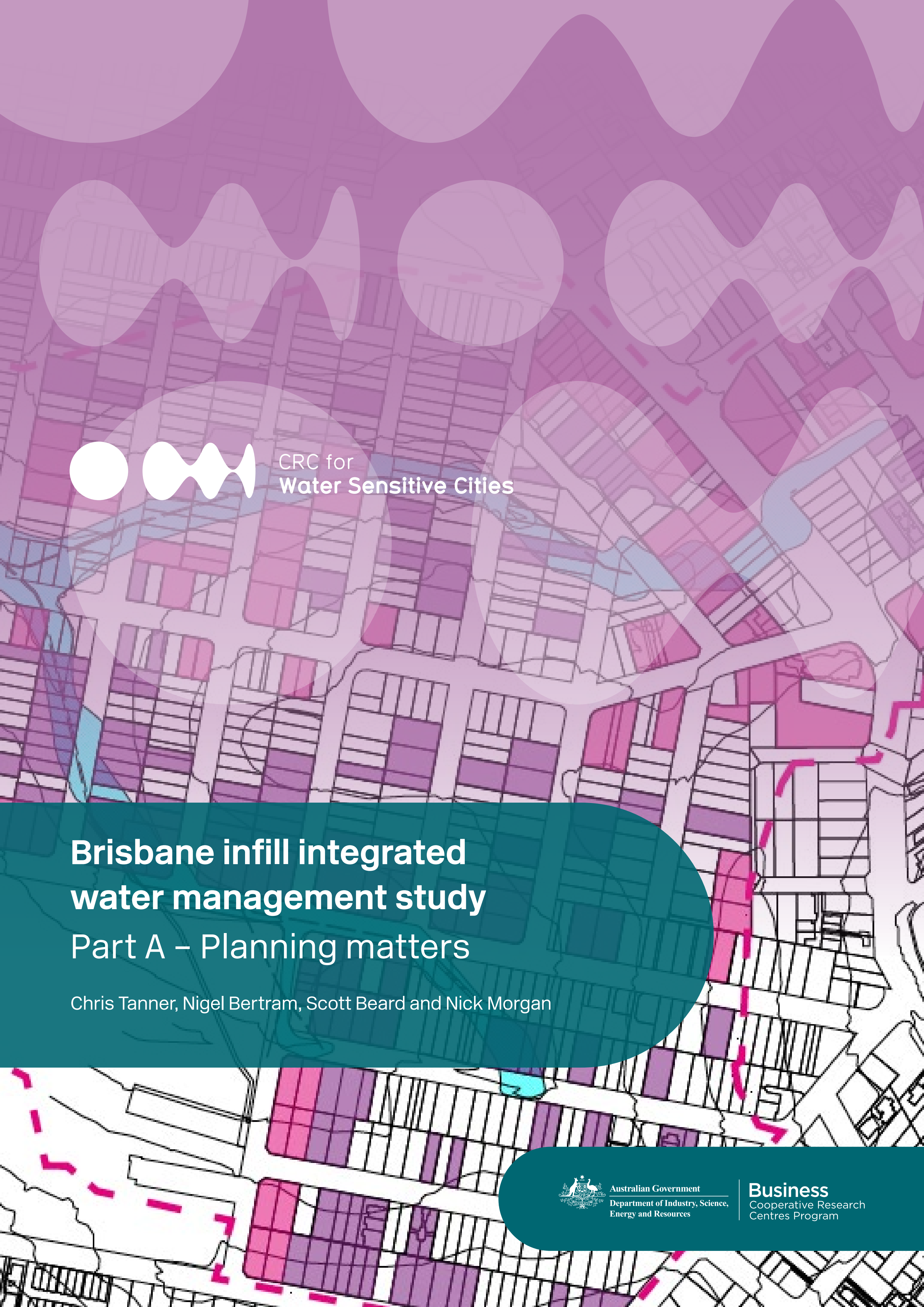

CRC for
Water Sensitive Cities

Brisbane infill integrated water management study

Part A – Planning matters

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Australian Government
Department of Industry, Science, Energy and Resources

Business
Cooperative Research
Centres Program

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CONTENTS

1 INTRODUCTION

This report by the CRC for Water Sensitive Cities (CRCWSC) investigates synergies between infill development and integrated water management (IWM). It is based on a case study undertaken by the CRCWSC and Brisbane City Council (BCC) in the Norman Creek area, Greenslopes. The report comprises two parts:

- Part A (this document) summarises the planning implications, identifies possible strategies for implementation and provides a brief commentary on the reasons for these ideas.
- Part B contains the technical investigations that underpin the ideas presented in Part A.

