Development of a Guiding Framework for Sustainable Urban Water Governance

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Abstract

Sustainable urban water management is an increasingly important socio-political objective, however implementation remains ad hoc. While numerous tools and technologies have been developed to achieve sustainable urban water management, significant socio-institutional barriers remain. These impediments include, among others, institutional fragmentation, poor political leadership and technological lock-in. Exacerbated by a lack of theory and conceptual frameworks to link sustainable urban water management principles with on-ground execution, these barriers contribute to low levels of system-wide implementation capacity.

Institutional capacity building is advocated in the sustainable urban water literature as a strategy to facilitate implementation; however, institutional capacity building has limited ability to provide an overview of regime operation, considered critical for enabling system-wide change. Focusing on processes, actor agency and institutions, the field of governance studies provides a useful perspective for understanding holistic regime operation and change. Yet the environmental governance literature remains contested; many scholars support a network or market governance approach while others advocate for hybrid approaches. Moreover, the governance systems needed for enabling sustainable urban water management have been given limited attention. Therefore, the purpose of this thesis is to develop a guiding framework for sustainable urban water governance.

Through an emergent research design, systematically drawing on the perspectives of scholars and leading Australian urban water sustainability practitioners, likely attributes of a sustainable urban water management regime were identified. The attributes were focused through the lens of individual, organisational, inter-organisational relationships, and administrative and regulatory regime components. A comparison of the scholarly and practitioner perspectives, together with governance, regime and institutional literatures, explored which governance modes are most likely to enable sustainable urban water management.

Overall, this investigation revealed a suite of likely sustainable urban water management regime attributes that are substantially different from traditional and contemporary practice highlighting the considerable regime change required to enable sustainable urban water management. The scholars supported a network governance approach, similar to current adaptive governance and conceptual scholarly urban water management projections, with interdependent actor relations and largely informal administrative arrangements. In comparison, the practitioners advocated hybrid governance arrangements comprising hierarchical and network modes, including a formal administrative framework, with mutually dependent and interconnected actor relationships to facilitate implementation of site specific sustainable urban water management solutions. Both scholars and practitioners supported using a variety of policy instruments, including market governance instruments.

The outcomes of this investigation suggest the hybrid governance approach supported by practitioners extends current scholarship by providing detailed information on regime attributes and operation, which can provide insight for practical implementation of network governance approaches which are supported in current urban water management and adaptive governance literature. Additionally, the hybrid approach offers suggestions for successfully integrating the three ideal governance modes and reducing potential tension among the modes. In practice, the proposed framework could be used to design capacity building programs and policy initiatives drawing on mixed governance approaches. To extend this research and improve insight into regime operation and governance dynamics, future research testing the tentative sustainable urban water governance framework in other locations is required.

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List of Abbreviations

LID	Low impact design
LIUDD	Low impact urban design and development
NRM	Natural resource management
SES	Social ecological system
SUWM	Sustainable urban water management
WSUD	Water sensitive urban design

List of Thesis Publications

Journals

* van de Meene, S. J. and Brown, R. R. (2009) Delving into the 'Institutional Black Box': Revealing the Attributes of Sustainable Urban Water Management Regimes, *Journal of the American Water Resources Association*, **45**(6): 1448-1464.

* van de Meene, S. J., Brown, R. R., and Farrelly, M. A. (2009) Exploring future sustainable urban water governance: a case study of institutional capacity, *Water Science and Technology*, **59**(10): 1921–1928.

* van de Meene, S. J., Brown, R. R., Farrelly, M. A. (in press) Capacity Attributes of Future Urban Water Management Regimes: Projections from Australian Sustainability Practitioners, *Water Science and Technology*, accepted 29 January 2010.

* van de Meene, S. J., Brown, R. R., and Farrelly, M. A. (submitted) Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective, submitted to *Global Environmental Change: Human and Policy Dimensions*.

Conferences

van de Meene, S. and Brown, R. (2007). Towards an Institutional Capacity Assessment Framework for Sustainable Urban Water Management. Coombes, P. (ed) in *Proceedings of the 13th International Rainwater Catchment Systems Conference and the 5th International Water Sensitive Urban Design Conference*, 21 - 23 August, 2007, Sydney, Australia, CD-ROM. (peer reviewed)

van de Meene, S. (2008) Institutional Capacity Attributes of Sustainable Urban Water Management: the Case of Sydney, Australia, Ashley, R. (ed) in *Proceedings of the 11th International Conference on Urban Drainage*, 31 August - 05 September, 2008, Edinburgh, Scotland, CD-ROM. (peer reviewed)

van de Meene, S. J., Brown, R. R., Farrelly, M. A. (2009) Investigating Sustainable Urban Water Management Regimes: What Tools are Available to Help? in *Proceedings of the 6th International Water Sensitive Urban Design Conference and Hydropolis #3*, 5 - 8 May 2009, Perth, Western Australia.

van de Meene, S. J., Brown, R. R., Farrelly, M. A. (2009) Characteristics of a More Sustainable Urban Water Management Regime: Insights from Two Australian Cities, in *Proceedings of the 6th International Water Sensitive Urban Design Conference and Hydropolis #3*, 5 - 8 May 2009, Perth, Western Australia.

* Denotes papers included in Chapters 4, 5 and 6, refer to Section 1.4 for full thesis structure.

General Declaration

In accordance with Monash University Doctorate Regulation 17/ Doctor of Philosophy and Master of Philosophy (MPhil) regulations the following declarations are made:

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes two original publication published in peer reviewed journals, one accepted publication and one submitted unpublished publication. The core theme of the thesis is sustainable urban water governance. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the candidate, working within the School of Geography and Environmental Science under the supervision of A/Prof Rebekah Brown, Prof Chris Cocklin and Dr Megan Farrelly.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of Chapters 4, 5 and 6 my contribution to the work involved the following:

Thesis chapter	**Publication title**	**Publication status**	**Nature and extent of candidate's contribution**
4	Exploring sustainable urban water governance: a case study of institutional capacity	Published	Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.
4	Capacity Attributes of Future Urban Water Management Regimes: Projections from Australian Sustainability Practitioners	Accepted	Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.
5	Delving into the "Institutional Black Box": Revealing the Attributes of Sustainable urban Water Management Regimes	Published	Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.
6	Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective	Submitted	Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.

I have not renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Signed: ……

Date: ……

Declaration for Publication 1

Declaration by candidate

In the case of Publication 1, van de Meene, S. J., Brown, R. R., and Farrelly, M. A. (2009) Exploring future sustainable urban water governance: a case study of institutional capacity, *Water Science and Technology*, **59**(10): 1921–1928, the nature and extent of my contribution to the work was the following:

Nature of contribution	**Extent of contribution (%)**
Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.	70

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	**Nature of contribution**	**Extent of contribution (%) for student co-authors only**
Rebekah R. Brown	Participation in the formulation of research problem and interpretation of results and writing.	N/A
Megan A. Farrelly	Participation in the formulation of research problem and interpretation of results and writing.	N/A

Candidate's Signature		Date

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
2. they meet the criteria for authorship in that they have participated in the conception, execution, or interpretation, of at least that part of the publication in their field of expertise;
3. they take public responsibility for their part of the publication, except for the responsible author who accepts overall responsibility for the publication;
4. there are no other authors of the publication according to these criteria;
5. potential conflicts of interest have been disclosed to (a) granting bodies, (b) the editor or publisher of journals or other publications, and (c) the head of the responsible academic unit; and

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Nature of contribution	**Extent of contribution (%)**
Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.	70

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

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Rebekah R. Brown	Participation in the formulation of research problem and interpretation of results and writing.	N/A
Megan A. Farrelly	Participation in the formulation of research problem and interpretation of results and writing.	N/A

Candidate's Signature		Date

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The undersigned hereby certify that:

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Declaration for Publication 3

Declaration by candidate

In the case of Publication 3, van de Meene, S. J. and Brown, R. R. (2009) Delving into the 'Institutional Black Box': Revealing the Attributes of Sustainable Urban Water Management Regimes, *Journal of the American Water Resources Association*, **45**(6): 1448-1464, the nature and extent of my contribution to the work was the following:

Nature of contribution	**Extent of contribution (%)**
Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.	80

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	**Nature of contribution**	**Extent of contribution (%) for student co-authors only**
Rebekah R. Brown	Participation in the formulation of research problem and interpretation of results and writing.	N/A

Candidate's Signature		Date

Declaration by co-authors

The undersigned hereby certify that:

1. the above declaration correctly reflects the nature and extent of the candidate's contribution to this work, and the nature of the contribution of each of the co-authors.
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Declaration by candidate

In the case of Publication 4, van de Meene, S. J., Brown, R. R., Farrelly, M. A. (submitted) Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective, submitted to *Global Environmental Change*, the nature and extent of my contribution to the work was the following:

Nature of contribution	**Extent of contribution (%)**
Formulation of research problem and the context of the research in the wider literature, data collection & analysis; interpretation of results and writing.	80

The following co-authors contributed to the work. Co-authors who are students at Monash University must also indicate the extent of their contribution in percentage terms:

Name	**Nature of contribution**	**Extent of contribution (%) for student co-authors only**
Rebekah R. Brown	Participation in the formulation of research problem and interpretation of results and writing.	N/A
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Location(s)	School of Geography & Environmental Science, Monash University

Signature 1		Date
Signature 2		

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CHAPTER 1 INTRODUCTION

1.1 RESEARCH PROBLEM

Our urban water socio-technical system has evolved to meet the needs of urban populations over the past 150 years. Traditional urban water management practices were developed in the 19th century to meet the growing needs of industrialising economies and urban populations (Cech, 2005). These traditional practices are now widely recognised as needing to change to meet future challenges (e.g. Mouritz, 1996; Niemczynowicz, 1999; Chocat *et al.*, 2001; Lundqvist *et al.*, 2001; Harremoës, 2002; Brown, 2005; Harding, 2006; Mitchell, 2006; Ashley *et al.*, 2007).

In addition to this identified need for change, pressures on urban water systems continue to increase. For example in 2009, urban residents comprised fifty percent of the world's population (UNPF, 2009) and as the population grows, demand for water supply, sewerage and drainage services also increases. In addition, environmental impacts from urban water management are observed within and outside of most cities; in rivers and catchments that are dammed for water supply, and in rivers, lakes and coastal areas where pollution discharges negatively impact ecological health (Haughton and Hunter, 1994; Niemczynowicz, 1999). Additional environmental impacts are presented in Table 1.1.

Furthermore, climate change forecasts indicate that extreme events (such as droughts, high intensity rainfall and heat waves) are likely to increase and that freshwater systems will be adversely affected (IPCC, 2008). Decreasing water availability and increasing rainfall variability will further stress already over-allocated water systems and decrease the water security of urban centres and other areas (IPCC, 2008). Furthermore, developed countries face infrastructure renewal challenges because of the end of infrastructure life-cycle and a lack of investment in infrastructure maintenance (Vlachos and Braga, 2001; Bakker, 2002; Palaniappan *et al.*, 2007).

There are also challenges within the management regime needing resolution before sustainable urban water management is realised (Brown *et al.*, 2009). The management regime is the associated individuals and organisations that come together to innovate, develop, produce, market, distribute and use the technologies, together with the cultural meaning and values attached to these technologies (Geels, 2004). The traditional values underpinning urban water management: supply security, public health protection and flood protection, were challenged when the global environment movement increased the value society places on ecosystem protection (Viessman, 1988; Pahl-Wostl, 2008; Brown *et al.*, 2009). The expansion in social values, together with increased demand for high quality social amenity in urban areas makes sustainable urban water management a complex problem (Pahl-Wostl, 2008). In sum, sustainable urban water systems need to concurrently provide for supply security, public health, flood protection, waterway health, biodiversity, social amenity and recreation, water conservation and efficiency, carbon neutrality, and urban heat island improvement (Chocat *et al.*, 2007; Brown *et al.*, 2009).

Table 1.1 Traditional Urban Water Management Impacts on the Environment

Element	Environmental Impacts
Water supply – dam construction	- Modification of river flows (unseasonal river flows, water quality changes due to dam releases) - Barriers to fish migration - Changes to channel morphology due to flow modification
Water supply – groundwater extraction	- Land subsidence - Salt water or polluted water intrusion
Sewerage – sewage treatment plants & combined sewer overflows	- Decreased water quality from effluent discharges (nutrients, salt, bacteria) - Possible unseasonal changes to flow regimes
Stormwater and drainage	- Increased erosion of natural channels - Decreased water quality due to poor quality runoff (nutrients, oil, sediment) - Degraded aquatic habitat due to straightening and piping of natural channels
Urbanisation	- Reduced groundwater recharge due to changed land use - Reduced water quality in urban waterways due to reduced groundwater inflow - Increased impervious areas leading to changed hydrograph (larger peaks occurring earlier), increased runoff and erosion and decreased water quality (also see stormwater section above)

(Adapted from: Hunter, 1998; Niemczynowicz, 1999; Walsh, 2000; Chocat *et al.*, 2001; Tejada-Guibert and Maksimović, 2003; Butler and Davies, 2004; Gordon *et al.*, 2004; Cech, 2005)

In seeking to meet this challenge, the water resources field has developed an alternative water management approach, aimed at enabling sustainable urban water management (SUWM) and underpinned by widely agreed principles, which are shown in Table 1.2. As part of this change, numerous technologies and methods which differ from the traditional approach have been developed. Examples include biofiltration technologies (e.g. Hatt *et al.*, 2007) and improvements in wastewater treatment technology and efficiency (e.g. Otterpohl, 2002). Many of these can be used in tandem with or to replace existing technologies and methods.

Table 1.2 Principles of Sustainable Urban Water Management

Principles
All parts of the urban water cycle, natural and constructed, are managed in an integrated and holistic way that protects ecological health, using diverse and flexible infrastructure
Multiple uses are considered and provided for, including ecological and human uses
Local context is considered, including environmental, social, economic, political and institutional
Relevant stakeholders, both community and organisational, are effectively involved in urban water planning and decision-making
A long-term, strategic approach is taken when developing plans, programs and policies

(Adapted from: Serageldin, 1995; Mouritz, 1996; Vlachos and Braga, 2001; Mitchell, 2006; Mostert, 2006; Brown and Keath, 2008; Maheepala and Blackmore, 2008)

Over recent years, dedicated water reform has become an important policy priority (Saleth and Dinar, 2005; Hussey and Dovers, 2006), influenced by the technical developments, and in response to the scientific call (e.g. Mouritz, 1996; Niemczynowicz, 1999; Chocat *et al.*, 2001; Lundqvist *et al.*, 2001; Harremoës, 2002; Brown, 2005) and general community desire for more sustainable approaches. Reforms have included considerable outlay across government levels from the supra-national and national, state or provincial and local government levels. Some relatively recent and notable international examples include the Water Framework Directive in the European Union (2000), the National Water Initiative in Australia (2004), the Sustainable Water Infrastructure Initiative in the United States of America (2006), the Québec Water Policy in Canada (2002), and local water cycle management and water sensitive urban design policies. Yet these water reform efforts face some common challenges such as institutional and regulatory fragmentation, balancing environmental needs for water with consumptive demands, difficulties in selecting the appropriate policy tools to meet diverse objectives, and the variable capacity of new organisations to successfully achieve their responsibilities (Hussey and Dovers, 2006). Criticism has also been levelled at the narrow scope of many reform objectives that often focus on only part of the urban water cycle (Wong, 2006b) and also the slow speed of reform implementation (Harding, 2006).

Another consideration, which perhaps explains the slow progress of SUWM reform, is the underpinning stationary design principles of the traditional urban water management regime (Milly *et al.*, 2008). The stationary design approach decreases the ability of the regime to respond to change (Dawson, 2007). Additionally, the significant investments, made over many years, into these large technical systems create considerable inertia (Unruh, 2000; Walker, 2000). Together these factors, which have been identified internationally (e.g. Niemczynowicz, 1999; Chocat *et al.*, 2001; Vlachos and Braga, 2001; Harremoës, 2002), result in significant barriers to enabling SUWM. The barriers include, among others, institutional fragmentation, lack of effective community participation and empowerment, limited resources and information, lack of political leadership and vision, poor organisational commitment and poor communication (e.g. Mouritz, 2000; Hatton MacDonald and Dyack, 2004; Brown, 2005; Brown and Farrelly, 2009). To overcome these barriers and enable a socio-technical system transition to SUWM, governance of the urban water management regime must be addressed (Elzen and Wieczorek, 2005; van der Brugge and Rotmans, 2007; Brown, 2008; Pahl-Wostl, 2009).

1.2 RESEARCH FOCUS

While there is significant knowledge about the institutional barriers outlined above, Brown and Farrelly (2009) argue that few strategies have been developed to overcome these impediments. One strategy receiving some attention is developing institutional capacity (Ivey *et al.*, 2002; de Loë and Lukovich, 2004; Ivey *et al.*, 2004; Brown *et al.*, 2006a; Wong, 2006a; Timmer *et al.*, 2007). Institutional capacity building is broadly considered as a means of achieving widespread social change in a number of fields including international development (e.g. UNCED, 1992a; Peltenburg

et al., 2000), urban planning (e.g. Wakely, 1997; Healey, 1998) and public administration (e.g. Grindle and Hilderbrand, 1995). Focusing on building capacity requires an overall objective, such as SUWM, to be established (Fisher *et al.*, 1996). Although the SUWM principles (Table 1.2) provide the broad objective for capacity building, there is a lack of detailed knowledge regarding the specific capacity building attributes needed, which hampers development of practical strategies to achieve SUWM.

While institutional capacity building encompasses individuals, organisations, inter-organisational relationships and the broader administrative and regulatory framework (Grindle and Hilderbrand, 1995; Fisher *et al.*, 1996; Brown *et al.*, 2006a), the systemic and widespread nature of the identified socio-institutional barriers suggests a broader approach will be needed to effectively overcome these barriers. Adopting available insights from sustainability literature (e.g. Dovers, 1997; Meadowcroft, 2007) to the urban water management field suggests that a significantly different regime will be needed for SUWM. Examining SUWM using governance theory, which is not often undertaken, provides insight into these issues as it focuses more explicitly on processes than institutional theory, and thus enables institutional change to be more readily explored through explicit identification of structures, processes and actor agency as key regime elements (Kjær, 2004). Processes, for example, may be "the setting of rules, the application of rules, and the enforcement of rules" (Kjær, 2004: 10), or in more practical terms policy and decision-making processes (Pierre and Peters, 2000). Constant rapid regime change requires an explicit emphasis on processes; as Pierre and Peters (2000: 23) state "we need moving pictures more than snapshots" of the regime to improve our understanding of societal dynamics and structures. In environmental management studies, Margerum and Born (1995) argue that understanding and focusing on processes is critical to implementing integrated environmental management. Therefore, a governance approach is considered appropriate to provide insight into the nature of regime change required to enable SUWM.

Governance theory draws on a range of disciplines with different preferences and foci (Rhodes, 1997; van Kersbergen and van Waarden, 2004). There is debate and discussion within the literature about the most appropriate mode (style) of governance for sustainable development. Three ideal types of governance commonly discussed in the literature are hierarchical, market and network (discussed further in Section 2.7.2). Historically in urban water management, the hierarchical mode has dominated with centralised organisations and vertical relationships and accountability (Brown, 2005; Pahl-Wostl, 2007). Contemporary urban water management is further influenced by market governance (new public management) which argues competition and market approaches are required to efficiently manage urban water services (Bakker, 2003b; Nickson and Franceys, 2003; Bakker, 2005; Crase *et al.*, 2008). The different governance modes for urban water management are discussed in more detail in Section 2.2. Within the environmental governance field, certain scholars (e.g. Folke *et al.*, 2005; Gunderson and Light, 2006) advocate a

strong network or negotiation mode of governance while recently others (e.g. Lemos and Agrawal, 2006; Kooiman and Jentoft, 2009; Pahl-Wostl, 2009) suggest a mixed or hybrid governance style will be more effective. However, there is little insight available in the literature regarding the governance characteristics for SUWM. While there has been some broad commentary advocating a network approach for SUWM (e.g. Pahl-Wostl, 2007; Pahl-Wostl, 2008; Brown *et al.*, 2009), it appears there is a distinct lack of knowledge and insight regarding the specificities of sustainable urban water governance. Additionally, the lack of widespread SUWM implementation internationally has been linked to the lack of conceptual frameworks to link SUWM principles (Table 1.2) with practice (Mitchell, 2006). Therefore, these two identified knowledge gaps have been combined to arrive at the overall aim for this thesis: *To develop a guiding framework for sustainable urban water governance.*

1.3 RESEARCH INVESTIGATION

An emergent research design was employed which enabled the research direction to adapt as insight was gained during the course of the investigation (Patton, 2002). While the research aim concentrates on sustainable urban water governance, the initial research focus was to develop an empirically informed institutional capacity assessment framework to inform capacity building strategies which, as identified in Section 1.2, has been identified as a key strategy for advancing SUWM implementation (Brown *et al.*, 2006a; Wong and Brown, 2009). Furthermore, it has been argued that a capacity assessment framework is essential to develop demand driven capacity building programs that address underlying problems (Grindle and Hilderbrand, 1995). As the research progressed and understanding of the characteristics of a SUWM regime deepened, the research focus evolved to incorporate governance theory. The development of my understanding and developing research focus is discussed in more detail in Section 3.2.

Sustainable urban water governance is an emerging field of research. As identified above, while there has been research into the barriers hampering SUWM implementation (Section 1.1), there are no empirically informed projections of desired or required regime attributes (Section 1.2). Indeed, Blomquist *et al.* (2004) argue for more detailed research into the regime. Therefore, the immature status of this research area suited the exploratory and emergent research design and the resulting exploratory regime projections. To meet the aim of this thesis and develop a guiding framework for sustainable urban water governance, two key areas needed to be explored: a) a detailed understanding of a sustainable urban water management regime, and b) insight into and understanding of the appropriate mode of governance for sustainable urban water management. Identification of these areas generated the following research objectives:

1. To characterise expert sustainability practitioner perspectives on sustainable urban water management capacities.

2. To map scholars' perspectives and findings on sustainable urban water management capacities.

3. To compare expert and scholarly perspectives on sustainable urban water management in relation to sustainable urban water governance.

4. To identify key governance characteristics of a sustainable urban water management regime.

Overall, three distinct stages emerged throughout the research process. These separate stages enabled the different perspectives of practitioners and scholars to be identified, analysed and compared. To date, existing projections of SUWM regime characteristics are primarily informed by theory (e.g. Pahl-Wostl, 2007; Pahl-Wostl, 2008; Brown *et al.*, 2009) and focused at the macro level, neglecting other regime components and interaction of these components across the whole regime. Additionally, while academics provide an objective and/or different viewpoint to urban water professionals, they are unlikely to be integrated with current urban water management practice and the challenges faced. In comparison, practitioners are likely to have detailed knowledge of urban water system operations. Thus, drawing on practitioners' perspectives helps provide tacit knowledge to inform strategic urban water management research (Lienert *et al.*, 2006) and extend current scholarship.

The three research stages correspond to the three results and discussion chapters (Chapter 4, 5 and 6). Additional detail on research design and methods for data collection and analysis is presented in Chapter 3. Qualitative data were collected and analysed in all three stages as it provides rich descriptions and explanations, and a detailed understanding of the phenomenon studied (Miles and Huberman, 1994; Patton, 2002; Creswell, 2007); these are important considerations for theory development (Blaikie, 2000) and corresponded with the overall aim of the study and the immaturity of this field of research. A grounded theory approach (Glaser and Strauss, 1967; Strauss and Corbin, 1998; Charmaz, 2006; Corbin and Strauss, 2008) was used as it is suitable for developing theory when little exists (Creswell, 2007).

The purpose of the first research stage was to identify the ideal regime capacity attributes for SUWM, in other words, to establish the capacity building target (Fisher *et al.*, 1996). The case study technique was selected because of the close relationship between the phenomenon investigated (institutional capacity) and the physical, historical and social context (Blaikie, 2000). As highlighted above, expert practitioner insights were sought to identify ideal capacity attributes.

The second research stage involved validation of the case study results using data triangulation (Neuman, 2003). Peer reviewed empirical studies were selected to validate the SUWM regime capacity attributes generated from the case studies as they provided a broader context for comparing the case study findings.

Moving to a governance perspective in the third research stage involved analysing the primary case study data using the three ideal governance modes (hierarchical, market, network). The outcomes from this governance analysis were compared with secondary scholarly data (from Stage 2) and scholarly perspectives available in the environmental governance literature. This research phase directly related the SUWM regime characteristics to governance, and enabled the overarching research aim to be addressed.

It is anticipated that this research will contribute to improved insight and understanding of a SUWM regime, its operation and characteristics and potential governance approaches for supporting SUWM practices, and through this will contribute to the development of strategies to overcome the entrenched socio-institutional barriers to advancing SUWM.

1.4 THESIS OUTLINE

This thesis uses a 'thesis by publication' format, comprising both standalone chapters (Chapters 1 to 3, and 7) and four scholarly publications incorporated in three results and discussion chapters (Chapters 4 to 6). Table 1.3 provides an overview of the thesis structure, including location of publications and purpose of each chapter. Each results and discussion chapter has a short introduction and summary to provide continuity between the publications and help to build a narrative throughout the thesis, explaining the relevance of the findings to the thesis aim and objectives. This thesis has been prepared in accordance with Monash University, School of Geography and Environmental Science guidelines for theses by publication. As the papers are self contained, there is occasional repetition regarding research rationale and methodology.

Table 1.3 Thesis Structure

Chapter	Title	Research Objective Addressed/ Chapter Purpose
1	Introduction	Outline research problem, thesis aim and objectives and the research investigation.
2	Challenges & Opportunities for Achieving Sustainable Urban Water Management	Review literature in the biophysical and technical, institutional and governance, and inter-disciplinary areas to expand research problem, clarify theoretical perspectives informing the research and justify the thesis aim and objectives.
3	Research Design and Methods	Describe the research design, data collection and data analysis methods and maintenance of research quality.
4	Sustainable Urban Water Management Regime Attributes: Insights from Sydney and Melbourne Including publication 1 - "Exploring sustainable urban water governance: a case study of institutional capacity" (van de Meene *et al.*, 2009) Including publication 2 - "Capacity Attributes of Future Urban Water Management Regimes: Projections from Australian Sustainability Practitioners" (van de Meene *et al.*, in press)	Research objective addressed: 1) To characterise expert sustainability practitioner perspectives on sustainable urban water management capacities.
5	Sustainable Urban Water Management Regime Attributes: Insights from Empirical Studies Including publication 3 - "Delving into the Institutional 'Black Box': Revealing Attributes of Future Sustainable Urban Water Management Regimes" (van de Meene and Brown, 2009)	Research objective addressed: 2) To map scholars' perspectives and findings on sustainable urban water management capacities.
6	Governance Analysis of Sustainable Urban Water Management Regime Attributes Including publication 4 – "Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective", (van de Meene *et al.*, submitted).	Research objective addressed: 3) To compare expert and scholarly perspectives on sustainable urban water management in relation to sustainable urban water governance. Research objective addressed: 4) To identify key governance characteristics of a sustainable urban water management regime.
7	Conclusion	Summarise the thesis findings and implications, identify research limitations and outline future research opportunities.

CHAPTER 2 CHALLENGES & OPPORTUNITIES FOR ACHIEVING SUSTAINABLE URBAN WATER MANAGEMENT

2.1 INTRODUCTION

The challenges facing urban water management were outlined in Chapter 1. In sum, enabling a socio-technical system transition to sustainable urban water management requires changes over the domains of economics, technology, institutions, behaviour, culture, ecology and belief systems (Rotmans *et al.*, 2001). The purpose of Chapter 2 is to provide a comprehensive understanding of the theoretical perspectives which inform this research and clearly locate current knowledge gaps. The diverse scholarship contributing to this body of knowledge comprises biophysical and technical, institutional and governance, and interdisciplinary literatures (e.g. transition management and adaptive governance).

The relationship between the literature reviewed and research aims is shown in Figure 2.1 and the literature review structure is summarised in Table 2.1. Following this introduction, the historical development of the urban water system is briefly presented, followed by sustainable urban water management, including physical and socio-institutional characteristics. Barriers to SUWM are then discussed, including institutional impediments and socio-technical system lock-in. A lack of detailed knowledge about attributes of a SUWM regime and limited insight into how to implement SUWM are identified as critical knowledge gaps. The regime is important in socio-technical system transitions (Rotmans *et al.*, 2001) and therefore, the review focuses on available regime frameworks and theoretical insights from institutional and governance literature to provide greater understanding of the regime components, operation and mechanisms for change. Finally, governance for sustainable development is discussed with particular focus on adaptive governance and transition management theories which integrate governance and institutions in the context of enabling sustainable development. The Chapter concludes by summarising key points and specific knowledge gaps.

