is developed. A further five gigalitres of capacity will be added in the near future with other augmentations being investigated for the longer term.
- 3. Deferring augmentations can be a significant financial benefit for a city, particularly if augmentations follow the convention in other cities to increase supply to meet a demand not expected for decades to come.
- 4. The volume of waste water and stormwater generated in Darwin far exceeds current annual water demand, although the timing of these flows throughout the year presents a challenge in making more use of them as water sources (Figure 8). Treated waste water and stormwater are typically used in cities for "fit-for-purpose" uses such as irrigation or toilet flushing.
- 5. Discharges of wastewater and stormwater have been identified as a growing threat to the health of Darwin Harbour. Avoiding discharge by reuse is a demonstration of the waste hierarchy.



Figure 8. Enough stormwater and wastewater is generated within Darwin to meet urban water needs many times over 1.

¹Recycled water volumes: Power and Water Corporation (2013a); stormwater volumes: MUSIC model.

Idea: A water resource planning framework that formally integrates concepts such as risk, resilience and sustainability in evaluating water supply options

- 1. Invest in the planned five gigalitre upgrade of Darwin's water supply (Power and Water Corporation, 2013a) and use use the time before initiating further augmentations to review the long term strategy.
- 2. Review the role of waste water and stormwater in the long term strategy, particularly to substitute potable water that is currently used to maintain Darwin's lush, green landscape.
- 3. Initiate local scale planning, particularly for urban development or redevelopment areas, to scope the potential for local scale water resource development.
- 4. Investigate options for city scale reuse projects, such as using treated alternative water sources for groundwater replenishment or to supply Manton Dam as a separate, fit-for-purpose supply source.
- 5. Identify and evaluate options in this planning process using an economic evaluation framework that includes the benefits of reducing discharges to the harbour, risk adjusted costs of different supply sources (at a city scale) and potential deferral of capital and operating costs for centralised networks (water, wastewater and drainage). The aim of this framework is to identify the optimal integration of sources, rather than choosing one option over another. Importantly it does not preclude consideration of the current planning options (eg. Adelaide River, Manton Dam).



How can we change residents' water use habits?

Darwin's water use is recognised as being very high (Power and Water Corporation, 2013b). The nature of the problem, and therefore the solution lies in understanding the diversity and values of Darwin's community. It also enables planners and policy makers to begin strategic conversations with the community about the role that innovation in water management can play in shaping Darwin's future. This design question builds on the existing *Living Water Smart* initiative to understand what can be done to increase the reach and impact of its messages.

Research and investigation insights

Research shows that:

1. Members of the 'disengaged' segment of the community in Australian cities share a number of characteristics (Figure 8). Understanding these characteristics helps to frame engagement approaches to reach them (Fielding, 2016).



Figure 8. Characteristics of the disengaged segment

- 2. People are influenced by what they think others in the community are doing and therefore what is expected of them. Change in behaviours will be more effective if there is a campaign to model new behaviours in their community.
- 3. Industry professionals tend to assume a greater level of awareness of the water cycle, and an understanding of the language of water management, than the community actually has.
- 4. Higher literacy is associated with better practice, with more informed people putting water saving devices in their homes and being more accepting to innovative water policy.
- 5. The way that water is valued has a strong influence. Some communities have experienced droughts and other communities have experienced floods. They will have different experiences of how these events were dealt with, ranging from bottom-up community driven action to top-down technological solutions from Government. These factors influence the cultures and values of water in a community. If change is needed, government needs to take control of the narrative for water and signal this change consistently in a whole-of-government approach.



Observations show that:

- 1. Darwin's community views water as being for irrigation, washing cars and boats or cleaning driveways. The community sees drinking water as an unlimited resource that is replenished each wet season. This is out of sync with the community's desire for sustainability and caring for the environment, as well as diverging from the reality of the water supply system.
- 2. High water use is the norm, both for community and Government.
- 3. Darwin's community relies on irrigated open space for recreation. These open spaces areas are largely irrigated with drinking water.
- 4. Temporary residents, such as tourists and short term workers, will have different information and incentives to a permanent resident.
- 5. Residents who relocate to Darwin often come from cities and towns where water restrictions have been common place. Nevertheless, these new residents generally adopt Darwin's water culture rather than preserving their previous values.