The purpose of the work was to better understand the impacts of a water sensitive cities (WSC) approach to infill development. The analysis includes:

- options for alternative development typologies
- bio-physical comparisons between current, business-as-usual and new, alternative typologies
- an economic comparison between current, business-as-usual and new, alternative typologies.

The work progresses the ideas developed in *Solutions for Norman Creek* (CRCWSC, 2018). It is exploratory in nature, intended to shape engagement and discussion with industry. The results are preliminary, and more detailed work is needed to gain a higher degree of certainty about the outcomes.

The work was completed by a team led by Anne Simi and Phil Young at BCC Natural Environment and Sustainability (NEWS) Branch:

- Nigel Bertram, Practice Professor of Architecture, Monash University
- Mark Gibson, City Projects Officer, BCC
- Niloo Tara, City Projects Office, BCC
- Chris Vos, City Projects Office, BCC
- Nick Morgan, NEWS Branch, BCC
- Scott Beard, NEWS Branch, BCC.

Chris Tanner (CRCWSC Queensland Regional Manager) managed the work and compiled the report.

2 INFILL DEVELOPMENT FOR A WATER SENSITIVE CITY

Water is integral to almost every feature of an urban landscape. Our cities and towns are complex, ever evolving places, and the way we interact with other people constantly changes too. In a water sensitive city, the community interacts with the urban water (hydrological) cycle in ways that:

- provide the water security essential for economic prosperity through efficient use of diverse available resources
- enhance and protect the health of waterways and wetlands, the river basins that surround them, the coast and bays, thereby offering a range of social, ecological, and economic benefits
- mitigate flood risk and damage
- create public spaces with better 'blue and green' infrastructure, enhancing liveability.

Most major cities in Australia expect intensified infill development over the coming decades (Commonwealth of Australia, 2017). Without significant intervention, this infill development is expected to have a considerable negative influence on the hydrology, resource efficiency, liveability and amenity of our cities (Jacobson, 2011; Brunner and Cozens, 2013). The water sensitive city approach aims to support higher density communities while enhancing environmental performance (Wong and Brown, 2009). It recognises the substantial effect that intensified infill development has on metropolitan water performance and urban thermal comfort, given its scale and proliferation.

Infill development, using efficient design strategies, presents an opportunity to transition towards water sensitive city outcomes (Newton et al., 2012; Newton and Glackin, 2014). Design led development can yield more outdoor space, valuable stormwater infiltration and tree canopy area. Well planned infill development can generate higher quality outdoor space and optimise resources, eventually reducing overall water and energy demand per dwelling/person (Newton et al., 2012). In addition, climate sensitive urban design can be applied to mitigate increases in urban heat associated with higher urban density (Coutts et al., 2013; Bowler et al., 2010). However, current infill practices—in this catalogue referred to as 'business-as-usual' (BAU) infill development—demonstrate poor water and thermal performance as a result of the the low site usability and overall performance (Thompson et al., 2017, pp 177–178). Large building footprints and low-rise developments result in residual and often unusable open spaces, with inadequate tree canopy cover and cross-ventilation, and poor solar access. This report explores opportunities to improve environmental performance and liveability for higher density living, proposing different typological models enabling high quality infill development to support and encourage water sensitive urban intensification.

3 TECHNICAL STUDIES (PART B REPORT) OUTCOMES

The technical studies (Part B of this report) examine development outcomes for the existing situation (EX), and compares outcomes under business-as-usual (BAU) or water sensitive city (WSC) development approaches. The studies demonstrate that a WSC approach to urban design and architecture and water servicing infrastructure results in the following:

1. A significantly higher potential development yield:
    a. In the existing scenario the study area population is estimated to be 2,670 people.
    b. Under BAU, the population increases to 4,380 people.
    c. In a WSC or WaterSmart city, the population increases to about 5,320 people.