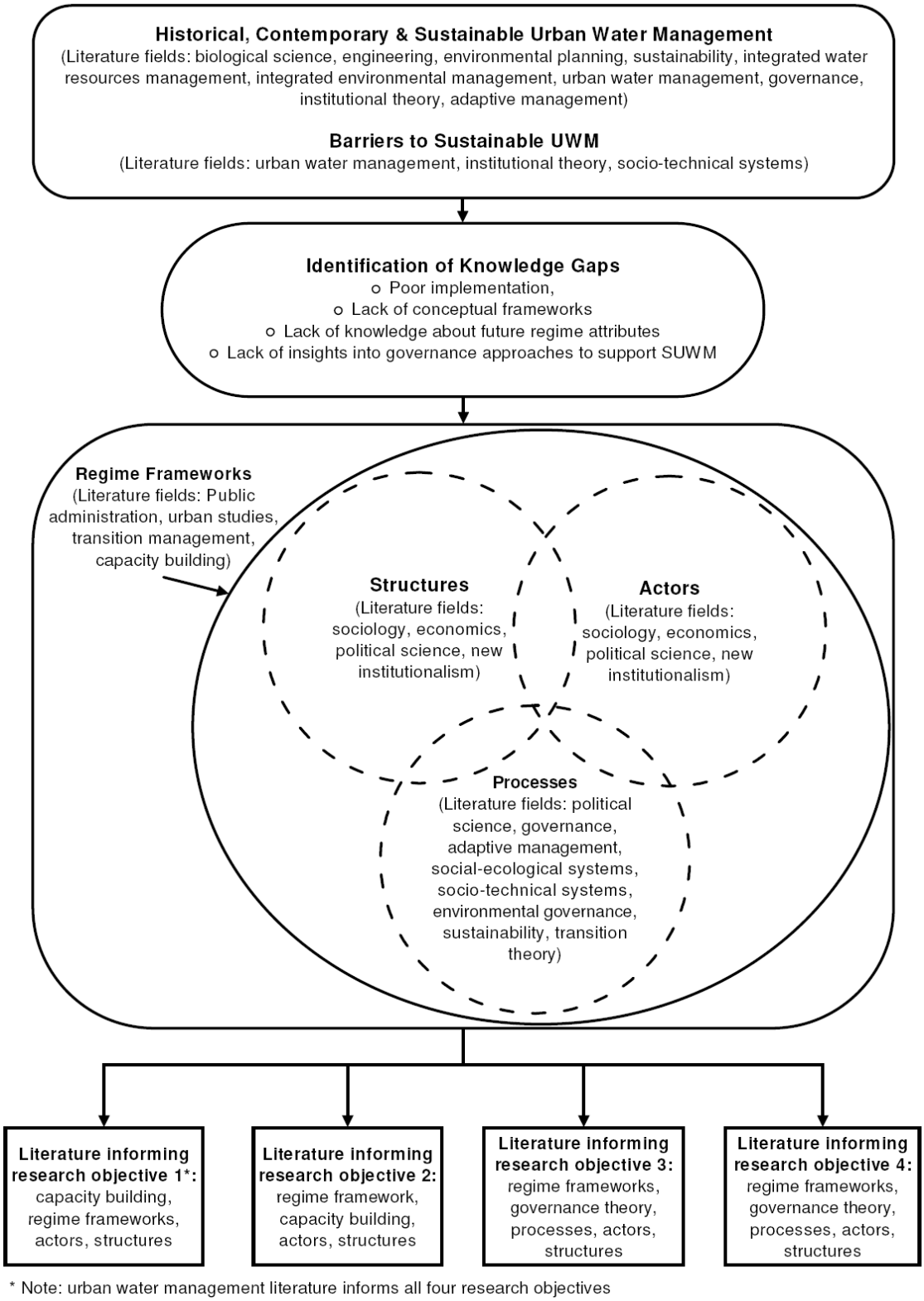

Figure 2.1 Overview of Literature Reviewed and Research Objectives

Table 2.1 Literature Review Structure

Topic Area	Literature Field	Literature Review Section
Historical, contemporary and sustainable urban water management	Biological science Engineering Environmental planning Sustainability Integrated water resources management Integrated environmental management Urban water management Governance Institutional theory Adaptive management	Section 2.2 Section 2.3
Barriers to sustainable urban water management	Urban water management Institutional theory Socio-technical systems	Section 2.4
Regime frameworks	Public administration Urban studies Transition management Capacity building	Section 2.5
Institutional theory	Sociology Economics Political science Common pool resource management New institutionalism	Section 2.6
Governance theory	Political science Adaptive governance Social-ecological systems Socio-technical systems Transitions theory Sustainability Environmental governance	Section 2.7

2.2 BACKGROUND

This section outlines historical urban water management regime changes over approximately the last 150 years. The overview provides contextual information to improve understanding of the current urban water regime and barriers preventing SUWM implementation; an understanding of urban water management system history is important as it influences current socio-technical systems (Raadschelders, 2005a). More detailed reviews of urban water system development are available from references such as Niemczynowicz (1999), Harremoës (2002), Chocat (2001; 2007) and Cech (2005).

The transition framework of Brown *et al.* (2009) (Figure 2.2), provides an overview of major regime changes, focusing on the social drivers and responses of the urban water management system. The framework describes the hydro-social contract (Brown *et al.*, 2009; Wong and Brown,

2009), which is an implicit contract outlining the allocation of risk and responsibility between the state and the community (Turton and Meissner, 2000; Lundqvist *et al.*, 2001). This contract is not fixed, for example if water becomes scarce and the government does not take adequate measures to provide a secure water supply, individuals may start to take responsibility for their own water supply and source water independently, such as supplementing their water supply using rainwater tanks.

Within the transition framework, the current status of each city is dependent on contextual factors, and therefore, while some cities may be located further to the right in Figure 2.2, others may be located towards the left. Generally, first three city states, water supply, sewered and drained cities, are considered to be currently active or in the past, while the waterways city is not yet consolidated and the water cycle city is largely described in policy documents (Brown *et al.*, 2009). Wong and Brown (2009) suggest there are no examples of a water sensitive city (sustainable urban water management) in practice, although Singapore and the Pimpama-Coomera development in South East Queensland have elements of a water sensitive city. The changes outlined in Figure 2.2 will be explained in the following sections (Sections2.2.1 and 2.2.2).

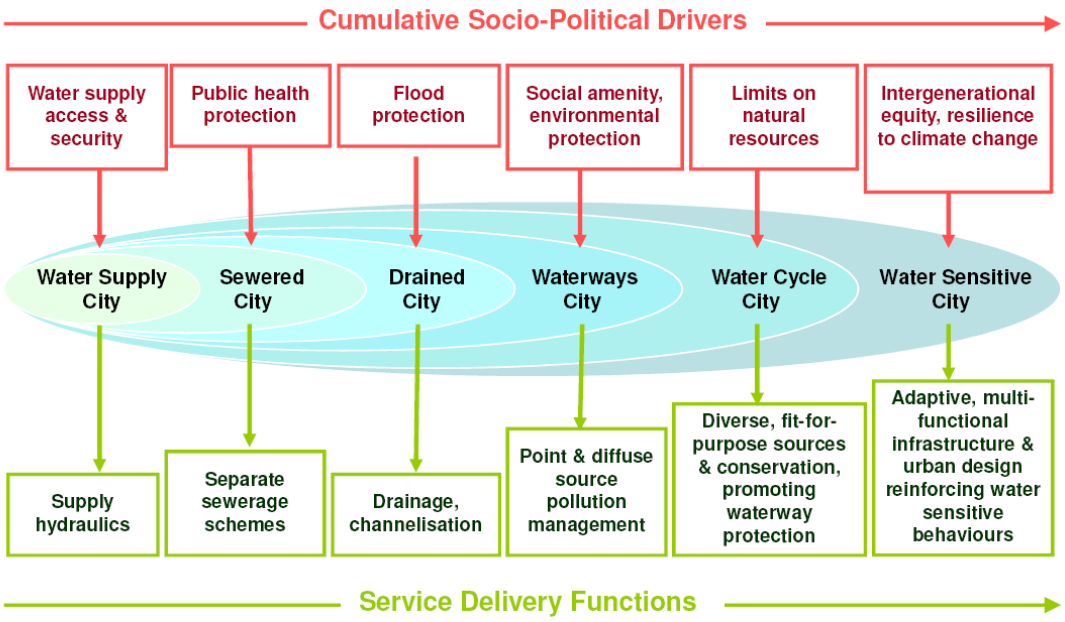

Figure 2.2 Urban Water Management Transitions Framework
(Source: Brown *et al.*, 2009: 850)

2.2.1 Focus on Water Supply, Sewerage and Drainage

Access and security of supply were the underpinning social values of the urban water management system during the 19th century (Brown *et al.*, 2009) and in response water sources were accessed and distributed through a complex infrastructure network to meet the needs of growing urban

populations (Boughton, 1999; Cech, 2005). When water supply systems were established, private companies took advantage of the lack of public systems to deliver water (see for e.g. Dingle and Rasmussen, 1991; Castro *et al.*, 2003), however outbreaks of waterborne diseases forced many companies out of business (Cech, 2005).

The link between public health, infectious disease and water quality was made in London during the 1850s (Butler and Davies, 2004) and signalled the next phase in the urban water regime, the sewered city (Brown *et al.*, 2009) (Figure 2.2). In response, stormwater and sewerage collection and disposal systems were constructed to avoid contamination of drinking water supplies (Butler and Davies, 2004). Initially, collected wastewater discharged to the environment without concern for environmental impacts (Brown *et al.*, 2009), while effluent treatment became prevalent during the 1920s (Cech, 2005). Variable rainfall in different locations resulted in a variety of infrastructure responses. Combined stormwater and sewerage systems were constructed in Europe and separate systems were constructed in Australia and North America to convey more intense rainfall and save money on construction (Butler and Davies, 2004). During this period of water supply and wastewater development, the hydro-social contract involved individuals placing responsibility for their water provision with the state (Turton and Ohlsson, 1999; Bakker, 2002). Engineers were dominant across the water sector because they had the requisite technical expertise which resulted in them influencing the discussion and debate of water related issues (Turton and Ohlsson, 1999; van der Brugge *et al.*, 2005).

Urban water management focused on drainage during the mid-20th century as protection of population and assets from floods became a government priority (Brown *et al.*, 2009). Expanding and developing urban areas, such as London, Sydney and Melbourne, resulted in larger impervious areas and consequently increased the quantity of stormwater requiring removal to ensure protection from floods (Aird, 1961; Dingle and Rasmussen, 1991; Castro *et al.*, 2003; Butler and Davies, 2004; Brown *et al.*, 2009). Drainage was achieved by modifying natural channels to improve water conveyance, for example by straightening the channel or by lining it with concrete (Walsh, 2000; van der Brugge *et al.*, 2005). At this time, the hydro-social contract remained largely unchanged and responsibility for water, wastewater and drainage management remained with public authorities, as the urban citizens' role in generating wastewater was not considered important (Colebatch, 2006).

2.2.2 Focus on Environmental Protection and Efficiency

The rise of the global environment movement during the 1960s resulted in significant changes to the philosophy of urban water management (Chocat *et al.*, 2001). During this period the dominant values supporting continued expansion of urban water services and infrastructure were challenged by alternative values of ecosystem protection, which advocated reduced expansion and reduced environmental degradation (Viessman, 1988; Brown *et al.*, 2009). In response, pollution from

point sources such as sewage treatment plants and industrial facilities was regulated, resulting in end-of-pipe pollution control (Harding *et al.*, 2009). After significant progress in point source pollution control, diffuse or distributed pollution sources, such as stormwater, were identified as significantly contributing to continued environmental degradation (Bickford *et al.*, 1999; Walsh, 2000; Chocat *et al.*, 2001). This realisation posed substantial technical and logistical challenges to the professional community given dispersed responsibilities and diffuse pollution sources requiring control (Brown *et al.*, 2009).

The challenge to the traditional urban water approach tested the dominance of engineers, and other professions such as ecologists, gained influence through their environmental knowledge which became more highly valued (Turton, 1999; Bakker, 2005; van der Brugge *et al.*, 2005). Evidence of the expanded social values included prioritisation of water allocation for fish or ecosystem protection over traditional consumptive allocations (Viessman, 1988), and also included waterway rehabilitation efforts, such as development of pedestrian and bicycle waterway access paths, and residential developments being constructed to face waterways (Brown *et al.*, 2009). The expanded social values significantly tested the hydro-social contract (Turton and Ohlsson, 1999; Wong and Brown, 2009) and the shift in values is not considered stable (Brown *et al.*, 2009); in the Melbourne context, ecosystem protection values require continual maintenance by a group of professionals committed to change (Brown and Clarke, 2007).

The 1980s and 1990s saw a shift in urban water management to focus on efficiency, influenced by the rise of market governance or New Public Management (NPM) (e.g. Bakker, 2002; 2003b; Nickson and Franceys, 2003; Bakker, 2005). Prior to this period, urban water management was characterised as hierarchical and centralised with strong government influence and control (Pahl-Wostl, 2007; Brown *et al.*, 2009), which are characteristics of hierarchical governance (Pierre and Peters, 2000; Kjær, 2004). However, the hierarchical approach was criticised as being inefficient, among other issues (Hood, 1991; Nickson and Franceys, 2003; Kjær, 2004), and inefficiency, together with an underinvestment in urban water infrastructure contributed to a change in management approach and the rise of market governance in urban water management (Bakker, 2002). The shift to market governance is discussed in more detail in Section 2.7.2.

The drive for efficiency further broadened the range of professions in urban water management. Economists became influential as their knowledge and analytical skills became more highly valued, challenging the dominance of technical experts (Turton, 1999; Colebatch, 2006). Private sector management principles aimed at improving efficiency of urban water management were transferred to the primarily public water sector (Bakker, 2002). For example, public water authorities were privatised or corporatised, services were contracted to the private sector, water users became ‘customers’, and full cost pricing was implemented to encourage customers to conserve water while promoting profit as a performance measure (Bakker, 2002; Nickson and Franceys, 2003; Colebatch, 2006).

Adoption of market governance principles varied across countries and the resulting institutional arrangements align along a continuum ranging from public water authorities through to private water management organisations (Bakker, 2003a) (Table 2.2). Typically market governance principles were applied to water supply and sewerage services, while drainage and waterway health remained under public control (Castro *et al.*, 2003; Brown and Clarke, 2007). Brown and Clarke (2007) identified that inclusion of waterway health and regional drainage responsibilities into the bulk water supply and sewage treatment operator was an important factor contributing towards embedding the social value of ecosystem protection in the metropolitan Melbourne urban water regime.

Despite this drive towards increased market governance approaches in urban water management, there does not appear to be conclusive evidence that efficiency and performance improves with private ownership (Renzetti and Dupont, 2004). Furthermore, tensions between the ecosystem protection value and drive for efficiency remain an issue to be addressed before SUWM can be realised (Brown *et al.*, 2009).

Table 2.2 Administrative Arrangements for Water Supply and Sewerage Services

Organisation Type	**Performance Drivers**	**Relationship with Government**	**Relationship with Community**	**Examples**
Public authority	Technical efficiency	Close	Community is seen as citizens	Germany
State owned corporation	Economic efficiency, return of dividend	Government major shareholder, can make appointments to the board Regulators for economics, environment, public health	Community is seen as customers	Melbourne & Sydney, Australia
Private operator	Economic efficiency, financial profit	Relationship maintained through regulatory organisations Regulators for economics, environment, public health	Community is seen as customers	France
Private owned & operated	Economic efficiency, financial profit	Relationship maintained through regulatory organisations Regulators for economics, environment, public health	Community is seen as customers	England and Wales

(Adapted from: Bakker, 2003a; Castro *et al.*, 2003; Renzetti and Dupont, 2004; Curnow and Wettenhall, 2005; Drewry, 2005; Raadschelders, 2005a; Jane and Dollery, 2006)

2.3 SUSTAINABLE URBAN WATER MANAGEMENT

2.3.1 Definition of Sustainable Urban Water Management

The sustainable management of urban water resources suggests the need to take an integrated and comprehensive approach to managing the three traditionally separate urban water services: supply, sewerage and drainage, while considering their institutional, physical and social contexts (Mitchell, 2006). The shift from traditional urban water management is similar to changes in environmental management, away from a reductionist and segregated approach to the holistic style of integrated environmental management (Marsalek *et al.*, 2001).

A number of different terms are used to refer to sustainable urban water management with different emphases and uses (Newman, 2001b). For example, integrated urban water management (see for e.g. Mitchell, 2006; Maheepala and Blackmore, 2008) and total water cycle management (see for e.g. Newman, 2001b; Chanan and Woods, 2006) emphasise the holistic approach also advocated by integrated catchment and environmental management (Marsalek *et al.*, 2001; Mitchell, 2005). The language relating to sustainable urban water management changes, which is illustrated by the concept of 'water sensitive urban design' (WSUD). WSUD was developed as an integrated approach to urban water management and land use planning during the 1990s (Mouritz, 1996). Following implementation challenges, WSUD implementation and development stalled until research into the environmental impacts of urban stormwater increased interest in the concept; consequently, WSUD is often associated with the drainage and stormwater components of urban water management (Wong, 2006b). Similar terms that integrate urban water management with a stormwater focus and urban design are used internationally: low impact design in the United States of America (LID) (Dietz, 2007), low impact urban design and development in New Zealand (LIUDD) (Frame and Vale, 2006) and sustainable urban drainage systems (SUDS) in the United Kingdom (Ellis *et al.*, 2002).

Despite these different terminologies and emphases, there are some common SUWM principles advocated in the literature (Table 1.2) which address the integration of the infrastructure and biophysical systems; provision for multiple uses, consideration of local context, incorporation of stakeholders and a long-term approach (Serageldin, 1995; Mouritz, 1996; Vlachos and Braga, 2001; Mitchell, 2006; Mostert, 2006; Brown and Keath, 2008; Maheepala and Blackmore, 2008). These principles embody the sustainable development principles of intra- and inter-generational equity; the precautionary principle; consideration of the environmental, social and economic issues ('triple bottom line'); and that citizens should have greater input into decision-making (UNCED, 1992b). Based on these observations 'sustainable urban water management' (SUWM) will be used throughout this thesis to encompass these principles.

2.3.2 Sustainable Urban Water Management Projections

The SUWM principles (Table 1.2) provide the founding concepts to be implemented in practice. Newman and Mouritz (1996: 343) and Newman (2001b: 94) have described a physical system which would embody the SUWM principles:

- ocean and rivers outfalls are no longer necessary;
- widespread recycling of water for various urban and peri-urban uses;
- recycling of nutrients and organics is undertaken;
- creeks and wetlands are an integral part of the city but are managed for their ecological integrity;
- there are increased soft surfaces for stormwater retention; and
- there is a reduced requirement for large pipes.

The SUWM principles have also been projected for the social component of the sustainable urban water socio-technical system (the regime) at a macro scale by academics such as Pahl-Wostl (2007; 2008) and Brown *et al.* (2009). In addition to the well-established social values of public health protection, flood protection and supply security, a SUWM regime will likely incorporate the social values of inter-generational equity, environmental repair and protection, amenity and concern that communities and ecosystems are resilient (Brown *et al.*, 2009). Furthermore, there will be greater participation and responsibility taken by private and civil sectors in water management with risk shared among stakeholders who will adapt over time to ensure challenges (e.g. climate change) can be addressed (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). The management approach and institutional arrangements will likely be flexible and polycentric with a focus on learning and innovation (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). Finally, Pahl-Wostl (2007; 2008) and Brown *et al.* (2009) recommend that there would be multi-scalar, diverse and flexible infrastructure, with a greater proportion of decentralised infrastructure than present, which is similar to Newman and Mouritz (1996) and Newman (2001b). Brown *et al.* (2009) also emphasise the need to recognise the implicit link between technology and society and thus infrastructure should be designed to reinforce sustainable practices and social capital.

2.3.3 Progress Towards Sustainable Urban Water Management

While the drive for efficient urban water management remains, efforts have been made to implement the value of ecosystem protection as professionals and politicians realise that water resources can no longer expand due to environmental limits (Brown *et al.*, 2009). Purposive water reforms have been undertaken internationally since the 1990s (Saleth and Dinar, 2004) and some specific and notable reforms were identified at different government levels in Section 1.1. While there is a general trend to pursue economic or market based reforms across countries, particularly

full cost water pricing, improving environmental outcomes has also been a focus (see for e.g. Bakker, 2005; Hussey and Dovers, 2006). However, this direction is contested; for example, Hussey and Dovers (2006) argue that using economic instruments as the solution to improving water management has not been proven in economic, social and environmental terms. They suggest that in Australia, there may need to be a shift away from the economic focus of the National Water Initiative (COAG, 2004) towards a more balanced approach, similar to that of the Water Framework Directive in the European Union, which has confined market governance tools to water pricing and educational campaigns (Hussey and Dovers, 2006).

Additionally, reform efforts have been criticised for not integrating the three urban water streams and the biophysical setting, which is one of the SUWM principles (Harremoës, 2002; Wong, 2006b). Furthermore, the overall pace of urban water reform has been considered to be "slight or nonexistent!" (Harding, 2006: 234). Often improvements are aimed at re-drawing or re-distributing organisational boundaries, however Moss (2003) argues such an approach can ignore other socio-political issues such as water consumption patterns, and will likely result in the creation of unintended boundary issues or consequences. It is recommended these potential adverse outcomes be considered prior to implementing the organisational restructuring (Moss, 2004). Finally, Breit (2003) considers institutional reforms can occur via mixed top-down and bottom-up approaches, yet many of these changes have only used a top-down approach (Bruns *et al.*, 2005).

Research and development has been undertaken in the technical areas of engineering and science and progress has been made, yet additional research is required to address the challenge of SUWM (Chocat *et al.*, 2001; Harremoës, 2002; Ashley *et al.*, 2007; Fletcher *et al.*, 2008). Some implementation has occurred (see for e.g. Mitchell, 2006) and cities such as Singapore have elements of SUWM (Wong and Brown, 2009), however the widespread on-ground realisation of SUWM remains variable and predominantly focused on the technical sphere (Harremoës, 2002; Mitchell, 2006). The uneven progress of the technical and social elements of the urban water socio-technical system will likely impede a system-wide socio-technical transition (Rip and Kemp, 1998; Elzen and Wieczorek, 2005). Reasons for these criticisms and slow implementation of technologies are discussed in the following section.

2.4 BARRIERS TO SUSTAINABLE URBAN WATER MANAGEMENT

2.4.1 Institutional Impediments

Investigation into urban water reform and implementation of SUWM practices has revealed significant institutional barriers that are preventing the transition to SUWM. Major institutional impediments include fragmentation of administrative arrangements, unproductive intergovernmental relations, a lack of long-term strategic planning, little integration between the water industry and other relevant sectors, lack of meaningful community participation in water planning and management, and limited political leadership (Child and Armour, 1995; Mouritz,

2000; Vlachos and Braga, 2001; Hatton MacDonald and Dyack, 2004; Brown, 2005). Brown and Farrelly (2009) undertook a systematic literature review and identified 12 types of barriers listed in Table 2.3. The authors concluded that the barriers are predominantly located at the administrative level and are interrelated meaning that effecting change on one barrier requires coordinated and concurrent efforts to change others. The systemic nature of these barriers together with their being observed internationally (Child and Armour, 1995; see for e.g. Niemczynowicz, 1999; Chocat *et al.*, 2001; Vlachos and Braga, 2001; Harremoës, 2002; Brown *et al.*, 2006b; Roaf, 2006) demonstrates the magnitude of change required to enable SUWM. While Hatton MacDonald and Dyack (2004) argue impediments can be perceived as opportunities, few strategies to address these barriers have been proposed (Brown and Farrelly, 2009).

Table 2.3 Typology of Institutional Barriers

	Institutional Capacity Assessment Framework			
Barriers	Human Resources[1, 4]	Intra-Organisational Capacity[2, 4]	Inter-Organisational Capacity[2, 4]	External Institutional Rules & Incentives[3, 4]
1. Uncoordinated institutional framework				
2. Limited community engagement, empowerment & participation				
3. Limits of regulatory framework				
4. Insufficient resources (capital and human)				
5. Unclear, fragmented roles & responsibilities				
6. Poor organisational commitment				
7. Lack of information, knowledge & understanding in applying integrated, adaptive forms of management				
8. Poor communication				
9. No long-term vision, strategy				
10. Technocratic path dependencies				
11. Little or no monitoring & evaluation				
12. Lack of political & public will				
1 = Professional Development 2 = Organisational Strengthening 3 = Facilitative Reforms 4 = Knowledge Building (Modified from Brown *et al.*, 2006a)				

(Brown and Farrelly, 2009: 843)

2.4.2 Entrapment of the Urban Water Socio-technical System

Another factor contributing to the systemic nature of SUWM implementation impediments is the historical investment underpinning large technical systems which contributes to entrapment (Walker, 2000) or lock-in (Unruh, 2000). Entrapment or lock-in is where the technological and socio-institutional components of the system have co-evolved to reinforce each other, creating a system that is stable and difficult to change (Unruh, 2000; Walker, 2000; Berkhout, 2002) across multiple dimensions (Geels, 2005b). Allison and Hobbs (2004) characterise systems exhibiting lock-in as those with low potential for change, high inter-connectedness and high resilience to external disturbances (resilience is discussed further in Section 2.7.3). Lock-in or entrapment is evident when benefits of alternative technological systems are demonstrated, but the existing system continues (Unruh, 2000; Walker, 2000). Initially, when a new technology is introduced, the positive feedback loops or reinforcing factors enable distribution networks to be developed. However, as these systems progress and become more advanced, they exhibit lock-in, becoming stable systems that resist change (Unruh, 2000).

Large technical systems such as nuclear power (Walker, 2000), industrial economies or carbon systems (Unruh, 2000; Unruh, 2002) and regional agricultural systems (Allison and Hobbs, 2004) have exhibited lock-in and similarly, the traditional urban water management system has characteristics that contribute to lock-in. Traditional urban water infrastructure comprises large blocks of capital in the form of dams, water and sewage treatment plants and pipe networks, which require significant investment for construction and ongoing maintenance (Vlachos and Braga, 2001). Additionally, the pipe network is entwined and closely related to urban design; for example through street layout, which makes change difficult (Bakker, 2003a). Recently, proliferation of desalination plants around the world (e.g. in Jordan - Al-Jayyousi, 2001; Spain - Gascó, 2004; Australia - Keath and Brown, 2008; Turkey - Sözen *et al.*, 2008) continues the investment in large infrastructure and lacks the requisite long-term perspective and low energy demand required for climate adaptation (Dawson, 2007). Additionally, the historical command and control approach to urban water management, together with the drive for efficiency influenced by market governance (Section 2.2), reduces the urban water management system's resilience and contributes to system breakdown (Holling and Meffe, 1996). Entrapment in the institutional component of the urban water socio-technical system (institutional inertia) has been identified as potentially the most significant barrier to SUWM (Mouritz, 2000; Brown, 2005). Saleth and Dinar (2005) identified institutional path dependency as an important constraint on reform efficacy, which affects the reform options available. A recent study by Keath and Brown (2008) concluded the Australian urban water sector is entrapped. The authors investigated the institutional response to the impact of an extreme event (drought) in Brisbane and Melbourne and found that despite evidence of progress towards SUWM, both cities reacted to the drought by reinforcing large, centralised urban water management solutions.

Given the systemic and interrelated institutional barriers (Brown and Farrelly, 2009) and demonstrated conditions for entrapment within the urban water sector (e.g. Keath and Brown, 2008), advancing SUWM is clearly an extensive and complex challenge. Despite calls for institutional change (Mouritz, 2000; Engels and Moss, 2003; Tejada-Guibert and Maksimović, 2003; Dovers, 2005; Wong, 2006b) and international and multiscalar reform efforts (Saleth and Dinar, 2005; Hussey and Dovers, 2006), the barriers and entrapment prevail, suggesting a lack of knowledge of the social component of the urban water socio-technical system (i.e. the regime). Indeed the need for improved knowledge and insight into the social dimension of the system and how this interacts with the technological component has been identified by Blomquist *et al.* (2004: 927) who consider the water resources community needs to focus on investigating the:

> 'black box' of institutional processes and effects, to provide explanations of how institutions matter – how they prompt people to try to change management practices, how they ease or try to hinder those changes, how they shape the management alternatives water users and organisations consider and adopt, and how they affect the outcomes.

Although scholarly projections of SUWM regime attributes are available (see Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) (refer Section 2.3.2), these predictions have several limitations when considered in the context of the significant barriers facing SUWM. Firstly, the projected attributes provide broad descriptions of a regime at a macro scale and lack detail about regime characteristics, such as actors and processes, which hampers the development of specific strategies to advance SUWM. Secondly, the predictions do not specify the relationships among the regime attributes which leaves the projections as a list of attributes offering little insight into how the SUWM regime will operate and how the specified attributes interact together. This lack of specificity impacts on regime understanding and also the potential for integrated and coordinated implementation studies to be undertaken, which are needed to overcome the systemic institutional barriers (Brown and Farrelly, 2009). Lastly, although the projections of Brown *et al.* (2009) and Pahl-Wostl (2007; 2008) are similar, which provides a level of confidence in these regime attributes, the authors acknowledge the projections are tentative. Additionally, the projections are informed by academic knowledge, experience and theoretical perspectives but have not been tested using empirical data or directly informed by practitioner perspectives. The lack of empirical data and also practitioner insight is a potential blind spot, limiting the applicability and confidence placed in these projections. While academics provide a valuable objective and theoretical perspective, they are unlikely to have close knowledge and experience of detailed daily operation of the urban water system which lies primarily with practitioners. These observations reveal a lack of detailed knowledge about likely attributes of a SUWM regime. Furthermore, once identified there is limited understanding of how to implement the SUWM regime attributes.

Margerum and Born (1995) distinguish between theory on *what* integrated environmental management should include and *how* it should be implemented. For SUWM, the principles presented in Table 1.2 and the regime projections (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) describe SUWM, or provide the 'what', but there does not appear to be any developed conceptual frameworks or tools to guide SUWM implementation. Mitchell (2006) argues that the lack of a coherent framework to link the SUWM principles with practice goes some way to explaining the variable international implementation of SUWM, while Rauch *et al.* (2005) argue there is an increasing need for implementation research focused on the socio-institutional dimensions of sustainable urban stormwater management, particularly institutional capacity. Additionally, the macro scale projections of a SUWM regime (Section 2.3.2) (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) and lack of insight into regime operation does not provide adequate detail for developing policy recommendations to facilitate SUWM implementation.

Based on the above observations, there appear to be two critical knowledge gaps related to SUWM implementation: a) a lack of detailed knowledge about attributes of a sustainable urban water management regime and b) a lack of conceptual frameworks to inform implementation of SUWM principles. So far this literature review has primarily addressed physical and technical scientific literature. Regime, institutional and governance literature provides theoretical insights which may assist in addressing these critical knowledge gaps in the field of SUWM. The review now examines two recent regime frameworks to evaluate them for their contribution to the above knowledge gaps and then focuses on institutional and governance literature to more accurately define these knowledge gaps and discuss the theoretical perspectives used in the research.

2.5 REGIME FRAMEWORKS

This section defines the regime and locates it within socio-technical transition theory. Two regime frameworks are then reviewed to determine how they can contribute to addressing the current limited knowledge of SUWM regime attributes and whether these frameworks could be used to inform SUWM implementation. The first framework reviewed is the regime capacity building framework of Brown *et al.* (2006a) and the second, the regime processes framework of van der Brugge (2009). These frameworks were selected because they addressed formal and informal institution components, considered important to gain a complete understanding of institutions (Powell and DiMaggio, 1991; Young, 2002) (refer Section 2.6.1 for more information). Additionally, while they are not as detailed as frameworks such as Ostrom's (1990) institutional analysis and development framework, they are more detailed than existing SUWM regime projections, and therefore are considered to facilitate the development of insights into a SUWM regime. As there are no SUWM regimes currently in existence (Brown *et al.*, 2009; Wong and Brown, 2009), it was considered important to balance the exploratory nature of this research with a greater level of detail than the currently available information.

2.5.1 Understanding Regimes

In the context of socio-technical transitions, a regime relates to the rules, dominant practices, shared assumptions, interests and beliefs that guide private action and public policy (Rotmans *et al.*, 2001). Some regime definitions focus on the technological aspects of the regime, and include the artefacts and technologies where the rules and dominant practices are embedded (Rip and Kemp, 1998), while others, such as that of Rotmans *et al.* (2001) above, emphasise societal systems (van der Brugge, 2009).

