WHAT'S GETTING IN THE WAY OF A 'ONE WATER' APPROACH TO WATER SERVICES PLANNING AND MANAGEMENT?

An analysis of the challenges and barriers to an integrated approach to water

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ABSTRACT

A range of factors prevents the development of institutional changes that would allow a shift to "One Water" systems. Foremost of these is the inertia associated with the dominant paradigm of centralised and siloed systems. This, together with the complex structure of regulations that currently exist for water supply, wastewater and stormwater management, poses significant obstacles to a fully integrated approach. The regulatory patchwork environment, with overlapping responsibilities and jurisdictions, particularly with respect to the need for management of both public health and environmental risks, currently hinders system integration. This paper aims to understand what institutional challenges organisations engaged in the One Water approach have faced.

INTRODUCTION

Urban water managers and policy makers around the world are struggling with the challenge of transitioning to a sustainable, integrated, urban water management approach, referred to in this paper as 'One Water'.

The One Water approach is closely aligned with, and builds upon, the extensive national and global work on integrated water resources management (IWRM) and water-sensitive urban design (WSUD) (US Water Alliance, 2013). The One Water approach strives for a move away from conventional approaches to one with greater coordination among diverse interests, stakeholders and decision-makers, recognising that water quantity and quality, whether above or below ground, depend on multi-faceted collaborations. Table 1 presents the key differences between conventional and integrated approaches.

Research to date has shown that, for the One Water paradigm to be accepted and integrated into infrastructure planning, the appropriate institutional structures need to be in place (Maheepala

Table 1. The key differences between conventional and integrated approaches to urban water management.

Aspect of urban water management	Conventional approach	Integrated approach
Overall approach	Integration is by accident. Water supply, wastewater and stormwater may be managed in the same agency as a matter of historical happenstance, but physically the three systems are separated	Physical and institutional integration is by design. Linkages are made between water supply, wastewater and stormwater, as well as other areas of urban development, through highly coordinated management
Collaboration with stakeholders	Collaboration = public relations. Other agencies and the public are approached when approval of a pre-chosen solution is required.	Collaboration = engagement Other agencies and the public search together for effective solutions
Choice of infrastructure	Infrastructure is made of concrete, metal or plastic	Infrastructure can also be green including soils, vegetation and other natural systems
Management of stormwater	Stormwater is a constant that is conveyed away from urban areas as rapidly as possible	Stormwater is a resource that can be harvested for water supply and retained to support aquifers, waterways and biodiversity
Management of human waste	Human waste is collected, treated and disposed of to the environment	Human waste is a resource and can be used productively for energy generation and nutrient recycling
Management of water demand	Increased water demand is met through investment in new supply sources and infrastructure	Options to reduce demand, harvest rainwater and reclaim wastewater are given priority over other sources
Choice of technological solutions	Complexity is neglected and standard engineering solutions are employed to individual components of the water cycle	Diverse solutions (technological and ecological) and new management strategies are explored that encourage coordinated decisions between water management, urban design and landscape architecture

Based on Pinkham (1999) – adapted by ICLEI (2011)

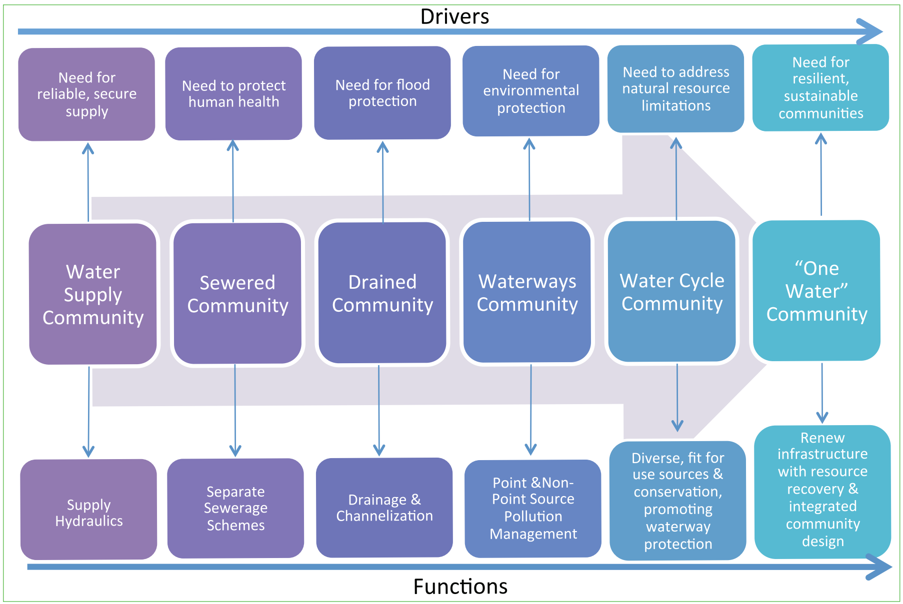

Figure 1. Sustainable integrated water management continuum (based on Brown, Keath & Wong, 2008).