2. A lower fraction of impervious surface (about 9% lower for WSC than for BAU), with the result that:
    a. Urban heat island effects are reduced. Figure 1 represents the change in the Urban Thermal Comfort Index[1] and shows thermal comfort results (using UTCI) for each urban design strategy when modelled for a long extremely hot period. The existing situation (or NOW) shows 60% of the total areas with a UTCI of 42 or above. BAU (or NEW) development increases to this result to 70%, while under WSC (or NEXT) this figure is reduced to 57%.
    b. Another way of interpreting these results is that there are more cool spaces to 'retreat' to in a hot period in a WSC.
    c. Stormwater runoff is reduced so waterway health is improved (Figure 3 and Figure 4).
    d. There is more space for green infrastructure.

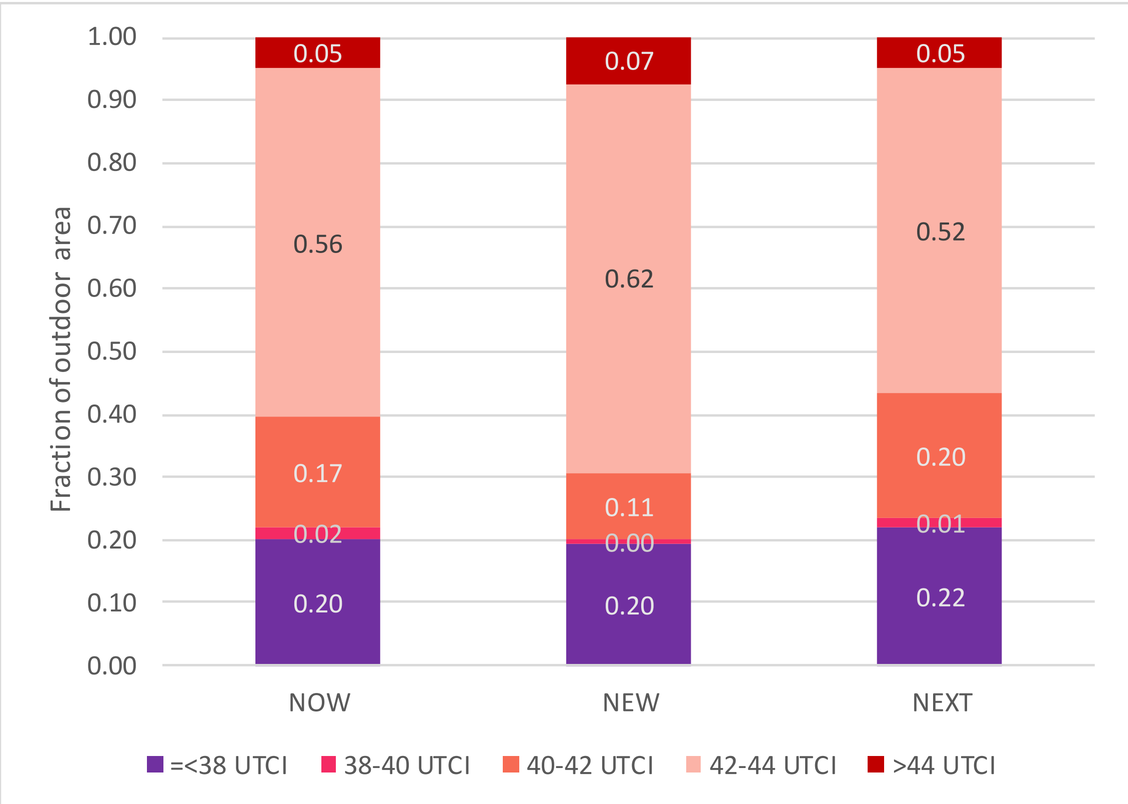

Figure 1: Proportion of outdoor areas meeting Urban Thermal Comfort Index (UTCI) thresholds

[1] UTCI - A single scale that combines the effects of various thermal comfort factors (such as air temperature, humidity, air movement and radiation) is called a THERMAL INDEX or COMFORT SCALE.

3. Improved flood and overland flow outcomes. For a 50-year average recurrence interval (ARI) storm event, an estimated 34,100 sqm of land experiences overland flow flooding in the EX scenario. Under WSC development (using a combination of stormwater harvesting (SWH) and rainwater tanks (RWT)), this area is reduced by 11% to 31,000 sqm, while BAU development increases the flooded area by 10% to 37,500 sqm. Significantly, overland flow flooding under the BAU scenario is 20% higher than the WSC scenario (Figure 2).

