Institutional Arrangements for Implementing Diverse Water Supply Portfolio in metropolitan Adelaide – Scoping Study

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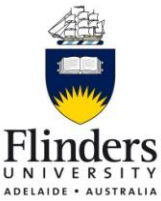

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EXECUTIVE SUMMARY

This report presents the outcomes of Task 5- Legal and Governance scoping study conducted as part of the Optimal Water Resource Mix project. The study objectives included:

- identifying the institutional issues impeding the implementation of diversified water supplies in general,
- identifying policy and legal challenges for implementing an integrated urban water management strategy, and
- inform the governance project-Assessment of Governance options to support the implementation of an Integrated Urban Water Management Strategy for Adelaide

These objectives were addressed through review of literatures related to institutional arrangements for diversifying the water supply source portfolio internationally and in Australia. The international case studies included experiences from Singapore, Israel, Windhoek (Namibia), and California (USA) and in Australia, the review included the experiences of implementing an integrated urban water management strategy in major cities. Additionally, face-to-face discussions were held with the key policy actors in South Australia representing different stakeholders/agencies (example SA Water, DEWNR, Local Council *etc*.). All of them were senior officials representing these agencies and had loads of experience working in the urban water management sector. Finally, based on the literature review and key actor interviews the optimised solutions were evaluated from governance perspective to inform decision making around the selection of the solutions and implementation approaches. The findings of this study will inform the separate project aimed at assessing governance options to support the implementation of an Integrated Urban Water Management Strategy for Adelaide.

Overall, the review of international and Australian case studies indicate there is a growing support for implementing a portfolio of water supply sources to meet the needs of growing population and rapid urbanisation. The governments at all levels and the urban water industry have undertaken a range of investments and actions to support integrated urban water management objectives. However, it was observed that the institutional arrangements for delivering these objectives are not always clear. The literature points out that the impediments to implementing an integrated urban water management (IUWM) strategy are not generally technological, but are, instead, socio-institutional.

International case studies demonstrated that specific needs and pressures are the drivers for implementing IUWM and that there is no 'one size fits all' solution to diversification of water supply; it has to be tailored to suit the specific characteristics and requirements of the different cities/jurisdictions. It was also clear that so far no city has implemented IUWM in its totality and there is still the potential to improve the integration of the institutional and infrastructure aspects of the key players and urban water components. However, there are some lessons to learn from the international experiences, particularly Singapore and Israel who have implemented the IUWM strategy effectively. Even though these jurisdictions are unique in some aspects, they have a lot to offer for implementing IUWM particularly in areas of cross-sector and cross-agency coordination, integration of land use planning and water management, and carefully planning and implementing water programs through partnerships and public education. Some of the arrangements in these countries that might be appropriate to SA are mentioned in Section 3.

In Australian context, the National Water Initiative (NWI, paragraph 92) aims to identify and develop innovative ways of managing and achieving more efficient water use in our cities. It (paragraph 92) states,

The Parties agree to undertake the following actions in regard to innovation:

- develop national health and environmental guidelines for priority elements of *water sensitive urban designs* (initially recycled water and stormwater) by 2005;
- develop national guidelines for evaluating options for water sensitive urban developments, both in new urban sub-divisions and high rise buildings by 2006;
- evaluate existing 'icon water sensitive urban developments' to identify gaps in knowledge and lessons for future strategically located developments by 2005;

- review the institutional and regulatory models for achieving integrated urban water cycle planning and management, followed by preparation of best practice guidelines by 2006; and
- review of incentives to stimulate innovation by 2006.

In view of that, many of Australia's state governments and their agencies have moved to better align planning and development requirements with an integrated approach to the management of the urban water cycle. However, the study found that implementation was a challenge caused by the presence of different institutional models to manage urban water supplies across Australia. The study found that the situation became more complex with inclusion of 'new sources' in to the supply mix. The addition of the new sources like stormwater and reclaimed water has resulted in a complex entitlements regime and related issues about security to access because the current entitlement arrangements governing these sources of water within the urban water supply are not clearly defined. Some of the other issues impeding implementation of IUWM in Australia include:

- The variety of regulatory regimes and lack of overall coordination.
- Lack of clarity about roles, responsibilities and accountabilities within the urban water sector.
- Extreme levels of restructuring and institutional role separation within the public sector departments.
- Conflicting agendas and/or differences in power among water agencies related to addressing water rights issues, pricing of the 'new water sources, and dealing with opponents to recycling or reuse.

In relation to diversifying water supply sources in metropolitan Adelaide, the City is unique in the depth of its approach to optimising several sources of water. Currently there are seven sources (the Adelaide and Mt Lofty Catchments, the River Murray, Groundwater, Stormwater, Rainwater/Rooftop water, Reclaimed water, and desalinated water) plus demand management. Even though there are different agencies/organisations involved in various aspects of water management in South Australia, the State leads the country in stormwater capture and reuse, rainwater tank ownership and wastewater recycling. Also, the State has a favourable policy environment to implementing IUWM strategy in the form of the following policy instruments:

- *Water for Good- A plan to ensure our water future to 2050 (2009),*
- *The 30-Year Plan for Greater Adelaide (2010),*
- *Stormwater Strategy- the future of stormwater management (2011), and*
- *Water Sensitive Urban Design- creating more liveable and water sensitive cities in South Australia (2013)*

Nevertheless, there is opportunity to do better and this is mostly in the policy and legal area as indicated during the interviews with key policy actors in Adelaide. Most of the policy and legal challenges highlighted by the interviewees were related to the 'new' water sources such as stormwater/wastewater and in agreement with those identified in the literature review. The challenges for Adelaide at large include:

- Institutional fragmentation,
- Unclear access rights to the 'new' water sources (e.g. stormwater, wastewater),
- Funding for stormwater projects due to lack of a clear and agreed approach to manage the resources in question,
- Public perceptions and acceptance of 'new' water sources, and
- Community participation/involvement

In summary, there is no 'one size fits all' structural arrangement for implementing diverse portfolio of water supply sources in urban areas because of the varying economic, social, legal, and institutional settings. The focus need to be on implementing institutional change through reform approaches that emphasise on introducing developed coordinating mechanisms and improving intra- and inter-organizational relationships. All of this needs to be in a context of engaged community consultation. The overall strategy to implementing diverse source portfolio should therefore include the following institutional practices: co-ordination across the relevant stakeholder organisations through a single entity; development of master plans (urban, water, sanitation) and ensuring planning framework has adequate regard of water resource management; stimulate cost recovery practices; enforceable laws and regulations; environmental regulation and public heath regulation; public participation; and capacity

building. This may require modifying existing legislation and policies to conform to a consistent framework based on the NWI principles in implementing a diverse water supply portfolio.

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1 INTRODUCTION

According to the United Nations Population Division, the world population is expected to grow by 2.3 billion between 2011 and 2050, reaching 9.3 billion people; and most of the population growth over the next four decades is expected to take place in urban areas (UNDESA 2012). This represents a considerable challenge for water resources management, the delivery of essential water and sanitation services and environmental protection. To help meet these challenges and better serve both economic and environmental objectives, there is a need to employ a broader range of tools than in the past. This means traditional approaches that have relied heavily on large scale infrastructure development (dams, levees, and conveyance facilities) have to make way to a new integrated approach - integrated water resources management (IWRM) -which explicitly recognises the complex sets of interdependency relationships which exist within and between human and environmental systems (Rees 2006). In an urban context this is commonly referred as Integrated Urban Water Management (IUWM) and is the integration of all components of the urban water cycle; and this integration happens within the City's urban development and in the context of wider basin management to achieve sustainable economic, social, and environmental goals (Bahri 2012, World Bank 2012).

In Australian context, urban water reform is one of the eight key elements of the National Water Initiative (NWI) which created a coherent and comprehensive framework for the management of Australia's water resources (COAG 2004). In relation to urban water management, paragraph 92 of the Initiative aims to identify and develop innovative ways of managing and achieving more efficient water use in Australian cities. Thus, most state governments in Australia have embarked on implementing IUWM by having a portfolio of water supply sources that includes climate independent and non-traditional water resources. In South Australia, the *Water for Good* Plan released in 2009 outlined a range of actions aimed at reform of the water sector to increase water security and transition South Australia towards a water sensitive State by 2050 (OWS 2009). One of the actions proposed in the plan was integration of urban water supply sources including new sources such as such as desalinated water, recycled water, rainwater collection and stormwater reuse. However, the implementation of a portfolio of water sources that are fit for diverse uses is an institutional challenge. Transitioning to a diverse water supply approach requires not only the development of new water sources and the application of associated technologies, but also an understanding of how new approaches will influence, or will be influenced by, current institutional frameworks. It will involve shifting deeply embedded and well-understood processes and practices that operate predominantly at centralized scales, towards more diverse, complex and reflexive approaches at multiple scales (e.g. Tjandraatmadja *et al* 2005, PMSEIC 2007, Wong and Brown 2008, McKay 2005). This implies effective implementation of an integrated approach depends on solutions beyond technological; it now depends largely on the social and institutional aspects of water management. While the information on the scientific and technical aspects of the approach has grown accordingly, there are significant institutional aspects which need equal attention (Lundqvist *et al* 2001, Vlachos and Braga 2001, MacDonald and Dyack 2004, Saleth and Dinar 2005, Brown *et al* 2006). This is true worldwide (World Bank 2012, OECD 2000), and in Australia the COAG water frameworks identified the need to reform institutional structures and adopt a range of policy instruments for stormwater management including among others 'clear allocation of accountabilities and responsibilities' (SLWRMC 1996). The NWC in its most recent assessment of the implementation of the NWI (NWC 2011) found that even though the number and scope of on-ground integrated water management projects across Australia continue to grow there is still a need for greater clarity about the role water service providers should have in contributing to water sensitive cities. The Commission in its report recommended that:

> *'Governments should commit to developing an urban water sector that is more resilient, flexible, efficient, transparent, accountable and customer-focused. They should ensure that service providers, regulators and other parties have clearly defined accountabilities, which align with specified roles, functions, resourcing and funding. Governments should also amend policy settings to allow an efficient portfolio of supply and demand measures to emerge and evolve over time, without direct and ad hoc government intervention.' (NWC, 2011, p.3)*

While a wide range of barriers have been observed, there remains a distinct lack of detail regarding the scope and priority of these social and institutional barriers, and there is little reliable guidance on how they might be overcome (Rauch *et al* 2005, Wong 2006, Brown and Farrelly 2009b, Biswas 2008).This report attempts to address this imbalance by presenting the outcomes of *Task 5- Legal and Governance Scoping Study*.

1.1 STUDY OBJECTIVES

- identifying the institutional issues impeding the implementation of diversified water supplies in general
- identifying policy and legal challenges for implementing the Optimal mix solutions generated by Task 3 of Optimal Water Resource Mix project
- inform the governance project-Assessment of Governance options to support the implementation of an Integrated Urban Water Management Strategy for Adelaide

1.2 METHODS

The study included two parts: (1) documentary analysis and (2) face-to-face discussions with key actors representing various stakeholder organisations such as the state government departments, local city councils, and the private sector.

1.2.1 Documentary analysis

Documentary analysis included targeted review of institutional arrangements for diversifying the water supply source portfolio in Australia and overseas. Some of the global experiences presented in this report include Singapore, Israel, Windhoek and California, and in Australia all major cities that have implemented a portfolio of diversified sources of water supply were included. The case studies include examples of both successful and/or unsuccessful attempts to implementing IUWM. The aim was to identify the drivers for implementing IUWM and illustrate how the new paradigm was operationalised by different cities.

1.2.2 Key actor interviews

Face-to-face discussions were initiated with key actors representing different stakeholders/agencies who are involved in delivering safe and secure water and wastewater services to metropolitan Adelaide. An invitation email with the information sheet attached was sent to the potential interviewees. The information sheet described the study background, and objectives of the study. A note on ethics approval was included to assure the interviewees about the anonymity and confidentiality issues during the interviews.

The interviews commenced after the project was approved by the University of South Australia Human Research Ethics Committee. The policy requires that any research involving humans should maintain anonymity and confidentiality during data collection and no individual participant can be identified. Accordingly, Table 1 includes the stakeholders/agencies and number of people interviewed.

Table 1: List of stakeholders and number of interviewees

Stakeholders	Number of interviewees
SA Water -Adelaide Desalination Plant	1
Department of Environment, Water and Natural Resources	2
Adelaide & Mount Lofty Range NRM Board	1
Local Governments	2
Private Sector - Water Industry Alliance	1
Total	7

All interviewees were senior officials working in the South Australian urban water sector and had more than 15 years' experience of working in the urban water management area. The interviews intended to elicit the participants' perceptions regarding various elements of implementing an IUWM strategy for Adelaide. Accordingly a semi-structured interview guide was used for this task (Appendix 1). The list of questions was used as a guide only and therefore, the order of the questions did not necessarily follow in exactly the same way as outlined in the interview guide. Most interviews were done at the University of South Australia's Centre for Comparative Water Polices and Laws, while two interviews occurred at the participants' work place in Adelaide.

The meeting concluded with general remarks and the participants were asked if they would like to be part of a separate project to assess the legal and governance options and risks to implementing an IUWM strategy for Adelaide.