et al., 2011). This includes the decisions made by various institutions that affect the management of water at different governance scales. The key drivers include environmental and financial resource constraints, infrastructure and network constraints, and public perceptions and demands, to mention a few.

The literature review presented in this paper is a summary of a study focusing on the institutional aspects of One Water systems. It explores the attributes of One Water systems, the mechanisms needed to transition to One Water and the major institutional barriers to this transition. The review is based on publicly available case studies involving the application of IUWM approaches in water, and on peer-reviewed literature and insights from urban water and transitioning experts.

ATTRIBUTES OF THE ONE WATER PARADIGM

A wide variety of collaborative networks have independently sought to define the attributes that make up an integrated One Water approach. Themes are centred on the idea of cities that are liveable, sustainable, resilient, productive and adaptable. These One Water attributes, sometimes referred to as goals or principles, set the long-term vision of where the urban water industry needs to go. Institutional innovation and capacity are fundamental to the achievement of these visions.

Brown *et al.* (2008), in their Urban Water Transitional City States, describe six phases in a transition towards the Water Sensitive City, which is akin to a One Water approach (Figure 1). Transitioning from one phase to another is seen as the natural evolution of the city in history, and the passage from one developmental phase to another is associated with different objectives and technical solutions:

- **The Water Supply City (early 1800s):** The first stage is characterised by efforts to expand piped water supply to city dwellers;
- **The Sewered City (late 1800s):** Once access to water supply is secured, emphasis moves to addressing access to piped sewerage services;
- **The Drained City (mid 1990s):** This phase is dominated by efforts at ensuring flood protection;
- **The Waterways City (late 1990s):** In this phase the aim is to achieve social amenity and environmental protection. It is characterised by the prevalence of point and diffuse source pollution management;
- **The Water Cycle City (2000s):** Limits on natural resources encourage a move to diverse, fit-for-purpose sources, conservation and the promotion of waterway protection;
- **The Water Sensitive City (Future):** The sixth and final phase is inspired by the goals of inter-generational equity and resilience to climate change. The prevalent approach to water resources management features a combination of adaptive, multi-functional infrastructure and urban design, reinforcing water-sensitive behaviours.

Most cities in Australia are situated in the Drained or Waterways stages. The linear path of water management needs to be broken and a mechanism found to accelerate or leap frog a city's progress to a One Water Community.

DRIVERS AND CHALLENGES OF THE ONE WATER APPROACH

The transition towards the One Water approach is characterised by three "dimensions or forces", viz. the push of the present, the pull of the future, and the weight of the past (Inayatullah, 2008).

The push of the present: Potable water and wastewater network and treatment facilities are becoming constrained under the current rate of population growth and densification. To upgrade these facilities is a costly exercise and generally disruptive. Substituting the demand for potable water with reused or recycled water will go some way to alleviating this impending problem. Extreme weather events such as flooding have caused substantial damage and disruption to basic services. WSUD has the potential to buffer the impacts of some of these events.

The pull of the future: Communities are beginning to demand green urban spaces that enhance liveability in the urban setting and that make use of stormwater and recycled wastewater. Innovations in the water treatment and energy sectors have resulted in cost-effective, small-scale treatment plants that have allowed a few private developers and operators to increase the marketability of new precincts. These approaches are likely to become mainstream in the future.

The weight of the past: The historically entrenched siloed approach to water management and regulation has meant that prospective developers need to engage with a complicated regulatory and institutional maze to get a scheme up and running. In addition to this, the culture, knowledge and skills to undertake integrated water planning across this sector is limited. This paper specifically focuses on these institutional challenges weighing down the transition to a One Water approach, which are discussed in detail in the following section.

LITERATURE REVIEW OF INSTITUTIONAL CHALLENGES

The major challenges identified in the review of published literature on institutional issues relating to integrated water management and water-sensitive urban design can be summed up in five key areas (Figure 2):

- Legislation and regulations;
- Economics and finance;
- Planning and collaboration;
- Culture and capacity;
- Citizen engagement.