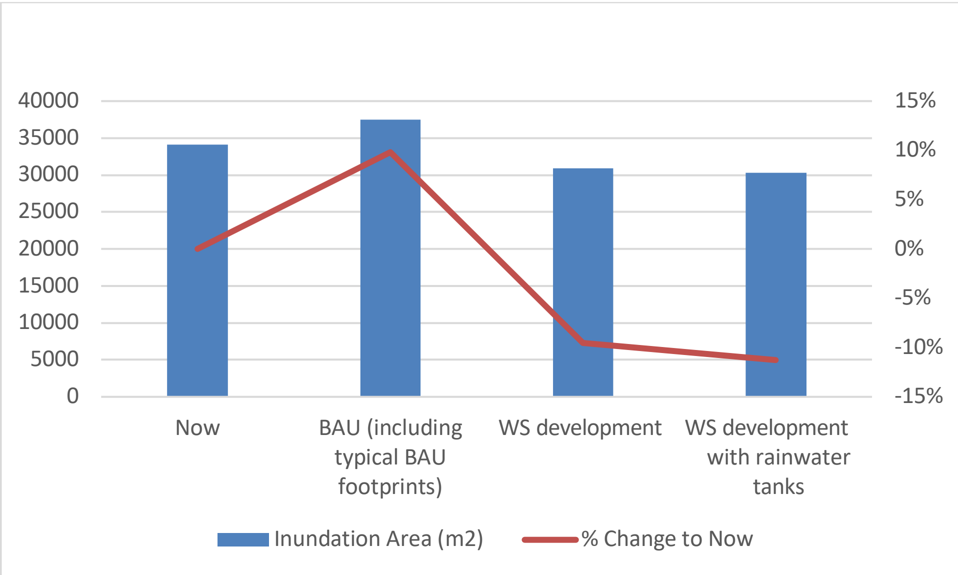

Figure 2: The effect of water sensitive development on flood impacts

4. Reduced per capita water demand and new opportunities for alternative water sources for irrigation of green areas (Figure 3 and Figure 4). Further:
    a. Alternative water can be sourced from harvesting rainwater and stormwater.
    b. Irrigating green areas, street trees, verges etc. is known to improve property values, and help manage urban heat.

These figures show that on a total basis (i.e. without factoring in population growth), infiltration and evapotranspiration are relatively static, water demand increases and stormwater runoff decreases. When considered on a per capita basis, infiltration and evapotranspiration decrease, water demand decreases by a small amount and stormwater runoff decreases significantly.

