

# **Sustainable Urban Stormwater Management in Australia: Professional Perceptions on Institutional Drivers and Barriers**

R.R. Brown<sup>1&2\*</sup> and M.A. Farrelly<sup>1</sup>

<sup>1</sup>*National Urban Water Governance Program,*  
<sup>2</sup>*Facility for Advancing Water Biofiltration*  
*School of Geography and Environmental Science, Monash University*  
*Victoria 3800 Australia*

\* corresponding author, email [Rebekah.Brown@arts.monash.edu.au](mailto:Rebekah.Brown@arts.monash.edu.au)

## **ABSTRACT**

In a time of climate uncertainty and drought in Australia, improved urban stormwater quality management practices are required not only for protecting waterway health, but also as a fit-for-purpose supply source. To conceive of urban stormwater as an environmental threat as well as a water supply source requires a substantial shift in our traditional linear supply and wastewater structures towards more hybrid and complex infrastructure systems. To understand what drives and limits treatment technology adoption for stormwater management, over 800 urban water professionals in three Australian capital cities completed an online questionnaire survey in November 2006. Using the conceptual framework of receptivity assessment, the results revealed the professional community to be highly associated with the importance of improving stormwater quality for receiving waterway health, yet they do not consider that politicians share this perspective by placing a substantially lower level of importance on stormwater quality management. Significant acquisition barriers within each city, including institutional arrangements, costs, responsibilities, and regulations and approvals processes were all identified as constraining more sustainable practices. Capacity building programs, fostering greater socio-political capital and developing key demonstration projects with training events are recommended as useful policy interventions for addressing current institutional impediments.

## **KEY WORDS**

adoption; barriers and drivers; professionals; receptivity; social and institutional; stormwater quality; treatment technologies

## **INTRODUCTION**

Urban stormwater management has undergone a transformation in recent years; from stormwater being considered as a nuisance requiring immediate and efficient drainage, to urban stormwater considered as an environmental threat (both quality and quantity) to receiving waterways in addition to being integral to more recent diverse water supply approach for cities. Indeed, in a recent report released by the Australian Prime Ministers Science, Engineering and Innovation Council (2007) the authors argued Australia needs a diverse portfolio of water supply options; thus stormwater should be viewed as a potential resource rather than as a waste product.

This shift in thinking challenges conventional technologies and management because traditional water resources management, particularly in urban environments, employs a reductionist approach whereby water supply, sewage and stormwater are controlled and managed separately through linear, engineered systems. Newman (2001) termed these as ‘19<sup>th</sup> century solutions’ which were designed to collect, store, treat and then discharge water within a framework of expansion and efficiency. However, as urban population densities increase, as waterways increasingly degrade, demand for and use of water supplies increases (Birrell *et al.*, 2005), and as variable climatic conditions continue (IPCC, 2007), a fundamental shift in the way urban water issues are perceived and managed is becoming increasingly necessary. The focus of this paper is on urban stormwater quality management.

Close to ten years ago Niemczynowicz (1999:12) argued that improved stormwater quality management requires a transition from ‘old-world’ management to one that operates in a ‘total water cycle’. Niemczynowicz highlighted the importance of facilitating a new cooperative management framework:

The future challenges within urban water management during the next decades will be to organize cross-sectoral cooperation between several actors in order to introduce innovative water technologies, management systems and institutional arrangements which are able to meet the multiple objectives.

This challenge has played center stage in the Australian innovation of the Water Sensitive Urban Design (WSUD) concept through helping to change the way urban water managers, and other professionals, think about water in our landscapes and the underpinning stakeholder relationships. WSUD aims to reintroduce the aesthetic, function and intrinsic values of waterways back into the landscape through urban design, based on contributing to the desires of place from the community and local stakeholders (Wong, 2006).