Further analysis of the challenges revealed some underlying causes that could be linked to a number of identified challenges:

- The lack of an agreed unifying vision;
- A lack of leadership and political will due to short-term political agendas;
- No clear drivers or sense of urgency;
- Poor systems thinking and integration across water, other utilities and urban planning;
- Uncoordinated methods and processes for data collection, information sharing and messaging.

These underlying causes are theoretically not too dissimilar to those that hinder other innovative progress at the local government level (Mukheibir *et al.*, 2013) and potentially have influence over a number of challenges across the board for local governments.

LEGISLATION AND REGULATIONS

Legislation and subsequent regulations are key drivers of how organisations structure themselves, develop strategies, and plan and implement programs. They are set at many levels, from federal to state/regional to local. Legislation can include laws, acts, directives and other mechanisms. Adler (2009) concluded that a significant legal barrier to sustainable urban water management is legal fragmentation, and that a practical way forward is through incremental steps to better coordinate various components of the laws that apply to urban water management issues.

INCONSISTENCY AND OVERLAP

Recent work by ISF (ISF, 2013a) found that implementing a recycling scheme required navigating a complex and time-consuming

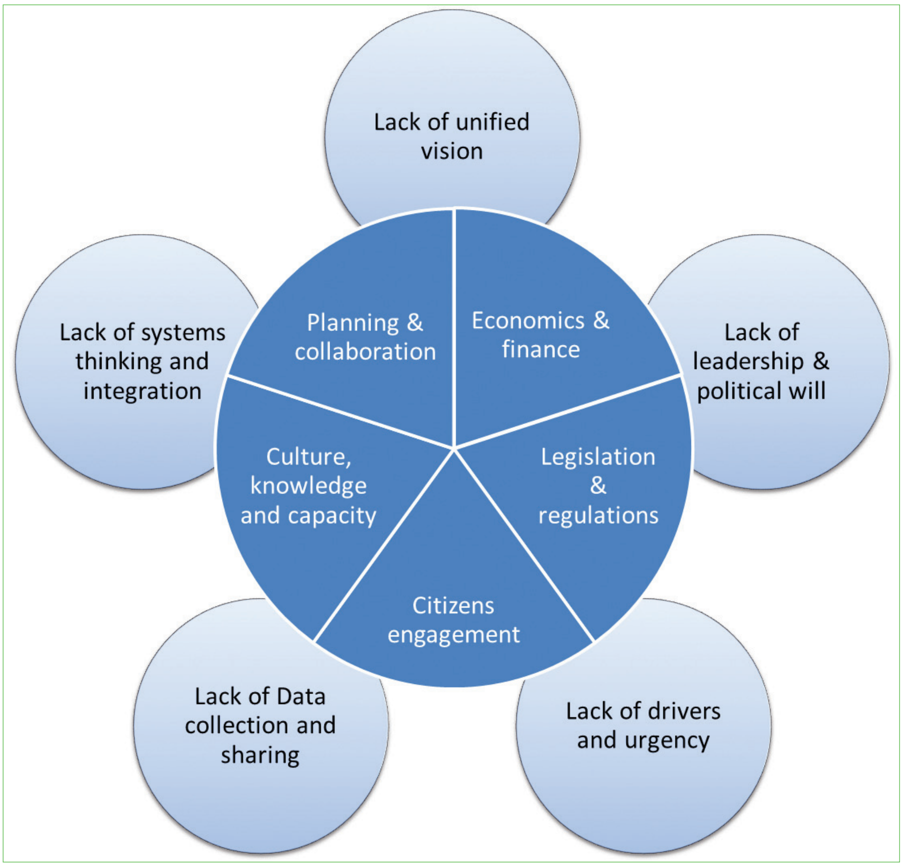

Figure 2. Barriers and their underlying causes to a One Water approach.

regulatory landscape. The complexity relates to two inter-related issues:

1. The rules and regulations themselves will shift as government seeks to improve and clarify current arrangements in this relatively new area of governance;
2. With personnel and regulatory changes, interpretation of requirements is likely to be contested and changeable.

Further, regulations are often inconsistently applied, as WERF (2007) found for decentralised systems. State environmental protection agencies or county health departments may each set standards for siting, designing, installing, servicing and performance monitoring of systems.