Idea: Community engagement for a diverse community

The *Living Water Smart* program can increase its impact using approaches designed to cater for community diversity. This will ensure that people understand the issues, shows them how these issues can be addressed and highlights what are others are doing to solve it. Specific tactics include:

- 1. **Avoiding jargon** even words like 'catchment' or 'stormwater' may not be clearly understood by some people.
- 2. **Targeting diverse groups** acknowledge that many in the disengaged segment will be temporary residents. Information can be provided at common points of entry to Darwin airports, caravan parks, property management, or places of employment. For permanent residents, strategies such as citizen science may be an efficient and effective way to build knowledge and increase ownership of water issues. This can be supported by local research institutions to ensure relevance.
- 3. Showing people what to do people may know a problem exists but not know how to act on it. Research shows that people have a good understanding of actions and concepts that are highly visible to them such as water conservation in the home. People have less knowledge about concepts beyond their home and things that are 'invisible' to them such as the treatment of water before discharge. Make the knowledge relevant and include clear calls to action that highlight the gains to them (such as financial savings or a healthy harbour). Examples of information may include:
 - Water smart rules to follow;
 - Information on the water cycle where your water comes from; and
 - Information on the financial rewards of sustainable behaviour.
- 4. Using local champions to demonstrate new social norms Champions will play a key role by modelling new behaviours. Champions can be developed in sporting clubs, community groups and indigenous centres such as the Michael Long Learning and Leadership Centre.
- 5. Leading by example through a whole of government approach Government can influence the conversation about water through its own actions and language. This includes adoption of water conservation practices, setting targets for Government's own activities and celebrating success using awards that recognise best practice to protect the Harbour.



How can we adapt water sensitive urban design to the wet-dry tropics?

Water sensitive urban design (WSUD) mimics the natural water cycle in urban catchments. This minimises the water quality and quantity impacts of stormwater runoff on waterways. By adapting the technical elements of WSUD to local conditions, this approach can be successfully applied in Darwin. This adaptation process also encourages designs that integrate into the urban landscape and provide a range of benefits to the community.

Research and investigation insights

Research shows that:

- 1. WSUD can deliver multiple benefits beyond treating stormwater. It can provide amenity, mitigate the effects of higher temperatures and deliver biodiversity outcomes if designed properly.
- 2. The role of WSUD in modifying local climate and mitigating the effects of higher temperatures is understood. Cities are hotter than surrounding areas and this heat affects both our comfort and our health.
- 3. Heat vulnerability has been mapped for Darwin to show areas at greatest health risk (shown as areas in red) (Figure 11).
- 4. Even a slight reduction in temperature (1-2 degrees) in extreme heats events may save lives.
- 5. Evidence shows that WSUD can reduce:
 - a. daytime land surface temperature from greening and irrigation
 - b. daytime mean radiant temperature through shade
 - c. local-scale air temperature, which limits heat-health impacts and' after impacts
 - d. micro-scale air temperature and radiant temperature, which improves human thermal comfort.
- 6. The green landscapes created by WSUD are highly valued by the community. This value is demonstrated in the premium people pay to live adjacent to WSUD. These results are based on recorded increases in property sales compared to similar properties, adjusted for other factors that could account for price differences.