However, progress in applying these new concepts has been somewhat slow, suggestive of a range of institutional barriers impeding implementation (Brown, 2008a and 2008b, Brown and Farelly, 2007). To understand the scope of the barriers, we need to understand what an institution encompasses. Cortner *et al.* (1998), although referring more broadly to ecosystem-based management, considered an institution to be the cumulative expression of the formal and informal rules and norms that shape the interactions of humans with each other and with the environment. To this we would separate out the built and natural environment, considering our focus is on urban (constructed) environments. Therefore, a socio-institutional barrier would be one that is influenced by political, social, legal, managerial and administrative constraints (Lee, 1999:186).

Several commentators have attempted to explain the resistance to shifting to more SUWM practices and importantly, commentators are beginning to identify that major impediments are not purely technological, but rather social and institutional (e.g. Maksimović and Tejada-Guibert, 2001). Indeed, Wong (2006:1) argues that, ‘institutional impediments are not well addressed, and are often beyond current concerns of many sectors of the urban water industry, which are more concerned with strengthening technological and planning process expertise.’ Similarly, Brown (2005) argues the fragmented administrative framework constrains the way urban water management is implemented, which in turn limits the development of institutional learning. Mitchell (2004:16) also observed that current institutional structures are “known to constrain integration and innovation”. A recent review of international literature identified a range of institutional impediments such as insufficient skills and knowledge,

organisational resistance to change, lack of political will and limited regulatory incentives (Brown and Farrelly, 2007). International commentators have also identified the problem of institutional inertia and its significant impact on the transition towards more SUWM practices (see, Lundqvist *et al.*, 2001; Rauch *et al.*, 2005; Brown *et al.*, 2006).

While the scope of socio-institutional drivers and barriers are being increasingly characterised in the literature, there is little empirical and/or statistical evidence revealing the significance of such socio-institutional drivers and barriers from the perspectives of urban water professionals. Therefore, this paper presents the findings of a social science research project undertaken to address this knowledge gap. Following a description of the methods, including the analytical framework, the paper details the perspectives of urban water professionals on the social and institutional factors either encouraging or preventing improved stormwater management practices in Australia. The results are discussed and possible policy interventions for overcoming perceived limitations are identified.

The paper documents one component of a larger research project aimed at providing a credible knowledge base in support of advancing sustainable urban water management in Australia through the National Urban Water Governance Program at Monash University. The full details of this research project is presented in an industry report by Brown *et al.* (2007), and available at [www.urbanwatergovernment.com](http://www.urbanwatergovernment.com).

## **METHODS**

Three capital cities of Australia were selected for a comparative case study: Brisbane, Melbourne and Perth. These capital cities share similar drivers for re-examining their water management options and collectively, represent three distinct governance structures, reflecting the breadth of institutional arrangements across Australian cities. An online questionnaire was available to urban water professionals in November 2006. This questionnaire was run concurrently with another questionnaire focusing on drivers and barriers to the adoption of diverse water sources in Australia (see the accompanying paper by Farrelly and Brown, 2008). The purpose of the questionnaire was to test professional receptivity to 1) the importance of receiving waterway health, and 2) the level of influence twelve social and institutional variables have on constraining and/or enabling stormwater treatment technology adoption. Other questions investigated the perceived effectiveness of institutional arrangements in supporting WSUD, levels of perceived stakeholder commitment to water sensitive urban design, and projected timeframes for various treatment technologies to become mainstream practice.

Across Australia, and internationally, there are different terms used to describe the stormwater dimension of the water sensitive approach. For example, in Europe the term sustainable urban drainage (SUDs) is often used, in America the term 'low impact design' is often applied, and in Australia it can vary from 'stormwater quality treatment' through to urban stormwater quality management being considered an integral component of WSUD. The questionnaire provided a definition of WSUD for respondents to ensure consistency across the three case studies.

- Water Sensitive Urban Design (WSUD) has evolved from its early association with stormwater management and aims to ensure that water is given due prominence within urban design processes. This is through the integration of total urban water cycle thinking in the detailed planning and design of the built form. In particular, WSUD reintroduces the aesthetic and intrinsic values of waterways back into the urban landscape.