In transition theory, the regime functions at the meso-level, and is considered to be stable with change occurring over decades (Geels, 2002). The regime is located between the macro and micro levels (Figure 2.3). The macro or landscape level comprises the broad social trends, such as political, economic and social movements such as environmentalism, while small scale innovations (e.g. technologies or strategies) are developed at the micro-level where individual actors are located (Rotmans *et al.*, 2001). Together, the three levels and their interaction, known as the multi-level perspective (Geels, 2002), improve understanding of the dynamics necessary for socio-technical system change.

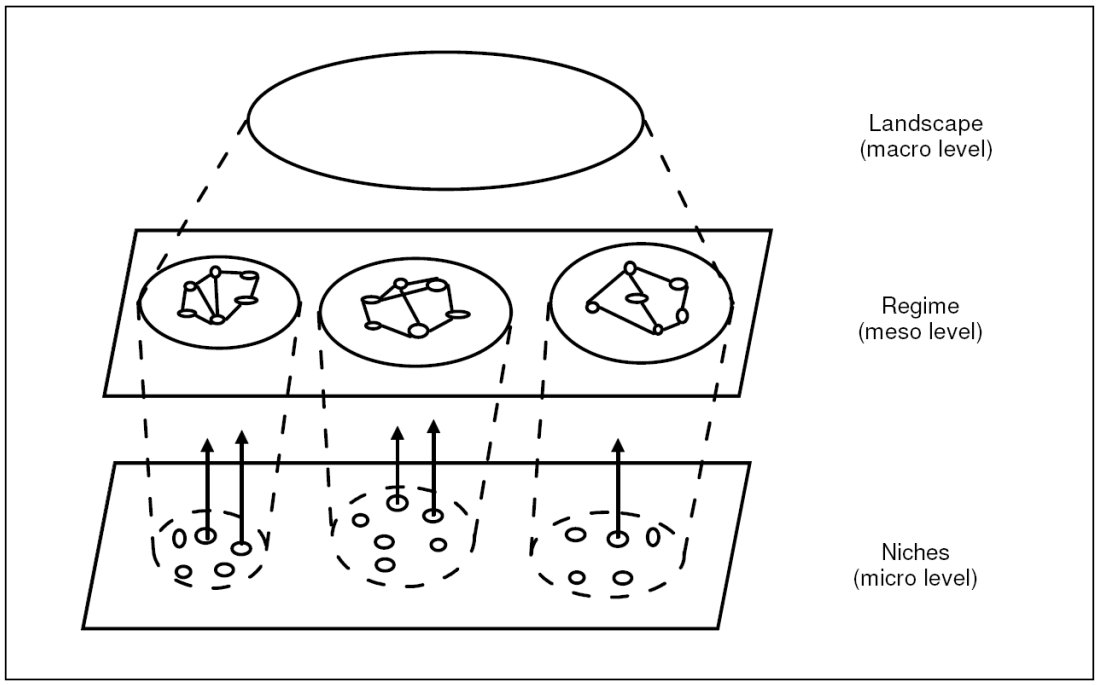

Figure 2.3 Multi-level Perspective of Transition Theory
(Geels, 2002: 1261)

2.5.2 Regime Frameworks

Capacity Building Framework

Building on public administration scholars, Hildebrand and Grindle (1997) and urban sustainability scholars (e.g. Wakely, 1997), Brown *et al.* (2006a) have developed a regime framework that can be used to map capacity across the regime to advance sustainable urban water management[1]. The framework is actor focused and identifies four nested spheres: individuals, intra-organisational, inter-organisational and the administrative and regulatory sphere (Figure 2.4). The individual sphere is the knowledge, skills, and motivation of individuals; the intra-organisational sphere refers to organisational culture, management practices and procedures; the inter-organisational sphere comprises organisational relationships, their structure and operation, and the administrative and regulatory sphere relates to the formal rules and incentives, legal and policy instruments. The four spheres of the regime capacity building framework are situated within the broader physical, economic, historical and social context.

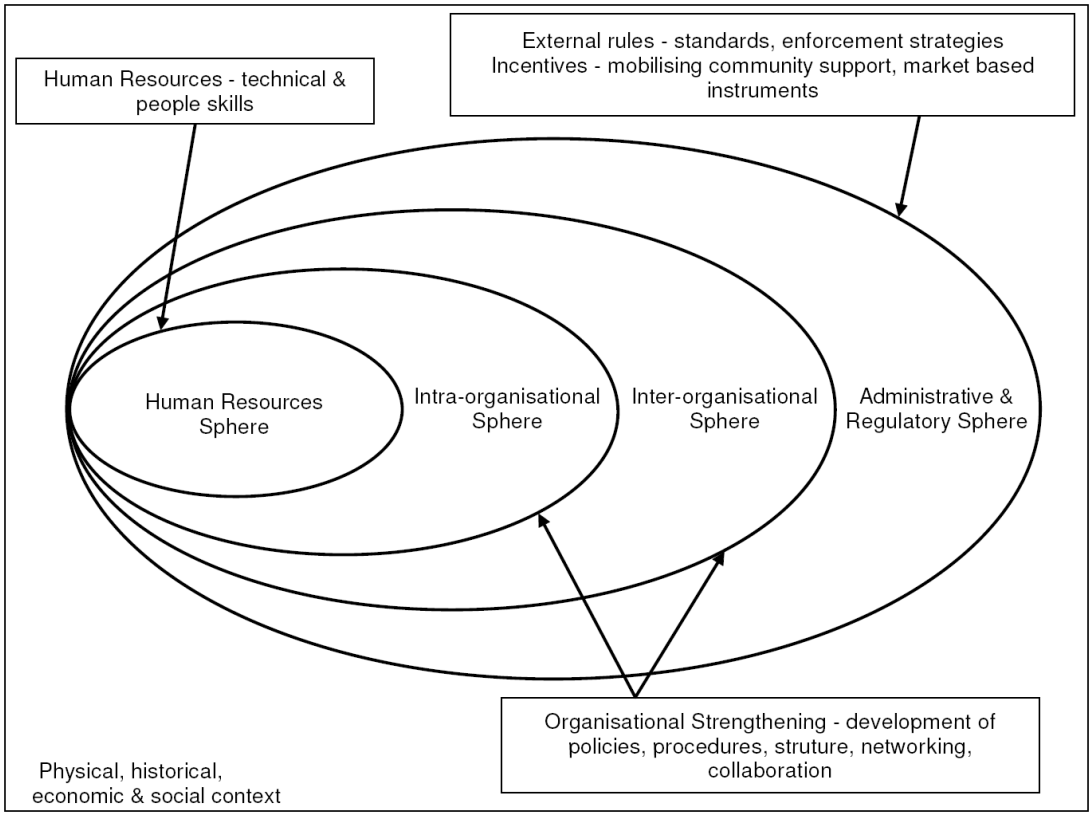

Figure 2.4 Regime Capacity Building Framework
(Adapted from: Brown *et al.*, 2006a: 5-3)

[1] The review and analysis of this framework was adapted and extended from van de Meene, S. J., Brown, R. R., Farrelly, M. A. (2009) Investigating Sustainable Urban Water Management Regimes: What Tools are Available to Help? in *Proceedings of the 6th International Water Sensitive Urban Design Conference and Hydropolis #3*, 5 - 8 May 2009, Perth, Western Australia.

Each regime sphere is related to a capacity building strategy (Figure 2.4). Strategies include knowledge building, professional development, organisational strengthening, and directive and facilitative reforms. Knowledge building in both technical and other areas should be applied across all four spheres and professional development to the human resources sphere. Organisational strengthening strategies (e.g. fostering leaders, improvements to inter-agency structures, networks and collaboration) should be applied to the intra- and inter-organisational capacity spheres while facilitative and directive reforms (e.g. establishing clear policy statements, regulations and standards, mobilising community and political support) should be applied to the administrative and regulatory sphere.

The framework of Brown *et al.* (2006a) provides a means for identifying different regime elements, particularly regime actors and their characteristics. It could therefore be used with the SUWM regime projections (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) to identify attributes for each regime sphere, with the actor attributes inferred from the projections. The capacity building strategies could be employed to realise the desired attributes. However, the resulting projected SUWM regime framework would be subject to the same limitations regarding the lack of empirical data used to develop the projections, as discussed in Section 2.4. Additionally, the framework identifies the regime spheres as nested but does not describe or identify more detailed actor interactions or processes of regime operation, and is therefore limited in its contribution to SUWM implementation beyond the specific capacity building strategies identified.

Regime Processes Framework

Drawing on complex adaptive systems theory (e.g. Gell-Man, 1994; Holland, 1995; Kauffman, 1995) and structuration theory (Giddens, 1984), van der Brugge (2009) developed a regime framework, which includes four elements: actors, processes, structures and influences (Figure 2.5) (van der Brugge, 2009: taken from 88-92):

- Actors are the individuals and organisations they represent. Individuals can act autonomously and have their own perspectives but are bounded by the rules of their organisations.

- Processes, or social practices, connect actors to the structures and are used by actors to modify structures. Processes can be grouped into clusters of social practices such as the policy process, construction process or the core functions of organisations such as research, spatial planning or knowledge exchange.

- Structures are the formal and informal social elements which are constantly created and recreated by actors. Formal elements of structures include legislation, contracts, permits and budgets, while the informal elements comprise values, knowledge, problem frame or view, and perceptions. Van der Brugge (2009) also includes the

physical context (e.g. infrastructure, biophysical system) within the structures regime element, but for the purposes of comparing this framework with the regime capacity building framework (Brown *et al.*, 2006a), physical context is treated as an additional component to the structures component. To clarify this exclusion, the structures regime element has been called institutions (Figure 2.5).

- Influences are the ways that structures (institutions) shape or have an effect on actors, either by constraining or enabling their behaviour.

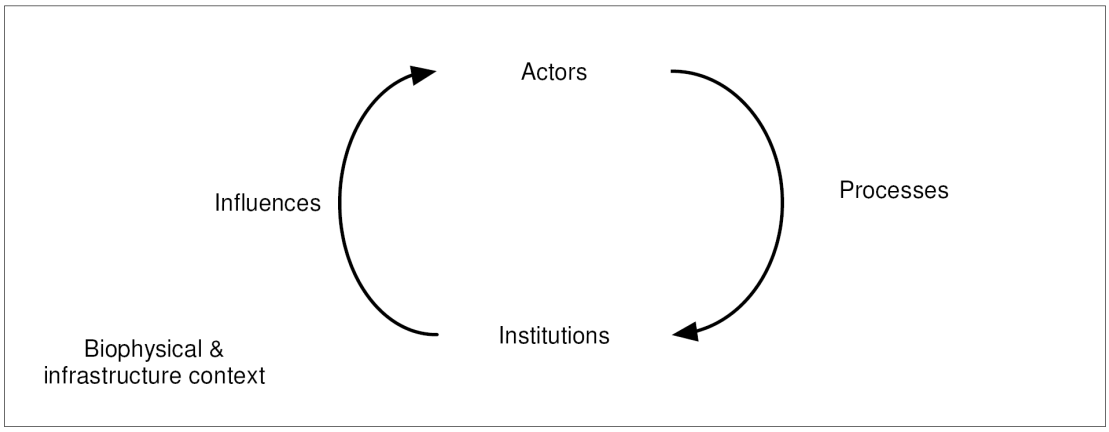

Figure 2.5 Regime Processes Framework
(Adapted from van der Brugge, 2009: 92)

The four elements of the regime framework operate within a cycle (Figure 2.5): actors use processes to modify institutions, while institutions influence and modify actor behaviour. The projected SUWM regime attributes of Brown *et al.* (2009) and Pahl-Wostl (2007; 2008) could be applied (inferring of attributes where necessary) to van der Brugge's (2009) framework, which is similar to the use of the regime capacity building framework. This projected SUWM regime processes framework would also be subject to the same limitations as the predicted regime attributes (Section 2.4.2). By identifying the regime components and how they are related, van der Brugge's (2009) framework contributes to improving knowledge of urban water management regime operation. However, this framework does not identify strategies for enabling change other than the gradual cycle of actors modifying institutions using processes and the institutions modifying actor behaviour. As identified in Section 2.4, advancing SUWM is an extensive and complex challenge, yet the regime processes framework of van der Brugge (2009) does not indicate the types, extent or location of the required change to realise SUWM.

In summary, both of these regime frameworks provide insight into and understanding of the urban water regime by identifying elements of the regime or breaking into the 'black box'. The framework of Brown *et al.* (2006a) is particularly useful for identifying actor attributes and potential strategies for change, although this framework lacks detail on the regime operation which

is provided more effectively by van der Brugge's (2009) regime processes framework. However, van der Brugge's (2009) framework is limited in its ability to identify specific strategies for change. To illustrate how these frameworks can be applied to facilitate practical understanding of urban water management regimes, key features of historical and contemporary urban water regimes (described in Section 2.2) have been applied to the strengths of both frameworks and are summarised in Table 2.4. Although the frameworks of Brown *et al.* (2006a) and van der Brugge (2009) are both useful for providing insight into the regime, without specific and detailed data on SUWM regime attributes, their utility for addressing slow SUWM implementation is limited to identifying current regime conditions and institutional barriers (see for example Table 2.3). While the projected SUWM regime characteristics could also be used with the frameworks, these projected attributes have limitations (refer Section 2.4.2). Therefore, additional insight is sought on operation and understanding of regime components in the following sections, specifically from institutional and governance literature with a focus on governance for sustainable development.

Table 2.4 Key Features of Historical & Contemporary Urban Water Regimes

Regime Feature	Historical Regime	Contemporary Regime
Individuals (actors)	- Engineers	- Engineers, ecologists, economists
Organisations (actors)	- Focused on one part of the urban water cycle	- Focused on one part of the urban water cycle, some interdisciplinary operation
Inter-organisational Relationships	- Limited interaction	- Some interaction
Structure/Administrative & Regulatory Framework	- Dominant values: public health protection; supply security; flood protection. - Centralised command and control - Regulation	- Dominant values: public health protection; supply security; flood protection; ecosystem protection; amenity. - Centralised command and control retained, some new public management, and decentralised autonomy - Market tools & regulation
Processes	- Limited flexibility - Primarily operate vertically	- Increased flexibility - Vertical and horizontal operation
Influences	- Centralised power & hierarchical actor relations	- Centralised power with relative autonomy for local actors

(Adapted from: Niemczynowicz, 1999; Chocat *et al.*, 2001; Harremoës, 2002; Raadschelders, 2005b; Mitchell, 2006; Pahl-Wostl, 2007; Brown, 2008; Brown and Keath, 2008; Brown *et al.*, 2009)

2.6 INSTITUTIONS

Institutions are an integral part of the regime frameworks discussed in Section 2.5.2, in the structures regime element of van der Brugge (2009), and in the administrative and regulatory framework sphere of Brown *et al.* (2006a). Institutions are also the site of systemic barriers to SUWM (refer Section 2.4.1). Therefore, understanding institutions and institutional change can contribute to identifying potential mechanisms and/or strategies for enabling regime change towards SUWM.

2.6.1 Understanding Institutions

Definition of Institutions

Institutions are the persistent and predictable formal and informal arrangements, laws, processes or customs that structure human interaction, including political, social, cultural or economic transactions and relationships in society (Dovers, 2005). They are often understood as 'rules' or 'prescriptions' that shape society (North, 1990; Ostrom, 2005). They consist of symbolic elements, social activities, and material resources (Scott, 2001) and are considered to guide (constrain or enable) the behaviour of actors, both organisations and individuals; however, they are not actors in their own right (Young, 2002). The word institution is sometimes used interchangeably with organisation yet organisations are:

> "manifestations of institutions, such as specific departments, associations, agencies, and so on. In some cases, an organisation may be persistent, recognisable and influential enough to be regarded as an institution, but generally organisations can be more quickly dissolved or radically changed whereas an institution is more durable" (Dovers, 2005: 12).

Actors in Institutions

The definition of an institution is generally agreed upon; however, explanations for actor motivations and behaviour and institutional operation vary. Explanations are generally grouped along disciplinary lines and are distinguished through emphasising the institutional components considered important (Scott, 2001; Young, 2002). Three groups of disciplines in institutional scholarship are often identified (Scott, 2001): economics (e.g. North, 1990; Saleth and Dinar, 2004), political science (e.g. Ostrom, 1990; Peters, 1999) and sociology (e.g. Powell and DiMaggio, 1991). The political science discipline views institutions as constraining behaviour but sociologists view them positively, as models for how to do something (Clemens and Cook, 1999), while economists consider institutions both constrain and enable behaviour (North, 1990).

Relationships between individuals and institutions generally stem from Giddens' (1984) theory of structuration, where actors influence the institutional structures and the structures influence actor behaviour; the situation is one of continual and mutual influence. Structuration theory informed

van der Brugge's (2009) regime framework (Section 2.5.2). Actors are considered to have agency, which is the ability to act, and power, which is the ability to achieve outcomes, both of which are employed to influence other actors and the social structures around them (Giddens, 1984). Based on structuration theory, structure only exists through the agency of actors (Giddens, 1984). Powell and DiMaggio (1991) and Clemens and Cook (1999) consider that as actors, organisations also demonstrate structuration theory by influencing and being influenced by institutions.

Developing from sociology, structuration has also influenced perspectives on actor behaviour in other disciplines such as anthropology (Young, 2002). In structuration theory, actor preferences are fluid and depend on continual interaction and reflection, which is often called the normative approach to actor behaviour (Young, 2002; Kjær, 2004). Another perspective on actor behaviour, popular in economics and political science, is the rational choice approach where actor preferences are fixed and depend on individual, rational choices with little outside influence (Ostrom, 1990; Young, 2002; Kjær, 2004). These perspectives have implications for the assumptions and/or predictions made when examining relations between actors and institutions. The rational choice perspective puts the actors before their context and gives them greater influence over their decision-making (Young, 2002). In contrast, the normative, structuration approach considers norms and expectations provide greater explanation for actor behaviour and institutional change (Powell and DiMaggio, 1991). The normative perspective considers context as a source of explanation; in this way, the normative approach is broader than the rational choice approach (Young, 2002). In sum, the rational choice perspective has advantages in that it is easier and simpler to use but does not provide as full an explanation of real life compared to the normative perspective (Young, 2002).

Characterising Institutions

Drawing on new institutional theory and arguing for a collaborative approach to urban planning, Healey (1997; 2006) and other scholars (e.g. O'Riordan *et al.*, 1998; Bursens, 2002; Breit, 2003; Engels and Moss, 2003) conceptualise institutions as being 'soft' and 'hard', or informal and formal. Soft institutional components are the informal cultural rules, the ways of thinking and speaking (discourses), symbolic structures, preferences, norms, shared understanding, ways of valuing and acting, and professional cultures. Hard institutional aspects are the formal structural rules, which are included in legislation, procedures and policies. Both institution types can be identified within organisations in the form of committees and organisational structure and cultural characteristics and values (Stubbs and Cocklin, 2008).

The soft and hard institutional characteristics can be also identified in other frameworks, such as Scott's new institutionalism framework (2001; 2008), applied to urban water management (Figure 2.6), where the regulative pillar of the framework is the formal institutions and the normative and cognitive pillars are the informal institutions. Brown (Brown, 2003; 2005) used Scott's framework

to compare different phases of stormwater management, characterising each of the cognitive, normative and regulatory elements as the management focus shifted from flood protection to stormwater quality. Recent developments in urban water management have been analysed using new institutionalism and some challenges were identified regarding water recycling, particularly the involvement of different stakeholders and their institutional positions regarding knowledge, values and organisational forms (Colebatch, 2006). Similarly, Stenekes *et al.* (2006) highlighted the need to consider all three cognitive, normative and regulative institutional pillars to effectively implement water recycling.

The division between soft and hard institutions provides a useful conceptualisation, however it is primarily an analytical construct used to simplify the complex and interwoven nature of formal and informal institutions that occurs in real life (Engels and Moss, 2003). The benefit of studying both hard and soft institutions has been identified by Young (2002) and Powell and DiMaggio (1991) who argue that to gain a more complete understanding of institutions, both the rational choice and normative perspectives of actor behaviour need to be understood. However, Engels and Moss (2003) assert that research focuses more on formal institutions and that greater emphasis should be placed on informal institutions to redress this imbalance.

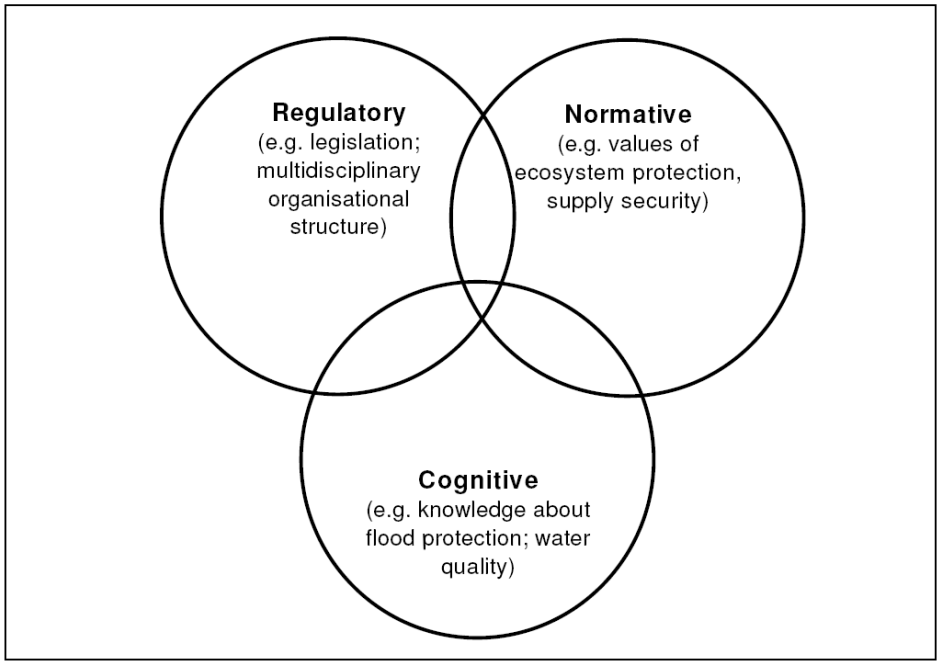

Figure 2.6 New Institutionalism Framework and Stormwater Quality Attributes
(Adapted from: Scott, 2001; Brown, 2005)

Actors are not always located on the same institutional level (e.g. federal, state and local governments) and may require different types of rules to match the different levels of action. Ostrom proposes three nested levels of rules with a different scope and function for each level, and where higher levels affect the lower institutional levels (Kiser and Ostrom, 1982; Ostrom, 2005) (Figure 2.7). At the operational level, actors take action or adopt a strategy for the future. Operational rules can change rapidly and affect daily decisions, for example water transfers between a bulk water supplier and a water distributor (retailer). Collective-choice decisions are made by officials who decide whether to enforce, continue or alter actions at the operational level. An example is a state or provincial government water allocation policy. The constitutional choice rules first affect the collective-choice and then operational level rules and can authorise actions in the collective-choice level. For example, national government discussions can lead to the establishment of a national water policy framework, which may affect the state or provincial government water allocation policy. Importantly, institutional actors may belong to one or more levels and designing the structure and allocation of roles and responsibilities across levels is important for institutional change.

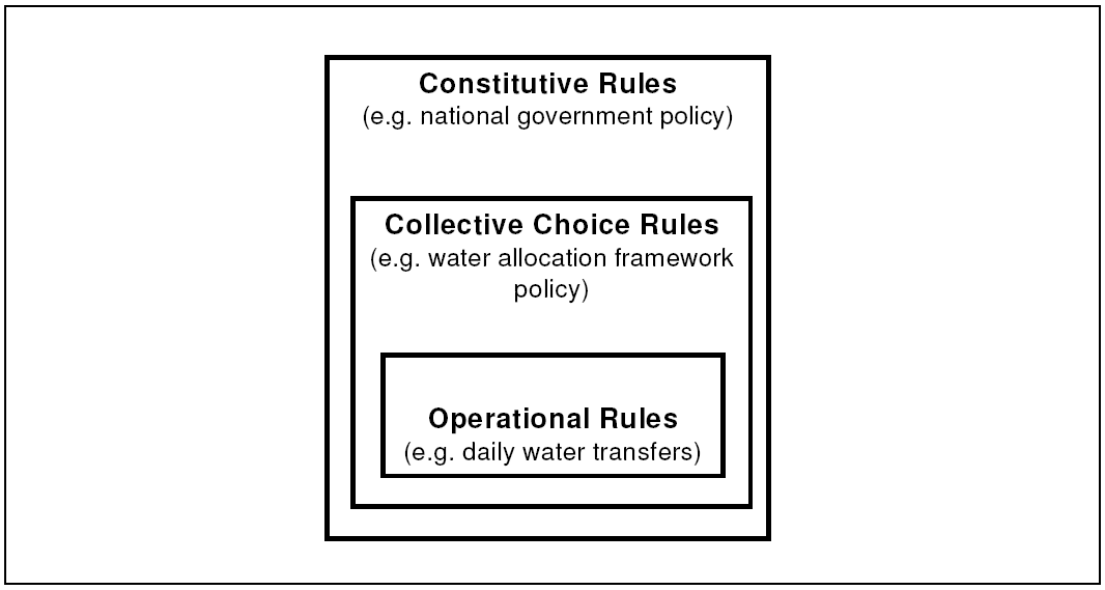

Figure 2.7 Levels of Institutional Rules
(Adapted from: Kiser and Ostrom, 1982; Ostrom, 2005)

2.6.2 Institutional Change

The theory of structuration provides a general explanation for how institutions change, however other scholarship focuses on different scales and more specific contexts. The challenge of institutional change is significant; overall, institutions are inherently stable and thus institutional change is generally slow and incremental (North, 1990; Dolsak and Ostrom, 2003; Dovers, 2005). Additionally, institutions are path dependent (North, 1991; Thelen, 1999; Voβ and Kemp, 2006;

Young, 2006); as Saleth and Dinar (2005) identified in Section 2.4.2, path dependency can influence the efficacy of institutional water reforms. Different parts of institutions are likely to change at different speeds and different times (Moss, 2003) and both soft and hard institutions need to be considered (Bursens, 2002; Breit and Troja, 2003). Without changing all parts of the institution (cognitive, normative and regulative, or collective, operational and constitutive, or formal and informal) long-term institutional change will not be realised and the misalignment between the institutional components may lead to social instability (Scott, 2001; Breit and Troja, 2003), or limit environmental management implementation and effectiveness (Engels and Moss, 2003).

Institutional change can occur through a variety of mechanisms such as top-down, bottom-up or as a response to an external influence (Scott, 2001; 2008). A method of institutional change often discussed is institutional design where the institutions are established to achieve a stated objective (Weimer, 1995). Institutional design involves specifying the relations between actors and allocation of responsibilities, for example the levels used and whether the structures are centralised, decentralised, or polycentric, where responsibility is located in multiple centres (McGinnis, 1999; Ostrom, 2005). Polycentric governance is discussed further in Section 2.7.2. Institutional design with centralised responsibilities can be effective for implementing standard solutions to a problem that are easily transferred and replicated across locations (Hirst, 1997)

For institutional design to be successful, commentators suggest the following are required at a minimum: varied institutional administrative forms (Lowndes, 2001), communication, clearly defined structural components of institutions, consequences if institutional rules are not followed and links between different institutional levels (Dolsak and Ostrom, 2003). These requirements align with Healey's (1997; 2006) formal institutional components, which scholars (e.g. Engels and Moss, 2003; Skelcher, 2005) consider a limitation of institutional design, and that equal emphasis should be placed on formal and informal institutions. Institutional design principles developed by Ostrom (1990) focus on formal institutions while those developed by Dovers (2005) include both formal and informal institutions (refer Table 2.5).

Institutional design can fail; it is constrained by our inability to foresee the future and predict change in the surrounding physical, social and economic context (Young, 2002). Furthermore, there may be unintended consequences such as changes in power (Moss, 2003) and unanticipated expenses (Dolsak and Ostrom, 2003), which may be caused by limited transferability of designs between locations (Roland, 2004) or ignoring the influence of informal institutions (Engels and Moss, 2003). A frequent change to formal institutional arrangements is the alteration of administrative boundaries to rectify problems of institutional fit or overlap, for example to align catchment or watershed borders with organisational boundaries. However commentators (e.g. Moss, 2003; Mitchell, 2005) consider this will only lead to more boundary or institutional fit problems and that such problems cannot be completely removed only minimised. Rather than modifying

organisational boundaries, both Mitchell (2005) and Moss (2003) advocate a flexible and context-sensitive approach with coordination across boundaries.

Table 2.5 Institutional Principles

Ostrom (1990: 90) Institutional Design Principles for Common Pool Resource Management	**Dovers (2005: 180-182) Principles for Institutional Change for Sustainable Development**
Clearly defined boundaries	Institutional accommodation of sustainability discourse – recognising sustainability is new, complex and contested idea, requiring conducive institutional arrangements and discursive policy-oriented networks
Rules regarding the appropriation and provision of common resources are adapted to local conditions	Role of normative change – build recognition that institutional and normative change are interdependent into poicy processes
Collective-choice arrangements allow most resource appropriators to participate in the decision-making process	Role of legal change – recognising statutory change is crucial to institutional change including statutory expression of sustainability principles
Effective monitoring by monitors who are part of or accountable to the appropriators	International law and policy and drivers – recognising the influencing role of international settings
There is a scale of graduated sanctions for resource appropriators who violate community rules	Integration in policy and practice –integration of social, ecological and economic is required through policy instruments
Mechanisms of conflict resolution are cheap and of easy access	Subsidiarity – most sustainability issues must be handled at multiple scales, requiring flexible implementation of sustainability
The self-determination of the community is recognised by higher-level authorities	Reiteration – the need to revaluate sustainability continually as it is a long term social and policy project with considerable uncertainty
In the case of larger common-pool resources: organisation in the form of multiple layers of nested enterprises, with small local common pool resources at the base level	

Institutional change can be influenced by external factors such as changes to the physical situation (e.g. climate change), or changes in the political and economic contexts (Hukkinen, 1999; Breit and Troja, 2003). Emphasising the link between the institution and the external biophysical or infrastructural context moves from institutions to discussing the regime (see for e.g. Rip and Kemp, 1998; Geels, 2002; Geels, 2004; van der Brugge, 2009), which is described and defined in Section 2.5. Another distinction between institutions and regimes in transition theory is the explicit emphasis of regimes on actors (e.g. see frameworks in Section 2.5.2) which are considered more implicitly in institutional theory.

This section reviewed institutional literature, exploring the concept and characterisation of institutions and mechanisms for institutional change. Considering the two key knowledge gaps identified in Section 2.4.2, institutional theory contributes to a more detailed understanding of the regime, particularly the nature of formal and informal rules. However, institutional theory has been

criticised for not providing detailed and robust explanations of institutional change. Governance theory is promoted as better able to facilitate understanding of regime change (Kjær, 2004), because of its focus on processes (Pierre and Peters, 2000; van Kersbergen and van Waarden, 2004), thus governance literature is explored next.