2 INTEGRATED URBAN WATER MANAGEMENT AND PORTFOLIO BASED PLANNING

Integrated Urban Water Management (IUWM) is an emerging concept and originates from the complexity of challenges affecting the provision of basic human services such as water supply in expanding cities worldwide. It is an approach that seeks to develop efficient and flexible urban water systems by adopting a diversity of existing technologies, management, and institutional practices to supply and secure water for urban areas. As Bahri (2012, p.12) explains, the IUWM approach integrates water sources, water use sectors, water services and water management scales; and it offers a set of principles that support better coordinated, responsive and sustainable resource management practices. Brown and Farrelly (2009a) suggest the idea of managing urban water as a 'total water cycle' is confronting because it challenges traditional and technical management practices. According to Mitchell (2006) the IUWM approach emphasises on demand and supply management, using non-traditional water resources, the concept of fit-for-purpose and decentralisation. In literature it is sometimes also referred to as total water cycle management (TWCM) and defined as an approach which involves making the most appropriate use of water from all stages of the water cycle that best delivers social, ecological and economic sustainability (Water by Design 2010). In simple words, IUWM can be viewed as an approach that recognises alternative water sources; views water storage, distribution, treatment, recycling and disposal as part of the same resource management cycle; recognises the relationships among water resources, land use and energy; and encourages participation by all stakeholders. In context of this study, the focus is on one of the components of an IUWM approach -diversifying water supply portfolio. Implementing diverse water supply sources involves 'portfolio-based planning' using a complementary mix of supply and demand management measures to achieve water security.

The idea of portfolio-based planning stems from the 'Modern Portfolio Theory' (MPT) proposed by Markowitz in 1952. The MPT is widely used in financial management and it provides a theoretical framework for using different portfolios to balance risks and returns through diversification. In other words, MPT aims at finding sets of investments that diversify risks thereby reducing the overall risk of the total portfolio of investments (Aerts *et al* 2008). In the MPT, Markowitz (1952) refers to risk as the variance or standard deviation of the return of investment and proposes expected return- variance of return rule (E-V rule) – 'diversify across industries because firms in different industries, especially industries with different economic characteristics, have lower co-variances than firms within an industry'(p.89).

While MPT is widely used in financial studies, there are a number of studies in other fields that use the portfolio concept; for example in areas of energy (Awerbuch 1993, Hobbs 1995), transportation (Johnston *et al* 1995) and more recently in natural resources management, including biodiversity (Figge 2004), agriculture (Gaydon *et al* 2012, Paydar and Qureshi 2012), flood management (Aerts *et al* 2008) and urban water supply (Beuhler 2006, Wolff 2008). However the general idea of the portfolio-based planning approach in all the areas is to employ a complementary mix of options (including supply-side, demand-side, and operational tools) to provide more cost-effective service that is reliable under a wide variety of conditions and able to serve multiple purposes (Hanak *et al* 2011). With regards to water supply, this report includes national and international case studies from cities that have adopted this approach to secure their water supply. In Australia, most state governments and their agencies have responded to this paradigm-shift and have moved to better align planning and development requirements with an integrated approach to the management of the urban water cycle (See Section 4).

3 INTERNATIONAL EXPERIENCES OF DIVERSIFYING WATER SUPPLY SOURCES

In the last decade several cities in developing as well as developed countries have realized the need for an integrated and holistic approach to urban water management. Some of the international experiences particularly with respect to implementing diverse sources of water supply are described in this section. International case studies presented here include both successful and/or unsuccessful attempts to implementing diverse sources of water supply. They demonstrated that specific needs and pressures were the drivers for implementing IUWM and that there is no 'one size fits all' solution to diversification of water supply; it has to be tailored to suit the specific characteristics and requirements of the different cities/jurisdictions. It was also clear that so far no city has implemented IUWM in its totality and there is still the potential to improve the integration of the institutional and infrastructure aspects of the key players and urban water components. Even though the cases discussed are tailored to suit the specific characteristics and requirements of the different cities/jurisdictions there are some lessons to learn, particularly in Singapore and Israel who have implemented the IUWM strategy effectively through cross-sector and cross-agency coordination, integration of land use planning and water management, and carefully planning and implementing water programs through partnerships and public education. For example, Public Utilities Board (PUB) – Singapore's national water agency works in close collaboration with Singapore's national land use planning Authority (Urban Redevelopment Authority) to prepare long-term strategic plans and detailed local area plans for physical development, and implementing them. PUB also works closely with the National Parks Board to create green and blue spaces in Singapore for residents to enjoy in their daily lives (Chiplunkar et al 2012).

Table 2 highlights the water sources, the institutional arrangements in the selected international cases and the drivers behind water sources diversification.

3.1 SINGAPORE

Singapore is in the forefront of water management and has adopted a multi-pronged approach in its water supply and water-management policies which comprises of physical infrastructure, legislation and enforcement, water pricing, public education, and ongoing research (Luan 2010). Singapore is a case where political stability, societal leadership, political will, and public–private partnership has resulted in achieving water security and sustainability (Chen et al 2011).

3.1.1 Drivers behind source diversification

The driver behind Singapore's water management scheme was the desire to reduce dependence on water sources in neighbouring Malaysia. In addition, with no natural aquifers and limited land to collect and store rainwater Singapore had to ensure its long-term sustainability through integrated water management and diversifying its water sources.

3.1.2 Singapore's water supply portfolio

The water supply system in Singapore includes efficient demand and supply management practices. The supply side includes 'Four National Taps': (i) the local catchment water, (ii) imported water from Malaysia by means of two water agreements with Johor, Malaysia[1], (iii) NEWater (highly-purified reclaimed water), and (iv) Desalinated water. The demand management side mainly includes environmental initiatives and programmes such as using water wisely, keeping the water catchments clean, and engaging the community to participate and take ownership.

[1] (1) 1961 to 2011 (not renewed due to disputes) and (2) 1962 to 2061

Table 2 Summary of international case studies

COUNTRY/ JURISDICTION	WATER SOURCE DIVERSIFICATION DRIVERS	WATER SOURCES		GOVERNANCE/INSTIUTIONAL SETTING
		SUPPLY SIDE	DEMAND SIDE	
Singapore	Water challenges such as no natural aquifers and limited land for water catchment and strong desire to reduce dependence on water sources in neighbouring Malaysia;	Four National Taps - water from local catchments, imported water, NEWater, and desalinated water	Public Utilities Board (PUB) uses water pricing, mandatory requirements (e.g. installing water saving devices) and public education to manage water demand	• Single national agency- PUB- manages the whole "water loop" in an integrated and holistic manner • PUB has a high degree of autonomy and strong government support to carry out its role as the national water agency. • Close and efficient interagency cooperation
Israel	Limited natural water sources, the water crisis of 2000 and the ongoing Palestinian Israeli conflict.	River waters, springs, floodwater run-offs, ground water, recycled purified sewage and irrigation waters, and desalination	• Water conservation and demand management programs including a combination of technology diffusion and seasonal usage. • Another pioneering policy decision as part of demand management strategy was the 'Virtual Water' Policy whereby the authorities decided to import majority of its grain needs instead of growing.	Single Professional Board - Israeli Water Authority- is responsible for managing the whole "Water Chain".
Windhoek (Namibia)	Low average rainfall associated with very high evaporation rates, no permanent water bodies exist near the city, and the surface and ground water sources have been developed and are nearing the limit of their potential	Groundwater, surface water, and reclaimed water	Market mechanisms (pricing), and direct interventions (introducing special measures - policy measures, information programs, regulations, and technical measures through municipal bylaws for water saving.	One government department- Department of Infrastructure, Water and Technical Services through its six divisions manage the supply, distribution and quality of potable water as well as the collection, reticulation and treatment of sewerage water.
California (USA)	The state's arid and semiarid climate, its evolving economy, less reliable water sources, complex water management and distribution systems, and urban growth.	Groundwater, imported surface water, ASR/water Banking, recycled water (stormwater, wastewater), and desalination	Water Demand Management Measures i.e., measures, practices, or incentives implemented by water utilities to permanently reduce the level or change the pattern of demand.	• California has a decentralized governance system. Urban water management authority is allocated to nearly 300 local water departments, special district governments, and private water suppliers. • New integrated water management approaches are emerging in the USA. The California state government passed the *California Integrated Regional Water Management Planning Act* (IRWM Act) to encourage local water agencies to cooperatively manage their water supplies for regional benefit and encourage coordination among agencies to improve regional water management.

Source: Literature review

3.1.3 Institutional arrangements to support IUWM in Singapore

Singapore's limited resources are managed by the Ministry of the Environment and Water Resources (MEWR) through its two statutory boards: (1) Public Utilities Board (PUB) which is the national water agency, and (2) the National Environment Agency (NEA). The supply management side is handled by the PUB which has adopted the 'Four National Taps' strategy which includes diversifying water supply sources. Previously, PUB was responsible for managing potable water, electricity and gas. But as of 1 April 2001 the responsibilities for sewerage and drainage were transferred to PUB and since then it manages the entire water cycle of Singapore. The transfer of responsibilities allowed PUB to develop and implement a holistic policy, which included protection and expansion of water sources, stormwater management, desalination, demand management, community-driven programmes, catchment management, outsourcing to private sector specific activities, and public education and awareness programmes (Tortajada 2006).

The demand management side mainly includes environmental initiatives and programmes such as using water wisely, keeping the water catchments clean, and building a relationship with and enjoy using waterways and reservoirs. The NEA spearheads these initiatives through its 3P approach which means partnership with the People, Public and Private sectors. According to Tortajada (2006, p.236), 'the overall governance of the water supply and wastewater management systems in Singapore is exemplary in terms of its performance, transparency and accountability.'

In addition, Singapore has comprehensive environmental legislation and strict implementation of water resource related regulations as evident from Table 3.

Table 3 Water management functions and applicable regulations

MAIN WATER MANAGEMENT FUNCTION	RELEVANT *ACTS* AND REGULATIONS
Production of public water and reused water, from treated secondary effluent and collective systems in Singapore	Environmental Pollution Control Act Cap. 24), 2002
Treatment and reclamation of water from municipal sewage and sewer systems	Environmental Public Health (Toxic Industrial Waste) Regulations
Planning, management, construction and maintenance of catchment, reservoir, drainage systems, flood control, and discharge of rain water	Sewerage and Drainage Act (Cap. 294), 2001
Private participation in water infrastructure	Public Utilities Act (Cap. 261), 2002
Planning and development of water resource policy and pricing	Public Utilities (Water Supply) Regulations
Exploration and identification of opportunities to outsource Public Utilities Board's work based on cost-effectiveness Planning, evaluation, testing and budget management for new technology and projects	Public Utilities (Central Water Catchment and Catchment Area Parks) Regulations

Source: Compiled from World Bank 2006

3.2 ISRAEL

Water consumption in Israel has increased dramatically since 1949 and by 1978 it was consuming 98 percent of its proven renewable water resources (Davis *et al* 1980). Therefore future economic development in Israel critically depended on either, tapping of new water sources or the development of new techniques. Accordingly, Israel has developed a diverse water supply portfolio to meet these demands. Like Singapore, Israel too is a world leader in water management.

3.2.1 Drivers behind source diversification

Israel is located in a semi-arid climatic zone and its natural water sources are severely limited. Also, the gradual increase in water consumption in Israel as mentioned above forced the country to provide a dynamic response to the quantity and quality of water supply. The situation worsened due to a water crisis that occurred in the year 2000 caused by the drought of 1999/2000, the lowered water level of Lake

Kinneret and declining groundwater levels. This awakened the concern and awareness of both, the citizens and decision makers about the interlinked issues of water quantity and quality (Fischhendler and Heikkila 2010). Then there is the ongoing conflict with the neighbouring regions because of the transboundary nature of the hydrologic regime (Mourad 2013). This combination of hard facts led the country to implement a water source management approach based on IWRM principles to tackle the current crisis and ensuring long-term sustainability.

3.2.2 Israel's water supply portfolio

Israel's water supply system comprises both supply and demand management options. Historically, the focus of Israeli water policy has been on increasing water supply and therefore most of the investments in the past have been made towards expanding water supply projects. As Tal (2006) describes, this was done through four initiatives:

1. Integrated management of Lake Kinneret and groundwater aquifers, which feed into an integrated national water grid,
2. Water harvesting via a network of rain-fed reservoirs,
3. Wastewater treatment and reuse for irrigation, and
4. Desalination of seawater and brackish groundwater.

As a result, today Israel's water supply sources include river waters, springs, floodwater run-offs, ground water, recycled purified sewage and irrigation waters, and desalination.

In addition, the Israeli Water Commission's national strategy identifies conservation and demand management programs as important as those above to achieve sustainability. These include a combination of technology diffusion (upgrading inefficient plumbing infrastructure, car wash and toilet regulations) and seasonal usage restrictions (e.g. spray irrigation in the urban sector, and drip and sub-surface drip irrigation in the agricultural sector). Another pioneering policy decision of the Israeli government as part of its demand management strategy was the 'Virtual Water' Policy in the 1960s whereby the authorities decided to import a majority of its grain needs instead of growing them in Israel. This meant the 'Virtual Import' of almost 3 billion cubic meters of water annually, almost twice the total availability of fresh water resources in Israel (Arlosoroff 2007, *per comm.* J. A. Allan 2013).

3.2.3 Israel's institutional framework for water governance

The foundational law for water governance in the State of Israel is the *Water Law* passed in 1955. As described in Plaut (2000), the Law defines water as a nationalized public good; all water is the property of the state, including waste, sewer and runoff water that can be used commercially. An owner of land does not own the water under his land. There is no private ownership of water resources in Israel, and virtually all water consumption is metered.

However, the flaws in the water management caused by institutional fragmentation led to the establishment of the Israeli Water Authority (a department of the Ministry of Infrastructure) in 2007. The Water Authority replaced the Water Commission created under the 1959 Water Law and grouped all regulatory bodies acting in water aspects under one roof. The main purpose of the reform was to enable the Authority in implementing an integrative management of the whole "Water Chain" and to transfer authorities from the political level of several ministers to one professional Board. The mandates of the Authority are:

- To sustainably supply water to consumers, based on approved requirements for quality, quantity, efficiency, and economic reliability, and
- To treat sewage effluents according to required standards.