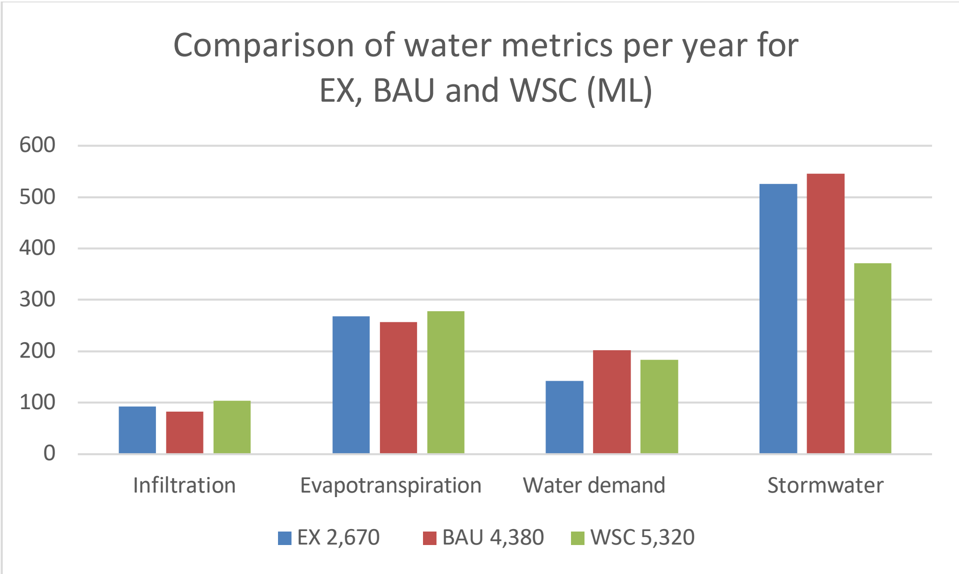

Figure 3: Total water cycle outcomes

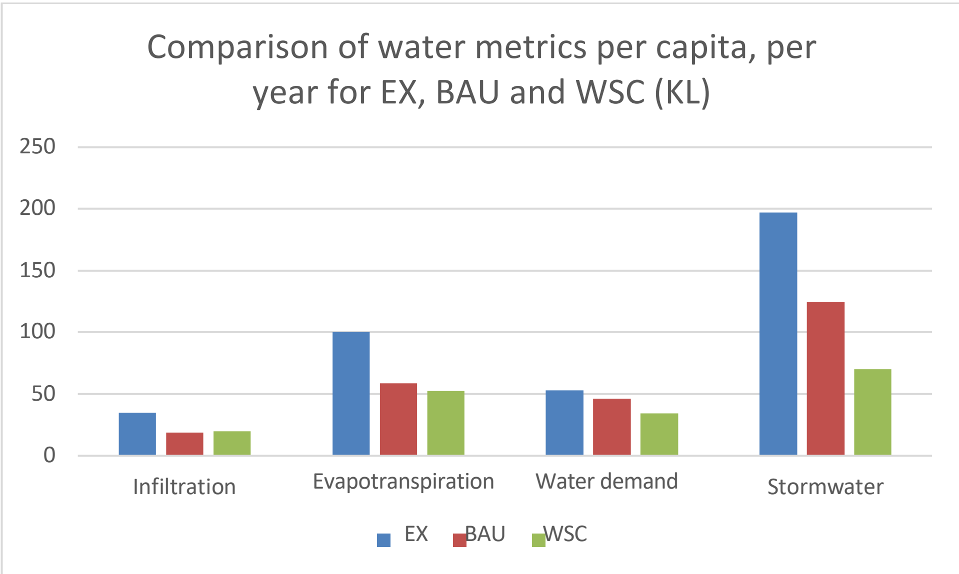

Figure 4: Per capita water cycle outcomes

5. Incorporating all of the above results into a benefit-cost assessment (BCA), indicated:
   a. a positive benefit-cost ratio (BCR) of about 2 for the overall project, underpinned by a significant economic benefit accruing to the development industry
   b. a positive BCR of about 1.3 for BCC
   c. Further, development revenue must fall by 23% to shift the BCR to an unfavourable position (less than 1).

   The BCA was undertaken using the CRCWSC BCA and Value tools.

Analysis of the relative costs and benefits is illustrated below at Figure 5, and the following comments are provided:

- Developer revenue dominates the benefits, primarily driven by the increased yield available in the WSC scenario. Nevertheless, these results need to be used with caution until the results are tested with the development industry to provide greater confidence.
- The dominant costs result from an allowance made within the analysis for council and the utility to cross-subsidise the costs of infrastructure works using revenue streams other than infrastructure charges. Infrastructure charges have been allowed for and assumed to be 100% allocated or offset against the cost of infrastructure works associated with the development.
- Benefits associated with the WSC scenario that directly affect water are significant. These benefits include reduced flood risk and reduced flood property damage, a significant reduction in stormwater runoff and entrained stormwater pollutants, savings on water supply and an uplift in property values associated with green and blue infrastructure. The utility incurs a small cost because reduced water sales will also reduce the utility's sales margin.
- Other benefits like reduced energy for cooling and reduced mortality resulting from a cooler temperatures were not included, but could be. Including these benefits would require more detailed analysis.