2.7 GOVERNANCE

This section reviews governance literature to improve understanding of regime processes and operation. Importantly, processes provide essential input into natural resource management implementation theory (Margerum and Born, 1995). The three ideal modes of governance (hierarchical, market and network) are discussed followed by environmental governance. Adaptive governance and transition management are reviewed as they are both governance frameworks explicitly aimed at enabling sustainable development.

2.7.1 Defining Governance

Governance focuses on a variety of stakeholders, not just the formal government, and the processes and mechanisms used to manage issues of collective interest (e.g. Kickert *et al.*, 1997; Stoker, 1998; Pierre and Peters, 2000; Kjær, 2004). During the 1990s, political scientists realised government, both its organisations and activities, are diverse and action within government is complex, which led to the development of governance theories (Colebatch, 1998; Pierre and Peters, 2000). Governance theory is broad and has a range of disciplinary influences (Kooiman, 1999), which is similar to institutional literature (Section 2.6). Governance is used in at least six separate contexts (Rhodes, 1997: 47): corporate governance, the minimal state, the new public management, 'good governance', a socio-cybernetic system, and self-organising networks. These uses are influenced by public administration and policy, organisational theory, political science, international development, economics, and international relations (Kjær, 2004; van Kersbergen and van Waarden, 2004). As governance theory emphasises interactions among structures (Pierre and Peters, 2000), it is often considered to be more focused on processes (Kjær, 2004) and outcomes than institutional theory (Peters and Pierre, 1998).

Legitimacy and accountability are core principles of governance (Hirst, 1997; Fischer, 2000; Pierre and Peters, 2000). Accountability implies responsibility, and is manifested through the relationships between citizens and the actors who make decisions and manage collective issues (Kjær, 2004), for example, through representative democracy, or reporting and communication mechanisms. Transparency occurs through access to or provision of information and is critical to maintaining accountability (van Kersbergen and van Waarden, 2004; Bäckstrand, 2006). Legitimacy is required for social stability and effective governance; without it, citizens may undermine the social rules and legislation (Stoker, 1998). Two types of legitimacy are often identified; input legitimacy refers to mechanisms for citizen participation in decision-making, and output legitimacy refers to the quality of the outcomes generated (van Kersbergen and van

Waarden, 2004). Stoker (1998) asserts that governance challenges traditional conceptions of legitimacy and that while legitimacy is contentious, it can be increased or decreased by adjusting rules. Legitimacy and accountability are observed in different ways in the three ideal governance modes discussed below.

2.7.2 Modes of Governance

The term 'modes of governance' is used in this thesis to refer to governance styles (Stoker, 1998) including the dimensions used to describe or characterise decision-making processes and the associated policy outputs (Treib *et al.*, 2007). In this way, examining modes of governance can improve our understanding of the regime, including historical regime change. There are generally three ideal modes identified in governance literature: hierarchical, market and network. Although some scholars refer to these using different names (e.g. state-led, decentred-out, and decentred-down, Pierre and Peters, 2000; command, exchange and dialogue, Jessop, 2003), the main elements of each mode correspond to the groupings of hierarchical, market and network. The following briefly describes each mode of governance, highlighting the key features and outlining the development of each mode.

Hierarchical Governance

In contrast to the new, broader understanding of governance, hierarchical governance is associated with traditional government (Kjær, 2004). Representative democracy forms the basis of the Weberian mode of hierarchical governance which views the relationship between citizens and government as being clearly defined and vertical (Pierre and Peters, 2000), with government exerting coercive power (Stoker, 1998). In this mode, large, neutral bureaucracies have responsibility for implementing policy formulated by the elected executive arm of government (Kjær, 2004). Formal policy instruments, such as legislation and regulation (Elzen and Wieczorek, 2005), are used which contribute to a slow rate of change and low flexibility (Newman, 2001a). Accountability mechanisms comprise vertical rules and contribute to control and political accountability (Hill and Hupe, 2002; Kooiman, 2003). The traditional urban water management system, with its publicly managed organisations and centralised control is generally considered to be characterised by the hierarchical mode of governance (Livingston *et al.*, 2005; Pahl-Wostl, 2007).

Scholars challenged the hierarchical governance mode after realising that representative democracy was influenced by powerful interests and government services had expanded from the traditional areas of the military and taxation, into more complex areas such as education and health (Hirst, 1997; Pierre and Peters, 2000; Kjær, 2004). This expansion required more daily decision-making by bureaucrats and there was a divergence away from the hierarchical accountability mechanisms to horizontal relationships among peers and recipients of government services (Newman, 2001a; Kjær, 2004). Another criticism of the hierarchical approach was that the large administrative

organisations implementing policy were inefficient (Pierre and Peters, 2000; Kjær, 2004). The market governance approach, often called New Public Management (Powell, 1990; Hood, 1991; Lynn, 1998; Nickson and Franceys, 2003; Hodges, 2005), was developed to improve efficiency and address the criticisms of hierarchical governance.

Market Governance

Market governance is an economically-oriented form of public governance, not to be confused with 'governance of the market' which refers to governance of actors in the private market (Meuleman, 2008). Market governance aims to allocate resources efficiently and empower citizens (Pierre and Peters, 2000). To improve public sector efficiency, private sector management principles were introduced ('managerialism' Rhodes, 1997), effectively reducing the role and expenditure of government through privatisation, increasing competition, decentralisation, and separation of policy implementation from political influence by establishing separate government agencies (Rhodes, 1997; Nickson and Franceys, 2003; Kjær, 2004). Mechanisms for accountability were established through consumer choice or 'stakeholderism' (Peters and Pierre, 1998; Pierre and Peters, 2000). Consultative committees were established to give citizens, now called consumers or customers (Colebatch, 2006; Meuleman, 2008), a greater role in governance to balance the increased power of low level bureaucrats (Kjær, 2004). Incentives or a lack of penalties are the preferred policy instruments (Elzen and Wieczorek, 2005). Market governance policies were adopted throughout Western nations as formal government policy (Pierre and Peters, 2000), affecting many sectors including the water sector during the 1990s (refer Section 2.2.2 for more information).

Decentralisation was undertaken to improve efficiency of policy implementation, increase legitimacy and responsiveness to citizens, although the approach to decentralisation varied (Kooiman, 2003). Firstly, the principle of subsidiarity was applied, where authority and responsibility was given to the lowest appropriate level of government (Kooiman, 2003). Secondly, policy implementation was altered; policy was developed centrally but implementation was decentralised while the lower levels of government remained accountable to the central government, reinforcing the hierarchical structure (Kjær, 2004; Meuleman, 2008). This style of policy development and implementation is characterised by high accountability for outputs implemented through performance management mechanisms (Newman, 2001a).

Market governance has been criticised for not being suitable for public sector implementation due to conflicts created between existing hierarchical control of the bureaucracy, the drive for autonomy (Meuleman, 2008) and the prioritisation of performance over accountability to citizens (van Kersbergen and van Waarden, 2004). Furthermore, the variable implementation of some market governance policies due to institutional fragmentation highlighted the decreasing control of the state in policy implementation and increasing influence of other actors through networks

(Kickert *et al.*, 1997; Kjær, 2004). Networks were identified as a means to overcome institutional fragmentation and improve policy implementation (Meuleman, 2008).

Network Governance

The founding concept behind the network mode of governance is that actors across the public, private and civil sectors can contribute, and indeed are essential for effective public policy development and implementation (Klijn and Koppenjan, 2000). In a network governance approach, actor relationships are founded on trust and respect (Streek and Schmitter, 1985). Network governance became popular during the first decade of the 21st century, although implementation has been variable (Meuleman, 2008). Network governance can increase legitimacy by providing opportunities for stakeholders other than those who hold power to have input, discuss and debate issues (Briassoulis, 2004; Leach and Scoones, 2005) and address issues of technocracy (where technical experts hold significant power because of their knowledge) (Fischer, 2000).

The mutual dependencies among actors change actor power relations (Stoker, 1998) and create a focus on long-term and sustainable relationships (Klijn and Koppenjan, 2000). Decision-making requires consideration of the network members' perspectives, and strategies such as member consent and/or unanimous agreement are often used (Streek and Schmitter, 1985). Favoured policy instruments in network governance include providing opportunities for learning and experimentation, such as demonstration projects, developing visions through workshops and network building (Elzen and Wieczorek, 2005). Yet, this mode of governance has also been criticised for a lack of accountability and transparency due to the potentially closed nature of the networks, which may ignore governance directives or may act in opposition to them (Stoker, 1998; Young, 2002; Kjær, 2004).

Polycentric governance is a form of network governance where actors can interact through both vertical and horizontal relationships, and where there are overlapping jurisdictions which are not necessarily vertically related (Skelcher, 2005). Polycentric governance is closely related to polycentric institutional design (Section 2.6.2) and is considered useful for analysing natural resource management problems by scholars such as McGinnis (1999), Ostrom (2005) and Huitema *et al.* (2009). Polycentric governance systems are considered more resilient and better able to cope with change and uncertainty than other governance forms (Huitema *et al.*, 2009) because they do not rely on one centre of control which may catastrophically fail, are more responsive to local changes and issues, and use local knowledge (Ostrom, 2005). However, mechanisms of coordination and decision-making have been identified as potential disadvantages of polycentric governance (Huitema *et al.*, 2009). Yet, although Huitema *et al.* (2009) argue there is little robust empirical evidence to support the claims of polycentric governance advantages, they consider it remains a desirable style of governance supported by scholars.

Moving Beyond the Ideal Governance Modes

The three ideal governance modes are summarised in Table 2.6 using van der Brugge's (2009) regime framework which comprises the main elements of governance theory: actors, structures, and processes. Each of the three ideal modes of governance have been criticised: hierarchical for being inefficient and inflexible (Kjær, 2004); market for increasing fragmentation and not being suitable for the public sector (Hood, 1991; Meuleman, 2008); and network for lacking transparency and accountability (Stoker, 1998; Young, 2002; Kjær, 2004). Combining or modifying the ideal modes of governance offers one way of addressing these criticisms. However, Newman (2001a: 37) argues that mixing modes will not produce coherent governance "since the logics of appropriate action generated by one may well undermine the requirements of the other". Colebatch and Larmour (1993) consider that the ideal modes are not mutually exclusive but rather provide different perspectives which can be used in part or total for different situations to overcome weaknesses. Additionally, a number of scholars (e.g. Pierre and Peters, 2000; Hill and Hupe, 2002; Meuleman, 2008) assert the hierarchical, network and market governance styles are ideal-type modes and do not exist independently in reality. It appears that mixing and modifying governance modes is advocated by many scholars, evidenced by the development of associative (see for e.g. Streek and Schmitter, 1985; Hirst, 1997) and deliberative democracy (see for e.g. Fischer, 2000; Kjær, 2004; Leach and Scoones, 2005; Bäckstrand, 2006), together with discussions about hybrid governance (see for e.g. Lemos and Agrawal, 2006; Kooiman and Jentoft, 2009).

Table 2.6 Summary of Ideal Governance Modes for a Regime

Regime Element	Mode of Governance		
	Hierarchical	**Market**	**Network**
Actors	- Little autonomy, follow predefined orders - Dependent relationships - Rational - Considered as 'subjects' - Subordinate actors are motivated by fear of punishment - Superordinate actors are motivated by career advancement, bureaucratic stability - Common motivation is to minimise risk	- Exercise self choice - Independent relationships - Rational - Considered as 'customers' or 'consumers' - Subordinate actors motivated by material benefit - Superordinate actors motivated by profit - Common motivation is to maximise advantage	- Depend on others; trust others, empathetic - Interdependent relationships - Considered as 'partners' - Subordinate actors motivated by belonging to a group - Superordinate actors motivated by the esteem of followers - Common motivation is to satisfy identity
Processes	- Clearly defined and applied across locations - Decisions based on authoritative formal adjudication - Accountability exercised through political system	- Emphasis on private sector management practices – efficiency, competition - Decisions based on consumer preference - Accountability exercised through consumer choice	- Context dependent - Emphasis on cooperation and negotiation - Decisions based on general consent, unanimous agreement - Accountability and transparency difficult to identify
Structures	- Strong vertically, formalised, static - Low flexibility - Establishes clear actor roles and responsibilities	- Provide guidance to actors - Establish explicit standards for performance - High flexibility - Establishes principal with local actors	- Strong horizontally, informal - Moderate flexibility - Context dependent
Influences	- Centralised power - Power exercised through coercion, administrative and legal expertise, procedural correctness - Collective goods are produced and distributed	- Centralised power with autonomous actors - Resource allocation linked to performance - Power is exercised through entrepreneurship - Private goods are produced and distributed	- Distributed power and resources - Power is exercised through respect and trust - Solidaristic goods are produced and distributed

(Adapted from: Streek and Schmitter, 1985; Powell, 1990; Hood, 1991; Pierre and Peters, 2000; Elzen and Wieczorek, 2005; Meuleman, 2008)

The ideal types appear to have very different founding principles, thus the development of a hybrid mode of governance may not be apparent, yet scholars have identified that some governance modes are better suited to operating in combination than others. Networks can enable hierarchies to permit more participation and facilitate markets to incorporate criteria that are not strictly economic

(Pierre and Peters, 2000). Elements of hierarchies and networks have been combined to enable decentralised and collaborative decision-making within a broader policy framework, with hierarchical elements introduced in the form of sanctions (van Bueren and ten Heuvelhof, 2005). Hierarchical and market modes are often combined because self regulation can be influenced by the state (Treib *et al.*, 2007). In the context of urban regeneration partnership organisations, Lowndes and Skelcher (1998) identify different governance modes as dominant during the partnership: pre-partnership collaboration is regarded as network governance; partnership creation and consolidation is considered hierarchical governance; partnership programme delivery is characterized by market (or quasi-market) mechanisms of tendering and contracts; and partnership termination or succession comprises a re-assertion of a network governance mode as a means to maintain agency commitment. Meuleman (2008: 15) suggests that there are at least six types of hybrid governance:

- "Oligopolies (a market form of coordination with important network characteristics, that is not restricted to the private sector);
- Public private partnerships (also a combination of market and network governance);
- Chain management (a form of network governance concentrating on functional instead of social relations between actors, which borrows its structure from hierarchical thinking);
- The Open Method of Coordination of the European Commission;
- The related concepts of self-regulation and self-organisation; and
- An emerging type with mainly network and market features: 'bazaar governance'."

These examples are more specific than the broad modes of governance (Table 2.6) and thus, in this thesis, are not considered new types of governance but demonstrate the complimentary elements between the ideal governance modes which can be implemented in practice. Clearly there are different conceptualisations of hybrid governance and many different combinations of the ideal modes in different situations. Van Kersbergen and van Waarden (2004: 165) identify a knowledge gap in governance literature, that "there is a need to better understand precisely what the new forms, locations and capacities of governance look like and how relevant they are in diverse areas and at different levels". This knowledge gap could also be applied to sustainable development, where governance is increasingly becoming a focus (Jordan, 2008), generating a variety of viewpoints across the literature.

2.7.3 Governance for Sustainable Development

Governance is critical to sustainable development because the sustainable development principles often conflict with each other and therefore governance systems are needed to overcome this conflict and develop coordinated policies (Jordan, 2008). In their review of environmental governance, Lemos and Agrawal (2006: 299) state that "there is no escaping it [environmental governance] for anyone concerned about environmental outcomes. Environmental governance is varied in form, critical in importance, and near ubiquitous in spread". However, there is no single form of governance suitable for sustainable development (Elzen and Wieczorek, 2005; Kemp *et al.*, 2005) and there is a lack of consistent and detailed information about decentralised environmental governance (Lemos and Agrawal, 2006), which is likely to be important for SUWM (see projections developed by Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) (Section 2.3.2). Additionally, contributing to the debate on environmental governance, recent studies (e.g Kooiman and Jentoft, 2009; Pahl-Wostl, 2009) advocate a hybrid governance approach.

In the context of integrated water resources management and contributing to the Global Water Partnership from a developing country perspective, Rogers and Hall (2003) propose broad principles for effective water governance:

- open and transparent;
- inclusive and communicative (participatory, includes transparency and accountability);
- coherent and integrative (requires political leadership);
- equitable and ethical;
- accountable (clear roles and responsibilities);
- efficient (triple bottom line efficiency); and
- responsive and sustainable (clear objectives, inter-generational equity).

However, they also acknowledge that "much more work remains to be done to establish effective water governance regimes" (Rogers and Hall, 2003: 30). Expressing a similar perspective, Grover (2006) considers that in addition to the governance principles there must also be governance objectives to enable effective governance. Given the developing country context and broad scale of the water governance principles (Rogers and Hall, 2003), the literature review continues with a discussion of two governance approaches which are proposed as a means to enable sustainable development: adaptive governance and transition management.

Adaptive Governance

Adaptive governance is the social dimension that enables adaptive management of social-ecological systems (SESs) (Folke *et al.*, 2005), which is critical for enabling sustainable natural resource management (see for e.g. Folke *et al.*, 2005; Gunderson and Light, 2006; Pahl-Wostl, 2009). The adaptive governance approach aims to develop techniques to address uncertainty in human and institutional areas of a complex or wicked problem (Scholz and Stiftel, 2005b) and it emphasises learning, trust, leadership (Folke *et al.*, 2005) and collaboration (Lee, 1999; Olsson *et al.*, 2004a).

Key concepts in adaptive management (Holling, 1978; Walters, 1986) and governance are uncertainty and resilience (Folke *et al.*, 2005). Uncertainty is accepted; it is not possible to have complete knowledge (Holling, 1978). However, to decrease uncertainty of SES behaviour, carefully designed physical or simulated experiments are undertaken to reduce uncertainty over time (Holling, 1978; Gunderson and Light, 2006). Resilience is the ability of the SES to withstand and recover from disturbances, or even benefit from them; it depends on variability of ecosystem resources and functions of species (Holling, 1978; Folke, 2006). Managing SESs for efficiency and control through optimisation decreases natural variability and resilience and increases the vulnerability of the system to collapse (Holling, 1978; Holling and Meffe, 1996; Holling *et al.*, 2002a; Elzen and Wieczorek, 2005; Lemos and Agrawal, 2006).

Considered in the light of uncertainty and resilience, the drive for efficiency initiated as part of market governance reforms and continued today in urban water management (Bakker, 2005; Livingston *et al.*, 2005) (refer Section 2.2.2) is likely to have left the urban water regime with lowered resilience to adequately deal with the significant challenges faced (refer Section 1.1). Indeed, Wong and Brown (2009) emphasise the importance of resilience for enabling SUWM. Furthermore, the optimisation approach is self perpetuating, building expectations of control but leading to failure and erosion of trust in the management authorities (Yorque *et al.*, 2002).

Investigations into SES dynamics revealed that undesirable, maladaptive or pathological systems can arise when there are extremely high or extremely low levels of resilience (Holling *et al.*, 2002a; Gunderson and Light, 2006). Systems with low levels of resilience, which move from crisis to crisis, are considered to be caught in a 'poverty trap', with little opportunity for change, while systems with high levels of resilience are either in a rigidity trap (high system connectivity, high resilience and high potential for change, e.g. long established bureaucratic systems) (Holling *et al.*, 2002b; Allison and Hobbs, 2004) or locked-in (high system connectivity, high resilience and low potential for change) (Allison and Hobbs, 2004) (refer Section 2.4.2). The objective is to manage SES resilience levels to maintain system function in the face of disturbance, and also enable the system elements to renew or reorganise when the structure and function of the system are radically altered (Walker *et al.*, 2002).

Change in SESs generally occurs in response to crisis (van der Brugge and van Raak, 2007) in ecological, economic, social or political circumstances (Walker *et al.*, 2004; Olsson *et al.*, 2006). In such situations, the system needs to fundamentally change or transform (Folke *et al.*, 2005; Olsson *et al.*, 2006). Transformation has three phases: 1) preparing the system for change, 2) seizing a window of opportunity, and 3) building social-ecological resilience of the new desired state (Olsson *et al.*, 2004b). For a change in governance to be successful, there needs to be alignment between the scale of the problem and the perceived extent of the required change (Olsson *et al.*, 2006). Similarly to institutions, change in SESs can vary, being slow and steady or rapid and turbulent (Folke *et al.*, 2005). Two Swedish governance transformations, one in the Helgeå River catchment wetlands (Olsson *et al.*, 2004b) and the other in the Lake Racken catchment took approximately 10 years (Olsson and Folke, 2001).

Strategies for transforming non-adaptive systems to adaptive governance systems have been identified empirically and include developing shadow networks and leadership, and seizing windows of opportunity (Folke *et al.*, 2005; Scholz and Stiftel, 2005a; Olsson *et al.*, 2006). Informal or shadow networks operate separately to the mainstream political processes which enables more lateral and innovative thinking; they also provide opportunities for fostering knowledge sharing, and the identification and trial of alternative governance forms which can be tested and then implemented during a window of opportunity (Olsson *et al.*, 2006). Bridging organisations can initiate shadow networks to link different stakeholders or institutional levels, facilitate discussion and build capacity of local stakeholders (Folke *et al.*, 2005). Preparation of networks and support for alternative forms of governance before the window of opportunity arrives can enable a more rapid response (Olsson *et al.*, 2006). However, the presence of networks does not guarantee a transformation to adaptive governance as other strategies, such as leadership, are also needed (Olsson *et al.*, 2006).

Leadership across technical, social and political domains is critical to articulate an alternative governance approach and maintain momentum throughout the transformation (Olsson *et al.*, 2006). Leaders need to generate support for the transformation and alternative governance approach (Olsson *et al.*, 2006) by inspiring trust and collaborative approaches (Jones, 2005).

Overall, adaptive governance provides a model for natural resource governance, particularly in response to crisis (van der Brugge and van Raak, 2007). It contributes to improved understanding of SESs and the requirements for successful management including processes, actor interaction and challenges faced. Adaptive management has been adopted in some urban water policy documents, such as the Australian National Water Initiative (COAG, 2004), Victorian Central Region Sustainable Water Strategy (DSE, 2006a) and Québec Water Policy (Quebéc Government, 2002). However, realisation of adaptive management and governance in practice faces significant challenges such as conflict, developing trust (Scholz and Stiftel, 2005a) and undertaking experiments (not just planning) to learn and decrease uncertainty (Gunderson and Light, 2006).

Adaptive governance has some similarities with network governance, particularly in its focus on stakeholder participation, learning and collaboration (Folke *et al.*, 2005). Leadership is emphasised in adaptive governance, however it is consultative and focuses on encouraging stakeholder input, and therefore is considered to be more collaborative and aligned with the network mode of governance than the leadership styles associated with hierarchical or market governance modes.

Another governance theory aiming to enable sustainable development is transition management (discussed in the following section). Van der Brugge and van Raak (2007) identify some similar concepts in adaptive management and transition management, such as shadow networks and transition arenas, the focus on continual change towards sustainable development and an emphasis on learning and experimentation.

Transition Management

The dynamics of structural societal change, particularly the initiation, facilitation and influence of societal transformations form the core focus of transition management (van der Brugge and van Raak, 2007). Transition management has been identified as a model for governance (Kemp *et al.*, 2007), or in other words, process-focused management (Kemp *et al.*, 2005). Similarly to adaptive management and adaptive governance, transition management stems from complexity science; these insights are integrated with socio-technical system studies and environmental studies (van der Brugge and van Raak, 2007; van der Brugge, 2009).

Transition management is explicitly advocated as a means to enable sustainable development, however while theoretical developments continue (see for e.g., Geels and Schot, 2007; Loorbach, 2007; Avelino and Rotmans, 2009; van der Brugge, 2009), the link between sustainable development and transition management is tenuous as transition management is predominantly theoretical. Where empirical data are used in transition management, historical transitions are typically used (see for e.g. Geels, 2005a; van der Brugge *et al.*, 2005; Geels, 2006b; Geels, 2006a; Brown and Clarke, 2007; Geels, 2007), which were not initiated with a preconceived goal, which is in contrast with the normative objective of sustainable development (Loorbach and Rotmans, 2006). However, there are contemporary opportunities for transition management research; the Dutch government has adopted transition management as a policy strategy for a number of sectors (energy-supply, mobility, agriculture and biodiversity) and as part of the *4th National Environmental Policy* (Loorbach and Rotmans, 2006). Despite uncertainty regarding preconceived goals, proponents of transition management argue that because sustainable development is inherently subjective and reflexive (involving self confrontation and learning (Kemp *et al.*, 2007; Rotmans and Kemp, 2008)), deliberative governance is needed (Kemp and Martens, 2007), and that transition management provides such an approach (Kemp and Loorbach, 2006).

There are a number of frameworks within transition management to describe and explain the dynamics of socio-technical transitions.

- The multi-level perspective (Rip and Kemp, 1998; Geels, 2002) comprising micro (niche), meso (regime) and macro (landscape) levels (refer Section 2.5.1 and Figure 2.3 for more detail) describes the dynamics of different components and scales of the socio-technical system. Change can occur through niches modifying the regime or macro-level drivers changing the regime, which then changes the micro-level.

- The technology diffusion curve (S-shaped curve), also known as the multiphase concept, describes the different transition phases and rates of system change (Rotmans *et al.*, 2001). There are four phases of a transition: a slow preparation phase, which moves into a take-off phase, followed by an acceleration phase and finally the stabilisation phase. The S-curve is similar to the three phases of transformation in adaptive governance (see Olsson *et al.*, 2004b).

- The different pathways or mechanisms for transition are called pattern dynamics or the multi-pattern concept (van der Brugge, 2009). Pattern dynamics considers issues such as the origin of niches (endogenous or exogenous), duration of niche formation, niche-regime interactions or if the system is transformed by a powerful actor within or outside of the system (van der Brugge, 2009).

Managing a transition in terms of control is not possible because of the complex nature of the many interacting components that influence each other; rather it is possible to steer or influence it (Loorbach and Rotmans, 2006), similar to network governance (Klijn and Koppenjan, 2000). Loorbach and Rotmans (2006) outline a transition management strategy which focuses on the transition arena, which is similar to shadow networks in adaptive management (van der Brugge and van Raak, 2007). The transition arena also includes a visioning process, development of an agreed transition agenda or plan of action, implementation of experiments and monitoring and evaluation of the progress made in terms of policy content, the participants and the overall transition process (Loorbach and Rotmans, 2006). Government has a unique position as the transition develops, comprising facilitating, stimulating, controlling and directing roles (Rotmans *et al.*, 2001).

Transition management has been criticised for emphasising 'transition managers' and the steering or management of complex social systems (Shove and Walker, 2007). However proponents of transition management dispute these claims citing the dynamic nature of actor values and multiple stakeholders interacting over time which does not facilitate steering (see for e.g., Rip and Kemp, 1998; Loorbach and Rotmans, 2006). Other critiques suggest transition management does not adequately address issues relating to accountability and legitimacy; for example, Shove and Walker (2007; 2008) raise particular concerns about transition management ignoring power dynamics. In their transition management strategy, Loorbach and Rotmans (2006) relate accountability and legitimacy to representative democracy and government developing the vision. Furthermore, transition management theory is developing and evolving to address these concerns, evidenced by

the recently published conceptual framework of power developed specifically for transition management by Avelino and Rotmans (2009).

Overall, transition management is advocated as a governance approach specifically aimed at realising socio-technical transitions towards sustainable development. It enables understanding of complex dynamics and processes involved in socio-technical system transitions, which may be useful for informing SUWM implementation, and identifies the regime as an integral element in transitions. A key limitation is the lack of contemporary transition studies; although this is currently being addressed (see Loorbach and Rotmans, 2006). Transition management has elements of the network mode of governance, through the use of multiple stakeholders and also through the emphasis on learning. However, the promotion of the transition arena being a network of "selected" participants (Loorbach and Rotmans, 2006: 199) raises some concerns about accountability and legitimacy; these may be addressed through further theoretical development and empirical testing.

This section has addressed the concept of governance, including historical developments in governance theory which have resulted in the identification of three ideal modes of governance. The interaction of the hierarchical, market and network governance modes was discussed, together with the realisation that a hybrid or mixed mode of governance is likely to be prevalent in reality. Finally, governance in the context of sustainable development was discussed, with particular emphasis on the adaptive governance and transition management theoretical frameworks, which are most closely aligned with the network mode of governance.

2.8 SUMMARY

This Chapter reviewed a diverse body of literature to identify the current knowledge gaps relating to SUWM implementation and also to provide a detailed understanding of theoretical perspectives which inform this research.

The description of the historical and contemporary urban water management regimes provided an overview of major changes in the underpinning social values and response of the urban water services, illustrating that overtime the breadth of social values that need to be provided by the urban water regime has become significantly broader (Chocat *et al.*, 2007; Brown *et al.*, 2009). The SUWM principles were illustrated in the physical context (Newman and Mouritz, 1996; Newman, 2001b) and the regime using available regime attribute projections (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). The gap between SUWM principles and projections was highlighted by a discussion of key institutional barriers and socio-technical system lock-in.

Although the technical component of the socio-technical has been a focus of SUWM research and implementation (e.g. Harremoës, 2002; Mitchell, 2006), the regime appears to be hampering the co-evolution of the socio-technical system and therefore impeding the transition towards SUWM.

The historical development of the urban water regime is strongly influenced by the investments in large scale, centralised infrastructure and it appears the urban water socio-technical system is entrapped within the historical development path, evidenced by continued selection of large centralised infrastructure systems when faced with crisis (see for e.g. Keath and Brown, 2008) (Section 2.4.2). The significant challenges hampering the realisation of SUWM posed by the institutional barriers, socio-technical system lock-in and entrapment, illustrate the need for research into the SUWM regime.

Progress in stimulating regime change towards SUWM appears to be hampered by a lack of knowledge in two critical areas. Firstly, there is a lack of detailed, empirically informed information about the characteristics of a SUWM regime. Secondly, there is a lack of conceptual frameworks for implementation, or a lack of theory about 'how' to enable SUWM (see for e.g Margerum and Born, 1995). While there are regime frameworks currently available that could be used to advance SUWM (e.g. Brown *et al.*, 2006a; van der Brugge, 2009) (Section 2.5.2), they are limited by a lack of knowledge of SUWM regime attributes and operation.

Institutional literature provides insight into the rules, both formal and informal, which guide and structure actor behaviour. Institutional change mechanisms such as institutional design were discussed (Section 2.6.2), however, they are considered to be limited due to the complex interaction between formal and informal institutions. Governance theory, with its focus on processes is considered to better explain institutional change (Kjær, 2004). The three ideal modes of governance, hierarchical, market and network, were discussed (Section 2.7.2), however it is suggested that a hybrid mode of governance will likely be most effective in complex real world situations, such as SUWM (Hill and Hupe, 2002; Lemos and Agrawal, 2006; Meuleman, 2008; Kooiman and Jentoft, 2009). Governance literature on sustainable development advocates hybrid governance mechanisms, yet the two theoretical frameworks reviewed, adaptive governance and transition management, exhibit predominantly network governance characteristics (Section 2.7.3). Based on this review, it appears there are different views within the sustainability literature and a lack of insight regarding the most appropriate mode of governance to enable sustainable development. More specifically, sustainable urban water governance appears to be an under-developed field of research.