The Water Authority Council forum is responsible for the timely authorization of all decision making and policy-setting made by the Israeli Water Authority and any ministries. The 8-member Water Authority

Council forum contains a leading representative from each of the government ministries: Infrastructure, Environmental Protection, Finance, Interior, and Health, and from the Water Authority, as well as two public interest group representatives. Together the Israeli Water Authority and the Water Authority Council forum effectively regulate very limited water resources to provide for both short and long-term water requirements of the State of Israel.

3.3 WINDHOEK, NAMIBIA

The city of Windhoek is probably best known for the fact that it is the world pioneer of drinking water reclamation from purified sewage effluent. But it is also true that the City utilises all existing water resources optimally through an integrated approach that includes, both using water that is fit for purpose and diversifying water sources.

3.3.1 Drivers behind source diversification

Namibia is Southern Africa's most arid country, and barring the rivers on the Country's borders, there are no natural resources of perennial surface water (Biggs and Williams 2001). Windhoek is the capital and largest city of the Country and it utilizes approximately 90% of the water consumed in Namibia's central region. All potable water resources within a radius of 500 km are fully exploited (Lahnsteiner and Lempert 2007), and further supply augmentation was becoming increasingly expensive. Furthermore, a growing economy, and increased population growth exacerbated the situation over time. As a result the City had to explore options to meet the need for a reliable and sustainable water supply. In response, in 1994 the city council of Windhoek decided to adopt the 'integrated water demand management programme' to manage its increasing water demand. The programme emphasises on reducing demand rather than continuing to augment supply and also using non-conventional supply sources.

3.3.2 Windhoek's water supply portfolio

Windhoek's water supply portfolio includes both supply and demand side measures. On the supply side, there are four main sources of water supply: groundwater, surface water obtained from the integrated three dam system, reclaimed water recovered from the New Goreangab Water Reclamation Plant (NGWRP), and reclaimed water recovered from the Old Goreangab Water Reclamation Plant (OGWRP).On the demand management side, the measures used are market (pricing) mechanisms and direct interventions - introducing special measures through municipal bylaws for water saving (Lahnsteiner and Lempert 2007). These measures include policy measures, information programs, regulations, and technical measures as summarised in Table 4.

Table 4 Direct interventions as part of demand management in Windhoek

POLICY MEASURES	IMPLEMENTATION
Maximum reuse of water	Semi-purified effluent for irrigating municipal areas and recycling of water to potable standards
Plot sizes	Reduced for new developments and encourage higher density housing for existing developments
Reduction of municipal water use	For public gardens reduced by 50%.
Wet industries	guidelines for efficient water use in wet industries and re-use of water by new wet industries
INFORMATION PROGRAMS	**Implementation**
Education programs	Lectures in schools and other educational institutions, use of radio, television and local media, pamphlets on water saving ideas distributed with water bills.
Consumer advisory service	Advice on water related issues and information on leak detection.
REGULATIONS	**IMPLEMENTATION**
Compulsory water efficient equipment	Metering taps in hotels, taps outside non-residential building to be self-closing or lockable, toilet cisterns must be dual flush units, automatic flushing devises prohibited;

	replacement of inefficient devices within 3 years.
Groundwater	Monitoring of abstraction and groundwater levels controlled.
Gardens	watering prohibited between 10.00 and 16.00
Swimming pools	must be covered when not in use
Prevention of undue private water consumption	A Water Control Officer addressed wastage of water on private properties immediately
TECHNICAL MEASURES	**IMPLEMENTATION**
Lowering of unaccounted for water	Leakage detection, repair programs in place, water audits undertaken, proper management of meters, and systematic pipe replacement program.
Efficient watering methods	Proper irrigation systems for municipal gardens, advice given on efficient watering methods

Source: Based on Briggs and Williams 2001, Magnusson and Merwe 2006, Lahnsteiner and Lempert 2007

3.3.3 Institutional arrangements for water service delivery in Windhoek

The Department of Infrastructure, Water and Technical Services is responsible for the supply, distribution and quality of potable water as well as the collection, reticulation and treatment of sewerage water. This is done through six divisions:

- *Bulk Water and Wastewater Division* -responsible for managing all water resources including collection and treatment of wastewater, production of irrigation water, and distribution of potable water to customers,
- *Engineering Services Division* -responsible for all water and wastewater research, planning, design, and construction of water and wastewater bulk and distribution infrastructure,
- *Roads and Stormwater Division* - responsible for the construction and maintenance of roads, sidewalks and storm water (rainwater) in the City,
- *Scientific Services Division* - responsible for ensuring that drinking water is safe for human consumption at all times, that wastewater discharges conform to quality guidelines, and also implementing and maintaining a quality management system in accordance with international guidelines , and
- *Architecture and Building Maintenance divisions* are responsible for planning, designing, execution and maintenance of all building related assets of the City of Windhoek.

At the national level, the new *National Water Policy* adopted in August 2000 (Government of the Republic of Namibia, 2000) recognises the importance of an integrated approach to water resources management. The policy clearly states:

> *"The Government advocates a new approach emphasising the management of demand for water and water conservation. Water conservation includes the need to control pollution and minimise water wastage. Demand management uses a range of regulatory, economic and technical measures to achieve its objective of more efficient water utilisation. Effective measures include economic instruments (particularly tariff structures), comprehensive metering, standard setting, public awareness raising, environmental awareness, improved water efficient technology particularly in irrigation techniques, and enabling legislation. The implementation of these approaches will require the adaptation of institutions and legal reform." (Government of the Republic of Namibia, 2000)*

The Water Policy proposed several institutional reforms and most important among them was establishing a Policy and Strategy Unit in the Ministry of Agriculture, Water and Rural Development, a water resources management agency, an independent water regulator, and a water tribunal to improve functional capabilities. This Policy also formed the basis for the new *Water Resources Management Act 2004* (Kranz *et al* 2005). However, the legislation to enforce the new policy and the actual creation of the required institutions to implement the policy are still being developed (Heyns 2005, Falk *et al* 2009). A draft bill - the *Water Resources Management Bill* - was introduced to address the technicalities that hampered practical implementation of the Act. The bill was approved by the Cabinet in 2010 and under the new Water Resources Management Bill several new institutions including *Water Advisory Council, Basin Management Committees, Water Regulatory Board,* and a *Water Tribunal* are to be established (Tompkins 2007).

3.4 CALIFORNIA, UNITED STATES OF AMERICA

In the United States generally the regional and local water districts use portfolio-based management strategies and water marketing to reduce water supply vulnerabilities and avoiding the environmental and fiscal burdens associated with structural increases to the water supply (Kasprzyk *et al* 2009). In addition to using portfolio-based planning, the concept of 'Water Banks' is growing in popularity, and almost every Western State has either proposed or has a water bank in operation (Clifford *et al* 2004). However, for this study we focussed on portfolio-based planning used in Southern California where urban water scarcity is an ongoing reality because of its arid climate and cyclical droughts.

Water Banking

Clifford et al (2004) define water banking as an institutional mechanism that facilitates the legal transfer and market exchange of various types of surface, groundwater, and storage entitlements. According to Hadjigeorgalis (2009, p.52) a water bank is 'a central institution that acts as a clearinghouse for users who wish to purchase or sell water. Water is sold at cost with a margin added to cover the operating costs of the bank, which are typically borne by the buyer. Water banks may be temporary or permanent institutions.' In Australian context, water banking is mostly seen as 'a conjunctive water management (treating groundwater and surface water together) tool that uses the vast storage capacity of aquifers to store water' (Hostetler 2007).

3.4.1 Drivers behind source diversification

Urban water scarcity is an ongoing reality in California, especially, in Southern California with its arid climate and cyclical droughts. Less reliable water sources, complex water management and distribution systems, and urban growth are just some of the issues that California has to address. Over the past two centuries, California has tried to adapt to these challenges through major changes in water management including portfolio-based planning to provide more cost-effective service that is reliable under a wide variety of conditions and able to serve multiple purposes (Hanak et al 2011).

3.4.2 Southern California's water supply portfolio

Southern California relies on upstate water imports provided by the Metropolitan Water District of Southern California (MWD) for a significant portion of its water supply. MWD also imports water from the Colorado River, conveyed through the Colorado River Aqueduct. But due to the cyclical droughts in the State the reliability of water supply is precarious. To deal with water scarcity, the State initiated in the early 1990s a voluntary urban water conservation program managed by the California Urban Water Conservation Council (CUWCC), which promoted the implementation of Best Management Practices (BMPs) to achieve more efficient water use. This target was incorporated into the 2009 Comprehensive Water Package that was passed by the California legislature in November of 2009. Furthermore, as part of the 2009 state legislation, regional and local water districts will be required and provided incentives to enact conservation and other measures to develop "diverse regional water supply portfolios that will increase water supply reliability and reduce dependence on the Delta" (State of California 2009).

In response, the Southern California Metropolitan Water District (MWD) has embarked on an ambitious *Integrated Resource Plan* (IRP) to immunize itself against the risk of a supply shortfall. The plan is to diversify its water source portfolio, in particular by reducing California's reliance on traditional sources from 56% in the 1990s to 25% of the water supply portfolio by 2020. The water source portfolio has been achieved through strong investments in conservation (demand management programs) and local resources including recycling, desalination and conjunctive groundwater use, and significantly expanded local storage for surplus flows (Kidson *et al* 2009). Table 5 presents Southern California's water supply portfolio options.

Table 5 Southern California's water supply system portfolio options

DEMAND AND ALLOCATION OPTIONS
• Urban water use efficiency (water conservation)
• Urban water shortages (permanent or temporary water use below desired quantities)
• Agricultural water use efficiency
• Ecosystem demand management (dedicated flow and non-flow options)
• Ecosystem water use effectiveness (e.g., flows at specific times or with certain temperatures)
• Environmental water shortages
• Recreation water use efficiency, Recreation improvements, Recreation water shortages
SUPPLY MANAGEMENT OPTIONS
Expanding supplies through operations (affecting water quantity or quality)
• Surface water storage reoperation (reduced losses and spills)
• Conveyance facility reoperation
• Cooperative operation of surface facilities
• Conjunctive use of surface and groundwater, Groundwater storage, recharge, and pumping facilities
• Blending of water qualities
• Changes in treatment plant operations
• Agricultural drainage management
Expanding supplies through expanding infrastructure (affecting water quantity or quality)
• Expanded conveyance and storage facilities
• Urban water reuse (treated)
• New water treatment (surface water, groundwater, seawater, brackish water, contaminated water)
• Urban runoff/stormwater collection and reuse (in some areas)
• Desalination (brackish and seawater)
• Source protection
GENERAL POLICY TOOLS
• Pricing, subsidies, taxes
• Regulations (water management, water quality, contract authority, rationing, etc.)
• Water markets, transfers, and exchanges (within or between regions/sectors)
• Public education

Source: Hanak *et al* 2011

3.4.3 Water governance arrangements in California

Generally, water governance in the United States is a layered and fragmented system and includes public and private organizations from the Federal to the local level. Traditionally, the ground water and surface water resources have been managed separately, and the management of water supply and the treatment and disposal of wastewater, although integrally connected, have been managed by different special districts or municipal departments.

In case of Southern California which relies heavily on the imported surface water and local groundwater resources, the divisions or fragmentation are amplified because the imported from Northern California and the Colorado River are managed by the Metropolitan Water District of Southern California, while the local groundwater resources are managed by a multiplicity of local and regional agencies. A brief description of the water governance arrangements in Southern California is presented to point out the complexity.

Federal agencies play an important role in Southern California water supply issues and urban water planning is highly decentralized with the state delegating authority over urban water supplies to localities (Hughes and Pincetl 2014). At the Federal level, 37 different federal agencies have some jurisdiction over water resources, but only three federal agencies have major responsibilities for water resources (Adler 2009): the Bureau of Reclamation is in charge of water supply; the US Army Corps of Engineers is responsible for flood protection; and water quality is regulated by the Environmental Protection Agency. Coming to the State level, three major agencies- the Natural Resources Agency, the Environmental

Protection Agency and the Health and Human Services Agency- have jurisdiction over water issues. Finally, at the regional level the Metropolitan Water District of Southern California (MWD) is the largest water agency has authority over water issues and it is comprised of 26 agencies: 15 retailers and 11 wholesalers. Therefore, the institutional framework for water management in Southern California is complex, overlapping in some areas, and fragmented in others (Blanco *et al* 2012). This has resulted in coordination failures among the various agencies ultimately leading to inefficiencies in reservoir operations, ecosystem management, and water marketing (Hanak *et al* 2011).

3.5 SUMMARY OF INTERNATIONAL CASE STUDIES

International case studies presented above include both, successful (e.g Singapore, Israel) and not so successful (e.g. Califronia) attempts to implementing diverse sources of water supply. As described in each case study and summarised in Table 2 specific needs and pressures were the drivers for diversifying the water sources in these jurisdictions. They are unique in their own aspects and severe water scarcity was the main driver in all the cases. The international examples also illustrate that there is no 'one size fits all' solution for implementing a portfolio of water supply sources. The cases discussed here are all tailored to suit the specific characteristics and requirements of the different cities/jurisdictions. However, the situation in Adelaide is different; nevertheless the Millennium Drought that extended over a decade posed serious threat to Adelaide's water security. In response, and like all the other jurisdictions across the country, Adelaide developed a discourse around drought-proofing the state's water supplies through diversification of water sources (Bettini *et al* 2012). Therefore, some lessons from these countries, particularly successful case studies like Singapore and Israel might be appropriate in Adelaide. As described earlier these countries have implemented the IUWM strategy effectively through cross-sector and cross-agency coordination, integration of land use planning and water management, and carefully planning and implementing water programs through partnerships and public education. The integration of land use planning and water management in Singapore could offer some insights. The PUB (Singapore's national water agency) works in close collaboration with Singapore's national land use planning Authority (Urban Redevelopment Authority) to prepare long-term strategic plans and detailed local area plans for physical development, and implementing them. PUB also works closely with the National Parks Board to create green and blue spaces in Singapore for residents to enjoy in their daily lives (Chiplunkar et al 2012). This also emphasises on the cross-agency coordination and careful planning and implementation of the programs. Similarly, in Israel water demand management is considered as a form of governance and not just a program to deliver (Brooks and Wolfe 2007). It is treated with equal importance as supply management, and is a policy goal. New institutions for water demand management and new water policies like the 'Virtual Water' Policy emphasising on importing majority of Israel's grain needs instead of growing them (Arlosoroff 2007) made this possible.