Due to the length limitations of the online survey instrument, questions targeting each individual stormwater technology could not be tested. Therefore, rather than testing the social and institutional variables for only a few possible stormwater treatment technology types, the questions were framed against the scale of technology application at the local, precinct and regional scales. The preliminary qualitative research indicated that scale could be a significant variable in the realisation of the technologies in practice.

However, some individual treatment technologies (listed in Table 1) were tested in relation to professionals' perceptions of their likely implementation timeframes. This was in part an attempt to account for the distinct lack of reliable data on implementation rates of such technologies across cities, and most importantly to assess perceptions of implementation timeframes.

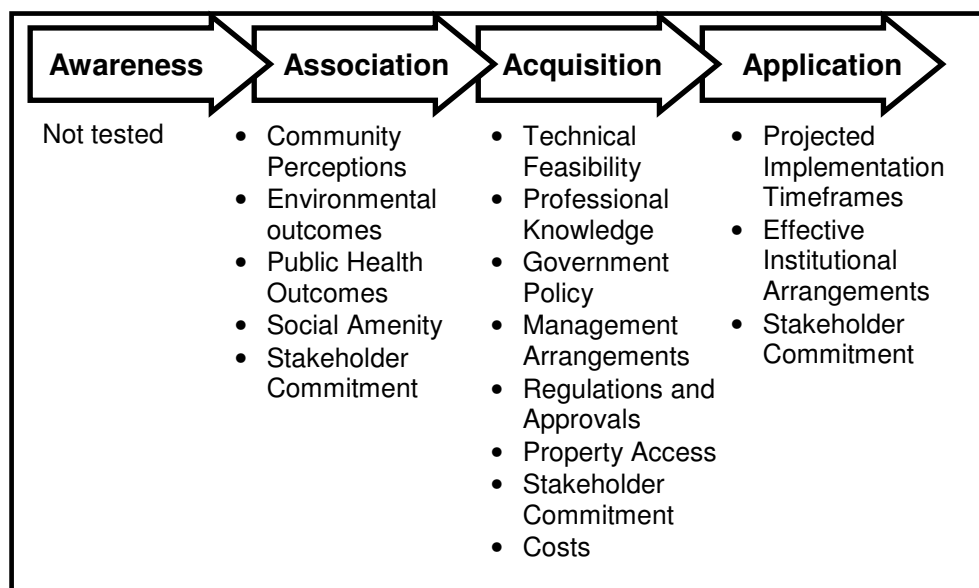
**Table 1. Stormwater Quality Treatment Technologies Tested in the Survey.**

<b>Stormwater Quality Treatment Technologies</b>	
• Treatment Wetlands	• Sedimentation Basins/Ponds
• Gross Pollutant Traps	• Porous Pavements
• Infiltration Systems	• Rain Gardens/Bio-retention Systems
• Street Tree Bio-retention Systems	• Swales

The concept of *receptivity*, drawn from 'innovation and technology transfer policy' studies (Jeffrey and Seaton, 2003/2004), was applied as the analytical framework for assessing the professional community's readiness to improve urban stormwater quality management practices in their respective cities. The philosophy behind receptivity considers that for a new technology or initiative to be successfully implemented, reform approach must be designed from the end-user or recipient's point of view. The value of the receptivity concept is that it assists with locating the types of policy mechanisms needed to improve practice. Receptivity comprises four important attributes that policy makers and strategists should be knowledgeable of from the recipient's perspective, these are:

- 1) **Awareness** - individual or organisation is aware of a problem and need for a solution.
- 2) **Association** - individual or organisation relates to the potential benefits, enough to expend effort to apply solution(s).
- 3) **Acquisition** – individual or organisation has requisite skills, capacities and support to implement solution(s).
- 4) **Application** - incentives are available to encourage the individual or organisation to implement solution(s).