Figure 11. Heat related illness and death is influenced by: 1. Exposure to heat (eg heatwave intensity and urban design) 2. Vulnerability (eg older people are more vulnerable) 3. Adaptive capacity (eg ability to stay hydrated or use air conditioning). The areas of greatest vulnerability in Darwin have been mapped. (Source - http://www.mappingvulnerabilityindex.com/)

Observations show that:

- 1. WSUD adopted in Darwin to date has used designs better suited to locations with more regular rainfall patterns. These systems have been unsuccessful in the wet-dry tropical climate and are unsustainable without a regular water supply to maintain the vegetation.
- 2. Dry season base flows of 1-2 mm per day have been recorded in drains from urban catchments in Darwin. This flow may come from groundwater or irrigation runoff and is consistent with observations from other tropical cities such as Townsville. These base flows can maintain soil moisture through long dry periods if incorporated into the design of vegetated stormwater treatment systems.
- 3. Natural systems provide the best templates for constructed stormwater treatment systems. Figure 12 provides an example of a system observed downstream of an urban drainage line in Palmerston.



Figure 12. This outfall at Palmerston provides a model of a sustainable, naturally occurring drainage system. It comprises (a) a *Melaleuca* forest; (b) formation of pilot channels carrying base flows; and (c) stable ground cover comprising sedges and grasses.

4. New development in Darwin already incorporates a number of climate adaptations (Figures 13a and 13b).



Figure 13a. A skillion roof and an absence of guttering are examples of tailoring house design to local conditions



Figure 13b. A high flow drainage channel in a new housing estate in Palmerston. This land (or an equivalent footprint) could be designed as a multi-functional asset for the community



Figure 14. The corridor design allows wet season flows to be stored, slowed and conveyed safely through the development. Following rainfall, flows will drain back to permanent pools which act as a refuge for mosquito predators. Weedy grass species will be controlled by shade.

Idea: A WSUD template for new development

A new WSUD template can be achieved by mimicking natural systems. It is acknowledged that individual designs will differ based on local topography, however this template provides design principles that could be applied in a range of scenarios.

Key features of the template include:

1. A network of local drainage systems within the development – While the climate and vegetation in Darwin are unique, the development fabric is essentially the same as that found elsewhere in Australia. This template addresses drainage in an urban design sense using a network of roads and drainage lines to convey stormwater (Figure 15).

The template manages stormwater run-off by distributing the required storage volumes into linear elements are integrated into the development. This drainage line includes checks for flood retardation that double as stormwater quality and quantity controls, as well as small pockets of ponded water to recharge groundwater following rain.

- A waterway corridor based on a natural waterway template The waterway corridor will function as both a stormwater treatment system and flood retarding storage. Its design mimics ecological systems found naturally in Darwin. Elements include an urban forest, sedge ground cover and a gravel trench to carry baseflows.
- 3. **Making the waterway corridor multi-functional** When it is not raining, the corridor can provide a range of services to the community such as:
 - a. **Aesthetics:** the design provides an 'urban forest' that allows wind flow and visibility through the vegetation. This area will be maintained by regular baseflows from the urban catchment to provide a passively watered landscape.
 - b. Facilitating recreational and active lifestyles: the design includes open space and parks for local residents along with pathways that provide active transport corridors.
 - c. **Providing cooling and protection from heat:** Shade is crucial to human comfort in the wet-dry tropics. The trees in the urban drainage corridor will shade adjacent road pavements and enhance comfort for those using the active transport network. The urban design is enhanced if shade trees are retained on individual allotments and nature-strips. These simple design elements help reduce local heat load on the suburb.



Figure 15. Drainage can be managed using road networks to convey stormwater to a waterway corridor which mimics natural systems found in Darwin.





Figure 16. The corridor provides open areas within the reserve and crossing points. There is minimal understory vegetation to maintain visual permeability and safety.

How can we promote collaboration to reorient urban water approaches?

No agency or organisation has complete responsibility for the water cycle in cities. Instead the water cycle is managed by the decisions of utilities, governments, regulators, councils, developers and home owners. Guiding these decisions are a mix of regulations, best practices and social norms.

Moving to a more water sensitive Darwin will require a strategy to manage this complexity and marshal the funds, resources and expertise that would otherwise have limited individual means to deliver the new water solutions required.