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4 AUSTRALIAN EXPERIENCES OF DIVERSIFYING WATER SUPPLY SOURCES

Australia, like in other countries discussed above, has embarked on implementing the IUWM approach to supply and secure water for urban areas. The overall strategy is to develop efficient and flexible urban water systems by adopting a holistic approach in which all components urban water of the cycle are integrated, and includes a mix of water supply sources- freshwater(surface water, groundwater), and produced water (desalinated water, stormwater and treated effluent). This report includes experiences of implementing IUWM strategy from some of the Australian cities.

In Australia, urban water reform is one of the eight key elements of the National Water Initiative (NWI) which is a joint commitment by all state and territory governments and the Australian Government to manage surface water and groundwater resources for rural and urban use, and optimise economic, social and environmental outcomes (COAG 2004). The initiative created a coherent and comprehensive framework for the management of Australia's water resources; specifically, paragraph 92 of the NWI aims to identify and develop innovative ways of managing and achieving more efficient water use in our cities. Furthermore, the Initiative recognises a nested relationship between three related terms:

1. Integrated Urban Water Cycle Management (paragraph 92iv),
2. Water Sensitive Urban Design [paragraph 92(i)], and
3. Water Sensitive Urban Developments [paragraphs 92(ii) and (iii)].

The National Water Commission (NWC) in order to assist the NWI Parties meet commitments under paragraph 92 provided working definitions of the three terms. The definitions were developed in consultation with NWI Parties and the Urban Water Advisory Group, and consequently integrated urban water cycle management is defined as:

> *'the integrated management of all water sources, to ensure that water is used optimally within a catchment resource, state and national policy context. It promotes the coordinated planning, sustainable development and management of water, land and related resources (including energy use) that are linked to urban areas. It directs the application of Water Sensitive Urban Design principles within existing and new urban environments.'(NWC, 2007)*

4.1 WATER GOVERNANCE ARRANGEMENTS IN AUSTRALIA

Water management in Australian states and territories is the responsibility of various government agencies, water authorities and water utilities. Responsibility for regional and local water management lies with various organisations, including Catchment Management Authorities, rural water utilities and local water utilities. These organisations undertake a range of regulatory, administrative and governance functions.

The National Water Commission while reviewing the institutional and regulatory models for achieving integrated urban water cycle planning and management in Australia provided the following definitions for the terms "institutional models" and "regulatory models". According to the Commission (2007, p. 12):

> *The term "institutional models" is generally taken to refer to the roles, powers, functions, incentives and accountabilities of the various entities or institutions involved in a particular sector or activity.* AND
>
> *The term "regulatory models" is generally taken to refer to the body of regulatory controls (specified and enforced) to condition the otherwise unconstrained behaviour of individuals or organisations.*

Accordingly, there are different institutional models for water management (Table 6). The state of Victoria (excluding Melbourne) offers the only example of regional utility model. In 1995, the water service provider for the city of Melbourne was disaggregated into a wholesaler (Melbourne Water) and three retailers (Yarra Valley Water, South East Water and City West Water). The remainder of the state of Victoria is served by a number of regional water service providers (the result of a series of amalgamations of smaller local government and independent water bodies). These amalgamations have generally resulted in regional utilities with a clear focus on water services, substantially greater scale of service provision with commensurate gains in operational capability, efficiency and skill base (AATSE, 1999).

Table 6 Institutional and regulatory model for water, wastewater and stormwater service provision in Australia

REGIONS	WATER AND WASTEWATER SERVICE PROVIDERS	STORMWATER AND DRAINAGE	HEALTH REGULATOR	ENVIRONMENT REGULATOR	ECONOMIC & CUSTOMER SERVICE (PRICING) REGULATOR
New South Wales	State-owned utilities, statutory authorities, local governments	State-owned utilities, regional water authorities, local governments	NSW Health	Environment Protection Authority	Independent Pricing and Regulatory Tribunal (IPART)
Victoria	State-owned utilities, regional water authorities	State-owned utilities, local governments	Department of Health	Environment Protection Agency	Essential Services Commission
Queensland	State-owned utilities, statutory authority Council-owned entities, local governments, state-owned water boards	Local governments, Drainage Boards	Queensland Health	Queensland Water Supply Regulator	Queensland Competition Authority
South Australia	State-owned utility, local governments	State-owned utility, local governments and Stormwater Management Authority, DEWNR	Department of Health & Ageing	Environment Protection Authority	Essential Services Commission of South Australia
Western Australia	State-owned utility, statutory authorities	State-owned utility, local governments	Department of Health	Department of Environment & Conservation	Economic Regulation Authority
Tasmania	State-owned entity	Local governments	Department of Health & Human Services	Environment Protection Authority	Office of the Tasmanian Economic Regulator
Australian Capital Territory	State-owned utility	Roads ACT	ACT Health	Environment Protection Authority	Independent Competition and Regulatory Commission
Northern Territory	State-owned utility	Local governments	Department of Health & Families	Environment Protection Agency	Treasurer

Sources: Compiled from LECG Limited Asia Pacific 2011, NWC 2014, Productivity Commission 2011, PricewaterhouseCoopers 2011

Regarding ownership of the assets and operations, State or local governments own all the water utilities in Australia with the exception of some irrigation schemes. Australia also has an effective regulatory regime to protect public and environmental health along with an economic regulator in each State assigned with the responsibility both for prices and for customer service standards (Table 7). More details of these arrangements are discussed in the following sections on the case studies of Australian Cities that have implemented a portfolio of diversified sources of water supply.

4.2 MELBOURNE, VICTORIA

Historically, water cycle planning in Melbourne has been fragmented and often managed in five separate categories: *Water supply*: includes dams, catchments, pipes and desalination (recent addition); *Wastewater*: includes sewers, treatment plants and outfall; *Stormwater*: includes drains and flood mitigation; *River, creek and stream management*: includes water quality testing, litter management and flow management; and finally *greening and managing suburbs and parks*. However, the Millennium drought and rapidly growing urban population has made water planners and policy makers think of a new approach, and the 'Melbourne's Water Future' defines this new approach.

4.2.1 Melbourne's water supply portfolio

Melbourne's Water Future adopts a new approach that is based on the whole of-water-cycle management and planning, with use and reuse of all sources of Melbourne's water, and improved environmental and liveability outcomes. The focus now is on a water management approach that involves managing water in a way that:

- better integrates urban development planning processes and water planning processes,
- acknowledges the full costs and benefits of water services within cities and towns,
- creates market based incentives for more adaptive, innovative and productive water management,
- embeds water efficiency within the community,
- puts our currently under-utilised stormwater and recycled water resources to better use,
- focuses on decentralised, local solutions, whilst using the existing large-scale augmentations as efficiently as possible.

The draft Strategy proposes 'using local water locally' rather than making huge investments in building new infrastructures for water supplies. The Strategy explicitly mentions that:

> *'The existing framework of policies, institutions and regulations reflects an outdated model of planning, managing, delivering and using water. We are paying too much to build big infrastructure like the desalination plant, and we can no longer afford the energy and infrastructure costs of piping water around Melbourne when we could be better off using and reusing the rain that falls on Melbourne and the stormwater runoff generated by that rainfall.'*

It further offers to simplify and streamline (i) the strategies currently governing policy and planning for Melbourne's water cycle, and (ii) other regulatory and policy instruments.

4.2.2 Institutional arrangements

Water services in Melbourne are provided by four water utilities- Melbourne Water, City West Water, South East Water and Yarra Valley Water. The three Melbourne retail companies (City West Water, Yarra Valley Water and South East Water) operate the water distribution and sewerage systems for the Melbourne metropolitan area. Each retail company provides water supply and sewerage services within a specified geographic region of the metropolitan zone. Melbourne Water supplies the three retail companies and controls headworks and major sewerage treatment plants and is responsible for drainage and waterways.

Furthermore, Victoria is divided into ten catchment regions under the *Catchment and Land Protection Act 1994* with a Catchment Management Authority (CMA) established for each region. The *Water Act 1989* provides CMAs with regional waterway, floodplain, drainage and environmental water reserve management powers.

In January 2011, the Victorian government appointed the Living Victoria Ministerial Advisory Council to provide independent expert advice to them on the key changes needed to better manage urban water. The Council findings highlighted the need for reforms to the way Melbourne manages its water resources and suggested the following:

- diversify our water sources through integrated water cycle management
- empower customers through greater choice, and
- integrate water planning with urban planning in a way that allows all sources and uses of water to be considered..

The government's response to the advice received from the council outlines their commitment to urban water reform. Accordingly, the Office of Living Victoria (OLV) was established in May 2012 to drive the reform, and facilitate metropolitan Melbourne's first integrated water cycle management (IWCM) strategy; regional city water reform; and the Living Victoria Fund – a $50 million commitment to support the development of IWCM projects across Victoria and planning and regulation improvements to reflect IWCM. The Strategy (draft) is titled 'Melbourne's Water Future', and it defines the approach and proposed initiatives required to achieve the agreed vision and objectives. Table 7 highlights some of the initiatives discussed in the strategy that relate to institutional issues.

Table 7 Initiatives for improving developing resilient water systems in Melbourne

OUTCOMES	INITIATIVES
A community engaged in whole-of-water cycle management	• Ensure meaningful community involvement in local water cycle planning • Improve transparency and information provision • Improving disclosure of the water performance of homes for sale and rent
Suburbs (old and new) designed with water in mind	• Plan to use local water locally – metropolitan and regional water cycle planning • Plan to use local water locally – Local water cycle planning • Incorporate integrated water cycle management into growth area planning • Improving stormwater management in new developments • Influence design guidelines for stormwater quality and flooding • Support opportunities to link local water, energy and waste cycles
Sensible use of water in our homes and businesses	• Establish regulatory support for local water use • Reform the structure of water bills to reward water efficiency in the home
Resilient water systems	• Invest in and fast-track projects that enhance water system resilience • Change the incentives of our water authorities • Overhaul water planning and regulation • Increase scrutiny of major investment decisions in the water sector • Embed good water management in public buildings and major projects • Monitoring, access to and use of data • Improve the safety and emergency readiness of our water systems • Improve investment certainty and the efficient allocation of urban water • Reform bulk water arrangements • Address knowledge gaps and other barriers to improved water system resilience • Establish a whole-of-water‑cycle design competition
Improved natural waterways	• Engage the community on waterway health • Fund improved stormwater management • Protect our catchments and plan for the long term management of our waterways

OUTCOMES	INITIATIVES
Reduced inefficiency and waste	• Increase transparency about water sector costs and performance • Better allocate water sector investment • Develop new design guidelines for water and sewerage infrastructure • Enhance collaboration and sharing of research and data • Simplify and streamline regulation, and expand competition and the use of markets in the water sector
Accelerated innovation and world recognition of expertise	• Establish an investment portal for innovative water cycle management • Enhance research and policy capacity • Further build skills and capability in the water sector

Source: Melbourne's Water Future 2013

The State Government carried out a comprehensive review of the *Water Act 1989* and *Water Industry Act 1994* under the guidance of an expert advisory panel and released an Exposure Draft of the Water Bill Water for public consultation in December 2013. After extensive public consultation, these Acts were consolidated into a single, final Bill –*Water Bill 2014* and introduced in Parliament on 24 June 2014. If passed, the new *Water Act* will come into effect on 1 January 2016, and the *Water Act 1989* and *Water Industry Act 1994* will be repealed. Some key proposals of the Water Bill 2014 include:

- Enable new water resource management orders that will consolidate, in one place, all the water management arrangements for a particular area, which will help improve understanding of these arrangements
- Provide a streamlined and effective legislative framework for water management and use in Victoria, and enable the delivery of the Government's Living Victoria policy and Melbourne's Water Future strategy and other government policies
- Allow the Minister for Water to set out how whole-of-water cycle management plans for urban areas will be produced
- Clarify and simplify processes for licences, water shares and bulk entitlements
- Clearly define the functions of water corporations and catchment management authorities

In addition, the State has implemented some key institutional reforms in order to establish a more uniform and improved governance and operational framework for all water businesses in Victoria. Figure 1 below highlights a couple of reforms related to water governance and deliver of water services.

- Victoria has entrenched in its *Constitution Act 1975* a requirement that delivery of water services shall be by a body that reports to a Minister. Accordingly, the *Constitution (Water Authorities) Act 2003* was passed to amend the *Constitution Act* and a new part (PART VII—DELIVERY OF WATER SERVICES) was added to the constitution to require public ownership of water authorities. If a public authority has the responsibility for ensuring the delivery of a water service, that responsibility must be carried on by that authority or another public authority. This does not exclude public-private partnership arrangements whereby the private sector provides infrastructure or performs services under contract with a water authority. This bill makes it clear that a public authority may enter arrangements with the private sector for the provision of water services but cannot abdicate its ultimate responsibility for ensuring the delivery of water services under these arrangements or have that responsibility removed from it.
- On 29 March 2012 the Victorian Parliament passed the *Water Amendment (Governance and Other Reforms) Act 2012* [*Governance Act*] which establishes a more uniform and improved governance and operational framework for all state-owned water businesses in Victoria. The Governance Act converts the three Melbourne water retailers (City West Water Limited, South East Water Limited and Yarra Valley Water Limited) from *Corporations Act* companies operating under the *Water Industry Act 1994*, into statutory water corporations that will operate under the Water Act 1989. The amendment has resulted in all water corporations in Victoria being governed under the same legislation – *the Water Act 1989.*

Figure 1 Constitution (Water Authorities) Act 2003 and Governance Act 2012

Source: *Constitution (Water Authorities) Act* 2003, www.vicwater.org.au

4.3 SYDNEY, NEW SOUTH WALES

In New South Wales, urban water planning for the metropolitan areas (greater Sydney and the lower Hunter) is the responsibility of the Metropolitan Water Directorate within the Department of Finance and Services. The NSW Office of Water leads the NSW Government's policy agenda on regional urban water to secure potable water supplies for country towns and to assist regional water utilities to meet water supply and sewerage services performance standards. The long term water supply for the greater Sydney metropolitan region is addressed by the 'Metropolitan Water Plan'. The implementation of the Metropolitan Water Plan is supported by the 'Water for Life' education and engagement program.