The social and institutional variables tested in the on-line survey that were assessed in relation to the four receptivity attributes are listed in Figure 1. The online survey was structured so that each question would provide data on one or more of the receptivity attributes. A high level of awareness of the need for more sustainable urban water management practices amongst the professional community was assumed. Demographic data were analysed using chi-square tests to identify any significant differences amongst respondents within a range of categories: professional background, level of experience in urban water management, level in organisation, government status, main field of work, and stakeholder group.



**Figure 1. Social and Institutional Variables that Underpinned the Receptivity Assessment**

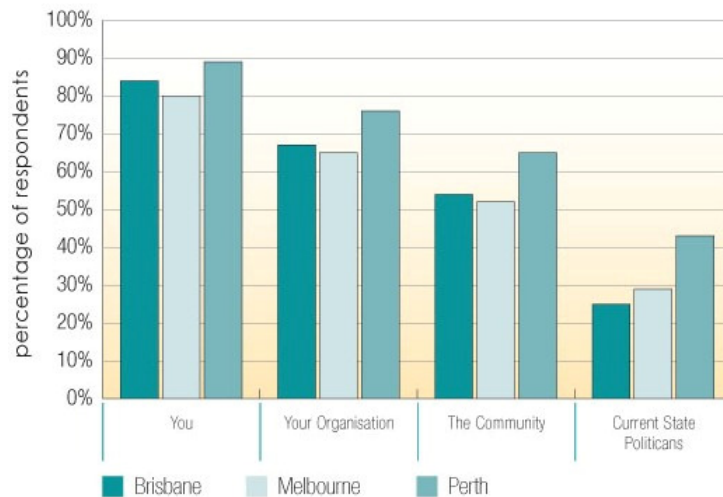
## RESULTS

Over 800 urban water professionals completed the stormwater management section of the on-line survey: 30% from Brisbane, 40% from Melbourne, and 30% from Perth. A good representation of respondents from each of the stakeholder organisations involved in urban water management in each city was achieved. The majority of respondents had more than 11 years experience in the sector with, on average, 22% of respondents having less than 2 years experience and 19% with more than 20 years experience. The majority of respondents had professional training in engineering and/or science while the remaining respondents had professional training in business and/or economics followed by planning. A similar distribution of between 20-23% of respondents in each city indicated that they worked in the specialty fields of water supply, stormwater/waterways and sewerage. Of note, 12% of respondents in each city indicated they worked in the area of 'total water cycle management' that encompasses each of the traditionally separate water streams. Over 40% of respondents in each city indicated they worked in design/technical/operations and over 30% in strategy/policy. Overall, this is relatively representative of the Australian urban water sector.