Whether a local health department or state environmental agency regulates systems usually depends on system design flow and varies significantly from state to state (ISF/Stone Environmental, 2009). An Australian review of institutional impediments to water conservation and reuse found the overarching barrier to be a lack of coordination of policies and regulations that govern conservation and reuse (Hatton MacDonald and Dyack, 2004).

PRESCRIPTIVE OR PERFORMANCE-BASED REGULATIONS

A key factor that affects the ability to introduce innovation is whether regulations are prescriptive or performance-based. The change in focus from prescriptive, end-product management to a risk management approach for recycled water has, however, failed to deliver the anticipated outcome (LECG Limited Asia Pacific, 2011).

While a risk management framework is, in theory, more flexible, it has been suggested that the uncertainty surrounding new technologies and unclear policy positions has created a climate of risk aversion (Tjandraatmadja *et al.*, 2008). This has resulted in delays and additional costs (for example, validation testing (Power, 2010a)) and a perception that best quality and not 'fit-for-purpose' water is required, which again increases costs.

The complexity of regulation, combined with an aversion to taking risks, has the potential to make investing in distributed recycled water systems expensive, uncertain, prolonged and too difficult to pursue (Watson, 2011).

The *Australian Guidelines for Water Recycling* (AGWR) require treatment processes to be validated prior to operation of the water-recycling scheme. This is a positive approach that shifts the focus from end-point monitoring to process barriers and the operational monitoring of those barriers. In the case of pathogens, end-point monitoring is expensive and does not identify water quality issues until potentially well after the public has been exposed to the water (ISF, 2013b). Validating the treatment process for low-risk schemes has been cited by potential developers as excessive in its requirements and has proven to be costly (Power, 2010b).

In response, the Australian Water Recycling Centre of Excellence (AWRCoE) has worked with regulators and industry to develop a draft National Validation Framework with the aims of: setting rules or guidelines to validate specific technologies; sharing knowledge on existing schemes and the validation processes undertaken; making available data to assess the feasibility of approaches; and setting up quality assurance programs for measurement requirements within validation programs (Muston and Halliwell, 2011).

The AGWR requires that every house in a development where recycled water is provided for non-potable household use be audited every five years, to check for cross-connections between the potable and non-potable water supplies (ISF, 2013b). This has been viewed as onerous by some developers, since cross-connection events in Australia are reportedly rare within distribution systems, with the incidence so far being on average within the order of 1 event in 10,000 dwellings per year (Storey *et al.*, 2007).

RISK AND REGULATION

Brown and Clark (2007) noted that the debate around alternative supply sources and the efficiency of managing alternative sources at different scales reflects the current dilemma of how to address the real and perceived risks, and who should be responsible for these risks. These risks relate to current societal values around water supply security, public health, economic efficiency, and protecting and enhancing the physical environment.

The National Water Commission recognises that there are risks associated with future water availability and has moved to clearly assign responsibility for dealing with these risks. Its aim is to ensure that the risks arising from reductions in the water available for consumption are shared between governments and water users according to an agreed framework. This is intended to provide investors and entitlement holders with certainty about how changes will be dealt with (National Water Commission, 2011).

In a review of eight case examples in Australia, the level of recycled water treatment was revealed to generally exceed the recommendations set by the *Australian Guidelines for Water Recycling* (AGWR). While there were various reasons for higher than required treatment standards for recycled water, the overarching driver was related to the perceived public health risk associated with the use of recycled water. In certain cases changing circumstances also played a role (ISF, 2013b). The fear of residential cross-connections through plumbing faults, for example, has resulted in higher treatment levels being applied to avoid the potential risk of illness resulting from pathogens present in the wastewater.

PUBLIC VERSUS PRIVATE

Integration of water services and a move to green infrastructure can involve a larger number of smaller, private entities. Many new, on-site or cluster-size decentralised systems are managed by private entities rather than traditional government utilities. In Australia there are three key areas that could be expected to limit private investment in water services (Watson, 2011):

- Regulation is complex, which leads to higher costs, time delays and uncertain outcomes;
- Regulatory pricing policies limit viable competition;
- Government policies distort or restrict markets.

Australia's urban water sector has undergone substantial reforms in the last two decades. These reforms have successfully improved service levels, encouraged efficiency gains, and improved environmental and public health outcomes (LECG Limited Asia Pacific, 2011; National Water Commission, 2011). Despite major reforms, the regulatory framework is still overly complex (National Water Commission, 2011; Power, 2010a). For example, in NSW a decentralised recycled water system may trigger six Acts; it may be covered by four specific guidelines and it may require the approval or advice of up to eight authorities, although this situation is currently under review (MWD, 2012; Watson, 2011).