The available SUWM regime projections (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) follow the sustainable governance frameworks (adaptive governance and transition management) and advocate a predominantly network governance approach. Therefore, the lack of empirically informed SUWM regime attributes and conceptual frameworks to facilitate SUWM implementation, together with the lack of consistent advice and insight from sustainability governance literature on governance approaches, demonstrates the need for the overarching aim of this thesis: to develop a guiding framework for sustainable urban water governance. The next

chapter presents the research design and data collection and analysis methods used to address the research aim and objectives, which were presented in Section 1.3.

CHAPTER 3 RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

Constraints facing and opportunities for advancing SUWM implementation were discussed in Chapter 2, which concluded that using a governance approach would enable insights into likely SUWM regime attributes to be identified and a guiding framework for sustainable urban water governance to be developed. This Chapter has six sections; following this brief introduction, the research design is presented which traces the development of the three research stages and evolving understanding of SUWM regimes. The data collection and analysis methods for each of the three stages are then described, followed by research quality considerations. The Chapter closes with a summary of the research methods and structure of the results and discussion chapters.

3.2 RESEARCH DESIGN

This investigation into SUWM regimes and governance was undertaken using Patton's (2002) research strategy of emergent design flexibility where the research focus changes as understanding deepens during the research. While this investigation evolved over the research period, the emergent design can be divided into three stages where the results and insights generated from each stage informed the following stage(s). An overview of the emergent research design and the three stages is presented in Figure 3.1.

An important knowledge gap identified in Section 1.1 was the lack of an institutional capacity assessment framework for SUWM and subsequently, the initial research aim was to develop such a framework. A grounded theory approach (Glaser and Strauss, 1967; Strauss and Corbin, 1998; Dey, 1999; Charmaz, 2006; Corbin and Strauss, 2008) was selected to focus the research as it is suitable for developing theory where little currently exists (Creswell, 2007), which is the situation for institutional capacity assessment frameworks in the field of SUWM (Brown *et al.*, 2006a). In this thesis, the term framework is used to describe an analytical schema of a phenomenon generated through the grounded theory approach (Creswell, 2007); it is an example of an empirical theory which contributes to explaining and interpreting the phenomenon of interest (Judge *et al.*, 1995).

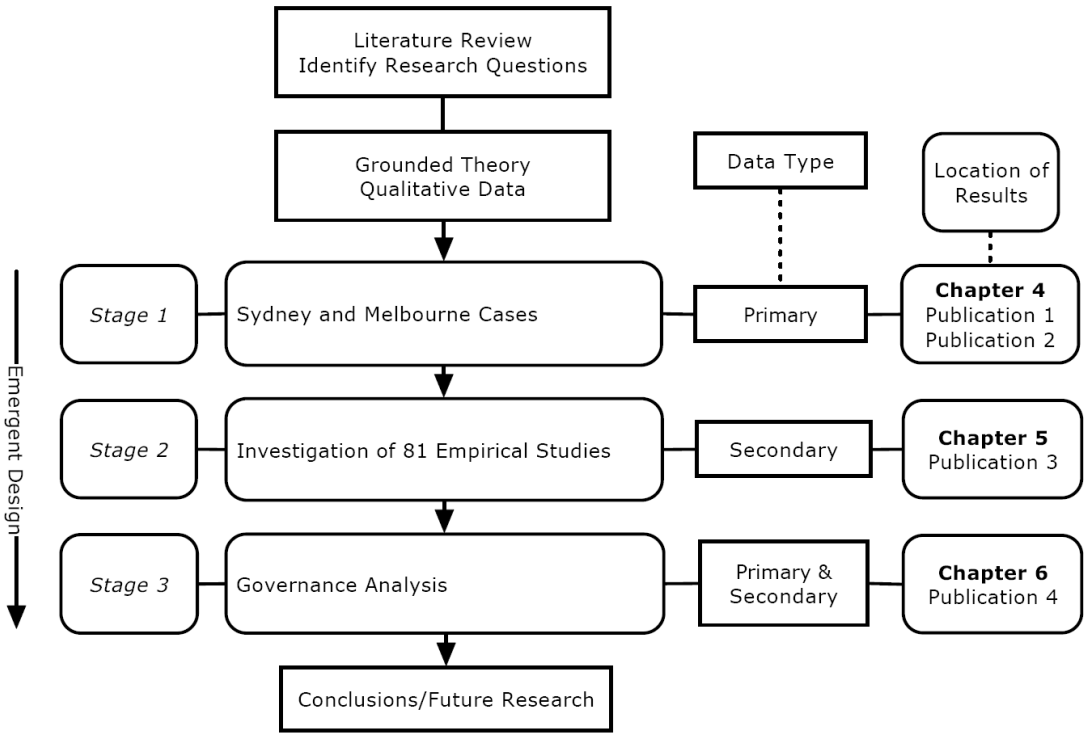

Figure 3.1 Overview of Research Design

Grounded theory recommends minimal use of preconceived theoretical ideas and concepts (Glaser and Strauss, 1967), although this has been interpreted in different ways (see Schwandt, 1993; Blaikie, 2007). A literature review can influence a researcher's theoretical perspective; in this study a scoping literature review was conducted prior to entering the field, to establish knowledge gaps and develop research questions (Figure 3.1). To maintain consistency with the grounded theory approach, the researcher followed Creswell's (2007) advice and set aside theoretical ideas as much as possible, letting them 'lay fallow' until a significant portion of the data collection and analysis had been conducted for each stage of the research (Charmaz, 2006).

The first step in developing the capacity assessment framework was to identify the required capacity attributes for SUWM. In grounded theory, qualitative or quantitative data can be used; however, due to the link between grounded theory and sociology, qualitative data are generally used (Glaser and Strauss, 1967). Qualitative data provide rich descriptions and explanations and a detailed understanding of the phenomenon studied (Creswell, 1994; Miles and Huberman, 1994; Patton, 2002), which are appropriate considerations for theory development (Blaikie, 2000) and also for institutional and policy research (Dovers, 2003). A variety of data collection methods can be used within the grounded theory research approach, including case studies, experiments and surveys (Glaser, 1978). The case study technique was selected for data collection during Stage 1 of

the research because of the close relationship between the phenomenon investigated (institutional capacity) and the physical, historical and social context (Blaikie, 2000).

The investigation into SUWM institutional capacity attributes revealed substantial differences between the traditional and contemporary capacity characteristics and those proposed for SUWM. This observation prompted the researcher to question whether the institutional attributes identified from Stage 1 were an anomaly or were reflected in existing empirical research. Therefore, the next stage of the research focused on examining peer reviewed empirical studies to validate and or contradict practitioner perspectives, using the strategy of data triangulation (Neuman, 2003).

The objective of Stage 2 was to identify the ideal SUWM regime attributes from empirical studies and subsequently determine whether they reflected those identified in Stage 1. The investigation of empirical studies combined the approaches of Leach and Pelkey (2001), who apply clearly defined criteria to select studies to review, and Robins (2007) who examined literature beyond her primary focus area. The outcome of reviewing the empirical studies confirmed the results of Stage 1, that there were substantial differences between the traditional and sustainable urban water management regimes. By using data from primary and secondary sources, data triangulation (Neuman, 2003) was used, which gave the researcher greater confidence in the results and which also motivated the researcher to consider the broader implications of the data from both stages in the third stage of the research.

Data from Stages 1 and 2 emphasised the processes to be employed in a SUWM regime. Investigation of the theoretical literature highlighted the potential application of governance studies to reveal more detailed insights into regime change. Compared to an institutional approach, governance theory, with its focus on processes, is more appropriate for examining change (Kjær, 2004). Thus, Stage 3 incorporated two new research objectives: to compare expert and scholarly perspectives on SUWM in relation to sustainable urban water governance, and to identify key governance characteristics of a SUWM regime.

Stage 3 involved analysing the SUWM regime attributes generated from the case studies using an integrated regime and governance analytical framework. The analytical framework was developed by integrating van der Brugge's (2009) regime framework and the three ideal governance modes (refer Table 2.6, Section 2.7.2). The three ideal modes of governance provide a relatively simple but complete analytical tool for understanding governance (Colebatch and Larmour, 1993; Meuleman, 2008), while applying the three governance modes to the regime framework focuses our attention on the regime scale, identified as important for enabling sustainable socio-technical system transitions (Rotmans *et al.*, 2001). The outcomes of the governance analysis were compared with scholarly perspectives of a SUWM regime from Stage 2, and other scholarly perspectives available in the SUWM literature (e.g. Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009).

During Stage 3 of the research, the overarching research aim was redefined to reflect the emerging research focus on sustainable urban water governance. The subsequent research aim for this thesis is: *to develop a guiding framework for sustainable urban water governance.* It was anticipated that developing the guiding governance framework would contribute to addressing the lack of conceptual frameworks which link SUWM principles with practice (Mitchell, 2006) and also extend the knowledge of SUWM regime operation (also refer Section 1.2). The grounded theory approach was maintained in Stage 3 because the focus of the thesis on developing a framework continued. Table 3.1 summarises the research stages and objectives addressed, together with location of the results.

Table 3.1 Summary of Research Objectives and Methods

Research Design Stage	**Data Source**	**Research Objectives Addressed**	**Location of Results**
Stage 1 – Sydney and Melbourne Cases	Primary interview data from Sydney and Melbourne cases	1) To characterise expert sustainability practitioner perspectives on sustainable urban water management capacities.	*Chapter 4* Publication 1 - "Exploring sustainable urban water governance: a case study of institutional capacity" (van de Meene *et al.*, 2009) Publication 2 - "Capacity Attributes of Future Urban Water Management Regimes: Projections from Australian Sustainability Practitioners" (van de Meene *et al.*, in press)#
Stage 2 – Investigation of Empirical Studies	Secondary 81 empirical peer reviewed studies	2) To map scholars' perspectives and findings on sustainable urban water management capacities.	*Chapter 5* Publication 3 - "Delving into the Institutional 'Black Box': Revealing Attributes of Future Sustainable Urban Water Management Regimes" (van de Meene and Brown, 2009)
Stage 3 –Governance Analysis	Comparison of primary and secondary data	3) To compare expert and scholarly perspectives on sustainable urban water management in relation to sustainable urban water governance. 4) To identify key governance characteristics of a sustainable urban water management regime.	*Chapter 6* Publication 4 - "Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective" (van de Meene *et al.*, submitted).

An opportunity to publish the Sydney case results arose prior to the completion of the Melbourne data analysis which explains why there is a publication with only the Sydney results (Publication 1) and one with both Sydney and Melbourne results (Publication 2).

3.3 DATA COLLECTION

3.3.1 Case Selection

The first stage in developing the institutional capacity assessment framework was to identify the ideal capacity attributes required for a SUWM regime. It was intended that the ideal attributes would form the foundation of the institutional capacity assessment framework against which the existing urban water management regime could be compared, revealing capacity deficits and strengths. Semi-structured interviews with leading urban water sustainability practitioners were the primary data collection tool used to identify the attributes (refer Sections 3.3.2 and 3.3.3).

Due to the close relationship between institutional capacity and context (Sections 3.2 and 2.5), the researcher decided to target expert urban water sustainability practitioners located in specific urban areas. Selection of the case locations was informed by the grounded theory approach, which uses theoretical sampling to maximise the development of new concepts and their dimensions, uncover variations and identify relationships between concepts (Strauss and Corbin, 1998; Corbin and Strauss, 2008).

In theoretical sampling, the researcher identifies a potential group of interviewees likely to inform the theory development and then continues to sample to further construct and extend the categories identified within the data. Case selection and data collection design for this study was influenced by Dey's (1999) observation that theoretical sampling procedures do not provide a strong basis for generalising the theory developed to other populations. Therefore, the data collection strategy of targeting expert urban water sustainability practitioners in large urban areas aimed to utilise both theoretical sampling and also develop an institutional capacity assessment framework that would be valid in other large, urban areas in more developed countries. Large urban areas were selected as the scale of focus because existing urban water management infrastructure is often designed and managed at this scale (Cech, 2005), and future practice will need to integrate SUWM strategies and technologies with existing infrastructure (Marsalek *et al.*, 2001).

Metropolitan Sydney (Figure 3.2) was selected as it faces similar challenges enabling SUWM to other large urban areas. Sydney faces population growth (ABS, 2008a), environmental impacts from traditional urban water management practices (Bickford *et al.*, 1999; Gehrke *et al.*, 1999; Taylor *et al.*, 2004; Courtenay *et al.*, 2005), and uncertainty regarding climate change implications (Chiew and McMahon, 2002; Hennessy *et al.*, 2007). Moderate population forecasts predict Sydney's population will increase from 4.3 million (2007) to 7.0 million in 2056 (ABS, 2008a). Additionally, the urban water governance arrangements in Sydney have followed international trends, evolving from hierarchical and centralised management structures to reflect a market approach (Bakker, 2002; Raadschelders, 2005b; Jane and Dollery, 2006). In metropolitan Sydney, water supply and sewerage services were provided by government organisations, with one large organisation for the Sydney metropolitan area - the Board of Water Supply and Sewerage from

1888 to 1924, which was replaced by the Metropolitan Water, Sewerage and Drainage Board between 1924 and 1995 (Aird, 1961; Beasley, 1988; DoC, 2007).

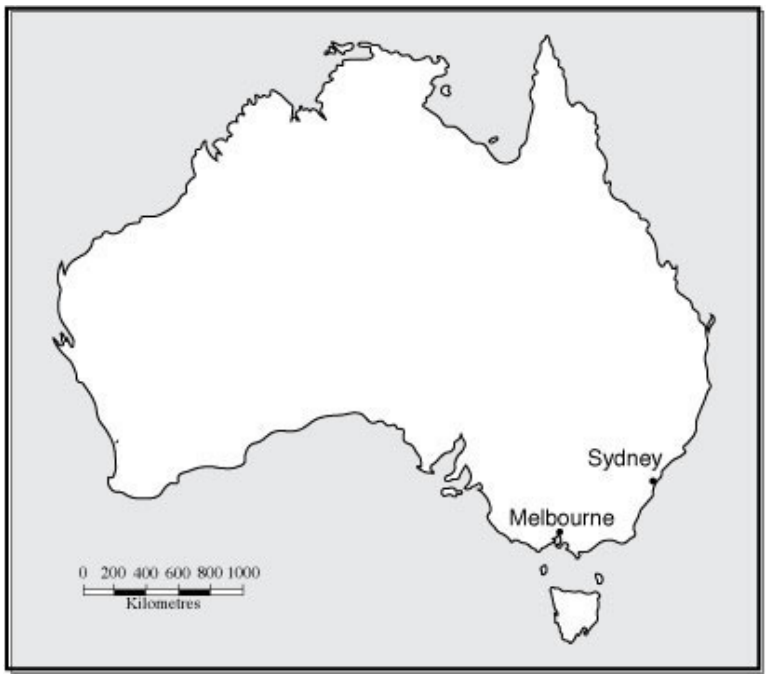

Figure 3.2 Location of Sydney and Melbourne
Source: School of Geography & Environmental Science

In line with the international shift towards market governance, water supply and sewerage services became the responsibility of the newly established Sydney Water Corporation, a wholly owned statutory corporation, in 1995 (Jane and Dollery, 2006). Sydney Water Corporation also manages trunk drains in 25% of Sydney while local government manages the remaining 75% (Sydney Water, 2008d). More recently, market governance structures have been strengthened through the enactment of the *Water Industry Competition Act 2006* (NSW), which enables private sector organisations to compete with Sydney Water Corporation to provide water supply and sewerage services to consumers (IPART, 2009). Further information about Sydney's urban water infrastructure and governance arrangements is available in Appendix A.

At the conclusion of the Sydney data collection and analysis, the researcher considered that the categories identified from the data were not fully developed in their properties and dimensions, or not fully 'saturated' (Glaser and Strauss, 1967; Strauss and Corbin, 1990; 1998; Corbin and Strauss, 2008). Therefore, in line with the theoretical sampling approach, a second case location was selected. The researcher decided that conducting interviews in an additional location, rather than interviewing more practitioners in Sydney, was preferable because many of the expert urban water sustainability practitioners and stakeholder groups in Sydney had already been contacted as part of this study. Metropolitan Melbourne (Figure 3.2) was selected as the second case location as the

city faces comparable challenges to Sydney regarding implementation of SUWM: population growth (ABS, 2008a), environmental impacts from traditional water management practices (Brizga *et al.*, 1996; Harris *et al.*, 1996; Walsh, 2000), historical development of the water infrastructure (Dingle and Rasmussen, 1991) and forecast impacts of climate change (Howe *et al.*, 2005). Melbourne also shares similarities with Sydney in following international governance trends.

Between 1891 and 1992, the Melbourne and Metropolitan Board of Works (MMBW), a government organisation, was responsible for water supply, sewerage, drainage services, waterway management and regional urban planning across the metropolitan area (Dingle and Rasmussen, 1991; Brown and Clarke, 2007). In the 1990s, following international market governance trends and the efficiency agenda, the MMBW was corporatised to become Melbourne Water Corporation and three retail water authorities were created as state owned corporations: Yarra Valley Water, City West Water and South East Water. Responsibility for the water supply distribution network and the sewerage collection network, trade waste, and household and industrial customer interaction was transferred to the retailers. Melbourne Water Corporation retained bulk water supply, sewerage and catchment management functions, and also trunk drainage responsibilities. Responsibility for the main drains and waterways serving catchments greater than 60 hectares lies with Melbourne Water Corporation and local government are responsible for street and property drainage systems serving catchments smaller than 60 hectares within their municipality boundaries (EPA *et al.*, 2002). During this restructuring the "non-core services", often environmental functions, were separated from the "core services" of water supply, sewerage and drainage and assigned to a different public agency; however the responsibility for parks, waterways and environmental operations was re-integrated into Melbourne Water Corporation's operations in 1997 (Brown and Clarke, 2007). Further information about the Melbourne urban water management regime is available in Appendix A.

While there are recent differences in the urban water management regimes of Sydney and Melbourne, the broad influence of governance trends in both cities are similar to other large national and international urban areas. Therefore, using data from both cities is considered to satisfy the balance between theoretical sampling and generalisation (Dey, 1999). At the conclusion of the Melbourne data analysis (Section 3.4.2), sufficient data had been collected and categories were saturated and therefore, the researcher decided that more interviews in other locations were not required.

During the case selection process, it was anticipated that collecting and analysing data relating to SUWM regime capacity was likely to be complex and an organising framework was sought to facilitate the data collection and analysis. The institutional capacity regime framework of Brown *et al.* (2006a) (refer Figure 2.4, Section 2.5.2) comprising human resources, intra-organisational, inter-organisational and the administrative and regulatory framework spheres was selected for this task as it focuses on regime actors, thereby providing a more accessible means for discussing the

SUWM regime with interviewees and more likely to facilitate collection of high quality data from the interviewees through effective communication and understanding of the concepts discussed.

3.3.2 Interviewee Selection

While academics have identified potential SUWM regime characteristics (e.g Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009) and can provide an objective perspective, they may be less likely to have close and detailed knowledge of current thinking and the challenges facing implementation of SUWM. In comparison, practitioners are likely to have detailed knowledge of urban water management system operation, and current constraints and opportunities. Therefore, practitioners provide a unique perspective and tacit knowledge useful for strategic urban water studies (Lienert *et al.*, 2006). Sustainability practitioners were targeted as they are likely to have encountered the socio-institutional barriers that face SUWM implementation (refer Section 2.4.1). It was assumed that through their experience the sustainability practitioners would understand the current urban water regime and therefore provide relevant insight into the capacity characteristics of the regime needed to implement SUWM.

Expert urban water sustainability practitioners were purposively selected for interviews using the snowball referral method (Neuman, 2003)[2]. Introductory letters were sent to senior organisation representatives (e.g. Chief Executive Officer, Managing Director, Director-General etc.) requesting their organisation's participation in the research. The organisation representatives were then requested to nominate senior staff with relevant experience in urban water management and who are able to think strategically. Additionally, interviewees were selected through identification in industry and academic (e.g. conference proceedings) publications and informal processes seeking individuals to be identified by at least two independent sources.

Following receipt of an organisation's consent and interviewee nominations, the researcher contacted the nominees to discuss the project, their participation and organise an interview time. Table 3.2 and Table 3.3 provide a summary of the organisations and the distribution of interview participants across the stakeholder groups for Sydney and Melbourne. The breadth and diversity of stakeholders interviewed reflects proposed SUWM principles (Table 1.2), which advocate the integration of infrastructure and biophysical components of urban water systems and related sectors, such as urban planning and development (Mitchell, 2006; Mostert, 2006). Fifty-nine interviews were conducted in Sydney and 68 in Melbourne. Some scholars (e.g. Patton, 2002) consider that there is no ideal or set sample size that can be routinely applied to qualitative studies. However, Auerbach and Silverstein (2003) recommend that approximately 60 interviews be undertaken for a grounded theory study, which closely corresponds to the number of interviews conducted in each

[2] The procedures used to approach interviewees, keep their identity confidential and the content of the interviews anonymous were approved by Monash University's Standing Committee on Ethics in Research Involving Humans (SCERH) (approval number 2006/1038LIR).

of Sydney and Melbourne. Furthermore, a larger number of interviewees suits an exploratory investigation of an emerging phenomenon (Patton, 2002), which is consistent with this study.

Table 3.2 Sydney Organisations Involved in Interviews

Stakeholder Group	**Organisation Name**	**Number of Interviewees**
Water Management Organisation	Sydney Catchment Authority Sydney Water Corporation	7
Private Water Management Organisation	Services Sydney*	1
State Government	Department of Environment & Climate Change Department of Health Department of Planning Department of Water & Energy Hawkesbury-Nepean Catchment Management Authority* Sydney Metropolitan Catchment Management Authority	11
Local Government	City of Sydney Council Hornsby Shire Council Kogarah City Council Ku-ring-gai Municipal Council Marrickville City Council	12
Consultant	Ecological Engineering (now EDAW) GHD Grassick SSG* Lincolne Scott	7
Developer	Delfin Lend Lease LandCom Mirvac Stockland	10
Professional Association	Australian Water Association Engineers Australia Planning Institute of Australia Urban Development Industry Association – New South Wales	4
Environmental Non-government Organisation	Total Environment Centre Nature Conservation Council Clean Up Australia*	3
Research Organisation	Institute for Sustainable Futures	1
Bridging Organisation	Hunter & Central Coast Regional Environmental Management Strategy Water Sensitive Urban Design in Sydney	3
Total		59

* Indicates interviewee identified through direct referral.

Table 3.3 Melbourne Organisations Involved in Interviews

Stakeholder Group	Organisation Name	Number of Interviewees
Water Management Organisation#	Melbourne Water South East Water Yarra Valley Water	12
State Government	Department of Human Services Department of Planning and Community Development Department of Sustainability and Environment Environmental Protection Authority Essential Services Commission Office of the Commissioner for Environmental Sustainability Port Phillip and Westernport Catchment Management Authority Sustainability Victoria	16
Local Government	Banyule City Council Cardinia Shire Council Knox City Council Manningham City Council Shire of Yarra Ranges	9
Consultant	Coomes Consulting Group GHD EDAW Parsons Brinckerhoff	8
Developer	LandCom LendLease Communities Mirvac Stockland VicUrban WestWyck	8
Professional Association	Australian Water Association Engineers Australia Municipal Association of Victoria Urban Development Industry Association – Victoria Water Services Association of Australia	3
Environmental Non-government Organisation	Australian Conservation Foundation Environment Victoria Victorian Women's Trust* Yarra River Keeper Association	5
Research Organisation	Institute of Sustainable Water Resources Monash Sustainability Institute Water Studies Centre	3
Bridging Organisation	Clearwater ICLEI (International Council of Local Environment Initiatives)	4
Total		68

Note: the third water retailer, City West Water, declined to participate in the research. In accordance with Monash University ethics procedures, no reason for declining the invitation is required.

* The Victorian Women's Trust was approached because they undertook a community development and research project, aimed at improving the 'water literacy' of community groups, called *Our Water Mark* (VWT, 2007).

3.3.3 Conducting Interviews

The objective of the interviews was to identify the ideal capacity attributes of a SUWM regime. Semi-structured interviews were conducted as they provide flexibility in responding to issues raised during the interview (Bryman, 2004). An interview schedule (Bryman, 2004), including questions, was prepared prior to fieldwork and identical schedules were used for both Sydney and Melbourne; only the city name was changed (refer Appendix B).

Interviewees were asked to describe the SUWM capacity characteristics of the four spheres of the Brown *et al.* (2006a) regime framework (Figure 2.4, Section 2.5.2) and the biophysical and infrastructure systems. The interview questions were initially developed to determine the capacity attributes 40 – 50 years into the future. Three pilot interviews were conducted and feedback suggested interviewees would likely find projecting 40 – 50 years into the future difficult because of the large timeframe and potential magnitude of changes which could occur. Interview questions were then modified to focus on a shorter time period, 10 – 15 years. The researcher acknowledges that the 10 – 15 year timeframe is unlikely to see SUWM realised across the urban water sector as socio-technical system transitions can take decades (Rotmans *et al.*, 2001). However, it was considered that the 10 – 15 year timeframe would provide valuable insights into the likely capacity characteristics of a more SUWM regime.

The majority of Sydney interviews were conducted in person between August and September 2007, with six phone interviews conducted during October 2007. Phone interviews were conducted because the interviewees were unavailable during the main data collection period and only available after the researcher had returned to Melbourne. No differences between the face-to-face or telephone interviews were identified. The Melbourne interviews were conducted between late January and March 2008, with the final interview conducted in July 2008 due to the limited availability of this particular interviewee.

Interviews were conducted in private meeting rooms in the participants' workplace or over the phone if a face-to-face interview was not possible and ranged from 45 minutes to 1.5 hours, but typically lasted approximately one hour. Interviews were generally audio recorded enabling the researcher to focus on what was being said (Bryman, 2004) or if not recorded, due to interviewee preference, detailed notes were taken. After the interviews, the audio recordings were transcribed; if not recorded, the handwritten notes were typed as soon as possible. To allow for more open responses, all interviewees were assured their opinions would remain anonymous, therefore encouraging the interviewees to discuss pertinent issues currently faced and how they should be improved. Summary notes and short memos were also documented as soon as practicable after interviews to capture the researcher's initial ideas and reflections.

3.3.4 Empirical Studies Selection

The investigation of empirical peer reviewed studies was the second stage of the research. The purpose of Stage 2 was to identify capacity attributes of a SUWM regime from peer reviewed publications and subsequently compare these attributes with the characteristics generated from Stage 1. Publications were selected according to the following five criteria.

- First, only peer reviewed publications were selected to improve the reliability of the results reported.
- Second, publications were included if they reported on qualitative or quantitative empirical data collected using in-depth case studies, surveys and/or interviews.
- Third, only papers published during and after the year 2000 were included to ensure the attributes were relevant to contemporary urban water management practice. Studies published until July 2008 were included.
- Fourth, only research based in developed countries was included to remove the influence of potentially confounding issues of significantly different institutions and traditions of governance in less developed countries which could unduly influence the results (Leach and Pelkey, 2001).
- The fifth criterion was to select publications that specifically recommended measures that should be taken to improve the regime. This criterion was established to exclude publications that would not provide insight into desired SUWM regime attributes.

Preliminary review of the urban water literature revealed there were only eleven publications that met these criteria. Therefore the scope of the literature search was broadened to include water resource management, urban studies and natural resource management practice areas. A similar strategy of examining literature in related fields outside the area of focus has been employed by Robins (2007), who considers this strategy provides opportunities for insights not available in the core study area. Natural resource management (NRM) was included in the investigation as both NRM and SUWM have been identified as complex problems, meaning the administrative and systemic barriers faced require integrated, multidisciplinary solutions (Freeman, 2000; Holling, 2001). Urban planning and management studies were also included as urban planning shares similar systemic problems to SUWM and NRM, being described by Rittel and Webber (1973) as a 'wicked problem'. Additionally, urban areas and their governance are likely to be a future focus for sustainability efforts (Haughton and Hunter, 1994; Bulkeley and Betsill, 2005). To find publications in these practice areas, a literature search was conducted using the key words of 'water', 'natural resource management' and 'urban' to detect potentially useful publications. Relevant databases available through the Current Contents and Proquest search engines were examined.

Over 2 400 publications were returned from the literature search. The selection criteria were systematically and rigorously applied to publications to improve the reliability of the results (Patton, 2002). After applying the first four criteria 139 publications were returned. Application of the final criterion further reduced the number of publications to 81.

3.4 DATA ANALYSIS

3.4.1 Data Analysis Approach

The data analysis of all three research stages was guided by the grounded theory procedures. Coding of the data is the primary analytic tool used in grounded theory development (Kitchin and Tate, 2000). Although there are different interpretations of the grounded theory approach (Charmaz, 2006; Corbin and Strauss, 2008), the general understanding is that grounded theory development involves moving from "generating codes that stay close to the data to more selective and abstract ways of conceptualizing the phenomenon of interest" (Bryman, 2004: 402).

Three stages of coding were employed in this study: open, axial and selective coding (Strauss and Corbin, 1998; Corbin and Strauss, 2008). Open coding is "the analytic process through which concepts are identified and their properties and dimensions are discovered in data" (Strauss and Corbin, 1998: 101); axial coding is "the process of relating categories to their subcategories, termed "axial" because coding occurs around the axis of a category, linking categories at the level of properties and dimensions" (Strauss and Corbin, 1998: 123); and selective coding is "the process of integrating and refining theory" (Strauss and Corbin, 1998: 124). Throughout the coding process, the emerging categories and relationships between them were constantly compared with the data to ensure there was a close relationship between them (Strauss and Corbin, 1998; Auerbach and Silverstein, 2003). Open and axial coding were used in Stages 1 and 2, while axial and selective coding were prominent in Stage 3.

Documenting coding decisions in memos is essential (Corbin and Strauss, 2008) to help crystallise ideas and not lose track of thinking on different topics (Bryman, 2004). Memos were written throughout the data collection and analysis process and were used to record the definitions and descriptions of codes, trace the evolution (merging or deletion) of codes, and development of different types of codes and theoretical insights.