The Metropolitan Water Plan sets out how the NSW Government will:

- provide a secure supply of water to meet the medium-term needs of a growing city, while keeping long-term goals in mind (a key concern for the community)
- help protect the health of our precious rivers
- ensure our water supplies are adequate during drought
- minimise costs to the community.

4.3.1 Sydney's water supply portfolio

The *Sydney Metropolitan Water Plan 2010* concentrates on four major areas – dams, recycling, desalination and water efficiency – to secure greater Sydney's water supply now and in the future. The development of the 2010 plan involved the community's input, complex modelling and analysis to identify a portfolio, or mix of measures, that delivers water security into the future.

Progress under the Metropolitan Water Plan is reviewed and reported every year while a major review of the plan is undertaken every four years.

4.3.2 Institutional arrangements

The water and wastewater services in metropolitan NSW have generally been provided by government owned water utilities (Sydney Water and Hunter Water) and, in non-metropolitan areas, by local water utilities (LWUs) including councils and water supply authorities. Regional water supply and sewerage services are currently provided by 99 general purpose local government councils, and five water supply authorities. These have traditionally provided water sourced from surface water – dams and rivers – or groundwater. Water is extracted, treated to potable quality and supplied to users. Wastewater management systems have conventionally involved collecting, transporting, treating and discharging effluent to the environment.

However with a greater focus now being given to integrated water cycle management, the government needed to think of bringing water and wastewater networks closer together without creating new risks to public health. This is opposite to the traditional approach of managing water and wastewater separately. Consequently the government realised there were significant differences between the regulatory frameworks created by the *Water Industry Competition Act 2006* (*WIC Act*) and *Local Government Act 1993* (*LG Act*). While the *WIC Act* was designed to facilitate new approaches to water and wastewater service provision, the *LG Act* was designed to regulate conventional wastewater infrastructure such as council sewage treatment plants and domestic septic systems. The differences between the two acts had implications for the capacity of the current regulatory framework to protect public health, and also raised some cross sectoral issues. As a result, the government opted to conduct a joint review of the*WIC Act* and regulatory arrangements for water recycling under the *LG Act*. The review was led by the Metropolitan Water Directorate which released a Discussion Paper in November 2012. The paper discussed the current and potential future frameworks to accommodate the growing diversity of the NSW urban water sector. The public consultation on the Discussion paper was completed in February 2013 and based on the feedback, the Metropolitan Water Directorate will develop a preferred approach for government consideration for reforming the *WIC Act* and other regulatory arrangements.

Regarding public health regulation in NSW, the *Public Health Act 2010* and the *Public Health Regulation 2012* that commenced on 1 September 2012 make provisions relating to the safety measures for drinking water and these commence at different times. As a result, from 1 September 2014 drinking water suppliers need to develop and adhere to a 'quality assurance program' (or drinking water management system). This requirement applies to water suppliers defined in the Act, including water utilities, private water suppliers and water carters. In relation to environmental regulation, the NSW Environment Protection Authority (EPA) is the primary environmental regulator. The EPA was part of the Office of Environment and Heritage (OEH) within the Department of Premier and Cabinet. But in February 2012 the NSW Government re-established the EPA as an independent statutory authority established under s.15 of the *Protection of the Environment Administration Act 1991* (POEA Act).

4.4 BRISBANE, QUEENSLAND

In Queensland, Seqwater is the Statutory Authority responsible for ensuring a safe, secure and reliable water supply for South East Queensland, as well as managing catchment health and providing recreational facilities to the community. The region's long term water security is managed under the *South East Queensland Water Strategy*, which is based on three key principles:

- Water conservation through efficient and responsible water consumption,
- Planning for future droughts/climate change impacts by maintaining a portfolio of future supply options, and
- Managing water efficiently on an integrated basis.

4.4.1 Brisbane's water supply portfolio

The *South East Queensland Water Strategy* is the blueprint for delivering a 'Water Supply Guarantee' for South East Queensland. The Strategy adopts total water cycle management (TWCM) framework which involves integration of land use and infrastructure planning across SEQ as a whole and for major development areas, local areas and specific sites. The key features include:

- water efficiency and recycling
- integrated management of urban and rural water
- water-sensitive urban design in development
- stormwater management to improve water quality and water supply and to minimise the alteration to natural flow regimes
- a focus on catchment management to protect drinking water supplies and waterways from pollution.

In addition to the TWCM framework, the Strategy also proposes 'Demand management program' which includes structural, operational and behavioural elements as described below:

- structural- making sure the homes and businesses have water-efficient devices, appliances and equipment installed
- operational- making sure that water-efficient equipment is used correctly to achieve efficient outcomes
- behavioural- encouraging good water use behaviours and ensuring that the community understands the benefits of conserving water.

Besides, as a regional approach to managing water resources, the Brisbane City Council has developed its own WaterSmart Strategy (see Figure 2 below) to guide Brisbane's community in achieving sustainable water management into the future.

Approach

- Create opportunities to enhance community appreciation of alternative water sources as good practice in new and existing infrastructure, addressing community concerns in a transparent and comprehensive way.
- Advocate for the appropriate legislative and communication frameworks for the use of alternative water sources.
- Address public health concerns associated with alternative water sources and communicate requirements to users in the Brisbane community.
- Work with regional, state and national partners to plan and deliver integrated water cycle infrastructure with a focus on innovative, sustainable solutions.
- In partnership with the Queensland Government, provide information, resources and access to networks to support community self-reliance in using all water efficiently, and in using alternative water sources effectively.

OUTCOMES	KEY ACTIONS
The community supports and uses a diverse mix of alternative water sources, improving our resilience to the effects that drought and climate change will have on our water supply systems.	• Investigate and map alternative water sources in Brisbane based on their suitability regarding physical availability, associated regulations, community acceptance, technical ability to use and the economic viability of each source. • Demonstrate leadership by using alternative water sources in Council buildings and spaces to further our understanding of how to make available alternative water sources for all of Brisbane.
The community uses water from all sources efficiently and effectively.	• Engage and partner with the Brisbane community to facilitate the acceptance, understanding and implementation of alternative water sources, such as wastewater recycling, rainwater harvesting or stormwater capture via wetlands, in new and existing developments and in shared public resources such as parks, plazas and open spaces. • Assist developers, designers and builders (through guidelines, partnered projects and incentives) in implementing design solutions that significantly demonstrate or increase the uptake of alternative water sources such as stormwater harvesting or greywater recycling within buildings for green walls, climate cooling, landscape irrigation and urban food production.
Brisbane's use of water from all sources is sustainable, balanced with environmental needs.	• Work with regional partners and the Queensland Government, fostering strong intergovernmental support and alignment to integrate water supply, environmental flows and water quality information, ensuring adequate volumes of the right quality of water are available at the right times to support ecological processes. • Led by the Queensland Government, Council will partner with other South East Queensland local governments, regional partners and Queensland Urban Utilities to develop a total water cycle management framework. This framework will be used by all parties to deliver integrated water, wastewater and water quality plans for sub-regional areas and the Brisbane local government area.

Figure 2 Brisbane City Council WaterSmart Strategy

Source: Brisbane WaterSmart Strategy 2010

4.4.2 Institutional arrangements

Governance arrangements in Queensland are fragmented, with bulk source, transport and treatment assets being owned by 25 different entities. Customer service standards and water pricing were variable, there was no means of equitably sharing the cost of new infrastructure across the beneficiaries, and there was minimal transparency in the structure and level of water pricing. As a result Queensland implemented two phases of institutional reforms in order to fully realise the benefits of the SEQ Water Grid and ensure the efficient and effective operation of the diverse range of supply sources:

The first phase of reform implementation was completed on 1 July 2008 with the establishment of the four new entities:

- Seqwater (owns all dams, groundwater infrastructure and water treatment plants in SEQ)
- WaterSecure (owns the desalination plant at the Gold Coast and the Western Corridor Recycled Water Scheme)
- Linkwater (owns all major pipelines in SEQ), and
- the SEQ Water Grid Manager.

These entities are all Queensland Government owned statutory authorities and they own and operate the SEQ Water Grid.

The second stage of the reforms that was completed on 1 July 2010 saw the establishment of three new council-owned distribution and retail entities:

- Unitywater, servicing the Sunshine Coast and Moreton Bay areas
- Queensland Urban Utilities, servicing the Brisbane, Scenic Rim, Ipswich, Somerset and Lockyer Valley areas
- Allconnex Water, servicing the Gold Coast, Logan and Redland areas.

These entities own the water and sewerage distribution infrastructure and sell water and sewage disposal services to customers.

Furthermore, the SEQ Water Strategy released in 2010 highlighted some the potential benefits delivered to the community through the institutional reforms:

- simplified business structures to deliver water services in a coordinated manner
- creation of economies of scale and scope due to the reduced number of entities
- efficiency in service provision by specialist entities, with the amalgamation of technical skill sets
- higher technical skill levels across the industry through coordinated training and education
- clarification of the respective roles of state and local governments
- improved transparency and accountability for bulk transport and distribution networks with a strong asset management regime, and
- enhanced economic regulation.

Accordingly, the Queensland Government recently implemented further reforms to create a water sector that can deliver integrated catchment-based recreation, water supply, sanitation, irrigation and environmental services at the lowest cost. As a result, the Queensland Water Commission which provided independent policy advice to Government on SEQ regional water security, demand and supply options ceased its operations from 1 January 2013. Its policy functions moved to the Department of Energy and Water Supply (DEWS) and its planning and regulatory functions (including setting water restrictions) are now the responsibility of the new bulk water supply authority, SEQwater, and the SEQ council water businesses (distributor-retailers).

Furthermore, the DEWS is developing a '30-year water sector strategy', and in relation to this it recently released a Discussion paper titled 'Shaping our Water Future' as the first phase of this process. The second phase involves developing the Strategy itself based on the feedback and submissions received from local councils, water service providers, industry, researchers and the community on the Discussion Paper. The discussion paper highlighted some priority areas that needed attention to make the transition to the future and Table 8 presents some of the important issues identified in the paper.

Table 8 Current and future needs of Queensland water sector

CURRENT	FUTURE
Climate-dependent water supplies • Reliance on climate-dependent supplies (e.g. rivers and groundwater) • Difficulty for some service providers to plan for climate variability, including cycles of drought and flood • Seasonal shortages in some communities • Limited use of alternative water supplies (e.g. recycled water, stormwater, desalination, coal seam gas water) by the agriculture, mining and urban sectors	**Diverse and reliable water supplies** • Water supply and sewage management solutions that are adaptable and resilient to climate and future changes in water needs • Greater community understanding of the role of alternative water supplies • New opportunities for recycling schemes and storage and distribution infrastructure for agriculture and mining
Complex regulation • Complex institutional/regulatory frameworks with multiple departments, each having differing roles	**Light-handed regulation-performance reporting** • More flexible institutional arrangements and regulatory frameworks • Flexible frameworks to support innovative, localised solutions
Unfulfilled customer expectations • High expectations of reliability and service quality with weak recognition of costs • Varying service standards • Limited awareness of how the costs of water and sewerage services influence price	**Empowered customers to encourage smarter water use** • Better engagement between service providers and community and industry to promote understanding of the water cycle and environmental impacts • Customer input into affordable, locally relevant water supply and sewage management solutions • Cost-reflective pricing • Better demand and supply measures, including signals to consumers (e.g. billing)
Planning focused on water and sewerage services • Planning focused on individual urban developments and not catchment based • Service providers focused on their local needs for water and sewerage services • Various planning approaches for new (greenfield) and existing (infill) developments	**Proactive planning of water supply and sewage Management** • Movement towards total water cycle management • Catchment-based or cost-effective decentralised solutions • Integrated planning for water and energy • Cooperation in the planning and delivery of catchment-based scalable water and sewerage solutions

Source: Queensland's water sector: a 30-year strategy 2013

4.5 PERTH, WESTERN AUSTRALIA

In Western Australia, the Water Corporation wants to ensure that Perth and surrounding areas can adapt to the drying climate and ensure enough water for future generations. To do so, it was identified that there is need for a portfolio approach to address increasing water demand, with less rainfall was identified. Accordingly, the Water Corporation has developed a 50 year plan -*Water Forever: Towards Climate Resilience* - to ensure that there is enough water for all, and addressing the challenges of our drying climate, increasing population and minimising environmental impact.

4.5.1 Perth's water supply portfolio

The *Water Forever* plan provides a portfolio of options to manage Perth's demand and supply balance to 2060 which includes:

- reducing water use by 25%;
- increasing wastewater recycling to 60%; and
- developing new sources.

At present, Perth's water supply portfolio comprises of groundwater, surface water, desalinated water, rainwater, recycled water and demand management options via water efficiency programs.