ECONOMICS AND FINANCE

FULL COST/BENEFIT ACCOUNTING

There is a lack of appropriate economic tools to value integrated water services, including the ability to monetise indirect costs, understand and account for cross-subsidies, and evaluate short-term versus long-term costs.

Watson *et al.* (2012) found that most public sector investment assessment frameworks have difficulty including risk and uncertainty. This disadvantages less well-understood options, including small-scale recycled water schemes. Due to the public health aspects of water and wastewater services, decisions tend to avoid risk (Nelson, 2008; Productivity Commission, 2011; Water Corporation, 2011).

This aversion to risk is compounded by the tendency of decision-makers to remember and place more emphasis on dramatic or bad outcomes (Hammond *et al.*, 1998). This can lead to the benefits of small systems being negated by the risks, and it results in the early exclusion of potential small options due to perceptions of poor public acceptance or high health risks.

On the other hand, Watson found that large centralised solutions are susceptible to optimism bias, where planners overestimate benefits and underestimate costs, which again favours larger options. Regulators often require stringent and frequent performance monitoring and reporting for new systems, which can add significant cost to a project (ISF and Stone Environmental, 2009).

Private investment has evolved rapidly and appropriate regulatory frameworks are still being developed and adapted. There is still great uncertainty about how direct private investment in the water sector is best managed and how broader public benefits are best accounted for (Watson, Mitchell & Fane, 2012).

Current avoided cost calculations mitigate against investment in distributed recycled water systems. Current methods for calculating avoided costs use a system-wide average approach; however, avoided costs vary significantly across the network (Mitchell *et al.*, 2007). Calculating avoided costs is generally not well understood. Lack of experience makes outcomes uncertain and it is difficult to calculate the value of avoided costs for small increments of demand in relation to infrastructure with very large capacity.

This is particularly true for water because, once a large investment has been made it is usually viewed as a 'sunk' or unavoidable cost in the context of cost-benefit analysis (Australia Office of Best Practice Regulation, 2006). This means that once a decision to augment infrastructure is made there is little opportunity over the short to medium term for decentralised investments to 'avoid' costs.

COST RECOVERY

Cost recovery for smaller-scale water services (decentralised) or new water products such as recycled water poses substantial challenges when measured against traditional services. Sustainable solutions should include recovery of the social and environmental costs, but there is little guidance on how to accomplish this and it is unlikely to be through traditional funding mechanisms (Watson, Mitchell & Fane, 2012).

Pricing policies can limit viable competition. There are several ways utility water and wastewater pricing policies affect the financial viability of distributed recycled water systems, including the ability to:

- Access avoided costs;
- Be competitive due to the low unit price of potable water;
- Recover costs and be price competitive due to the regulated water and wastewater service charge.

In some areas there is a 'postage stamp' (common) price for basic water and wastewater services, while recycled water costs must be recovered directly from the user. Postage stamp pricing can mask opportunities for more efficient alternative investments. Postage stamp pricing arrangements allow large utilities to spread the cost of traditional water and wastewater infrastructure over a large customer base.

Decentralised solutions, particularly distributed recycled water solutions, often have to recover costs directly from the users. This makes comparing centralised extensions and augmentations to decentralised solutions difficult, particularly when assessing revenue recovery methods and risk (Mitchell, Abeysuriya & Willetts, 2008).

The low price of water makes it hard for small, private recycled water schemes to compete on unit price alone. The unit price of water across the US and Australia remains low despite the substantial progress utilities have made towards cost-reflective pricing. Even when a distributed recycled water scheme makes up part of an efficient suite of measures to contribute to the supply/demand balance, unless it costs less than the average long-run marginal cost of the potable supplied water, it will be difficult for it to be competitively priced by a private supplier.

PLANNING AND COLLABORATION

The conventional approach to planning for water management tends to address problems through large investments in a limited range of long-established technologies.