3.4.2 Sydney and Melbourne Interview Data Analysis

As discussed in Section 3.3.1, Sydney interviews and data analysis were conducted prior to the Melbourne interviews and data analysis. In each city, data were collected and analysed concurrently, consistent with the grounded approach (Corbin and Strauss, 2008). The qualitative data management and analysis software package, *NVivo 8* (QSR International, 2008), was used to organise and code the data, providing opportunities to link documents and also undertake searches within the data. Open codes were generated for the individual, intra-organisation, inter-

organisation, and the administrative and regulatory elements of the institutional capacity assessment framework (Brown *et al.*, 2006a). The codes were developed by reading the interview transcripts or notes through and recording prominent ideas and reflections. Examples of open codes identified across the Sydney data were the different areas of knowledge urban water professionals would require, such as social science and economics. Codes were then reviewed and refined to ensure the definitions were clear.

Some new open codes were developed during the Melbourne data analysis and information about the biophysical, institutional and historical context of both cities was used to provide possible explanations for the differences observed between the cities. Compared to the Sydney data, open codes generated from the Melbourne data focused more on 'softer' institutional characteristics such as the water industry culture and respect between organisations, which may reflect the different institutional arrangements of the urban water industry in Melbourne (refer Section 3.3.1). The Melbourne data also revealed greater insight into different dimensions of the codes generated from the Sydney data, particularly relating to the interactive and collaborative nature of the future institutional arrangements and actor relationships. As only a limited number of new open codes were generated from the Melbourne data and most codes expanded or contributed to those generated from the Sydney data, it was considered that following the Melbourne data analysis the categories were saturated (Corbin and Strauss, 2008).

Axial codes were identified by considering the prominence of codes in the data and their relevance for SUWM implementation. After the open and axial coding had been completed for Melbourne, numerous similarities between the cities were detected and therefore, the interview data were combined into one dataset. Consolidating the datasets enabled broad trends to be identified and examined, and also simplified the data analysis in Stage 3 (Section 3.4.4). After combining the Sydney and Melbourne data, the sustainable and traditional urban water management regime attributes were compared.

3.4.3 Empirical Studies Data Analysis

Following the collection and preliminary review of publications (refer Section 3.3.4), a detailed review of the selected 81 empirical studies was undertaken to identify and code SUWM capacity attributes. In the first part of open coding, the original wording containing the attributes was transcribed from the publications into a spreadsheet. The attributes were identified as the desired outcome of a 'recommendation', 'need', 'key factor', 'important', 'must have', 'requires' or 'critical' in the discussion and/or conclusion of the publications. These sections were targeted because they typically contain the most widely applicable conclusions and recommendations from each study and are therefore likely to be applicable to SUWM. Each attribute was allocated to the relevant regime sphere defined by Brown *et al.* (2006a) (Figure 2.4, Section 2.5.2). While some attributes could be related to more than one regime sphere, the attributes were expressed differently

in the publications depending on the regime sphere of focus which facilitated the attribute coding. For example, regarding organisational interaction, an intra-organisational focused publication generally recommended an organisation engage with stakeholders, while an inter-organisational focused publication recommended that partner organisations need similar interests and objectives to ensure successful inter-organisational relationships.

Following allocation of the attributes to the management regime spheres, key words related to the main idea of each attribute were assigned based on the original wording of the recommendation. Multiple key words were assigned for complex or long attributes and then attributes were categorised and grouped according to the similarity of key words and conceptual relationships to determine the final list of open codes. These categories and relationships were progressively recorded in memos. Examples of key words used include "leadership" and "culture".

Axial codes were then generated by combining the open codes and examining the data for relationships. Axial codes comprise more abstract ideas and were determined based on their prominence within the data and relevance to SUWM.

3.4.4 Governance Analysis

The data analysis for Stage 3, the governance analysis, comprised two phases: 1) coding of the interview data from the Melbourne and Sydney cases (Stage 1), and 2) comparison of the interview outcomes against the ideal governance modes and scholarly perspectives. The open codes generated from practitioner interviews formed the basis of the first data analysis phase, which involved iteration between the data and the theoretical literature, typical of qualitative data analysis (Ryan and Bernard, 2000; Auerbach and Silverstein, 2003). Although the grounded theory approach minimises the use of existing theory, it is acknowledged that the literature can provide useful insight and stimulus for analysis (Corbin and Strauss, 2008). The regime framework of van der Brugge (2009), including definitions of regime elements, was used to organise and clarify the open codes (refer Section 2.5.2, Figure 2.5). Van der Brugge (2009) focuses on actor functions within the regime, however this research aimed to identify core features of a SUWM regime and therefore a less functionalist interpretation of the framework was used during data analysis. Strong themes for each regime element emerged and when saturated, were determined to be axial codes, or core features of the regime. The relationship between open and axial codes (core regime features) are presented in Appendix C.

The next stage of data analysis involved relating the projected attributes to the ideal modes of governance. The attributes of the integrated regime and governance analytical framework which relates hierarchical, market and network governance modes with the regime framework of van der Brugge (2009) (Table 2.6) formed the basis of the assessment. A full regime assessment revealed there was no precise match with any of the ideal modes of governance. Therefore, each core regime feature (axial code) was evaluated against the individual modes of governance and the

number of interviewees who supported each mode of governance was recorded. Finally, the results of the governance mode assessment were compared with scholarly SUWM regime projections from Stage 2 and those from SUWM literature (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). The comparison of the practitioner and scholarly perspectives, and use of van der Brugge's (2009) regime framework, enabled the guiding framework for sustainable urban water governance to be developed. The overarching mode of governance, a hybrid mode, forms the selective code of the proposed sustainable urban water governance framework.

3.5 RELIABILITY AND VALIDITY

Strategies for evaluating the quality of grounded theory studies focus on the use of assessment criteria. Creswell (2007) presents five criteria for evaluating grounded theory studies, which overlap with and provide a mid-point in the level of detail between the 13 criteria of Strauss and Corbin (1990) and the two of Auerbach and Silverstein (2003). In the context of qualitative research, Neuman (2003: 170) defines reliability as being "dependability or consistency" and validity as "giving a fair, honest and balanced account" (Neuman, 2003: 171). Table 3.4 relates Creswell's (2007) five criteria to reliability and validity and the thesis sections where the criteria have been addressed.

Table 3.4 Quality Criteria Applied in this Study

Test	Criterion	Explanation	Section Discussed
Reliability	Key element in the theory is a process, action or interaction	Key focus is SUWM regime operation, comprising actors undertaking processes which interact and modify structures	Section 3.4.4 Chapter 6
	Coding process works from the data to a larger theoretical model	Open, axial and selective coding processes were used in the three research stages	Section 3.4
	Theoretical model is presented in a figure or diagram	Model is presented in Figure 1, Publication 4	Chapter 6
	Story line or proposition connects categories in the model and that presents further questions to be answered	Story line connects axial codes, the actors, processes, structures and influences to the core category, the mode of governance. Further research is outlined in Chapter 7, Conclusion	Chapter 6
Validity	Researcher discloses his or her stance in the study	Researcher takes an observer stance (Ison and Watson, 2007)	Section 3.5

(Adapted from: Creswell, 2007: 217)

In accordance with Creswell's (2007) final criterion, the researcher needs to disclose their position in the study, which can vary depending on the emphasis the researcher places on reflection (Corbin and Strauss, 2008). Ison and Watson (2007) define three positions that researchers can take:

observer – wanting to learn and understand the factors at play; enabler – as an enabler in the policy process wanting to identify factors conducive to sustainable management; and insider – jointly reflecting on environmental management with participants who seek to gain a deeper understanding of the situation. In this study, I adopted the observer role, seeking to learn and understand SUWM regime characteristics and governance. Additionally, I have some professional experience in the urban water industry and in this way understood the industry context and tried to use this knowledge to generate a rapport with participants and probe the interview responses to reveal greater insights.

Additional measures, such as data management procedures based on Yin's (2003) case study approach, were employed to strengthen the reliability of the results through all three research stages. A case study database was developed, which is important to maintain control over the data and the data analysis process (Yin, 2003). The database comprised the *NVivo 8* computer program and spreadsheets to record different data sources and trace the origin of the raw data excerpts. Additionally, memos were included in the database and were used to record links between data and the open, axial and selective codes developed for each of the three research stages.

Triangulation is advocated as a means to improve the reliability of qualitative studies (Creswell, 2007) and case studies (Yin, 2003). In this study, data triangulation (Neuman, 2003) was employed through the use of primary data in Stage 1 and secondary data in Stage 2 to identify the SUWM regime attributes.

3.6 SUMMARY

This Chapter has described the research design, data collection and analysis methods used to develop a guiding framework for sustainable urban water governance. An emergent research design, with three stages, was used to explore SUWM institutional capacity attributes and to examine the potential implications of these attributes for the broader SUWM regime and governance processes. Stage 1 involved identifying likely capacity attributes of a SUWM regime using two cases, Sydney and Melbourne. The capacity attributes identified from Stage 1 were considerably different to the traditional urban water management regime capacities and prompted the researcher to investigate whether these capacities might be found in existing empirical research. Eighty-one empirical studies were reviewed during Stage 2 and the capacity attributes identified confirmed the results of Stage 1. The SUWM regime capacity attributes identified in Stages 1 and 2 focused on regime processes and actor interaction, which caused the researcher to consider the data from a governance perspective as governance focuses on processes and actor interactions more explicitly than an institutional perspective (Kjær, 2004). Stage 3 involved analysing practitioner perspectives using a governance lens and then comparing the analysis results with scholarly perspectives to identify insights into governance approaches and solutions for supporting SUWM

practices. These practitioner insights and comparison of scholarly and practitioner perspectives enabled the guiding framework for sustainable urban water governance to be developed.

The results of the study are presented in the following three chapters in publication format:

- Chapter 4 comprises two publications and presents the results of the primary case studies in Sydney and Melbourne;
- Chapter 5 comprises one publication and presents the results of the empirical studies investigation; and
- Chapter 6 comprises one publication and presents the results of the governance analysis and development of the guiding framework for sustainable urban water governance.

Each chapter comprises a short introduction (linking passage) to explain the relevance of the publication(s) and how it contributes to achieving the research objectives. The publications follow each journal style regarding referencing format and language (e.g. American spelling).

Interview quotes are used where the Sydney and Melbourne cases are reported in Chapter 4 and Chapter 6 (Publications 1, 2 and 4) to provide a direct link between the analysis and the language used by interviewees. The quotes are only used where agreed to by participants via the interview consent form. Participants in the interviews and surveys were assured their identities would remain confidential. Reporting the interviewees' job position, organisation, gender or age is not essential to answering the research objectives; however, quotes are identified by stakeholder grouping to enable the different stakeholder perspectives to be distinguished.

CHAPTER 4 SUSTAINABLE URBAN WATER MANAGEMENT REGIME ATTRIBUTES: INSIGHTS FROM SYDNEY AND MELBOURNE

4.1 INTRODUCTION

Although there have been widespread calls by the scientific and general community for more sustainable urban water management (e.g. Mouritz, 1996; Niemczynowicz, 1999; Chocat *et al.*, 2001; Lundqvist *et al.*, 2001; Harremoës, 2002; Brown, 2005; Harding, 2006; Mitchell, 2006) (also refer Section 1.1), there has been limited detailed investigation into SUWM regime attributes or consideration of potential insights to be gained from practitioner perspectives. Existing scholarly perspectives are typically informed by theoretical and empirical insights and practitioner perspectives were targeted in this Chapter because they are typically informed through professional knowledge and operational experience. Therefore, this Chapter addresses the first research objective: to characterise expert sustainability practitioner perspectives on sustainable urban water management capacities.

Primary data from expert Australian urban water sustainability practitioners from two locations, Sydney and Melbourne, were collected and analysed. The results are presented in two publications: Publication 1 (Section 4.2) comprises the results of the Sydney case (van de Meene *et al.*, 2009) (published in *Water Science and Technology*) focusing on the similarities and differences across stakeholder groups, and Publication 2 (Section 4.3) integrates the Sydney and Melbourne cases (van de Meene *et al.*, in press) (in *Water Science and Technology*). Common attributes across the four regime spheres (Brown *et al.*, 2006a): individuals, intra-organisational, inter-organisational and the administrative and regulatory spheres, are identified and then compared with the traditional urban water management regime attributes. Together, the publications provide a description of the capacity attributes of a SUWM regime, as perceived by expert urban water sustainability practitioners, and discuss key themes and the specific challenges facing efforts to develop these attributes.

4.2 PUBLICATION 1 – EXPLORING SUSTAINABLE URBAN WATER GOVERNANCE: A CASE STUDY OF INSTITUTIONAL CAPACITY

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4.2.1 Abstract

The sustainable urban water management system is likely to be characterised by complex and flexible governance arrangements, increased inter-organisational interaction and wide stakeholder participation, which contrasts significantly with the traditional approach. Recently there has been significant financial investment in urban water reform, however the reforms have not been as successful as anticipated and numerous institutional barriers remain. Understanding and assessing institutional capacity is central to addressing institutional impediments. Institutional capacity comprises individual, intra- and inter-organisational and external rules and incentives capacities. This paper reports on the first case study of a social research project that aims to develop an institutional capacity assessment framework. Empirical data from semi-structured interviews with 59 water industry experts in Sydney, Australia, and a broad literature survey were used. The key capacity attributes identified could form the basis of an institutional capacity assessment tool and reveal common and differing attributes across stakeholder groups which provide insight into stakeholder relations. Synthesis of the results revealed that intra- and inter-organisational capacities were facing particular challenges and should be explicitly addressed in reform, policy and capacity development initiatives.

Key words Capacity assessment framework; institutional capacity attributes; Sydney, Australia; sustainable urban water management.

4.2.2 Introduction

Development of the traditional urban water management approach resulted in separate systems of water supply, sewerage and drainage, underpinned by the social value of protecting public health, whether it be provision of clean drinking water, conveyance of floodwaters or removal of wastes using water (Cech, 2005). Separation of the three streams was often reflected in the segregation of organisational roles and responsibilities where one organisation or part of an organisation was responsible for water supply, one for sewerage and one for drainage. Due to the separate nature of the physical systems, there was generally little encouragement or need for organisations to interact with each other or with other sectors such as infrastructure and planning (Vlachos & Braga, 2001).

Today, traditional urban water management is widely recognised as needing to change to enable sustainable urban water conditions. Transitioning to more sustainable urban water management (SUWM) requires a complex array of values and factors to be considered: environmental integrity, social equity, landscape aesthetics, economic efficiency, integration of different professions, organisations and water systems, community engagement, and physical uncertainty

(Niemczynowicz, 1999; Harremoës, 2002; Rauch et al., 2005). Both the physical and socio-institutional components need to be considered otherwise progress towards SUWM will be hampered (Wong, 2006).

In response to these challenges dedicated water reform has become an important policy priority. This has included considerable investment across tiers of government from the supra-national and national, state and local government levels. Examples of reforms include the European Water Framework Directive, the Australian National Water Initiative, and local water sensitive urban design policies. Recent water reforms are focussed on increasing efficiency and competition, and utilising market mechanisms (Saleth & Dinar, 2005).

However many commentators argue that despite wide-spread recognition of the need to change from the traditional water management approach, the transition is too slow and ad hoc. Harding (2006:234) states that progress towards sustainable urban water management has been "slight or nonexistent!". Furthermore Dovers (2005) suggested that sustainability reform has been initiated at the edges of institutions and policy rather than undertaking the more substantial change considered to be required.

In addition to these criticisms, many institutional barriers stand in the way of the transition to sustainable urban water management (Vlachos & Braga, 2001; Harremoës, 2002; Cech, 2005). Brown and Farrelly (2009) characterised barriers to SUWM as being predominantly administrative and systemic and note that few strategies have been proposed to overcome them. Building institutional capacity has been identified as a strategy across a number of disciplines for overcoming institutional impediments and achieving sustained institutional change (e.g. urban management, technology innovation and development, and natural and water resources management) (e.g. Grindle & Hilderbrand, 1995; Healey, 1998; de Loë & Lukovich, 2004). In urban water management, capacity building programs have been established focusing on developing professional skills and knowledge in new technology and policy areas. Examples include Clearwater (Melbourne, Australia) and SWITCH (Sustainable Water Management Improves Tomorrow's Cities' Health) in Europe.

This paper attempts to build on the current knowledge of institutional barriers and focuses on institutional capacity and how it can be improved and assessed. The paper reports on a case study which forms part of a social doctoral research project, aiming to develop an institutional capacity assessment framework for sustainable urban water management at the city scale. A broad survey of the literature and interviews with water industry experts across different stakeholder groups in Sydney, Australia, were combined to identify key capacity attributes for the external rules and incentives, inter- and intra-organisational and individual capacity spheres. The resulting schema of capacity attributes can be used as a preliminary institutional capacity assessment framework and to

provide insight into stakeholder relations, thereby informing the design and implementation of future reform initiatives.

Building Capacity to Advance Sustainable Urban Water Management

Institutional capacity refers to the ability of the whole institution, from individuals through to organisations and the legislative and policy instruments used, to undertake a task, in this case, sustainable urban water management. Institutional capacity has recently been recognised as underpinning the successful development, adoption, and implementation of sustainable urban water technologies (Wong, 2006). Once the objective is determined and associated 'characteristics of good capacity' identified, existing capacity can be assessed, and capacity building strategies developed and implemented to achieve the objective (Fisher et al., 1996).

However, the current challenge to the design of capacity building programs is that we do not reliably know what the 'characteristics of good capacity' should be to deliver sustainable urban water futures. While there has been research into various aspects such as the technical need for diverse water sources, and perhaps more complex governance arrangements, this has largely not moved from the position of rhetoric. Hence this subject is the focus of doctoral research currently being undertaken, aimed at identifying the ideal capacity attributes for sustainable urban water futures and developing an institutional capacity assessment framework which will inform the assessment of capacity deficits.

Institutional capacity assessment (ICA) is essential to form coherent strategies for investment in capacity development and water reform. The objective of ICA is to identify the underlying constraints so that relevant, demand driven and effective capacity building interventions can be designed and implemented (Grindle & Hilderbrand, 1995).

In order to undertake ICA, an assessment tool is needed. There are some suggested frameworks developed, however, there are no empirically informed, practical frameworks that could be used as an ICA tool that encompass the holistic nature of SUWM and take an institutional approach. Examples of frameworks include de Loë and Lukovich (2004) and Ivey et al. (2006). These frameworks identify different components of capacity from the literature and apply them to case studies in North America. They vary in the level of focus and provide some indications of linkages between capacity components. The most recent ICA framework developed for urban water management is that developed by Brown et al. (2006) which draws on public administration and urban management literature. The framework comprises four nested capacity spheres and links each sphere to capacity building interventions to advance SUWM (Figure 1).

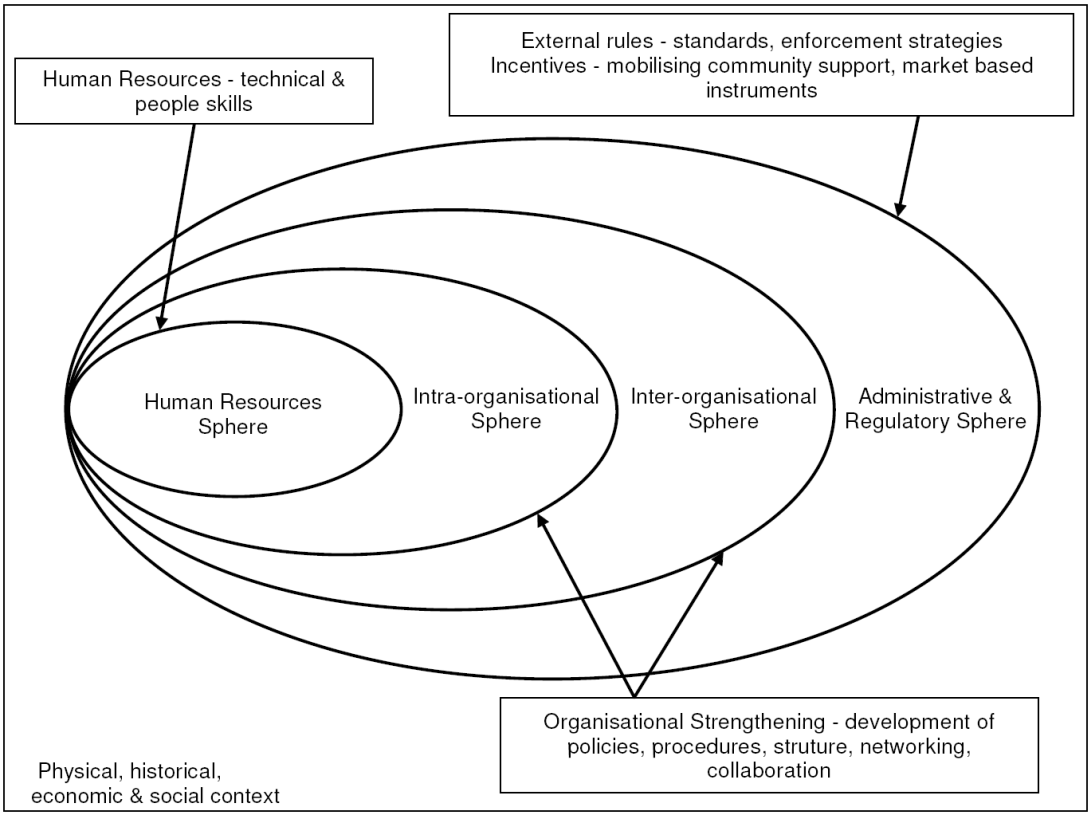

Figure 1. Institutional Capacity Assessment Framework and Capacity Building Initiatives for Sustainable Urban Water Management.

Source: Brown, *et al.*, 2006.

In developing the framework based on their experience and literature from other disciplines, the authors state "there has been limited research or available guidance on how to assess and determine the quality of institutional capacity" to advance SUWM (Brown et al., 2006:5.3). This paper acknowledges this call for research into ICA and contributes to this knowledge gap by exploring knowledge held by practitioners and presenting a tentative framework of key capacity attributes that could be used as the basis of an assessment tool.

4.2.3 Method

The future institutional capacity attributes of a more SUWM system were identified using Yin's (2003) case study approach and drawing on multiple data sources: i) semi-structured interviews with 59 urban water professionals from different stakeholder organisations in metropolitan Sydney; and, ii) a broad survey of empirical studies that identified attributes that contribute to institutional capacity as reported in van de Meene and Brown (2007). The interviews were used to explore the in-depth experiential knowledge held by urban water practitioners. Drawing on this knowledge was regarded as essential to inform the development of a practical institutional capacity assessment framework. The qualitative research technique (e.g. Miles & Huberman, 1994) was considered

appropriate as it enabled interview participants to talk in greater depth and identify significant attributes for each capacity sphere and also links between capacity attributes. The institutional capacity assessment framework described above (Figure 1) was used to structure data collection and analysis.

Metropolitan Sydney (Figure 2) was selected as a case study because it is the largest Australian city and faces similar challenges to other large developed urban areas. A moderate population forecast predicts that Sydney's will increase from the current population of 4.3 million to 5.6 million in 2051 (ABS, 2008). Environmental impacts from urban water management are observed within and outside of most cities, including Sydney, in rivers and catchments that are dammed for water supply, and in rivers, lakes and coastal areas where water pollution negatively impacts ecological health and aging and degraded infrastructure is a continuing problem (e.g. Niemczynowicz, 1999; Vlachos & Braga, 2001; Harremoës, 2002). Climate change forecasts indicate that the security of water supplies is likely to decrease and the design criteria for infrastructure are likely to be exceeded more frequently (Hennessy et al., 2007).

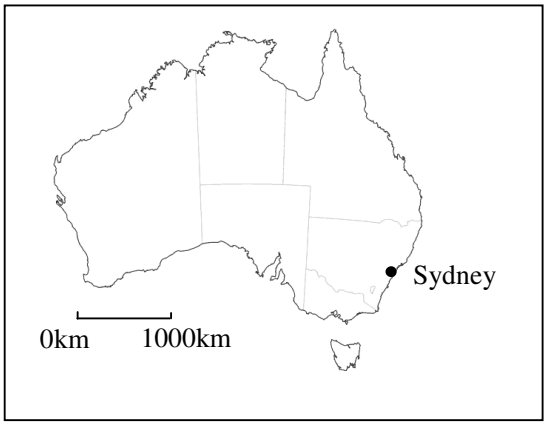

Figure 2. Location of Metropolitan Sydney, Australia

Source: Geoscience Australia.

A combined purposive and snowballing approach (Neuman, 2003), common in qualitative research, was used to identify and recruit interview participants. Key criteria for identifying participants were that they represent the leading practitioners in their areas of speciality, and that they were sustainability leaders within their organisations. To ensure this leaders from all organisations were asked to identify their sustainability champions. This process resulted in 59 interviewees being identified and agreeing to participate in the research project. Interview participants were selected from state government (20%), local government (20%), water management organisations (12%), research (2%) and non-government organisations (5%), land development (19%) and consulting organisations (12%), professional associations (7%) and government liaison (bridging) organisations (3%). To allow for more open responses, all interviewees were assured that their

opinions would remain anonymous, therefore improving the validity of the research. Interview questions and discussion focused on the four spheres of institutional capacity, individuals, organisations, inter-organisational relationships and the external rules and incentives.

Qualitative data analysis followed the methods outlined by Miles and Huberman (1994), using both literature-based and inductive themes (codes). The top five themes for each capacity sphere were identified by examining the frequency of discussion in the interview transcripts, consideration of the context and relationships with other attributes and results from the literature survey. They represent the ideal attributes of a SUWM system that received the highest level of saturation in the interviews and literature survey.

4.2.4 Results and Discussion

The top five capacity attributes of a more SUWM system are presented in Tables 1 and 2. They are organised according to the capacity spheres of the institutional capacity assessment framework of Brown et al. (2006) (Figure 1).

Table 1. Ideal Capacity Attributes and Stakeholder Observations (in italics) of SUWM for the External Rules and Incentives and Inter-organisational Capacity Spheres

Top 5 Capacity Attributes	
External Rules and Incentives Capacity	Inter-Organisational Capacity
1. A mix of regulatory and incentive based approaches are used *(Developers consistently supported regulation)*	1. Both formal and informal relationships, between different types of organisations are acknowledged and actively maintained *(NGOs preferred formal relationships with government. Consultants and developers employed informal influencing mechanisms)*
2. Roles and responsibilities are transparent and enable coordinated urban water management *(State and local government consider that state government has a role in strategic planning)*	2. Relationships are founded on the principle of collaboration *(Stakeholder perspectives were similar)*
3. Stakeholder and community engagement underpins decision-making *(Stakeholder perspectives were similar)*	3. Organisations are receptive to engage productively with other stakeholders *(Developers and WMOs thought state government should be more open. State government recognised that increased stakeholder engagement would be beneficial)*
4. Adequate and consistent technical and financial resources are available *(Resources concerned local government)*	4. Open and transparent communication between organisations is essential *(Stakeholder perspectives were similar)*
5. Policy is coordinated and consistent across administrative boundaries (Local government, consultants and developers identified this need)	5. Information sharing is a dedicated and regular activity *(Local government saw state government as an information provider. State government and consultants considered themselves information providers)*

Table 2. Ideal Capacity Attributes and Stakeholder Observations (in italics) of SUWM for the Intra-organisational and Individual Capacity Spheres

Top 5 Capacity Attributes	
Intra-Organisational Capacity	Individual Capacity Sphere
1. Culture is focused on sustainability, supportive of staff innovation and organisational learning *(Local government, consultants and developers thought this sustainability focus will increase)*	1. Technical knowledge, environmental communication and community engagement skills are essential *(All stakeholders identified these skills)*
2. Organisation has a clear strategic direction and plans for implementation *(WMOs, state government, consultants and developers identified this as important)*	2. Individuals are skilled at working with other professional disciplines *(State and local government and WMOs identified this as desirable)*
3. Organisation embraces an adaptive management approach and reports on action learning *(Local government and developers considered this would become more important)*	3. Both specialists and 'big picture thinkers' are valued within organisations *(State government thought there would be more specialists. Local government, consultants and developers thought people would also have a broader understanding)*
4. Human resources and organisational development are continually evaluated and improved *(WMOs, state government and consultants recognised the likely skills shortage)*	4. Staff are motivated to work towards the organisation's objectives *(State government and developers considered this important)*
5. Organisation has leadership dedicated to inspiring and supporting staff *(Stakeholder perspectives were similar)*	5. Individuals identify sustainability values as critical to their work *(Developers and consultants considered this positive)*

Stakeholder Observations

There were some similarities and differences observed across stakeholder groups. The four capacity attributes common across stakeholder groups were information sharing between organisations, collaborative inter-organisational relationships (both inter-organisational attributes), the need for community participation and engagement (external rules and incentives attribute) and the need for effective organisational leadership (intra-organisational attribute). Collaborative relationships require positive interactions among stakeholders and are they are founded on communication, including the ability to express oneself and listen (Healey, 1998). Information sharing is essential to address knowledge gaps and promote individual, organisational and institutional learning (de Loë & Kreutzwiser, 2005; Pahl-Wostl, 2008). The consistent support across stakeholder groups for these attributes suggests that the urban water sector is likely to support initiatives aimed at improving performance in each of these areas.

Indeed, these four attributes identified as being important across all stakeholder groups in the Sydney case study align with forecast characteristics and principles of a future sustainable urban

water management system identified by scholars such as Pahl-Wostl (2008). In the future, a cross-sectoral approach to address challenges is needed (Pahl-Wostl, 2008) which requires inter-organisational collaboration and communication. Community and stakeholder participation and engagement is considered to be a foundation of sustainable urban water management systems (Brown, 2008; Pahl-Wostl, 2008) which was also identified by the water industry experts interviewed. These capacity attributes contribute to transparency of the external rules and incentives and inter-organisational relationships, an integral characteristic of a sustainable urban water future (Brown, 2008).

Differences between stakeholder groups were also observed, which can be illustrated by an example of local and state government, developer and consultant perspectives. At the external rules and incentives level, developers and consultants considered that local government policies should be consistent across administrative boundaries. Conversely, local government participants emphasised the importance of a policy framework that enabled local governments to adapt their policies to suit local conditions. At the inter-organisational capacity sphere, local government respondents were not consistent regarding the need for organisations to be open minded and willing to engage. However, developers thought that consent authorities, which in Sydney are typically local government, and state government organisations, could provide support for new ideas and early input on a project. But local government participants often felt that their organisations were constrained by resources and a lack of technical capacity to review innovative solutions to challenging urban water management issues. There is clearly a divergence in the understanding of organisational and operational limitations between these stakeholders in the Sydney case study. These differing opinions highlight the need to consider integration among stakeholders when formulating policy initiatives and capacity building programs.