Research and investigation insights

Research shows that:

- 1. A vision can be instrumental in formalising collaboration and building collective capacity for change. This is particularly important if:
 - a. The water narrative needs to shift from an essential services focus to liveable cities.
 - b. The water authority is not directly responsible for these broader outcomes but must work in collaboration with others including the community.
- 2. The process of developing a vision may be transformational as it allows stakeholders to learn together, recognise the connection between their individual objectives, to understand each other's priorities and to challenge different perspectives of the conventional approach.
- 3. A stakeholder envisioning methodology that achieves these outcomes has been developed and tested (Figure 17). This approach has been shown to work effectively with both community and with agencies. The process of clarifying the shared problems and creating space for collaborative problem solving also leads to innovative solutions.
- 4. Integrated urban water solutions overlap multiple areas of regulation. Examples include water, health, environment and urban planning regulations. In many cities this regulatory overlap remains uncoordinated, although examples of integration are emerging. In Victoria, Clause 56 of the Victorian Planning Provisions requires new developments to adopt integrated water cycle management approaches. A link to water planning is achieved by referencing best practice guidelines developed by the water sector. These prescribe performance outcomes that must be achieved.



Figure 17. The elements of a visioning process.

Observations show that:

- 1. A self-assessment of Darwin's water sector by the workshop attendees shows that:
 - a. The water sector² has a number of strengths (Table 1). The water sector has the skills, the right people and a relationship with its local community. There is also a practice of adapting ideas to suit local conditions, and of using evidence to ensure the right solutions are adopted.
 - b. There are a number of other areas where further work is required. Although Darwin's water sector is well-connected, there is no clear or common purpose to guide action. There is also an opportunity to broaden the range of benefits that are being delivered by urban water management services, and to engage the community more actively in decision making.

Table 1. Assessment of Darwin's water sector as identified by the Research Synthesis workshop participants.

Strengths	Areas requiring further development
Networks Networks across organisations, sectors and level	Vision and narrative Aspirations of a city, why they are important and how to achieve them
Learning culture A professional and organisational learning culture	Operations and maintenance Integrating and managing green infrastructure in an asset base
Capacity The knowledge, skills and experience of practitioners	Cost benefit analysis and incentives Quantifying the costs and benefits – including non-market values - of water services to create better incentives
Water systems planning Planning of urban infrastructure	Citizen engagement Interacting and engaging with citizens in decision making processes
Monitoring and evaluation Improving existing practices through monitoring & evaluation	
Community connection Citizens' attitudes and appreciation of water and its role in the place they live	

Idea: Establish a common vision for Darwin that articulates the role of water

An envisioning process can engage community and agency stakeholders in a series of facilitated workshops. It is recommended that community groups and agencies be engaged separately to acknowledge the different starting points of each group and the different scale at which success will be described.

The steps include:

- 1. **Analyse the system** building a shared understanding of the system and how it currently works.
- 2. **Horizon scanning** what are the future risks to Darwin's water system, harbour and lifestyle?
- 3. **Envisioning** the creative process of building a shared vision for 50 years time by imagining conditions of a desirable future.
- 4. **Diagnosis** identfiying the challenges by validating, expanding and refining the insights from previous steps.
- 5. **Backcasting** examining how the future vision could be achieved in an approach that emphasises solving long term problems.
- 6. **Operationalising** focusing on the key areas for change and the critical strategies to implement including the importance of collaboration to mobilise the necessary resources.



Idea: Establish a high level steering group for water

A high level, whole of government steering group can sponsor this process. This group would authorise collaborative and cross disciplinary projects needed to implement any outcomes. Investigating opportunities to integrate water planning and urban planning may be a powerful first initiative and support the implementation of the proposed WSUD template. This group should establish clear and measurable outcomes for it's projects.

Idea: Strengthen science to policy partnerships

Science-policy partnerships with local and national research organisations can be adopted to use the best and most current evidence in policy making. These partnerships can be created for policy, planning and technology forums.