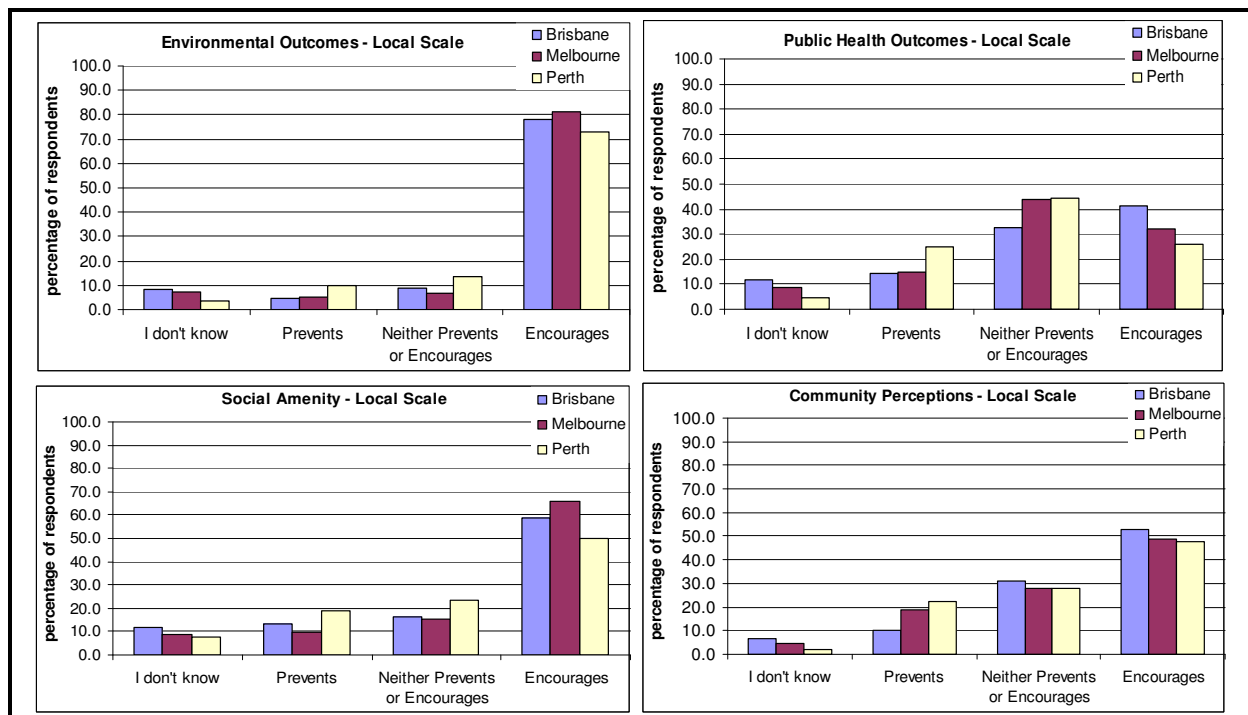
The survey was designed to test differences based on experience, professional background, stakeholder representation and city. However, there were very limited statistically significant differences from the correlation testing, with the exception of some minor differences in perspectives between respondents with professional backgrounds in planning and engineering.

### Association and Acquisition

On average, over 80% of urban water professionals across Brisbane, Melbourne and Perth indicated they place a high or very high level of importance on protecting receiving waterway health (Figure 2). However, professionals do not feel their view is as equally supported by their organisations, the community or state government politicians. The decreasing trend is common across the three cities, with a substantial difference with perceived political views.



**Figure 2. Perceived Importance of Protecting Waterway Health (high and very high responses).**



**Figure 3. Perceived Influence of Association Factors for Technology Adoption at the Local Scale.**

Environmental outcomes, community perceptions, social amenity and public health outcomes (the first four variables tested in Association receptivity as shown in Figure 1) were overall considered to be drivers across the three cities for the adoption of stormwater quality treatment technologies at local, precinct and regional scales. Figure 3 provides an example of responses to the influence of these four association variables at the local scale. Only in Melbourne and Perth were there a number of professionals who considered public health outcomes would have a neutral influence at the local scale, but overall this remained a driver.

In contrast to the high levels of association, professionals in Brisbane, Melbourne and Perth identified a number of acquisition and application barriers, particularly in Perth. The overall perceived barriers and mixed views (i.e. equally distributed between encouraging, neutral and

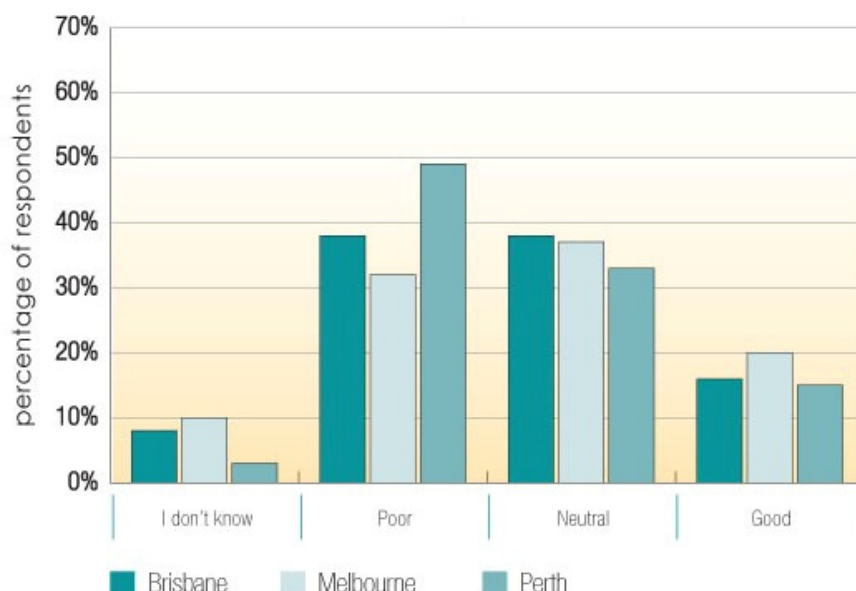
preventing) in relation to the common drivers between the three cities at across all the scales is listed in Table 2.