Institutional Capacity Building in Practice

The interview participants identified common attributes, which align with key scholars and indicate a common understanding of the changes required which could provide the basis of future capacity building initiatives. However they also emphasised some barriers that prevent these attributes being realised. A lack of trust between organisations, a lack of understanding and consideration of the organisational roles and responsibilities and empathy of the constraints, drivers and operational limitations of organisations, a lack of vision and understanding how their organisation fits into enabling SUWM were identified as barriers. These impediments are predominantly located in the intra- and inter-organisational capacity spheres, suggesting that these areas should be prioritised in capacity building initiatives. The following quotes represent typical views of interview participants.

> "I think some people in the community and other organisations are often quick to blame councils without fully understanding the significant constraints councils are operating under and without being willing to assist." (Local Government)

> "But they think we've got an ulterior motive a lot of the time when a lot of the stuff that we do in engaging with other agencies isn't even from a [organisational] perspective a lot of the time, it's just a general public policy perspective." (Water Management Organisation)

> "they need to understand what developers want too, that we want the continuity and we need the confidence that the designs and the community that we're building and designing can be sustainable. So they need to not just think as a water authority but need to think that they're community builders, too." (Developer)

> "…there needs to be, and I despair of this happening, but there needs to be a greater degree of vision." (Non-government Organisation)

Existing capacity building initiatives provide urban water management professionals with training and development, that is, they focus on the individual capacity sphere. Reform efforts and initiatives generally focus on the external rules and incentives capacity spheres through increased regulation (Brown & Keath, 2008). While these capacity building and reform initiatives are aimed at improving urban water management they do not have intra- and inter-organisational capacity development as an explicit objective. Future urban water management systems are likely to have complex governance arrangements consisting of multiple organisations at different levels (Pahl-Wostl, 2008), which will further emphasise intra- and inter-organisational capacity. Focusing on one area of capacity without the others is unlikely to result in sustained and widespread change (Brown, 2008), additionally the relationships and linkages between capacity spheres need to be considered (de Loë & Lukovich, 2004). Links among capacity attributes and spheres are complex and often context dependent and this is being investigated as part of the ongoing doctoral research. The barriers identified in the interviews point to the need for intra- and inter-organisational capacity building as a priority and the need to address all capacity spheres to achieve long term change.

4.2.5 Conclusion

Building institutional capacity as a means to overcome the systemic barriers and lack of progress in water reforms requires capacity deficits to be identified and then used to inform future policy and reform initiatives and capacity building programs. However there is no empirically informed, holistic and practical institutional capacity assessment tool to advance SUWM. This paper has reported the top five attributes for each of the external rules and incentives, inter- and intra-organisational and individual capacity spheres for SUWM. These attributes form the basis of a preliminary institutional capacity assessment tool.

The research revealed, in the metropolitan Sydney context, that the intra- and inter-organisational capacity spheres require significant attention in order to build inter-organisational trust and understanding of drivers, constraints and operational limitations between organisations. These findings, while being explicitly relevant for the Australian context may also be relevant for other large, metropolitan areas in developed countries. The stakeholder groups agree that communication, collaborative inter-organisational relationships, community participation and engagement and information sharing are important for sustainable urban water management, however the lack of trust and understanding between organisations appears to be hampering the development of these shared capacity attributes. It is therefore recommended that existing capacity building and reform efforts focus more explicitly on building intra- and inter-organisational capacity.

4.2.6 Acknowledgements

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4.3 PUBLICATION 2 - CAPACITY ATTRIBUTES OF FUTURE URBAN WATER MANAGEMENT REGIMES: PROJECTIONS FROM AUSTRALIAN SUSTAINABILITY PRACTITIONERS

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4.3.1 Abstract

Transitioning to more sustainable urban water management is widely accepted as an essential societal objective. While there has been significant progress in developing technical solutions to the challenges faced, numerous barriers remain at the regime level, indicating that further investigation into the regime is required. This paper reports on a social research project aimed at identifying capacity attributes of a more sustainable urban water management regime. Attributes were identified for the administrative and regulatory framework, inter- and intra-organisational and individual regime spheres. Over 125 urban water practitioners specialising in sustainability in Sydney and Melbourne were interviewed to identify the attributes of a more sustainable regime. The attributes reveal that a sustainable urban water management regime emphasises learning, diverse policy tools and institutional arrangements, together with interaction among stakeholders and professional disciplines. The interaction is characterised by respect, trust and mutual understanding. The sustainable regime attributes are compared to the traditional regime and reveal that while progress has been made towards a sustainable regime, additional improvement is required. Attributes identified across multiple regime spheres indicate potential focus areas for capacity building programs or reform efforts to more effectively enable regime change towards sustainable urban water management.

Key words Institutional capacity attributes; institutional capacity assessment; regime; sustainable urban water management.

4.3.2 Introduction

The well documented challenges facing urban water management include increased population growth, uncertainty regarding climate change implications and the environmental impacts from our traditional urban water management systems. It is widely acknowledged that addressing these issues and transitioning towards more sustainable urban water management is an essential socio-political objective (e.g. Harremoës, 2002; Harding, 2006). Significant progress has been made in developing technical solutions to advance urban water practice across Australia and internationally (Mitchell, 2006; Wong, 2006; Chocat et al., 2007). Solutions include new technologies such as biofiltration systems, concepts such as water sensitive urban design and increased use of alternative water sources. Additionally there has been significant financial investment in urban water reform across tiers of government from the supra-national and national, state and local government levels, for example the European Water Framework Directive, the Australian National Water Initiative, the Québec Water Policy (Canada) and local government strategies and policies. However these reforms have not been as successful as anticipated (Harding, 2006) and numerous institutional barriers remain (Brown & Farrelly, 2009).

A whole system transition to sustainable urban water management (SUWM) requires co-evolutionary change between the technical and management regime components (Geels, 2002). The management regime comprises the individuals and organisations that innovate, develop, produce, market, distribute and use the technologies, together with the cultural meaning attached to these technologies (Geels, 2002). These elements are often highly self-stabilising and therefore present significant inertia to change (Holtz et al., 2008). Furthermore, the literature on socio-institutional barriers indicate that urban water regimes have typically not yet developed the required capacity characteristics to enable SUWM in every day practice. Proposed attributes of such a future regime (Mitchell, 2005; Mostert, 2006; Pahl-Wostl, 2008) suggest that it is likely to be complex, with multiple organisations sharing responsibility for water, leading to enhanced cross-sectoral interaction, a greater focus on learning, and a willingness to share information. The next step in this area of research needs to focus on identifying more specific capacity attributes of a SUWM regime to guide policy, planning and institutional capacity building. This paper aims to contribute to this knowledge gap through an empirical study of sustainability practitioners' perspectives on what they believe these capacity characteristics should be.

The regime framework of Brown et al. (2006) (Figure 1) is one of a number of frameworks available to investigate the regime (others include Geels, 2002; Holtz et al., 2008). This framework was selected to guide this study because it is actor focused and therefore lends itself more readily to analysing practitioner perspectives and experiential knowledge. As shown in Figure 1, it comprises nested spheres of individuals, intra-organisational, inter-organisational and administrative and regulatory elements. The individual sphere represents the knowledge, skills, and motivation of individuals; the intra-organisational sphere refers to organisational culture, management practices

and procedures; the inter-organisational sphere refers to relationships between organisations which include communication, information sharing and formal agreements. Finally, the administrative and regulatory sphere relates to the rules and incentives, from formal legal and policy instruments used through to more facilitative mechanisms (e.g. grants or tax concessions).

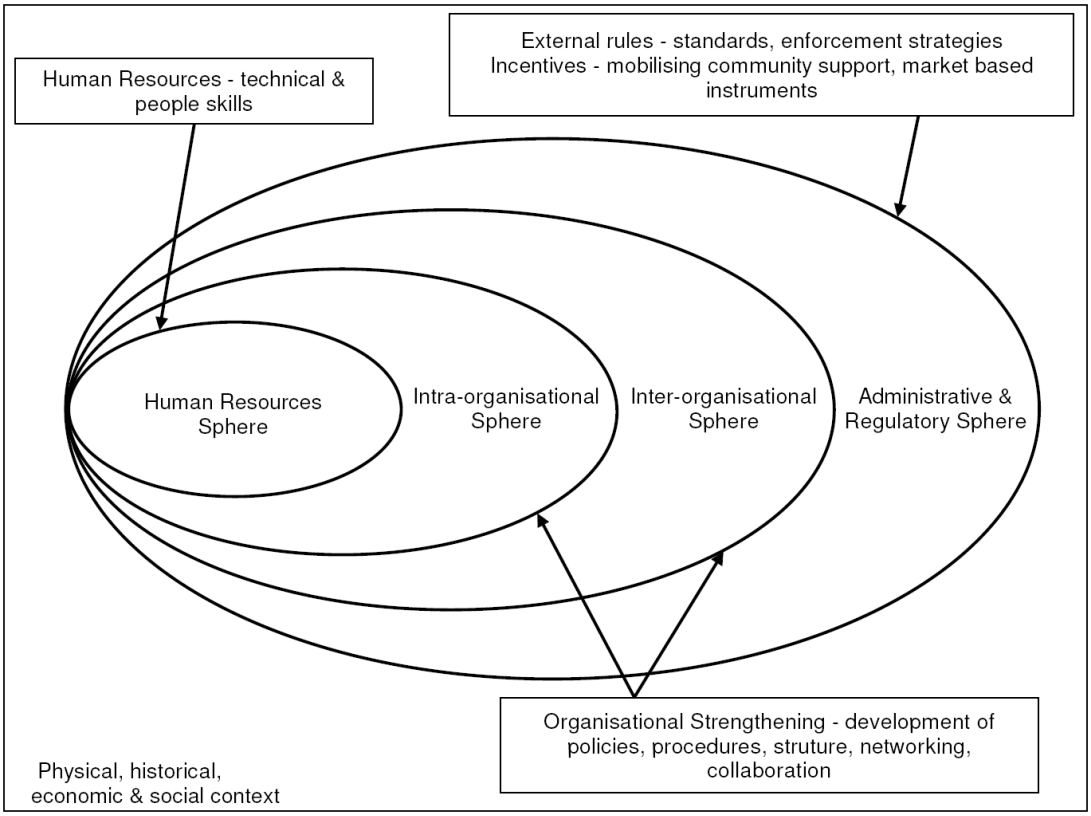

Figure 1. Regime framework and capacity building initiatives for sustainable urban water management

Source: Brown, et al., 2006: 5-2.

The traditional urban water management (TUWM) regime can be described as founded on the social values of public health protection, safeguarding against flood risk and supply vulnerability (Chocat et al., 2007), with an administrative and regulatory framework that is hierarchical and centralised. The TUWM regime is protected by strategies and solutions which have been long established (Niemczynowicz, 1999), comprising organisations that are typically focused on optimising single urban water management streams in isolation of one another (Raadschelders, 2005), with little community involvement or inter-organisational interaction (Niemczynowicz, 1999). At the individual level, engineers, as the system builders and managers, are the dominant profession and this technocratic culture frames how risk is understood and addressed with regards to the design, construction and management of infrastructure systems (Harremoës, 2002).

Table 1. Attributes of the traditional urban water regime.

Regime Sphere	**Attributes**
Administrative & Regulatory	- Hierarchical, centralised - Compliance focused - Application of technologically optimal solutions across locations - Minimal stakeholder involvement
Inter-organisational	- Minimal inter-organisational interaction
Intra-organisational	- Individual organisations focused on efficiency and optimisation of the specific urban water service - Separate sections focused on parts of urban water services - Stability valued
Individual	- Engineers are the main profession
(Niemczynowicz, 1999; Harremoës, 2002; Raadschelders, 2005)	

This paper aims to improve the knowledge and understanding of SUWM regime characteristics. It extends and reinterprets the results of a previous paper by the authors (van de Meene et al., 2009) which reported on a single case study. This study draws on the tacit knowledge of leading sustainability practitioners in the Australian urban water sector (across the metropolitan regions of Sydney and Melbourne) to assist our understanding of the attributes of sustainable urban water regimes and provide the focus needed for future reform and institutional capacity building efforts.

4.3.3 Methods

The qualitative case study method was employed because it is suitable for investigating phenomena, such as regime capacity attributes, which are closely related to the broader physical, social, economic and historical context (Yin, 2003). Metropolitan Sydney and Melbourne were selected as case locations because they are large Australian cities, facing global challenges that are comparable to other large developed urban areas, additionally the cases share similar urban water governance characteristics. These cities face poor waterway health due to traditional urban water management practices (e.g. Brizga et al., 1996; Courtenay et al., 2005), changed water supply and urban flooding regimes due to climate change (Hennessy et al., 2007) and aging infrastructure (Palaniappan et al., 2007), to identify just a few such challenges. Additionally, both cities are stressed by rapid population growth, with populations expected to increase by approximately 60% over the next 50 years (ABS, 2008). The urban water governance arrangements of the cities are similar, although not identical; the key difference is the organisational accountability for stormwater and waterway health. In Sydney, stormwater management is the responsibility of local government, while the catchment management authorities and state government provide some

advice and funding; the formal responsibility for waterway health is unclear. In Melbourne, there is a strong intergovernmental responsibility for stormwater and waterway health between local government and Melbourne Water (an agent of the state government).

Over 125 urban water professionals identified as 'sustainability leaders' from different stakeholder groups were subject to semi-structured interviews (59 from Sydney, 68 from Melbourne). The interviews focused on revealing detailed experiential knowledge about the current regime and what the practitioners perceived to be capacity attributes of a SUWM regime necessary to realise their technology and/or policy goals in practice. The semi-structured interviews enabled participants to talk in detail about each regime sphere and identify capacity variables that were integral across more than one sphere as shown in Figure 1, 10 – 15 years into the future. This timeframe was determined to be appropriate through pilot interviews. Context information, of the biophysical, institutional, historical, economic and social settings in relation to urban water management in these cities, was collected and analysed from publicly available sources.

Two criteria were established to select interviewees: 1) participants should represent leading practitioners in their area of urban water practice (such as wastewater treatment and regional water supply planning), and 2) participants are identified by their colleagues as sustainability leaders within their organisations. To ensure the appropriate people were targeted, a snowballing technique was used where leaders from a range of organisational types were asked to identify their sustainability champions, who were subsequently interviewed. Participants from across both cases represented the full spectrum of key stakeholder organisations including: state government (22%), local government (17%), water management organisations (15%), land development (15%) and consulting organisations (12%), professional associations (6%), non-government organisations (NGOs) (6%), liaison (bridging) organisations (5%) and research organisations (3%). To allow for more open responses, all interviewees were assured that their opinions would remain anonymous, therefore improving the insight and validity of the research.

Data analysis followed the general qualitative coding strategy which involves generating themes, from the raw data and moving to more abstract codes through theoretical analysis (Creswell, 2007). Following analysis of the cases separately, substantial similarities were identified and therefore the datasets were combined to identify overall trends and key themes. The results presented here represent the capacity attributes of a SUWM regime that received the highest level of saturation for each of the four regime spheres.

4.3.4 Results and Discussion

The overall results of the key capacity attributes of a SUWM regime are displayed in Tables 2 to 5, including quotes from interviewees which were typical responses. The capacity attributes represent the spectrum of regime foci from 'establishing vision' (Table 2), to more effective inter-

organisational communication (Table 3), through to individuals' personal qualities such as respect for other actors (Table 5).

The interviewees emphasised the co-relationship between the technical and management regimes and discussed the overall regime characteristics with this relationship in mind. The physical SUWM systems were foreseen to comprise infrastructure that integrates the three urban water streams, with the infrastructure managed holistically in a way that best fits the local biophysical, social, economic, political and institutional context (Mitchell, 2006). To deliver these SUWM systems and practices, interviewees underscored the need to foster the development of new knowledge and learning processes within the intra-organisational and individual spheres. Interviewees also highlighted the need to foster a culture of creativity to ensure each solution is suitable for its context and offers multiple benefits. Participants discussed developing and implementing complex, integrated SUWM systems which are likely to require multiple disciplines and organisations that do not historically have a collaborative relationship and have also not been understood as mutually dependent. Regime characteristics that were continually emphasised include stakeholder engagement, collaborative inter-organisational relationships, inter-disciplinary organisational operation and diverse knowledge at the individual sphere. In particular interviewees highlighted how professionals needed to understand the whole system to be able to design integrated solutions. For example, how to design wastewater treatment to meet water quality standards for particular reuse applications and other technical requirements of the water supply system.

The operation and interaction of these regime capacity attributes is complex. Brown et al.'s (2006) framework identifies the four regime spheres as nested, meaning individuals contribute to organisational capacity which contributes to inter-organisational capacity and so on. The reverse direction of influence also occurs, for example organisational policies are likely to discourage or prohibit individual employees advocating strategies contrary to the organisation's position. Identifying links between regime capacity attributes beyond the nested relationships of the regime framework is currently tentative, although some links can be intuitively identified. Drawing on this, and the nested regime sphere, it can be proposed that an individual with a systems view will understand the need for and be open to engaging with others across their organisation and also outside of their organisation to implement projects. This will clearly affect the interdisciplinary operation of the organisation and inter-organisational relationships. Additionally, they are more likely to understand the range of policy tools available and target their project to align with the most appropriate policy tool.

Table 2. Administrative and regulatory sphere capacity attributes for a sustainable urban water management regime.

Attribute	**Qualitative Example**
Establish a clear vision A vision provides the long term objective to which all stakeholders contribute, as well as the framework for long term strategic planning.	- "if we've got some clear long term vision …. and policy to back that up then that would be a really positive thing" (State government) - "I'd like to think that there was a common vision and outlook across all the different departments and organisations that are involved" (Water management organisation)
Develop diverse institutional arrangements that are coordinated and integrated Multiple stakeholders will have responsibility for different parts of urban water which will require coordination.	- "And joint responsibility and joint evaluation and joint funding and yeah, that extends to the private sector." (State government) - "I'd like to see a more integrated approach, I'd like to see a more transparent approach" (State government)
Employ a mix of policy tools Different stakeholders respond best to different tools including incentives, regulation and education.	- "It needs to be mandated so it flows down into the smaller developments" (State government) - "if you do have a sliding scale of developer contributions that are performance based, … that would provide incentives for the whole range of developers to implement their solutions." (Developer)
Community contributes to SUWM in a variety of ways Community members will play a range of roles in SUWM from co-design, co-management through to very limited roles. This choice and flexibility is important.	- "in the future what we'll start to see again is more community based water cycles and people taking a bit more control of their own destiny." (Consultant) - "Certainly there needs to be increased community engagement on integrated urban water management." (Local government) - "I think it's more about getting the participation rate as high as possible" (Developer)

Table 3. Inter-organisational sphere capacity attributes for a sustainable urban water management regime.

Attribute	**Qualitative Example**
Organisations collaborate and cooperate The complexity of SUWM solutions cannot be achieved without recognising the mutual dependence and contribution of multiple stakeholders.	- "There just needs to be far better coordination, cooperation, and respect." (Local government) - "one of the reasons I guess for being more collaborative comes from a recognition that you can't do it on your own." (Water management organisation) - "there are some complexities that come from having to cooperate and collaborate but it actually, I think, provides what is ultimately a good creative tension." (Water management organisation)
Organisations committed to effective and transparent communication Collaboration and cooperation requires commitment communication to share information, clarify expectations and develop shared objectives.	- "all these people have to be talking to each other and understanding each other." (Developer) - "communication is the key to 90% of these problems" (Local government) - "the lines of communication would be two way" (NGO)
Partner organisations have adequate resources to engage Collaboration and cooperation involves depending on other organisations. Therefore their resources (cultural, financial, technical, human resources) for participating effectively are a joint responsibility.	- "you need people who are really committed, who have the right kind of skills and you know, that's got to be reciprocal, there's got to be the right kind of skills at the other end, too." (State government) - "ideal clients for us are the ones that have a good idea of what's achievable with a project from a technical point of view." (Consultant)
Organisational relationships require mutual trust, shared objectives and understanding These characteristics form the foundation for effective collaboration and cooperation.	- "it's really about having a common understanding and actually developing that." (State government) - "You've got to find the people that understand, understanding of each other's priorities is the other one." (NGO) - "it would be trusting, it would be respectful on both parts. I think it would be open and honest" (Water management organisation)

Table 4. Intra-organisational sphere capacity attributes for a sustainable urban water management regime.

Attribute	**Qualitative Example**
Organisational leadership works to instil a culture of reflexivity Organisational leadership has significant influence and needs to provide ongoing leadership for reflexive approaches.	- "there needs to be 100% commitment at the highest levels within organisations to support these principles of water sensitive urban design and other general approaches to water management." (Developer) - "the people need to be open to those ideas but then you really need leadership to drive it through" (Water management organisation)
Organisational departments effectively integrate with each other and external stakeholders With the importance of collaborative and cooperative relationships, organisations themselves need to effectively and positively interact with stakeholders.	- "a council needs to be responsive to its community needs. It needs to be accountable and transparent in its decision making." (Local government) - "the ability to be able to have really good stakeholder engagement is really the key" (Water management organisation)
Organisations value and support learning Achieving SUWM will require continuous learning and application of skills and knowledge to develop solutions.	- "it's critical for us and I think it's critical for pretty much any organisation to have extremely effective data capture and also learning and sharing programs" (Developer) - "obviously in the consulting field you're going to need to be able to be a learning organisation " (Consultant) - "there are always new things to learn" (State government)
Organisations support interdisciplinary operation To develop integrated solutions professions or departments of the organisation will need to work together.	- "So the most important thing is when you set up a structure you set up the inter-linkages to make sure that the various ivory towers talk to each other." (Water management organisation) - "I think within organisations it's got to be a greater inter-disciplinary working environment." (State government)

Table 5. Individual sphere capacity attributes for a sustainable urban water management regime.

Attribute	**Qualitative Example**
Diverse knowledge is valued and broadly held by individuals Professionals need broad knowledge to address the complexity of SUWM solutions.	- "the next wave of people that come through that industry and start to make their mark will be educators, communicators, marketers…" (Developer) - - "So if you want to be successful you're going to have to operate with diversity, so they will have to be, you know, you'll want an economist, someone who's got an economic degree and an engineering degree." (Water management organisation)
Individuals respect others' points of view SUWM solutions will require different stakeholders to be engaged and interact with respect for differences.	- "people have to be more willing to listen to what other people have got to say and take those things on board and try and build on what they're saying and work with that rather than resist that." (State government - "there's a real need for individuals who are genuinely and prepared … … to engage in it in a multi-disciplinary way." (State government)
Individuals have a systems perspective of the urban water management sector Urban water professionals need to have a systems view to understand how they, different organisations, professions and communities contribute to SUWM.	- "You need to have a good view across the scientific, technical, the triple bottom line approach to things. … … You need to know about how that works within systems as well, so how, say a water business fits into the scheme of things in terms of government and other agencies, regulatory agencies and things like that." (State government) - "we need people who understand and implement full systems thinking to water management." (Developer)
Improving society through SUWM is a key value and principle for urban water professionals An individual's values contribute to their motivation for finding solutions to urban water problems.	- "they'd be very passionate and excited and motivated and really keen to make a difference" (Water management organisation) - "You really do need somebody who's passionate enough to push it through the obstacles." (Developer) - "You need to be motivated….open minded and also to have a sort of pioneering attitude I think" (Local government)

Comparison of Sustainable, Traditional and Contemporary Regime Attributes

Overall the sustainable urban water management regime capacity attributes identified by interviewees (Tables 2 to 5) appear to be significantly different (across all capacity spheres) to the traditional regime (Table 1). In the administrative and regulatory sphere, the SUWM capacity attributes are realised through community involvement and diverse policy tools whereas central control and minimal stakeholder involvement characterise the traditional approach. Similarly, the minimal stakeholder involvement of the TUWM regime in the inter-organisational sphere contrasts substantially with the inter-organisational collaboration and cooperation emphasised for SUWM. Within the intra-organisational sphere organisational learning and reflexivity are SUWM capacity attributes, while the TUWM regimes privilege the use of stable and inert solutions. Finally, in a SUWM regime, the individual sphere includes a large number of disciplinary knowledge bases underpinned by a systems perspective of the technical and management regimes. This increased

complexity in the individual sphere directly contrasts to the mono-disciplinary dominance of engineers as the core TUWM profession.

While from today's perspective, the SUWM regime capacity attributes appear far more complex than those of the TWUM regime, there were four common characteristics that permeated all regime spheres. These were collaboration and inter-disciplinarity, leadership, innovation and a common strategic vision. Each characteristic was expressed slightly differently across the regime spheres. For example, leadership was discussed at the administrative and regulatory sphere in the context of political leadership while at the inter-organisational level interviewees expressed the need for actors to effect change through leadership and at the intra-organisational sphere leaders were important in influencing organisational culture change. Interestingly these characteristics are mainly 'soft' or informal attributes (Healey, 2006), such as innovation which is considered a cultural attribute at the intra-organisational sphere and a personal quality of thinking laterally at the individual sphere. A few attributes, such as agreements or memoranda of understanding between organisations, were highlighted as structural ('hard') attributes. The informal nature of most of these permeating characteristics poses significant challenges to realising these capacities because soft attributes are widely recognised as being substantially more difficult to develop than hard attributes (Healey, 2006). A structural attribute can be changed through enacting laws or re-structuring organisations, while informal attributes involve influencing values and social norms.

Despite these challenges, some evidence of regime change was observed during the research. The interviews and policy documents revealed that the current urban water management regimes of Sydney and Melbourne have moved somewhat beyond the TUWM regime. For example, partnerships between stakeholders, such as local government, the private sector and Sydney Water Corporation have been formed to support innovations such as sewer mining at Beverley Park in the Kogarah Council area (Sydney Water, 2008). Additionally, a number of different stakeholder organisations appear to be undergoing some changes that integrate some of the identified sustainability capacity attributes, as these interviewees reflected:

> "I've only been here, well almost three years and there's been an enormous change in people's views on different things which is, I mean water is probably the best example. They've gone from a water sensitive urban design is something we have to do to, yeah that's just part of the development process." (Developer)

> "if I can just reflect more on the last five or ten years as a starting point. When I started, this company was very much a traditional engineering firm that basically employed engineers or the occasional scientist. Now we're a company of professionals, architects, scientists, management consultants. So there's been a broadening of the way we think and the type of projects that we've been trying to get involved in and services that we offer. (Consultant)

Furthermore, recent policy documents for Sydney (2006 Metropolitan Water Plan (NSW Government, 2006)) and Melbourne (Central Region Sustainable Water Strategy (DSE, 2006)) provide policy rhetoric and support indicative of some of the SUWM regime capacity attributes. Generally they are starting to emphasise the need for water management planning, highlighting the importance of providing water for human and environmental uses and prioritising learning through investing in research into climate change impacts. Not withstanding this, a significant majority of the interviewees emphasised the inertia of the current regime and discussed their disappointment with the announcement of new and massive infrastructure investments seen as traditional solutions. This included the construction of a desalination plant to provide additional water supply for Melbourne in 2007 (DSE, 2007) and a desalination plant is also under construction for Sydney at Kurnell on the south east coast of the metropolitan area (NSW Government, 2009).

While the current regimes of Sydney and Melbourne appear to be changing, this at present seems limited to some shifts at the intra- and inter-organisational regime spheres. Key areas in the current regime identified by interviewees as different from the sustainable regime were often expressed in terms of frustrations at the relationship level between various stakeholders. Issues relating to a lack of common organisational drivers and operating constraints, and a lack of trust were considered as exacerbating this frustration and retarding progress towards SUWM. Clearly there is significant progress to be made before SUWM is fully enabled in the case locations.

4.3.5 Conclusion

The challenge of transitioning to SUWM is substantial and significant progress has been made in the scientific and technological fields. Socio-institutional barriers remain and there is little known about the regime capacity attributes that will proactively enable SUWM. This paper has contributed to this knowledge gap by identifying capacity attributes for a SUWM regime, generated through two Australian case studies involving 127 leading urban water practitioners.

The results reveal that the capacity attributes are likely to be significantly different from the TUWM regime, particularly with the shift to more collaborative inter-organisational relationships, inter-disciplinary operation and the systemic perspective of urban water professionals. While there has been some advancement in regime change in the individual cities towards enabling SUWM, further progress is required. The attributes of innovation, leadership, collaboration and a shared strategic vision were identified as common characteristics across the four regime spheres and provide a potential focus for concentrating capacity building programs or reform efforts. However these informal or ‘soft’ capacity qualities are generally considered difficult to develop and require further investigation into the strategies that most effectively support their development. Overall, the difference between the traditional and the sustainable urban water management regime attributes highlighted here suggests there may need to be a systemic shift in the way urban water is governed.

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In Melbourne: Australian Conservation Foundation, Banyule City Council, Cardinia Shire Council, Clearwater, Coomes Consulting Group, LendLease Communities, Department of Human Services, Department of Planning and Community Development, Department of Sustainability and Environment, EDAW, Environmental Protection Authority, Essential Services Commission, Environment Victoria, GHD, ICLEI, Institute of Sustainable Water Resources, Knox City Council, Manningham City Council, Melbourne Water, Mirvac, Monash Sustainability Institute, Municipal Association of Victoria, Office of the Commissioner for Environmental Sustainability, Parsons Brinckerhoff, Port Phillip and Westernport Catchment Management Authority, Shire of Yarra Ranges, South East Water, Sustainability Victoria, Urban Development Industry Association – Victoria, VicUrban, Water Services Association of Australia, Victorian Womens Trust, WestWyck, Yarra River Keeper Association, Yarra Valley Water, and the Water Studies Centre.

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4.4 SUMMARY

The interview results, presented in this Chapter (Publication 1 and Publication 2) revealed that practitioners consider the urban water management regime requires new capacity attributes across the four regime spheres (individual, intra-organisational, inter-organisational, administrative and regulatory framework) to enable SUWM. A key characteristic identified by practitioners was the need for integration and positive interaction among actors across the water sector and professions to develop SUWM solutions. Considered as a whole, these regime attributes identified in Publications 1 and 2 provide a benchmark for an ideal SUWM regime, which is an important part of capacity assessment and subsequent development of demand driven capacity building programs (Grindle and Hilderbrand, 1995; Fisher *et al.*, 1996).

The comparison of the traditional and sustainable regime capacity attributes (Publication 2) indicates that there are substantial differences between these regimes. To improve data reliability, it was decided to use secondary empirical publication data to undertake data triangulation (Neuman, 2003), an established strategy for improving the reliability of the study (Creswell, 2007). The results of the investigation of empirical studies and triangulation evaluation are presented in Chapter 5.

CHAPTER 5 SUSTAINABLE URBAN WATER MANAGEMENT REGIME ATTRIBUTES: INSIGHTS FROM EMPIRICAL STUDIES

5.1 INTRODUCTION

This Chapter addresses the second research objective: to map scholars' perspectives and findings on sustainable urban water management capacities. The scholars' perspectives were generated from peer reviewed empirical studies and were used to identify SUWM regime attributes across the four regime spheres proposed by Brown *et al.* (2006a). The framework of Brown *et al.* (2006a) was used to facilitate the empirical studies analysis and comparison with the primary practitioner data presented in Chapter 4.