The management of urban water systems is often fragmented, with the design, construction and operation of the various elements carried out in isolation from one another. Short-term solutions are selected with little consideration for the long-term impacts on the entire system. More specifically, the conventional approach to planning for urban water management is typically associated with the following issues (ICLEI European Secretariat, 2011):

- Fragmentation – The various elements of the urban water system are often operated in isolation. Such a fragmented approach can result in technical choices that are based on the benefits to an individual part of the system, but may neglect the impacts caused elsewhere.
- Short-term solutions – Water management tends to focus on today's problems, opting for short-term solutions despite the risk that the implemented measures are not cost-effective or sustainable in the long term.
- Lack of flexibility – Conventional water infrastructure and management tends to be inflexible to changing circumstances. Water supply, wastewater treatment and stormwater drainage systems are constructed to match fixed capacities and when these are exceeded, problems occur. Likewise, the management of these systems becomes dysfunctional when faced, for example, with increasing climate variability and rapidly growing urban demand.
- Energy intensive – Conventional water distribution and treatment infrastructure is energy intensive. Power cuts and rapid increases in fuel costs can disrupt services. Intensive energy use also results in high levels of CO_2 emissions at a time when many cities are trying to reduce their carbon footprint.

CULTURE AND CAPACITY

Two important factors that influence this change are the organisational culture and technical capacity (or ability) of those involved in water management.

ORGANISATIONAL ATTRIBUTES THAT FOSTER CULTURE CHANGE

Within the water industry, the rigid cultural norms of organisations, professionals and academics, and a lack of incentives, reward systems and capacity development, are barriers to integrated and innovative water management.

NO TIME TO THINK

Driven by time constraints and a sense of urgency (often due to external events such as floods and droughts) individuals and organisations usually go with the 'known' options rather than innovative, new ideas.

COMMUNITY AND CUSTOMER CULTURAL ISSUES

In addition to understanding the cultural nuances that influence change in the water industry it is also important to understand the cultural issues that influence the behaviour of customers and the community.

A cultural literature review by the Cooperative Research Centre for Water Sensitive Cities (Supski & Lindsay, 2013) identified how social values associated with water play a key role in how Australians use and relate to water and how the deeply embedded ideals of cleanliness, comfort and convenience, trust and risk affect what options the community is likely to accept.

A NEED FOR A BALANCED TRANS-DISCIPLINARY APPROACH

Insufficient skills and knowledge and organisational resistance (Brown & Farrelly, 2009) were found to be common barriers to adaptive water management. A lack of trained systems thinkers and a strong tendency for solutions to be developed by teams of people, predominantly engineers, hydrologists and environmental scientists, who have worked together well in the past (Howe, 2012) has hampered green infrastructure and integrated systems.

This approach is entrenched at an early stage where traditional teaching, learning and practice in engineering and applied science has been largely confined to the technocentric sphere, with minimal interaction with the eco-centric and socio-centric areas (Mitchell *et al.*, 2005).

A LACK OF CHAMPIONS

It has been found that individual representatives called 'champions' within organisations from across government and other sectors are key agents for change to more sustainable systems, and such champions have formed loose networks pursuing change over substantial periods of time (Brown & Clarke, 2007).

CITIZEN AND STAKEHOLDER ENGAGEMENT

LEARNING TO SPEAK DIFFERENTLY

Simpson (2012) has been a consistent proponent of the need for the water industry to think about the way it talks about water and how this affects the public's perceptions. She advocates a shift away from an emphasis on water origin. For example, in the case of recycled water, water quality is usually spoken of in terms of its source (e.g. wastewater) and the degree of treatment it has had.

Areas that have been successful in moving to a One Water approach have often used 'branding' as a way to engage public support and confidence. Singapore introduced NEWater with a comprehensive education and communication package (Guan and Toh, 2012). In Gippsland, Victoria, the 'Water Factory' – a state-of-the-art green facility – highlights Gippsland as a leader in sustainability and innovation (CH2M Hill, 2012).

ACHIEVING ONE WATER

In order to arrive at the desired One Water state, the challenges and barriers discussed will need to be 'inverted'; in other words, the converse of the challenges will need to be in place, ie:

- Goal-oriented, collaborative legislation and regulations;
- New economic frameworks and enabling financing mechanisms;
- Integrated governmental institutions and organisations that encourage systems analysis and planning, data sharing, innovation and increased risk sharing;
- Changing cultural norms of organisations, professionals and academics, including incentive and reward systems, and capacity and knowledge development;
- Increased demand, awareness and engagement from the community, consumers and political entities.

The research project on which this study is based is currently undertaking case studies in the US and Australia to understand how institutions may have overcome some of these challenges.

ACKNOWLEDGEMENTS

This project is funded by the Water and Environment Research Foundation (US), Water Research Foundation (US) and Water Research Australia. Thank you to members of the Steering Committee and the project Peer Alliance for your valuable inputs and insights.

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