4.5.2 Institutional arrangements

The Department of Water is responsible for developing strategies and management plans to protect the quantity and quality of water resources, protect infrastructure from flooding, and enhance the living environment for the community. In 2007 the Department release 'The Urban Drainage Initiative' which recognises that future drainage planning should have multiple objectives and drainage water (stormwater) should be seen as a valuable resource as part of the urban water cycle and it recommends that drainage planning needs to be part of an overall plan for water management that is integrated with land use planning.

The initiative has four key components: (1) Regional water planning, (2) Planning advice and assessments, (3) Best management practices, and (4) Governance and coordination. Regarding governance and coordination, the Initiative sets out to develop a State-wide framework for drainage governance based on the total water cycle, and it will include reviewing funding mechanisms for drainage and the development of appropriate legislation for drainage and water management as part of the water legislation program. The 2007 governance priorities included:

1. Clarify and formalise roles and responsibilities for drainage management
2. Develop a clear understanding of how water quantity and quality objectives can be incorporated in urban drainage
3. Review funding models for implementing and managing drainage

Furthermore, in October 2008 the Western Australian Planning Commission released Better Urban Water Management (BUWM) framework to provide guidance on the implementation of *State Planning Policy 2.9 Water Resources* and to assist in achieving sustainable urban water management. The BUWM framework aims to achieve the integration of water and land use planning and the objectives of urban water management by (DoW 2011):

- Facilitating better management and use of our urban water resources by ensuring an appropriate level of consideration is given to the total water cycle at each stage of the planning process.
- Assisting regional, district, local, subdivision and development phases of the planning process by identifying the actions and investigations required at each planning stage.
- Applying to proposed greenfield and urban renewal residential, commercial, industrial and rural-residential uses and developments.
- Ensuring consideration of relevant issues at a level of detail appropriate to the planning decision being made and the degree of risk to ecological systems and community assets.
- Identifying the agencies responsible for provision of water resource information.
- Allowing a flexible approach to planning and development assessment.

4.6 SUMMARY OF AUSTRALIAN CASE STUDIES

Review of Australian experiences with diversifying water supply sources indicated that most States have embarked on implementing the IUWM approach to supply and secure water for urban areas. Even though the situation in Australia is not dire as in the international cases discussed earlier, the Millennium Drought prompted water managers and policy makers in Australia to develop drought-proofing strategies based on IWRM principles to avert the emergence of yet another crisis in the future. Overall the strategy has been to develop efficient and flexible urban water systems by adopting a holistic approach in which all components urban water of the cycle are integrated, and includes a mix of water supply sources- freshwater(surface water, groundwater), and produced water (desalinated water, stormwater and treated effluent). However, implementation is a challenge given that there are different institutional models for urban water management across Australia.

With respect to ownership and operations, State or local governments own all the water utilities in Australia. However, there has been restructuring and institutional role separation within the public sector departments. The public sector departments have been transformed to corporations, subject to the same

laws that govern the private sector, and with clear commercial objectives (Srivastava 2004). Further, a number of water utilities have contracted out their design, construction, and various operational roles to the private sector through service or management contracts. Furthermore, Australia has a variety of regulatory regimes: health regulation, environmental regulation and economic regulation. The emerging trends and practices in Australia with respect to economic regulation show a clear shift towards independent regulation, and most of the States and territory jurisdictions favour a multi-sector approach. For health regulation, in almost all the states, the health department controls compliance with national water and sewerage quality standards. Environment regulation comes under an Environment Protection Authority/Agency (EPA) in all states, except in Western Australia and the Northern Territory, where it is the responsibility of a government department. Proper pricing of rural and urban water is one of the key issues for reform in the Australian water industry; and as a part of the COAG reforms, the 'pay for use' principle was adopted, which provides for water services to earn fair rate of return, ensuring that their business is financially viable and sustainable. All states have adopted a two-part tariff for water provision, consisting of a fixed access fee and a charge for usage. Sewerage charges are generally fixed.

4.7 PARADIGM SHIFT IN URBAN WATER MANAGEMENT

Both, international and Australian case studies discussed above clearly point out a shift in urban water management- from a centralised system relying on climate dependent traditional water resources to a more decentralised system that adopts a holistic and/or integrated approach to urban water management. The 'new' paradigm includes both demand and supply management measures and Table 9 compares the 'old' and 'new' paradigms of urban water management.

Table 9 The 'old' and 'new' paradigms of urban water management

OLD PARADIGM	NEW PARADIGM
Stormwater is a nuisance.	**Stormwater is a resource.**
Convey stormwater away from urban area as rapidly as possible.	Harvest stormwater as a water supply, and infiltrate or retain it to support aquifers, waterways, and vegetation.
One use.	**Reuse and reclamation.**
Water follows one-way path from supply, to a single use, to treatment and disposal to the environment.	Water can be used multiple times for fit-to use purposes.
Build to demand.	**Manage demand.**
It is necessary to build more capacity as demand increases.	Demand management opportunities are real and increasing. Take advantage of all cost-effective options before increasing infrastructure capacity.
Limit complexity and employ standard solutions.	**Allow diverse solutions.**
Small number of technologies by urban water professionals defines water infrastructure.	Decision makers are multidisciplinary. Allow new management strategies and technologies.
Integration by accident.	**Physical and institutional integration by design.**
Physically, water supply, wastewater and stormwater are separated. However they may be managed by the same agency as matter of coincidence.	Linkages must be made between water supply, wastewater, and stormwater, which require highly coordinated management.
Collaboration meant public relations.	**Collaboration means engagement.**
Approach other agencies and public when approval or pre-chosen solution is required.	Enlist all stakeholders (other agencies and public) in search for effective solutions.

Source: Pinkham 1999

In Australian context, the 'paradigm shift' as mentioned in Mitchell (2006, p.590) is largely attributed to a group of key individuals in Western Australia, who in the early 1990's were calling for a new approach to urban planning and design, based on the premise that conventional water supply, sewerage, and drainage practices that rely on conveyance and centralised treatment and discharge systems cannot be sustained in the long term. Over the years the integrated approach has received lot of emphasis from the governments at all levels. The COAG in March 2008 agreed to develop a work program on water with actions under four main themes:

- addressing over allocation and achieving environmental outcomes
- enhancing water markets
- urban water reforms
- water information and capacity building

Again in 2009, the COAG agreed to intensify its efforts to accelerate the pace of reform under the National Water Initiative. As a result of the work program and subsequent COAG decisions the governments adopted the National Urban Water Planning Principles which are aimed at providing Australian governments and water utilities with the tools to develop plans to manage the supply/demand balance of a reticulated supply for an urban population. The principles are:

1. Deliver urban water supplies in accordance with agreed levels of service
2. Base urban water planning on the best information available at the time and invest in acquiring information on an ongoing basis to continually improve the knowledge base.
3. Adopt a partnership approach so that stakeholders are able to make an informed contribution to urban water planning, including consideration of the appropriate supply/demand balance.
4. Manage water in the urban context on a whole-of-water-cycle basis.
5. Consider the full portfolio of water supply and demand options.
6. Develop and manage urban water supplies within sustainable limits.
7. Use pricing and markets, where efficient and feasible, to help achieve planned urban water supply/demand balance.
8. Periodically review urban water plans.

Accordingly, most state governments in Australia have embarked on implementing IUWM and having a portfolio of water supply sources that includes climate independent and non-traditional water resources such as desalinated water, recycled water, rainwater and stormwater (evident from the Australian case studies).

5 DIVERSIFYING WATER SUPPLY SOURCES IN ADELAIDE

The objective of this report was to review the institutional arrangements for implementing diverse water supply portfolio nationally and internationally to support the implementation of an integrated urban water management strategy for Metropolitan Adelaide. For that reason, the case of Adelaide is discussed separately and the process involved documentary analysis and discussions with key stakeholders.

5.1 ADELAIDE'S EXISTING WATER SUPPLY SOURCES

Adelaide's water supply was historically considered to be secure with the Mount Lofty Ranges storages, River Murray, and groundwater. But the Millennium Drought posed threat to Adelaide's water security and highlighted the fact Adelaide largely relies on water supplies that are (1) predominantly generated outside its physical domain, and (2) are subject to the political discretions of the New South Wales, Victoria and Queensland state governments, and the intergovernmental arrangements of the Murray Darling Basin Authority (Rijke *et al* 2011). As a result Adelaide had to rethink the way it manages its water resources and reflecting on the drought was considered important as the next 25-50 years are expected to have more variable and reduced flows in the Mount Lofty Ranges and Murray-Darling Basin (Beal 2012). In response, the South Australian government adopted the 'triage approach' to planning and implemented a number of initiatives including establishment of the Water Security Council and development of a Drought Response Strategy (Maywald 2012).

The Water Proofing Adelaide strategy released in 2005 aimed to set out a blueprint for the management, conservation and development of Adelaide's water resources to 2025 (SA GOV, 2005). The work of the project made it clear that there is no single quick fix solution to Adelaide's water challenges, and identified the need to increase rainwater and stormwater use, and the use of recycled water to diversify the mix of supply options. (SA GOV, 2005 p. 6). Accordingly, in 2009 the State Government developed a State Water Security Plan that became Water for Good - a plan to ensure our water future to 2050, which incorporated relevant elements of the Water Proofing Adelaide strategy and also outlined the actions to ensure water security for South Australia into the future (OWS 2009). This included the plan for construction of the desalination plant at Port Stanvac and investigations into the harvesting, treatment and use of stormwater, and encouraging water conservation through restrictions, rebates on low flow devices and rainwater tanks (OWS 2009).Furthermore, the enactment of the *Natural Resources Management Act* in 2004 provided the legislative framework to establish an integrated approach to promote the use and management of natural resources in South Australia (DTEI 2010).

As a result of these initiatives, South Australia today leads the country in stormwater capture and reuse, rainwater tank ownership and wastewater recycling. The State has also embraced demand management by introducing a range of water saving measures for both residential and non-residential customers, and water restrictions during drier periods encouraging customers to use water more wisely (SA GOV 2005). More recently, the Adelaide Desalination Plant (ADP) became operational and has been feeding desalinated water into Adelaide's water supply (SA Water 2013). Currently, Adelaide's water supply portfolio includes seven sources of supply and demand management measures. The seven supply sources are: Mt Lofty catchments, the River Murray, groundwater, Adelaide Desalination Plant, roof top water/rainwater, recycled wastewater, and stormwater.

5.2 EXISTING INSTITUTIONAL ARRANGEMENTS FOR WATER MANAGEMENT IN SOUTH AUSTRALIA

In South Australia, SA Water Corporation (SA Water) is the main supplier of public mains supplies and sewerage services, and the Department of Environment, Water and Natural Resources (DEWNR) along with the regional Natural Resources Management Boards are responsible for the development of water allocation plans for prescribed water resource areas as required by the *Natural Resources Management Act 2004* (SA).

SA Water, as the state's supplier of urban water, is required under the *South Australian Water Corporation Act 1994* to deliver, monitor and report on its primary functions of:

- supply of water by reticulated systems
- storage, treatment and supply of bulk water
- removal and treatment of wastewater

Table 10 shows the key agencies/organisations who are involved in various aspects of water management in South Australia.

Table 10 Institutional arrangements for water management in South Australia

WATER MANAGEMENT FUNCTION	ORGANISATION	KEY RESPONSIBILITIES
Water planning and management	Department of Environment, Water and Natural Resources (DEWNR)	Water resource management and administering the *Natural Resources Management Act 2004*.
	Natural Resource Management Boards	Develop and implement regional natural resource management plans and water allocation plans.
Urban and rural bulk water businesses	SA Water	Responsible for providing water and wastewater services and managing water, wastewater, infrastructure assets and contracts
Urban retail water businesses	SA Water Some local government suppliers (e.g. Coober Pedy Council)	Coober Pedy produces and reticulates its own: water is bought in from a bore via a pipeline and then processed through a Desalination/Reverse Osmosis Plant.
Rural retail water businesses	Private Irrigation Trusts (e.g. Central Irrigation Trust-CIT)	CIT provides irrigation and drainage services to 1,400 family farms and domestic water to 2,800 households and industries.
Stormwater and Drainage	Local Government	Responsible for the provision of local stormwater infrastructure, as well as its maintenance.
	Natural Resource Management Boards	Role of NRMBs relating to stormwater is only insofar as this might be addressed in their regional NRM Plans.
	Stormwater Management Authority (SMA)	Responsible to implementing the Stormwater Management Agreement and operates as the planning, prioritising and funding body in accordance with the Agreement.
	SA Water and DEWNR	Have roles in maintaining certain stormwater assets and works as a result of previous metropolitan drainage acts.
Recycled water management	SA Water	Responsible for providing water and wastewater services and managing water, wastewater, infrastructure assets and contracts
	Local Government Association	Manages the community wastewater management systems (CWMS) program- many of the systems now also involve recycling. The role is largely coordination and provision of State funding to councils for new CWMS with local government
	Private Recycle Schemes[e.g. Virginia Pipeline Scheme (VPS) and Willunga Basin Water Company)	On-selling SA Water recycled water to farmers for irrigation of vegetable crops, vines, and fruit trees.
Water pricing and economic regulation	Essential Services Commission of South Australia (ESCOSA)	Review government price setting
	Private Irrigation Trusts	Rural retail
Water markets governance	DEWNR	Under the *Natural Resources Management Act 2004* approve water trade.
	Private Irrigation Trusts	Record water licenses and transfers.
Water quality	Environment Protection Authority	Administer the *Environment Protection Act 1999*

management	(EPA)	and issue environmental authorisations of activities prescribed as having environmental significance under Schedule 1 of the Act.
	SA Health	Administer and enforce *Safe Drinking Water Act 2011* and the S*afe Drinking Water Regulations 2012* to ensure drinking water supplies are safe *and SA Public Health Act 2011* to promote and to provide for the protection of the health of the public.