Idea: Implement pilots and trials of new technologies

Facilitate learning about new technologies and practices through large scale demonstration projects. This will provide evidence to assess infrastructure adaptations, demonstration to build understanding and pathways to scale up new practices.

Idea: Establish a local capacity building program

Establish a capacity building program for the Greater Darwin Region to ensure policy makers, practitioners and allied industry such as the development industry have the knowledge, common language, skills and networks to successfully implement next generation water technologies.

Conclusions

This Research Synthesis project set out to identify what a water sensitive Darwin could look like, to understand the drivers for this and to develop ideas to implement this new direction. It did this through a collaborative process lead by Power and Water Corporation and involving stakeholders from government, research institutions and councils.

It found that several challenges must be resolved to secure Darwin's water future. An opportunity lies in addressing these in an integrated manner. This will require:

- Urban water management to go beyond the provision of essential services. A greener, cooler, more sustainable city can be the outcome.
- A collaborative, whole-of-government approach.
- Adaptation of technologies to suit Darwin's climate.
- An engaged community.

The innovation behind these ideas is a framework for urban water cycle management that defines its success in the liveability of cities.

This is particularly relevant in Northern Australia. The Australian Government (2015) has signalled the growth potential of Northern Australia and the imperative to develop water resources to facilitate this. However, this agenda is too focused on rural opportunities; cities should not be ignored.

Kelly and Donegan (2014) refer to cities as the engine rooms of the Australian economy. They note that 80% of the value of all goods and services produced in Australia is generated in cities. Cities achieve this by increasing labour force participation. The Department of Infrastructure and Regional Development (2015) explains this simply: cities are where most jobs are and where most new jobs will be created. Enhancing human capital in cities will therefore be a significant driver of economic growth.

The Northern Territory is no different. Its future lies in attracting workers to live and work in Darwin and Darwin's future will be secured by water related investment that increases human capital as well as developing water infrastructure.

The template for this is outlined in the NT Government's (2016) Balanced Environment Strategy. This strategy reinforces the need to secure more sustainable and liveable cities and towns by harnessing the opportunities in urban development, population growth (increasing density of urban areas), harnessing wastes as resources and adapting to a changing climate. A water sensitive city achieves this.

The ideas for a water sensitive Darwin include:

- A common vision for Darwin that articulates the role of water.
- A high level steering group for water.
- A water resource planning framework that formally integrates concepts such as risk, resilience and sustainability in evaluating water supply options.
- Community engagement for a diverse community.
- A WSUD template for new development.
- Strengthening science to policy partnerships.
- Implementing pilots and trials of new technologies.
- A local capacity building program.

By implementing these ideas Darwin has the opportunity to re-define urban water management practice for wet-dry tropical cities. In the process it will develop expertise that has global relevance and demand. This report responds to this challenge.

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CRC for Water Sensitive Cities

The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) is a national research program that includes disciplines from the physical sciences, engineering, planning and climatology to the social sciences including economics, political science and behavioural sciences.

The CRCWSC was established in 2012 to facilitate research and industry partnerships to meet three critical drivers affecting Australian cities:

- population growth
- climate change and variability
- changing economic conditions

These drivers can act in unison to reduce water security, increase flood vulnerability, and degrade natural systems across our cities.

In collaboration with over 80 research, industry and government partners, the CRCWSC delivers the socio-technical urban water management solutions, capacity-building programs, and industry engagement required to make cities and towns more water sensitive.

Research Synthesis

Research Synthesis brings together CRCWSC researchers and local practitioners including participants and project stakeholders to identify, prioritise and apply emerging research relevant to a major urban planning and development project.

Research Synthesis focuses on the rapid adaptation and implementation of emerging research in a way that responds to local context to addresses project-specific needs. The creation of a neutral space for collaborative and constructive engagement enables complex challenges (often involving multiple agency and stakeholder interests) to be addressed.



CRCWSC Research Synthesis

Discussion Paper | CRC for Water Sensitive Cities

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