**Table 2. Drivers, Barriers and Mixed Views to Urban Stormwater Quality Technologies**

BARRIERS	MIXED VIEWS	DRIVERS
- Management arrangements & responsibilities	- Technical feasibility & performance	- Community perceptions
- Regulation & approval processes	- Professional knowledge & expertise	- Environmental outcomes
- Capital & maintenance costs	- Government policy	- Public health outcomes
		- Social amenity

However, there were a number of city based distinctions in the results. The ‘mixed view’ results including the influence of: a) technical feasibility and performance, b) professional knowledge and expertise, and c) government policy, were considered as drivers for the adoption of stormwater treatment technologies the regional and precinct scales in Brisbane and Melbourne; although, Melbourne respondents had ‘mixed views’ in their responses regarding the local scale. In Perth, however, the same acquisition factors were perceived to act as an outright barrier to treatment technology implementation. The only exception was for professional knowledge and expertise at precinct and regional scales, where Perth urban water professionals were mixed in their responses. Overall, property access rights were considered a neutral influence at all three scales in each city.

Figure 4 below, further emphasises the acquisition barriers faced in advancing water sensitive urban design in the three cities. A similar number of respondents in Brisbane and Melbourne considered their institutional arrangements as either poor or neutral in their effectiveness for supporting water sensitive urban design, whereas in Perth, almost 50% of respondents perceived their institutional arrangements to be ineffective.



**Figure 4. Perceived Effectiveness of Institutional Arrangements for Supporting Water Sensitive Urban Design.**

Due to a lack of reliable data on implementation rates for various treatment technologies, questionnaire participants were asked to identify how long before eight treatment technologies

would become mainstream practice in their city in both greenfield and existing development areas, based on a scale of: already integral, next 5 years, 6-15 years, 16-30 years, over 30 years, I don't know and not applicable. Overall, the majority of respondents (30% in each city) considered gross pollutant traps as already mainstream practice in both greenfield and existing development areas, and sedimentation basins as mainstream in greenfield areas. The majority of respondents projected most treatment technologies would be adopted over the next five to 15 years in greenfield areas, but were less certain over the timeframes for application in existing areas, spanning the next five to 30 years.

### **Stakeholder Commitment**

Advancing water sensitive urban design requires commitment from a variety of organisations involved in urban water management. Respondents were asked to rate the level of commitment of various organisations against the following scale: organisation/sector is fully committed, major organisational departments and internal champions are committed, increasing organisational/sector awareness and senior support, some individuals in organisation/sector are committed, no organisational/sector commitment, I don't know.

By combining the top two commitment ratings, the following organisations were perceived to be the most committed to advancing water sensitive urban design in Brisbane, the (then) Morton Bay Catchments and Waterways Partnership and Brisbane City Council; in Melbourne, Melbourne Water, and in Perth, the Department of Water. However, there were variable commitment ratings for many of the other organisations. Local governments (with the exception of Brisbane City Council), consultants and land developers were consistently regarded as only having 'some individuals committed' and 'increasing levels of awareness' in each of the three cities.