Source: Compiled from www.nationalwatermarket.gov.au; http://archive.nwc.gov.au/home/water-governancearrangements-in-australia

5.3 CURRENT POLICY ENVIRONMENT

In the context of implementing diversified water supply portfolio in metropolitan Adelaide the following State Government policies are relevant:

5.3.1 Water for Good – a plan to ensure our water future to 2050 (2009)

The Water for Good plan released in June 2009 is the high-level strategy which provides the broad policy framework for South Australia's water resources by incorporating the key elements of Water *Proofing Adelaide* released in 2005. The strategy recognises the need for a more integrated approach to urban water management to deliver multiple benefits. It identified legal, governance and ownership gaps that need to be addressed in implementing an integrated water management policy, particularly to provide definitions for the various types of wastewater, and certainty as to ownership (Action 87).

5.3.2 Stormwater Strategy – the future of stormwater management (2011)

In 2011 the State Government released a Stormwater Strategy with an aim to developing an integrated approach to stormwater management as envisaged in *Water for Good* Plan. In particular, the Strategy provides a 'road map' for achieving the stormwater-related targets in the Government's *Water for Good* Plan released in June 2009. The Strategy outlines how those targets could be achieved through an integrated approach to water management. To that end, the Taskforce agreed on four key objectives:

- to manage water resources in an integrated way
- to better mitigate flood risk
- to clarify roles and responsibilities, and
- to move towards water sensitive urban design.

5.3.3 The 30-Year Plan for Greater Adelaide (2010)

The 30-Year Plan for Greater Adelaide sets the strategic direction for urban growth in Greater Adelaide. In relation to water management, the Plan identifies eight relevant policies, and seven targets to implement the Water for Good Plan and provide sufficient water to meet Greater Adelaide's growing population and economy. Two of the eight policies identified in the Plan are relevant to implementing integrated urban water management in Adelaide:

- Mandate WSUD for all new developments (including residential, retail, commercial, institutional, industrial and transport developments) by 2013 (consistent with the Water for Good),
- Ensure appropriate policy links and consistency between Stormwater Management Plans, Development Plans and Structure Plans to address stormwater and flood management matters.

5.3.4 Water Sensitive Urban Design Policy – creating more liveable and water sensitive cities in South Australia (2013)

The aim of the new water policy for urban development is to integrate the management of the water cycle into land use and development processes. The policy aims to improve water security and climate resilience, contribute to public health and wellbeing, help to protect or improve the health of receiving water bodies and their ecosystems, help to reduce ecological impacts and support affordable living by reducing long-term costs associated with water management. The policy also outlines actions the State Government will pursue collaboratively with industry, local government, and others to facilitate the improved adoption of WSUD within the State's urban environments. The policy provides a coordinated approach to ensuring

appropriate consideration is given to WSUD implementation in the local context and the following key elements of the policy emphasise this point:

- Establishing clear and consistent objectives and targets for WSUD from a State perspective in regard to new urban developments and infrastructure,
- Ensuring stronger linkages between the urban development and planning system and urban water management,
- Ensuring a consistent approach to WSUD across all relevant State policy areas.

5.4 KEY POLICY ACTOR INTERVIEWS

For the purpose of this study, key stakeholders involved in South Australian water policy-making process were identified using snowball sampling. Face to face meetings were held with some policy actors representing some of the stakeholder groups/agencies (example SA Water, DEWNR, Local Council *etc*.). The details of the interview process are described earlier in section 1.2.2.

Interviews with key policy actors reiterated the issues highlighted in the review of international and interstate experiences of implementing additional water sources. Even though the situation in Adelaide is not dire as in case of the international examples where water scarcity was the main driver to implementing additional water sources, it is true that the Millennium Drought that extended over a decade across much of Australia resulted in concerns about security of supply from predominantly rain-fed systems (ATSE 2012). Looking ahead, it is projected that climate change impacts of increased temperature and more severe droughts can be expected to increase water shortages in the future (CSIRO 2008).This along with population growth pose serious challenges to water security in Australia. And, the responses to a decade long drought conditions that included among others supply augmentations (desalination plants), diversified supply sources (rainwater tanks, recycled water, stormwater), and water conservation and demand management programs suggest that having access to a broad portfolio of sources reduces risk in times of uncertainties (ATSE 2012). While there have been a lot of technological advancements the institutional arrangements for delivering the objectives of IUWM are not always clear. Literatures point out that the impediments to implementing an integrated urban water management strategy are generally socio-institutional. These include institutional fragmentation, unclear ownership and access rights, funding, public perceptions and acceptance, and community participation and public education. It is important to note that most of the challenges are related to the 'new' water sources. In line with this, the challenges to implement an IUWM strategy in Adelaide identified through the interviews are organised in two categories-policy challenges and legal challenges and presented in Table 11.

Table 11 Policy and legal challenges to implementing a portfolio approach in Adelaide and potential solutions

POLICY CHALLENGES	POTENTIAL SOLUTIONS TO FACILITATE IMPLEMENTATION
• Lack of integrated framework to draw policy perspectives together • Lack of clarity on rights and responsibilities for all aspects of water management and use • Too many different regulations and licenses are administered by a large number of different government agencies • Processing of licensing takes far too long	• Co-ordination across the relevant stakeholder organisations through a single entity • Co-ordination through one agency (fine as is) but with a clear lead role for one organization (e.g. DEWNR) • Set up a process to work more collaboratively • Developed an integrated water management plan
LEGAL CHALLENGES	**POTENTIAL SOLUTIONS FOR OVERCOMING THE LEGAL CHALLENGES**
• Cross boundary disputes • Unclear private ownership of water courses • Unclear access rights to water sources on private land • Unclear property rights/ownership rights for non-prescribed water sources	• Political solution NRM Code of Conduct for maintaining water sources • Clarify the ownership of stormwater and water in the creek if they need to be part of the optimal mix and in case of aquifer recharge injected water entitlements • There should be certainty, • Collaborative effort for best policy instrument

Source: Interviews with key policy actors

The interviewees were also asked to recommend possible solutions to overcome these challenges and facilitate implementation of a portfolio approach in Adelaide (see Table 11). However, these are opinions or views of only a few individuals; there is need to do further research on these issues which will be achieved through the Governance project funded by the Goyder Institute.

6 GOVERNANCE CHALLENGES RELATED TO STORMWATER AND RECYCLED WATER

Our desktop review and key actor interviews in Adelaide identified challenges to implementing an IUWM strategy in metropolitan Adelaide. However, in this report the focus is primarily on the new or alternative sources of water supply that include recycled wastewater and stormwater harvesting and reuse. The challenges in including these 'new' sources in to the water supply mix (from a governance perspective) are discussed below.

6.1 INSTITUTIONAL FRAGMENTATION

Historically the structure for water and wastewater service delivery has been that of 'monopoly service providers' (Abbot and Cohen 2010). These service providers were centrally owned by State governments and used freshwater water from river and reservoirs only (McKay 2006). Of late and in response to the Millennium Drought there has been emphasis on multiple sources of supply such as desalination, recycled wastewater and stormwater and their inclusion in to the mix of water supply sources has made planners and decision makers rethink the traditional water and wastewater industry structures. This is mainly because addition on new sources creates coordination complexity due to varying roles and responsibilities and overlapping concerns among the public agencies managing the resources (MacDonald and Dyack 2004, McKay 2007, Porse 2013). Furthermore, the fragmented institutional settings results in inefficient urban services management and planning, delayed policy implementation, and poor enforcement of existing regulations (World Bank 2012).

In Australia, there are different institutional models for urban water management; and Australia has a variety of regulatory regimes-health regulation, environmental regulation and economic regulation. The situation is similar when we consider the metropolitan Adelaide- fragmented institutional settings seem to be an issue. More about this complexity is discussed earlier in the report (see Section 4.5). However, this is more evident in stormwater management because wastewater infrastructures are often managed under a centralised system while the stormwater drainage network is a separate system from the wastewater network, and traditionally the focus has been on conveyance and flood control (Porse 2013). This is in the domain of Local Councils.

But over the last decade the way stormwater is managed has changed largely because urban stormwater now is seen as a valuable water resource rather than a nuisance. Accordingly, stormwater management now reflects values of water conservation, pollution prevention, and ecological restoration and includes flood reduction, pollution minimisation, stormwater retention, and urban land scape improvement (Brown 2005, Porse 2013). However, not much has changed when it comes to governance because the administration of flood management, water quality management, urban design, and environmental protection are still separated (Brown *et al* 2009) and there is a lack of clarity about the roles and responsibilities and the relationship between the various agencies (Keremane et al 2011, Wu et al 2012a, Porse 2013).

6.1.1 Attempts to coordinate stormwater management -Stormwater Management Authority

In response the Stormwater Management Authority (SMA) was established in 2007 under the *Local Government (Stormwater Management) Amendment Act 2007*. The MOU between the Local Government Association (LGA) and the State of South Australia recites the three aims of flood mitigation with long term land-use planning, pollution reduction and with securing a more sustainable use of stormwater (to help reduce reticulated water demand). The Authority is responsible for implementing the Stormwater Management Agreement (2006), and operates as the planning, prioritising and funding body in accordance with the Agreement.

The South Australian Government and the state's councils have now signed a new agreement to further improve delivery of key stormwater management initiatives. The agreement will ensure there is a carefully coordinated approach to stormwater planning in urban areas to reduce risk to the community and, where

feasible, reuse stormwater. It was developed after extensive consultation between the State Government, the Local Government Association of SA, and councils. The new agreement builds on the 2006 State-Local Government Stormwater Management Agreement, and acknowledges the recommendations of an independent review of Stormwater Management Authority governance, and the subsequent release of a consultation draft Agreement in 2012. The new Agreement reinforces key commitments and responsibilities identified in the Stormwater Strategy one of them is the commitment to develop a new operational model for the Stormwater Management Authority to enable it to play a more strategic coordination and leadership role. The new Agreement signed on 2 September 2013 articulates the operational model developed jointly by the State Government and the Local Government Association (LGA).

The collaborative approach being taken is reflective of the fact that all South Australian's benefit from well planned and maintained stormwater management systems. The collaboration in the past had guided more than $300 million worth of major urban stormwater harvesting and reuse projects over about the last decade. The signing is an important step in furthering the state and local government relationship in urban water management.

However, there are concerns that currently the Authority examines individual projects but does not manage a bigger picture with a co-ordinated approach (CCSA 2008). Therefore, there is need to develop a new working model for the Authority emphasizing inter-sectoral collaboration, stakeholder engagement and community participation in decision making. These will be done in the second project.

6.1.2 Broader scale regional governance body to coordinate all 7 water types

Another solution at the broader scale to address the challenges of institutional fragmentation would be regional governance (Feiock 2009) like the California's integrated regional water management (IRWM) program which enables self-identified regions to integrate and implement water management solutions for their region (Hughes and Pincetl 2014). The result, an additional layer did improve networks between some groups of actors and in other cases disrupted perfectly good working relationships (Hughes and Wilkinson 2013). However, South Australia does not have the same level of fragmentation as California, and the problems with such a body are numerous. Then there is also the issue of path dependency -historically benefitted interests become entrenched and are often unwilling to relinquish their control and authority (Ingram and Fraser 2006)-, which is not uncommon in the water sector; and sometimes new layers disturb these and actually contribute to worse outcomes. Therefore it is important to understand if adding another governance layer will contribute to better interactions and better choices? The aim of the second study is to identify the networks that exist now and look for ways to improve these. It would be interesting here to look at collaborative governance mechanisms and these will be defined and worked on during the detailed interview process in the second project.

6.2 UNCLEAR ENTITLEMENTS ARRANGEMENTS

With urban water supply sources now including 'new' sources such as stormwater, and recycled water, clarifying entitlement arrangements is a complex task. The current entitlements arrangements governing these sources of water are not clearly defined and this would need to be done by legislation especially for stormwater. Similarly, there may be issues when storing either of these resources using MAR. When these resources are stored in an aquifer, generally the person or entity injecting the water do not retain legal ownership rights, or have any guarantee that they can recover their water, these rights and guarantees need to be established (Ross 2012). The other concern with MAR is that the physical success depends largely on the local hydrogeological conditions as they determine the ability of the recharge water to percolate through the unsaturated zone and the ability of the aquifer to store the recharge water (UNESCO 2005). So if the schemes are not designed and maintained appropriately the chances of such schemes failing is high. Also there remains uncertainty about access by a third party to SA Water's sewerage pipelines and networks. As noted in a report by Frontier Economics (2008a) the urban water cycle includes sources that are interdependent and as a result of these interdependencies, 'attempting to clarify

entitlements at one point may actually impinge on other entitlements or rights at another. Simply assigning overarching control to the Crown for the sake of clarity alone may act as a disincentive to innovative investment proposals in other part of the cycle.'

The complex entitlements regime and related issues about security to access may create a barrier to future investment in a range of 'new' sources that potentially substitute potable supply. In addition, this has implications on the urban water market which traditionally has been dominated by monopoly providers, usually the publicly owned water authorities. However with the inclusion of the new sources (recycled wastewater, stormwater) in to the water supply mix there are two possibilities *(*Frontier Economics 2008b*):*

- *Entry of alternative suppliers, particularly for supply of non-traditional sources, and*
- *The prospect of third party access regimes to provide new entrants with access to the services provided by the monopoly network.*

But the uncertainty associated with the ownership and access rights of the new resources may prevent entry of new suppliers thereby worsening the market situation for these non-traditional sources which is already unbalanced.

Addressing these issues may require institutional reform to ensure that the new water sources are considered in the planning framework at the appropriate level supported by complementary legislative changes to clarify the rights and obligations for new water sources. Some states have already made progress in this direction. For example, Victoria's draft strategy for urban water management '*Melbourne's Water Future*' provides to improve investment certainty and the efficient allocation of urban water by extending Victoria's water rights and trading framework to include alternative water sources. Similarly, in 2006 NSW introduced the *Water Industry Competition Act* 2006 (WICA) which incorporates a licensing regime for private sector participation, a third-party access regime and a binding arbitration of sewer mining disputes (LECG 2011).