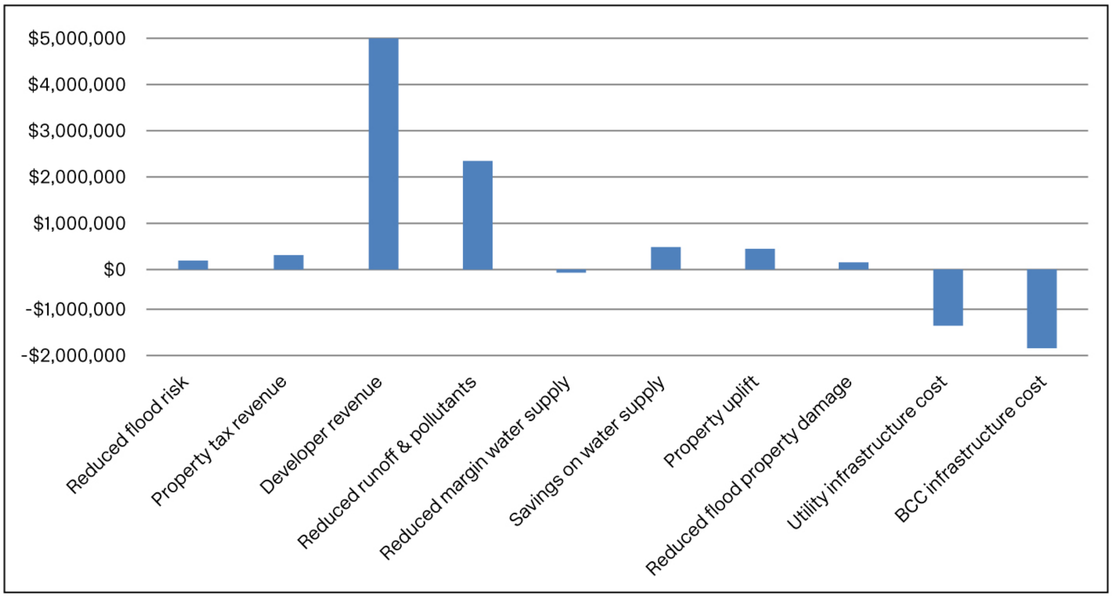

Figure 5: Breakdown of economic costs and benefits

These costs and benefits accrue to different stakeholders, as follows:

- Reduced flood risk and flood property damage, savings on water supply and property uplift accrue to households.
- Increased property tax revenue and reduced runoff benefit BCC.
- The development margin benefits developers.
- The reduced margin on water supply and utility infrastructure costs accrue to the utility.
- Other infrastructure costs accrue to BCC.

The results are positive and clearly provide a strong basis to support a WSC approach.

4 PLANNING IDEAS

The following ideas could be considered by BCC in its town planning policy. The ideas are based on the results presented above, along with the analysis that underpins those results. Each idea comprises:

- *the approach* including a description of the concept
- *implementation strategies*, with examples to be explored
- *background* and references to supporting reports.

It is considered likely that new policy or guidelines, with a mix of incentives and regulatory hurdles which may include fees or charges encouraging adoption, will be the best way to achieve implementation.

4.1 Planning Idea 1: Development typologies

- *Approach:* New infill development adopts WSC urban design and architectural typologies.
- *Implementation strategies:* for example:
  - Building typologies types A, B1, B2 and C further developed and tested.
  - Local Area Plan and related planning instruments amended to reflect the new typologies.
  - Development program put in place with the Urban Development Institute of Australia (UDIA), Property Council of Australia (PCA) and other similar institutions.
- *Background*
  - Brisbane Infill IWM Study, Attachment A – Technical report on urban design

4.2 Planning Idea 2: Enhanced overland flow corridors

- *Approach:* New development adjacent to waterways and overland flow drainage paths is arranged to enhance and provide more space for water flows.
- *Implementation strategies:*
  - Consider and investigate the economic impacts, benefits and other matters if land within the overland flow paths was arranged as drainage reserve or similar, repurposed for recreation and blue/green infrastructure, but not available for most types of development. (Given the strong BCA result, there is likely to be the opportunity to ‘quarantine’ this land while maintaining an acceptable BCA.)
  - Local area plans or similar instruments amended to reflect the new approach.
- *Background*
  - Brisbane Infill IWM Study, Attachment B – Technical report on scenario tool analysis: urban heat and water balance
  - Brisbane Infill IWM Study, Attachment C – Technical report on overland flow

4.3 Planning Idea 3: Rainwater and stormwater harvesting

- *Approach:* New development includes the storage and reuse of rainwater or stormwater with target storage of about 64 cubic metres per ha, or at a rate of around 20 dwellings per ha, with a 3 kilolitre tank per dwelling.