## **DISCUSSION**

The results from the online survey provides insights into a professional community which is highly associated to the benefits of protecting receiving waterway health, but also considers themselves highly constrained by a number of institutional acquisition barriers. These findings are not unique to the case studies presented here; many of the results align with other international research which has identified institutional impediments to advancing more sustainable urban water management practices (e.g. Harremões, 2002; Rauch *et al.*, 2005; Brown *et al.*, 2006). Many of these barriers are difficult to overcome for they are systemic and embedded within organisational cultures, practices and processes (Brown and Farrelly, 2007).

Further, the professional community does not feel politically supported in their views regarding the importance of protecting waterway health. Therefore the strong high association with the professional community is clearly not sufficient to galvanise widespread implementation, given the lengthy projected implementation rates (next five to 30 years) within the current rapid urban growth period across Australian cities. There will clearly be many lost opportunities in the coming years to improve urban stormwater quality. Therefore the acquisition factors which limit application need to be addressed immediately. It would appear that building socio-political capital through political and community engagement (via media and other forms of advocacy) will need to be an instrumental receptivity building activity.

Drawing from recent work by Brown and Clarke (2007), based on a retrospective case analysis of how metropolitan Melbourne transitioned from a 'drained' city to a 'waterways' city (definition of city states found in Brown *et al.*, 2008), a number of enabling context

factors were identified as supporting mechanisms for this transition. To help build the necessary acquisition levels in these Australian cities, work needs to be done on procuring 'trusted and reliable science' (particularly in Perth), establishing and supporting science-policy 'bridging organisations' and setting 'binding targets and accountability' for improved waterway health.

There were far more barriers identified in Perth, than in Melbourne or Brisbane; perhaps this reflects Perth's more complex geomorphological context, where, until recently, there was little concern around flooding due to their groundwater-dominated drainage system. More recently, however, Perth's metropolitan boundaries have encroached upon more marginal, duplex soils resulting in the need for improved drainage processes. The professional urban water communities of Melbourne and Brisbane, on the other hand, have long been exposed to the need for flood mitigation and drainage strategies, and have had the opportunity to benefit from targeted capacity building programs such as 'Clearwater' (Melbourne) and 'Healthy Waterways Partnership' (Brisbane), and have had training associated with key demonstration projects. These initiatives are designed to foster greater awareness, understanding and confidence on a range of topics related to sustainable urban water management in the respective cities. There is a strong need for a professional capacity building program around stormwater and waterways in Perth to help address the perceived professional limitations of knowledge and expertise and the acceptance of technical feasibility and performance. The recent initiative of 'New Waterways' should work towards reducing this professional capacity deficit. The development of key demonstration projects and associated training programs may also help build greater trust and confidence in the technical feasibility and performance of the various stormwater quality treatment technologies currently available.

The current research is focused on qualitatively exploring the results presented in this paper through face-to-face interviews and small industry workshops refine the scope of the most effective strategies for addressing the current institutional barriers to sustainable urban stormwater management.

## **CONCLUSIONS**

This paper has provided a statistical snapshot of the perceived social and institutional drivers and barriers to implementing improved stormwater quality management practices in three Australian cities. Professionals operating in the urban water sector were targeted to provide empirical evidence regarding influencing factors that encourage or impede the development and implementation of stormwater quality treatment technologies at local, precinct and regional scales. Framed using the concept of receptivity, this paper demonstrated how urban water professionals are aware of, and highly associate with the need to implement stormwater treatment technologies to protect waterway health. Community perceptions, environmental outcomes, social amenity and public health outcomes were all perceived as encouraging factors in technology adoption. However, there remain many serious acquisition factors that need to be addressed to support ongoing technology adoption, particularly in Perth, including management arrangements and responsibilities, regulations and approvals processes and costs. Capacity building programs, fostering greater socio-political capital and developing key demonstration projects with training events may be useful policy interventions in helping the urban water professional improve the quality of stormwater for both environmental and human benefits.

## ACKNOWLEDGEMENTS

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