6.3 USERS' WILLINGNESS TO PAY AND FUNDING

Users' willingness to pay for the resource in question (recycled wastewater and stormwater in this case) to a large extent influences the implementation of reuse schemes. The general tendency observed in case of water reuse schemes is that users might not be willing to pay more for this resource because it is considered as waste, so why pay for it? Therefore, users' willingness to pay is influenced by the tariff structure, and in Australia we find varying pricing principles for recycled water and stormwater use developed by different agencies (see Marsden Jacob 2013). However, there is a general consensus that a beneficiary pays model is appropriate which is in accordance with the NWI principles (CIE 2010) that states:

> *When allocating costs, a beneficiary pays approach — typically including direct user pay contributions -should be the starting point, with specific cost share across beneficiaries based on the scheme's drivers (and other characteristics of the recycled water/stormwater reuse scheme).*

The tariff structure should be such that the community being served should perceive it to be appropriate, as well as taking into account the long term viability of the service provider. Previous research (Marsden Jacob 2013a) has indicated that the broader community is prepared to provide a significant contribution toward the costs of water recycling, even if they do not directly use the recycled water, for example to avoid 'waste' of a water resource or reduce wastewater discharge. In Adelaide, a study conducted to evaluate community acceptance for non-potable and potable uses for treated stormwater (Mankad *et al* 2013) indicated that almost 50% of respondents preferred to pay the same as they were currently paying for the use of treated stormwater for either non-potable or potable purposes while 35% preferred to pay a little less than current prices. The study found 15% of respondents were prepared to pay a little more than current prices. A recent study funded by the Australian Water Recycling Centre of Excellence (Marsden Jacob 2013b) examined the commercial viability of non-potable recycled water schemes and recommended a pricing approach that allocates the costs to each of the beneficiaries (not just recycled water users) based on the benefit each party receives. Similarly, in their study investigating the issues affecting community attitudes and intended behaviours in stormwater reuse, Wu *et al* (2012b) found that the higher the price

was, the lesser number of people were willing to pay to use treated stormwater and no-one was willing to pay more than the current water price for the treated stormwater.

Likewise, funding is also an important issue that needs to be considered when implementing a diverse portfolio of water supply sources, particularly the stormwater schemes. Effective management of stormwater in an integrated way requires substantial resources and acquiring the funds is always a challenge. In the Australian context, the resources are typically obtained from short-term grants, consolidated revenue or general rates, environmental levies, and stormwater-related fees (DOE 2004).

However, short-term funding programs have led to poor outcomes in some stormwater management projects in Australia like the gross pollutant traps that were hastily built with grant funds, but never maintained due to a lack of ongoing funding (DOE 2004). Therefore, it is important to have a dedicated and stable source of funding for managing these schemes like the stormwater utilities in the United States. A stormwater utility operates much like an electric or water utility and collects fees related to the control and treatment of stormwater to be used to fund a municipal stormwater management program (USEPA 2009). Another option of a funding system could be the use of 'polluter pays' and 'user pays' principles. These funding mechanisms can be structured on a property based approach like in the case of Kitchener Waterloo Councils in Canada (see www.kitchener.ca). Yet another option would be developing innovative institutional arrangements to encourage private sector participation like private providers of localised wastewater and recycled water solutions as alternatives to local state-owned water utilities (Keremane & McKay 2006, 2009).

In Australia, Melbourne Water collects Waterways and Drainage Charge to fund a range of programs to protect and improve the health of our rivers and creeks, and provide regional drainage services, flood protection and flood warning systems throughout the Port Phillip and Westernport region. The retail water businesses collect these charges on Melbourne Water's behalf from property owners across the region. The Waterways and Drainage Charge varies with the property type and in 2013-14 residential properties were charged $ 89.12 while non-residential properties were charged based on the net annual value of the property, subject to a minimum of $102.48 (Melbourne Water 2013). In case of Adelaide, a recent study looked into the options for funding stormwater management in the State (Jeff Tate Consulting 2013, p.21) and recommended adopting a 'menu' approach to fit particular circumstances. fThe options among others included the following:

- general revenue (Australian, State and Local Governments),
- levies and charges at the State, catchment or Council level,
- infrastructure contributions,
- 'polluter pays' charges,
- special purpose funds,
- revenue from the sale of harvested stormwater, and
- PPPs – to facilitate private sector involvement in varying ways such as direct financing, construction and operation.

6.4 PUBLIC PERCEPTIONS AND ACCEPTANCE

The other factor to consider is the public acceptance of the use of both types of water – recycled wastewater and stormwater. This is also important for successful implementation of an integrated urban water management plan because it involves addition of 'new' sources such as recycled wastewater and stormwater in to the mix. There are clear research outputs on the community rejection of potable use of waste water but more relaxed attitudes to non-potable uses (Hurlimann and McKay 2006, Keremane *et al* 2011, Wu *et al* 2012b). The literatures on water reuse point out to the factors that influence community's acceptance of a reuse scheme including disgust or 'yuck' factor, the perception of risks associated with using recycled wastewater, the specific uses and cost of recycled water, the sources of water to be recycled, issues of choice, trust and knowledge, attitudes toward the environment, and socio-demographic factors (Po *et al* 2004, Leviston *et al* 2006, Hurlimann and McKay 2006, Keremane and McKay 2006, Dolnicar and Schäfer 2009, Hurlimann and Dolnicar 2009, Keremane *et al* 2011, Wu *et al* 2012b). Therefore,

if the ‘new water sources’ are to become an integral component of the water supply mix, the acceptance of these sources must be tackled in a systematic manner in the pursuit of policy goals; this is more critical if the application is for potable uses because all the previous studies indicated a great degree of community support and intention to use the new water sources for non-potable uses.

According to Jones (2005), ‘working with a community that does not have recycled wastewater and /stormwater as a highest priority requires building participation through a combination of discussions about community outcomes, and more detailed action steps of technology identification, design work, and management’. The author further suggests that lack of community participation results in a wide gap between what is desired from wastewater/stormwater reuse and what is necessary to get there, and an inability to bridge this gap is the primary reason for failure of locally driven wastewater projects. Therefore, when planning to include the new sources of water in to the supply mix the policies must include the human dimension (Robinson *et al* 2005) since it is the public who will be served by and pay for them. However, in case of Adelaide, public acceptance is not a serious challenge as evident from the uptake of recycled water which is higher than all the other states. Similarly, previous studies (Mankad *et al* 2013, Wu *et al* 2012b) have found that most people in Adelaide perceived stormwater to be an effective, fair and safe means of water reuse and they supported the use of treated stormwater for non-potable applications. Nevertheless, insights on community preference and the value placed on these resources help to inform decisions on investment and policy design.

7 CONCLUSIONS

There is enough evidence from case studies discussed in this report that there is a growing support for implementing diverse water supplies both, nationally and internationally. While the drivers for this change in the international cases was predominantly water scarcity and transboundary conflict (in case of Israel), in Australia the Millennium Drought prompted all jurisdictions to think of developing drought-proofing strategies based on IWRM principles. As a result, the responses to a decade long drought conditions included among others supply augmentations (desalination plants), diversifying supply sources (rainwater tanks, recycled water, stormwater), and water conservation and demand management programs. At the same time it is also true that having these strategies in place including access to a broad portfolio of sources reduces the risk in times of uncertainties associated with the climate change impacts, population growth and rapid urbanisation.

However, this approach is yet to be realized as mainstream accepted practice mainly because transitioning to a diverse water supply approach involves a paradigm shift in urban water management. Also, implementation of an integrated approach encounters various impediments including a wide range of social and institutional barriers. The commonly identified barriers to adoption of diverse supply sources in the literatures include insufficient practitioner skills and knowledge, organizational resistance, lack of political will, limited regulatory incentives and unsuitable institutional capacity. It is also important to point out that inclusion of the new sources of water supply such as recycled wastewater and stormwater in to the water supply mix have their own set of challenges. These challenges include institutional fragmentation, unclear entitlement arrangements, users' willingness to pay for the resource, and public preferences and values.

While in literatures we find a wide range of barriers, there remains a distinct lack of detail regarding the scope and priority of these barriers, and there is little reliable guidance on how they might be overcome. This report attempts to fill this gap by reviewing the institutional arrangements for implementing diverse water supply portfolio nationally and internationally, and discussions with key stakeholders in South Australia. Some potential solutions were identified during the project discussions and they include:

- Establishing governance model that links all the key stakeholders in a set of partnerships, and that promotes close collaboration and interactions between them.
- Institutional reforms to ensure new water sources are considered in the planning framework at the appropriate level and complementary legislative reforms to clarify the rights and obligations for new water sources.
- Establish a dedicated and stable funding source like the water utilities in the USA and Melbourne and/or encourage private sector participation. This may require institutional and regulatory changes
- Developing an effective water education plan
- Develop effective stakeholder engagement, and maintain transparency in the processes

However, there is scope to further refine, clarify and expand these challenges and potential solutions. Equally important is to have a better understanding of the perceptions, participation levels, and interaction of water agencies and collaborative governance. This will be done in the separate Goyder project on governance of water particularly with reference to implementing an integrated urban water management plan for Greater Adelaide region.

To conclude, irrespective of the drivers to have multiple sources of supply, there is no 'one size fits all' structural arrangement for implementing diverse portfolio of water supply sources. What is required is a new paradigm to address the challenges, specifically engaging the governments, corporations and community in a three way collaborative effort (Chiplunkar *et al* 2012, Brown 2005). In Australia, there are path dependency issues as well and acute Federal-State relations issues. But then again there are several forums and opportunities for dialogue in Australia and many administrative solutions to other problems to use as partial precedents. Therefore the focus has to be on implementing institutional change through reform approaches that emphasise on introducing developed coordinating mechanisms and improving intra- and inter-organizational relationships (Briassoulis 2004, Mitchell 2006). As mentioned in the World

Bank report (2012), the overall strategy to implementing diverse source portfolio should include the following institutional practices: integration of services in one institution; development of master plans (urban, water, sanitation); revision of building codes; stimulate cost recovery practices; enforceable laws and regulations; environmental certification; public participation; and capacity building. One way to achieve this may be through hybrid governance structures that disperse management and financial responsibilities among central authorities, businesses and residents (Porse 2013).

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9 APPENDIX 1: INTERVIEW GUIDE

Optimal Water Resources Mix for Metropolitan Adelaide: Governance Scoping Study

Interview Guide

The Centre for Comparative Water Policies and Laws based in the University of South Australia is conducting a scoping study to understand the governance and ownership issues related to 'new' sources of water. This project is part of the Optimal Water Resources Mix for Metropolitan Adelaide project funded by the Goyder Institute. The project methodology includes documentary analysis and key actor interviews and this interview is part of it. The interview will be completely anonymous. Every care will be taken to remove responses from any identifying material and all individuals' responses will be kept confidential and not be identified in the reporting of the research.

1a. What are the policy challenges to implement integrated urban water management?

1b. What are the potential solutions to overcoming the policy challenges?

2a. What are the legal challenges to implement integrated urban water management?

2b. What are the potential solutions to overcoming the legal challenges?

3. What are the possible solutions to improving take-up of integrated water management to create water sensitive Australian cities?

4a. What are the policy challenges to source diversification for augmenting drinking water supplies?

4b. What are the potential solutions to overcoming these challenges?

5a. What are the legal challenges to source diversification for augmenting drinking water supplies?

5b. What are the potential solutions for overcoming these challenges?

6. To create a water sensitive Adelaide and South Australia what governance arrangements possibly would facilitate the processes including diversifying the source portfolio and access to water through these sources?

7. How much of a barrier to implementing integrated urban water management is institutional uncertainty about ownership?

8. How much of a barrier to implementing integrated urban water management is institutional capacity?

9. What are the barriers to full compliance with public health and environmental regulations?

10. Who according to you are the key players to implementing integrated urban water management in Adelaide?

This study will form the basis for a new project again funded by the Goyder Institute which will assess the legal and governance options and risks of the scenarios identified in the development of the proposed Urban Water Blueprint. If you would like to be part of the new project please indicate below:

☐ Yes (Email:_____) ☐ No

Thank you.

This project has been approved by the University of South Australia's Human Research Ethics Committee. If you have any ethical concerns about the project or questions about your rights as a participant please contact the Executive Officer of this Committee, Tel: +61 8 8302 3118; Email: Vicki.allen@unisa.edu.au

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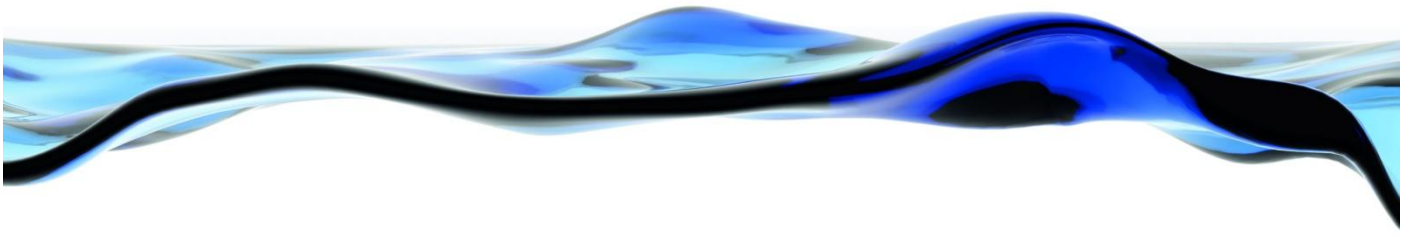

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The Goyder Institute for Water Research is a partnership between the South Australian Government through the Department of Environment, Water and Natural Resources, CSIRO, Flinders University, the University of Adelaide and the University of South Australia.