- *Implementation strategies:*
    - BCC to support water source substitution and encourage developers to use rainwater and stormwater tank storage via incentives e.g. density bonus yields.
    - BCC to develop water reuse strategies that maximise the outcomes from Planning Idea 4 (Urban cooling).
- *Background*
    - Brisbane Infill IWM Study, Attachment B – Technical report on scenario tool analysis: urban heat and water balance
    - Brisbane Infill IWM Study, Attachment C – Technical report on overland flow

4.4 Planning Idea 4: Urban cooling

- *Approach:* Road and frontage development includes mandatory Water Smart street trees. Development lots include mandatory trees with a target tree cover of approximately 140 trees per ha. Reuse of rainwater and stormwater to irrigate trees and surrounding vegetated areas is maximised.
- *Implementation strategies:*
    - BCC to develop typical plans and sections accommodating tree cover.
    - BCC and the development industry to engage to develop a suitable systems approach to implementation.
- *Background*
    - Brisbane Infill IWM Study, Attachment B – Technical report on scenario tool analysis: urban heat and water balance

4.5 Planning Idea 5: Development value activation

- *Approach:* BCC to develop a strategy to activate and share the values with stakeholders captured by a water sensitive cities approach.
- *Implementation strategies:*
    - Refine and test the BCA to confirm the activated value.
    - Determine a mechanism to share benefits and costs equitably with the development industry, community and BCC.

- Background
    - Benefit-cost assessment analysis and results

5 DISCUSSION

The ideas were introduced to a group of internal senior BCC stakeholders and also tested with internal BCC officers, prompting the following comments:

- BCC is constantly reviewing its planning scheme and looking for better ways of providing diverse housing types for the city. The Infill IWM study will provide a timely and useful input to this work.

- The needs of all parts of the community must be considered in strategy and implementation policy, e.g. the elderly and people with disabilities.
- It would be useful to articulate a vision for infill development and integrated water management.
- Ways to encourage duplex style development in the mix of infill development typologies could be considered.
- Participation by development industry representatives in a development project at a meaningful scale may be a useful means of discovering and resolving 'real world' issues and for development industry engagement.
- Policies across sectors need to be aligned, e.g. water and asset management, and stormwater with water and wastewater management.

It was also discussed that balancing the benefits and costs, with multiple outcomes accruing to distinct groups, will require careful consideration and is likely to require a mix of regulation and incentives to achieve adoption of these ideas.

6 CONCLUSIONS

This work investigated synergies between infill development and integrated water management (IWM) using a case study undertaken by the CRCWSC and Brisbane City Council (BCC) in the Norman Creek area, Greenslopes. The work progresses the ideas developed in *Solutions for Norman Creek* (CRCWSC, 2018). It is exploratory in nature and was intended to shape engagement and discussion with industry. It is preliminary and more detailed work is necessary to gain a higher degree of certainty about the outcomes.

The study found that water sensitive approaches to infill development were generally positive, summarised as follows:

- There was a significantly higher potential development yield.
- There is a lower fraction impervious (about 9% lower comparing BAU with WSC), with the result that urban heat island effects are reduced, stormwater runoff is reduced so waterway health is improved and there is more space for green infrastructure (planting/vegetation).
- A lower impervious fraction also results in improved flood and overland flow outcomes.
- Per capita water demand is reduced, and there are new opportunities for alternative water sources for irrigating green areas, street trees, verges etc., improving property values, and helping to manage urban heat.
- Economic analysis using the CRCWSC economics tools indicates a positive benefit-cost ratio (BCR) of about 2 for the overall project, underpinned by a significant economic benefit accruing to the development industry, and a positive BCR of about 1.3 for BCC.

The following planning ideas for adopting water sensitive practices were proposed:

- Idea 1: *Development typologies* - New infill development adopts WSC urban design and architectural typologies
- Idea 2: *Enhanced overland flow corridors* - New development adjacent to waterways and overland flow drainage paths is arranged to enhance and provide more space for water flows

- Idea 3: *Rainwater and stormwater harvesting* - New development includes the storage and reuse of rainwater or stormwater with target storage of about 64 cubic metres per ha
- Idea 4: *Urban cooling* - Road and frontage development includes mandatory Water Smart street trees. Development lots include mandatory trees with a target tree cover of approximately 140 trees per ha. The reuse potential of rainwater and stormwater to irrigate the trees and surrounding vegetated areas is maximised
- Idea 5: *Development value activation* - BCC to develop a strategy to activate and share the values with stakeholders captured by a water sensitive cities approach

BCC stakeholders considered it likely that a mix of regulation and incentives would be needed to adopt these ideas.

The work is preliminary and further work is needed to

- confirm assumptions, particularly in the economic analysis, and
- engage with other stakeholders, particularly in the development industry, utilities and the community.

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