The empirical studies investigation results are presented in Publication 3 (Section 5.2), published in the *Journal of the American Water Resources Association* (van de Meene and Brown, 2009). Like the practitioner perspectives of the SUWM regime attributes, the attributes derived from the empirical studies investigation can be used as a benchmark in the development of an institutional capacity assessment framework and subsequent development of capacity building programs (Grindle and Hilderbrand, 1995). Additionally, the SUWM regime attributes contribute to overcoming the lack of detailed knowledge about SUWM regimes identified by Blomquist *et al.* (2004) (Section 2.4.2).

5.2 PUBLICATION 3 – DELVING INTO THE "INSTITUTIONAL BLACK BOX": REVEALING THE ATTRIBUTES OF SUSTAINABLE URBAN WATER MANAGEMENT REGIMES

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Shortened title for page headings: Revealing the Attributes of Sustainable Urban Water Management Regimes

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5.2.1 Abstract

This paper is based on the proposition that the transition to sustainable urban water management has been hampered by the lack of insight into attributes of a sustainable urban water management

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regime. Significant progress has been made in developing technical solutions to advance urban water practice, however it is the co-evolution of the socio-institutional and technical systems that enable a system-wide transition. A systematic analysis of 81 empirical studies across a range of practice areas was undertaken to construct a schema of the sustainable urban water management regime attributes. Attributes were identified and analysed using a framework of nested management regime spheres: the administrative and regulatory system, inter-organisational, intra-organisational and human resources spheres. The sustainable urban water management regime is likely to involve significant stakeholder involvement, collaborative inter-organisational relationships, flexible and adaptive organisational cultures and motivated and engaging employees. Comparison of the constructed sustainable and traditional regime attributes reveals that to realise sustainable urban water management in practice a substantial shift in governance is required. This difference emphasises the critical need for explicitly supported strategies targeted at developing each management regime sphere to further enable change towards sustainable urban water management.

(Key terms: sustainability; water policy; urban areas; management regime; sustainable urban water management; literature review.)

5.2.2 Introduction

Improving the management of our urban water environments is now widely acknowledged as an important objective for a number of reasons. In 2008, urban inhabitants became more than fifty percent of the world's population for the first time (UNPF, 2007). As the population grows demand for water supply, sewerage and drainage services also increases. Environmental impacts from urban water management are observed within and outside of most cities, in catchments and rivers that are dammed for water supply, and in rivers, lakes and coastal areas where water pollution negatively impacts ecological health (Niemczynowicz, 1999). Climate change forecasts indicate that extreme events, such as droughts, high intensity rainfall and heat waves, are likely to increase and that globally freshwater systems will be adversely affected (IPCC, 2008). More developed countries also face the challenge of addressing the end of the infrastructure life-cycle and old, degraded infrastructure due to a lack of investment (Vlachos and Braga, 2001). Despite widespread recognition of this important challenge however, implementation of more sustainable urban water management technologies and practices appears to be slow (Harremoës, 2002; Harding, 2006).

Provision of urban water services is an example of a socio-technical system, a large scale system that meets human needs; other examples include transport, communication and the food production, supply and consumption chain. Socio-technical systems comprise the production and use of technology and the management regime - the associated individuals and organisations that come together to innovate, develop, produce, market distribute and use the technologies, together with the cultural meaning that is attached to these technologies (Geels, 2004). Socio-technical systems

are characterised by changes in both the technology and the management regime. In fact both components need to co-evolve and stimulate each other in order for sustained change to occur (Rip and Kemp, 1998; Unruh, 2002; Elzen and Wieczorek, 2005).

Since the 1960s the social values that underpin urban water management have changed (Viessman, 1988). Community expectations of the benefits and services provided by urban water systems have broadened and become more complex, driven by global environmentalism and the increasing demand for high quality social amenity in urban places (Pahl-Wostl, 2008). While there are numerous definitions of sustainable urban water management, often referred to in the literature as integrated urban water management or total water cycle management, there are some core concepts that provide the foundation for sustainable urban water management. These suggest that sustainable urban water management will consist of more integrated and flexible infrastructure at multiple scales, provide for both human and ecological needs, develop solutions that suit local conditions and consider long term objectives (e.g. Serageldin, 1995; Vlachos and Braga, 2001; Mitchell, 2006; Mostert, 2006). Therefore, sustainable urban water systems need to dynamically and simultaneously provide for supply security, public health, flood protection, waterway health, biodiversity, social amenity and recreation, water conservation and efficiency, carbon neutrality, and urban heat island amelioration (Chocat et al., 2007; Brown et al., 2009).

Similarly, over the last two to three decades, the water resources field has had numerous scientific advances and breakthroughs developing alternative options, approaches and processes to the traditional approach. Many of these technical advances offer the ingredients for designing opportunities to address future uncertainty and can be integrated within, superimposed upon and/or able to replace the existing urban water infrastructure (e.g. Chocat et al., 2001; Harremoës, 2002). Yet despite this substantial investment in developing technological and assessment alternatives, there is an increasing and overwhelming despondence within the scholarly community with the lack of change in traditional practice (e.g. Imperial, 1999; Chocat et al., 2001; Harremoës, 2002; Rauch et al., 2005; Harding, 2006).

Building on the technical developments, and in response to the scientific call and general community desire for more sustainable approaches, dedicated water reform has become an important policy priority, particularly across more developed countries. This has included considerable investment across tiers of government from the supra-national and national, state or provincial and local government levels. Examples include the Water Framework Directive in the European Union, the National Water Initiative in Australia and the Sustainable Water Infrastructure Initiative in the United States of America, the Québec Water Policy in Canada, and local water cycle management and water sensitive urban design or low impact urban design policies.

While water reform efforts are varied in their scope and level of implementation, Hussey and Dovers' (2006) comparative analysis of a number of reforms identify many common challenges

such as institutional and regulatory fragmentation in different political systems, balancing environmental needs for water with consumptive demands, difficulties in selecting the appropriate policy tool to meet varied objectives, and the variable capacity of new organisations to successfully achieve their responsibilities. Criticism has also been levelled at the narrow scope of many reform objectives that often focus on only part of the urban water cycle, with limited regard to achieving integration across the urban water service components or addressing the impact of urban development on receiving waters (Wong, 2006). Importantly, the overall pace of urban water reform implementation has been considered to be "too slow" (Harding, 2006: 234).

When considered analytically, this lack of progress in implementing sustainable urban water management (SUWM) reforms is perhaps not surprising given that the traditional urban water management regime is based on stationary design assumptions (Dawson, 2007; Milly et al., 2008). Additionally, the historical investments underpinning these large technical systems present the right conditions for entrapment (Walker, 2000) or lock-in (Unruh, 2000). These factors result in significant barriers to enabling alternative and more resilient trajectories. It can also be observed that the water resources community shares a number of blind spots that exacerbate the current challenge. These include lacking sufficient insight into the social dimension and its interface with the technological systems, with current research efforts often not going "beyond the observation that institutions are important" (Blomquist et al., 2004: 927). As Blomquist et al. (2004: 927) continue, the field is yet to rigorously examine the "'black box' of institutional processes and effects, to provide explanations of how institutions matter – how they prompt people to try to change management practices, how they ease or try to hinder those changes, how they shape the management alternatives water users and organisations consider and adopt, and how they affect the outcomes".

Hence, along with others (e.g. Dovers, 2005; Elzen and Wieczorek, 2005; Folke et al., 2005; Harding, 2006; Chocat et al., 2007; Allan et al., 2008; Pahl-Wostl et al., 2008), we come to the conclusion that there would need to be a substantial change in the management regime to enable more sustainable urban water management. However research into the attributes of a sustainable urban water management regime appears to be under-developed and it has not attracted the concerted attention of the water research community in terms of projecting what these attributes should be. This improved knowledge and understanding could be used by strategists, policy makers and capacity builders to diagnose deficits in the current management regime and formulate specific interventions to overcome these deficits (Dovers, 2001; Ivey et al., 2006a).

For these reasons, the purpose of this paper is to contribute to this identified knowledge gap and explore tentative attributes of a sustainable urban water management regime and compare them to the attributes of the traditional regime. Through this comparison, deficits or gaps between the conventional and sustainable regimes could be identified and then used to develop targeted capacity building efforts in these areas. Naturally, the sustainable regime attributes are tentative but

form part of a continual learning and evaluation cycle. The next section describes the analytical framework and applies it to the traditional urban water management regime, followed by the description of the research approach. The sustainable management regime attributes are presented and then compared with the traditional attributes and finally, implications for advancing sustainable urban water management are discussed.

5.2.3 Understanding the Urban Water Management Regime

A number of analytical frameworks potentially suitable for exploring and understanding management regime attributes are available (e.g. Ostrom et al., 1994; Scott, 2001; Geels, 2002; Brown et al., 2006; Holtz et al., 2008). The framework of Brown et al. (2006) was selected for analysis as it focuses on the institutional component of the socio-technical system, which the authors contend requires attention from the research community. Additionally, it was considered to have an appropriate level of detail to capture the significant outcomes of the literature review used to identify the sustainable urban water management regime attributes (refer to 'Research Approach').

The framework of Brown et al. (2006) is designed to improve our understanding of the components of the urban water management regime and identify possible strategies for developing specific characteristics of a more sustainable regime. Drawing from public administration and urban studies literature, the framework is presented as four nested spheres, defined as follows:

- Human resources - the technical and management knowledge, skills and expertise available within a region to promote SUWM, how individuals operate within the workplace and their personal characteristics (e.g. values, initiative, leadership);

- Intra-organisational - the key processes, systems, cultures and resources within organisations to promote SUWM, including organisational structure and engagement with external stakeholders;

- Inter-organisational - the agreements, relationships and consultative networks that exist between organisations to allow them to cooperatively promote SUWM, their structure and operation, and the characteristics of organisations important to form partnerships; and

- Administrative and regulatory – the overall approach or underlying principles (e.g. efficiency, resilience) and how this is conveyed in the tools and instruments, the regulations, policies and incentive schemes that provide guidance and structure to organisations and individuals working to implement SUWM in a given region.

Each sphere has been linked to suggested capacity building interventions to advance urban water practice (Figure 1). The nested nature of the regime spheres indicates the close links between each component: individuals are part of organisations which interact and form part of the broader urban water management practice (Brown, 2008a).

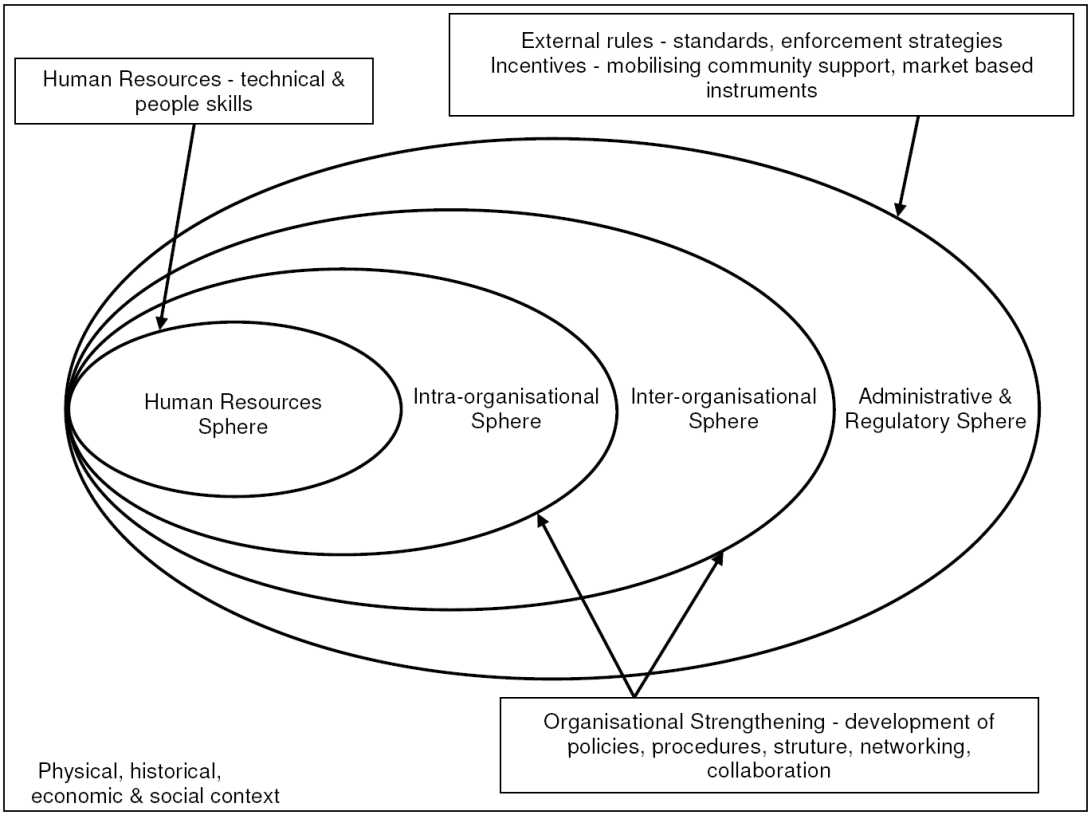

Figure 1. Management Regime Framework and Capacity Building Initiatives for Sustainable Urban Water Management

Source: Brown *et al.*, 2006.

5.2.4 Considering the Traditional Urban Water Management Regime

The influence of history on both infrastructure and management regime characteristics is well established (e.g. Walker, 2000; Weller, 2000). Therefore consideration of the historical basis of our urban water systems is important before considering potential future characteristics. Additionally, considering the traditional regime enables a sound comparison with the sustainable regime attributes.

The traditional urban water management regime can generally be characterised using the framework of Brown et al. (2006) (Figure 1) as follows. The administrative and regulatory framework had strong centralised and hierarchical control (Brown, 2005; Pahl-Wostl, 2007), often with separate organisations for each of the water supply, sewerage and drainage services (Raadschelders, 2005; Brown, 2008a). Core water management and government organisations undertook the decision-making with stakeholders rarely being involved (Pahl-Wostl, 2007). Urban water systems in new areas were sometimes developed by the private sector but then later became publicly owned and managed and have generally remained that way (Raadschelders, 2005). Efficient development of solutions was achieved through application of standard methods across

locations (Niemczynowicz, 1999). The natural environment was considered available for human use and the protection of public health has remained a dominant social value underpinning the system (Brown et al., 2009). Organisations were focused on efficiency, technical professions, well-accepted, traditional engineering solutions (Harremoës, 2002) and valued stability (Brown, 2008a). Typically little interaction between organisations within the water sector or between sectors occurred, given their focus on separate parts of the urban water cycle (Niemczynowicz, 1999). Organisations maintained their access to proprietary information which was supported by minimal organisational interaction (Pahl-Wostl, 2007). In the human resources sphere, engineers were the pre-eminent profession in traditional urban water management and their risk management approach influenced the strategies employed (Harremoës, 2002). Individuals viewed themselves working on particular parts of the system infrastructure and did not take an interest in their role in the broader urban water system (Niemczynowicz, 1999). These attributes are summarised in Table 1.

Table 1. Attributes of the Traditional Urban Water Management Regime

Regime Sphere	**Attributes**
Administrative & Regulatory	- Hierarchical, centralised - Compliance focused - Application of technologically optimal solutions across locations - Minimal stakeholder involvement
Inter-organisational	- Minimal inter-organisational interaction
Intra-organisational	- Individual organisations focused on optimisation of the specific urban water service - Separate sections within the organisation focused on parts of urban water services - Valued stability
Human Resources	- Engineers main profession involved in urban water management

The dominant social values underpinning the historical urban water management regime were public health protection and efficient service provision. The above management regime attributes served to meet these objectives effectively (Brown et al., 2009), with waterborne disease becoming rare in developed countries and demand for urban water services being met. However, with the onset of the environment movement in the 1960s and a shift towards ecosystem and adaptive approaches, these underlying social values have been challenged by the need to protect ecosystem health (Viessman, 1988). Subsequently, these traditional urban water management regime attributes are also being challenged. Defining regime attributes for a more sustainable regime poses a substantial challenge given the sometimes contested definition of sustainability (Harding, 2006) and also the uncertainty in anticipating or predicting future conditions. However, initial research in this area asserts that the likely sustainable regime attributes are significantly different to those of

the traditional management regime (Pahl-Wostl, 2008; Brown et al., 2009). This paper aims to expand on these conceptual forecasts.

5.2.5 Research Approach

Literature Review

This section describes the synthesis of secondary data collected using a literature review to identify the characteristics of SUWM based on the four spheres regime conceptualisation (Figure 1). The literature review adapts the methodology of Leach and Pelkey (2001) using clearly defined criteria to identify publications for review. Systematic and rigorous application of these criteria improves reliability of the results (Patton, 2002). Following selection of publications and identification of management regime attributes, the attributes were coded and analysed.

Selection of Publications. Publications were selected according to the following five criteria. First, only peer reviewed publications were selected to improve the scientific reliability of the results reported. While the authors acknowledge that the grey (non-peer reviewed) literature may contain valuable insights, this literature is difficult to systematically access. Furthermore the lack of scientific peer-review makes it difficult to verify the validity and reliability of the data and conclusions. Second, publications were included if they reported on qualitative or quantitative empirical data collected using in depth case studies, surveys and/or interviews. Third, only papers published during and after the year 2000 were included to ensure that the attributes were relevant to contemporary urban water management practice. Fourth, only research based in more developed countries was included as the research was funded by the Victorian State Government in Australia and as such is focused on implications for Australia and other more developed countries. Additionally confounding issues of significantly different institutions and traditions of governance in less developed countries could unduly influence the results (Leach and Pelkey, 2001). Less developed countries have different socio-political contexts and addressing this diversity is beyond the scope of this paper. The fifth and final criterion was to select publications that specifically recommended measures that should be taken to improve the management regime. This criterion was established to exclude publications that would not provide insight into sustainable management regime attributes.

Preliminary review of the urban water literature revealed that there were only eleven publications that met the criteria. Therefore other practice areas of water resources management, urban studies and natural resource management were selected for analysis. A similar approach of examining literature outside the area of focus has been employed by Robins (2007). Natural resource management (NRM) was included in the literature review as both NRM and SUWM have been identified as complex problems, meaning that the administrative and systemic barriers faced require integrated, multidisciplinary solutions (Freeman, 2000; Holling, 2001). Urban planning and management literature was also included as urban areas and their governance are likely to be a

focus for sustainability efforts (Haughton and Hunter, 1994; Bulkeley and Betsill, 2005). Using these practice areas, a literature search was conducted using the key words of 'water', 'natural resource management' and 'urban' (and variations of these) to identify potentially useful publications. Relevant databases available through the Current Contents and Proquest search engines were examined.

Over 2 400 publications were returned from the literature search. After applying the first four criteria (peer review, reporting qualitative or quantitative empirical data, published during and after the year 2000 and exclusion of less developed countries), 139 publications were returned. Application of the final criterion to identify recommendations reduced the selected number of publications to 81.

The selected publications were distributed across the practice areas as follows: 41% were from urban studies, 25% from water resources and 22% from NRM, and some covered two topic areas: 6% were found in both the water and urban related searches, 5% in the water and NRM searches and 1% in the urban and NRM searches. Origins of the studies were predominantly European (52%), followed by North American (38%) and Australian and New Zealand (11%). The 81 publications reviewed had 184 different authors. To understand the breadth of disciplines included in the review, the publicly available journal descriptions were analysed. Almost three quarters (73%) were from interdisciplinary journals, consisting of journals with more than one discipline, such as Ecology and Society, or journals publishing in broad disciplines such as geography, environmental studies and planning; the remaining journals were from social science (13%), physical science (11%), law and economics (2% each).

Coding of Selected Publications. Detailed review of the selected 81 publications was undertaken to identify and code management regime characteristics. The coding process generally followed that of Dey (1993). Attributes were identified as being the desired outcome of a 'recommendation', 'need', 'key factor', 'important', 'must have', 'requires' or 'critical' in the discussion and/or conclusion of the publications. Each factor was allocated to the relevant management regime sphere defined by Brown et al. (2006) (located above Figure 1). Although some elements could be related to more than one sphere, they were expressed differently in the publications depending on the regime sphere of focus. For example, regarding organisational interaction, an intra-organisational focused publication was more likely to recommend an organisation engage with stakeholders, while in an inter-organisational focused publication was likely to recommend that a partner organisation needs to have similar interests and objectives to ensure success. Management regime attributes identified from practice areas outside of urban water management were considered relevant for SUWM as each area is closely related as described above. Also, the regime characteristics were identified from the recommendations in each publication. These are typically the most widely applicable conclusions from each study and are therefore likely to be relevant for SUWM.

Following allocation of the characteristics to a management regime sphere, key words identifying the main idea were assigned to each element based on the original wording of the recommendation. Multiple key words were assigned for complex or long attributes and then attributes were categorised according to the similarity of key words and conceptual relationships. Examples of words used include "leadership" and "culture". Context specific information was not included in the key words so that the overall trends in the data could be identified. Table 2 shows the distribution of elements across each practice area resulting from systematic application of the publication selection criteria. The attributes were predominantly in the administrative and regulatory framework sphere (52%), followed by the inter-organisational (23%), intra-organisational (22%) and human resources (3%) spheres. This distribution was unexpected as anecdotal evidence suggests that the human resources attributes require attention and existing capacity building programs concentrate on this regime sphere. This indicates the distribution broadly reflects scholars' areas of interest and opportunities for research.

Table 2. Summary of Attributes and Literature Search Area

	Urban		**Urban + Water**		**Water**		**Water + NRM**		**NRM**		**NRM + Urban**	
	No.*	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Administrative & Regulatory	119	49	19	51	168	51	32	91	76	44	6	100
Inter-organisational	109	45	10	27	32	10	3	9	41	23	0	0
Intra-organisational	15	6	8	22	114	34	0	0	47	27	0	0
Human Resources	1	0.4	0	0	18	5	0	0	12	7	0	0
Total	244	100	37	100	332	100	35	100	176	100	6	100

* Number of attributes in this regime sphere and practice area.

5.2.6 Results

For each management regime sphere, the characteristics identified from the literature were combined into five core attributes to emphasise the main concepts. These core attributes are presented in Tables 3 to 6. These factors represent characteristics that scholars identified as critical attributes to enable more sustainable approaches across all of the publications analysed.

Administrative and Regulatory Framework Management Regime Attributes

The administrative and regulatory framework sphere had the largest number of elements, with publications from all practice areas containing attributes in this sphere. The characteristics focused on strategic planning and design, followed by tools and guiding principles (Table 3). This may reflect the ease of identifying strategies or instruments that may fix the problem at hand, rather than addressing underlying or systemic problems, a challenge Dovers (2005) identified as facing

sustainability scholars and practitioners. Overall, the administrative and regulatory characteristics were diverse, reflecting the complexity of this sphere which must provide guidance and structure to the other regime spheres.

Table 3. Sustainable Management Regime Attributes for the Administrative and Regulatory Sphere

Attribute	**No. Times Identified in Publications**
Strategic planning and design A long term and strategic view is taken when designing institutional arrangements, including stakeholder engagement, and drawing on past experience.	152
Tools and instruments Political, institutional, financial and technical support is available and accessed by appropriate organisations. A range of incentive and regulatory mechanisms are used.	99
Guiding principles Principles of integration, participation, transparency, innovation, flexibility, trust, resilience and collaboration inform design, management and implementation.	83
Management and implementation A range of coordination and implementation mechanisms are used that advance synergies between sectors and mutually beneficial solutions and leadership resources are utilised.	70
Underlying philosophies An adaptive and learning philosophy underpins all administrative and regulatory framework components.	16

The attribute grouping of strategic planning and design were the most frequently identified characteristics. Taking a strategic view entails consideration of the links between global and local conditions, the institutional context, government policies and coordination across agencies (Swaffield and Primdahl, 2006). Design of these components should also draw on past experiences and history (Genieys et al., 2004; Keune et al., 2004). Organisational roles and responsibilities need to be clearly identified (de Loë and Lukovich, 2004), ensuring that organisations have the authority to undertake their allocated responsibilities (Keivani et al., 2002) or control activities that are contrary to SUWM (Timmer et al., 2007). Consideration needs to be given to developing institutional arrangements that are polycentric, multi-layered and multi-scaled to best match the local conditions and which are often fundamentally different in structure to the conventional arrangements (Table 1) (Olsson and Folke, 2001; Lebel et al., 2006). Refer to McGinnis et al. (1999) and Huitema et al. (2009) for further information on polycentric institutional arrangements. Stakeholder engagement mechanisms and processes should also be established at this strategic level to ensure that these mechanisms are embedded in legislation where appropriate and it is implemented as intended. Successful and meaningful stakeholder involvement and participation requires effort and input from all actors, from the government though the establishment of clear mechanisms for participation (McGuirk, 2001); by the facilitating organisation to provide the

resources to improve knowledge, awareness and participation (Leibovitz, 2003); and also by stakeholders, to be interested in and engage with the topic, to learn about and understand the issues and demonstrate interest through participation (Leibovitz, 2003; Cumming et al., 2006; Timmer et al., 2007).

The next most frequently identified group of characteristics is that of policy tool and instrument selection. This group of attributes is considered in the administrative and regulatory regime sphere as it can influence the inter-organisational relationships and intra-organisational capacity. Policy tools and instruments include incentives, taxes, regulation and tradeable permits. A diverse but targeted range of tools is considered to be more effective in achieving the objective (Borgstrom et al., 2006). Provision of resources, including political support, financial and information resources, also occurs in this sphere. Political support refers to the importance of government and leaders having a clear vision and demonstrating initiative, and is often manifested in public support for strategic plans (de Loë and Lukovich, 2004). Additionally political support is critical as it affects the provision of financial and technical resources (de Loë and Lukovich, 2004; MacKendrick and Davidson, 2007). Clear arrangements to enable access to and security of financial resources are important considerations for organisations and should be evident in this sphere (Crabbe and Robin, 2006; Robins and Dovers, 2007; Ryan and Bidwell, 2007). Technical support could be in the form of administrative resources or long term research for improving the general knowledge base (Dovers, 2001; Ivey et al., 2006a; Ivey et al., 2006b; Robins and Dovers, 2007). As a resource, information should be relevant, consistent, credible and available at the appropriate scale (Crabbe and Robin, 2006).

The third most common attribute group, the guiding principles, inform planning and design, management and identification of tools to be used. These guiding principles link the underlying philosophical approaches with implementation efforts. Principles include trust, transparency, accountability, integration, collaboration and cooperation, flexibility, innovation and a focus on clear objectives. Transparency in institutional arrangements is important (Ivey et al., 2002; Ivey et al., 2004) to develop trust and accountability among stakeholders (Tippett et al., 2005). Integration across different sectors, particularly land use planning and water management, was emphasised due to the close relationship and interactions between these two sectors (Tol et al., 2003; Mumme, 2005; Borgstrom et al., 2006; Furey and Lutyens, 2008). Flexibility of institutional arrangements enables improved learning, effective use of information and allows the management regime to respond to altered conditions (Liverman and Merideth, 2002; Meijers and Romein, 2003; Borgstrom et al., 2006; Gunderson et al., 2006; Ivey et al., 2006b; Walter et al., 2007; Lurie and Hibbard, 2008).

The management and implementation group of SUWM attributes requires a range of mechanisms to be used, such as top-down and bottom-up approaches, and utilisation of solutions that have multiple benefits (Tippett et al., 2005; Downs, 2007). Leadership by politicians, organisations, community members and other stakeholders can positively influence implementation (de Loë and

Lukovich, 2004; Nunes Silva and Syrett, 2006; Timmer et al., 2007). Coordination of policy objectives and organisation's activities across administrative boundaries can help avoid wasting effort and resources (Wilhite, 2002; de Loë and Lukovich, 2004; Heikkila, 2004; Nunes Silva and Syrett, 2006). Mechanisms to address risk management (Belliveau et al., 2006) and potential conflicts also need to be employed (McGuirk, 2001; Tippett et al., 2005).

An adaptive and learning philosophy enables adjustment to changing external contexts, such as ecological changes (Rova and Carlsson, 2001). This approach also provides a framework to harness the benefits of experimentation and may help to overcome distrust among stakeholders (Habron, 2003). Learning is considered to be the foundation of innovation (Lehmann and Fryd, 2008) and underpins an adaptive philosophy which requires continual experimentation and evaluation (Pahl-Wostl et al., 2007). To ehance learning risks need to be taken, mistakes learnt and links outside of the system develpoed (Gunderson et al., 2006).

Inter-organisational Management Regime Attributes

The inter-organisational sphere was the second largest group of attributes identified from 29 publications, primarily from the urban (12 publications) and water (8 publications) practice areas followed by NRM (5 publications) and finally the "urban and water" and "NRM and water" practice areas each with two publications. This distribution may be the result of an emphasis on collaborative urban and NRM planning and management in recent years. Overall, the publications revealed a coherent range of attributes covering the founding relationships principles, structure and process, operation and member characteristics (Table 4).

Table 4. Sustainable Management Regime Attributes for the Inter-organisational Sphere

Attribute	**No. Times Identified in Publications**
Operation Organisations effectively coordinate activities and engage in regular and open communication, focusing on learning and flexibility, and drawing on experience.	58
Partnership, cooperation & collaboration These attributes are essential in achieving SUWM and should form the basis for all inter-organisational relationships with close links and networks.	54
Shared qualities Organisations have a shared vision, interests, sense of ownership and norms of cooperation and reciprocity.	39
Member characteristics Organisations enter the relationship with a cooperative attitude, willingness, commitment to the relationship and be willing to share power.	24
Relationship structure and processes Team composition, including leadership, agreements, responsibility, rules for interaction and opportunities for feedback are carefully considered.	20

During inter-organisational relationship operation, organisations need to engage in proactive management of the relationships, which involves focusing on coordinating organisational activities, information sharing, training and communication (Ivey et al., 2002; Ivey et al., 2004; Suarez-Balcazar et al., 2006; Pahl-Wostl et al., 2007). Continuity of communication is important to maintain organisational interest (Ray et al., 2007), and a range of communication methods used to ensure a variety of stakeholders can access information (Tippett et al., 2005). Experiential learning provides greater uptake and deployment of skills and knowledge (Williams, 2006) and organisations with experience of working together or on similar projects are more likely to develop successful inter-organisational relationships (Getimis and Grigoriadou, 2004; Suarez-Balcazar et al., 2006).

Partnership-based, cooperative and collaborative relationships were advocated as they can result in development of trust, institutional learning and enable objectives to be achieved (Getimis and Grigoriadou, 2004; Pahl-Wostl et al., 2007; Ryan and Bidwell, 2007). Partnerships between: university experts and local newspapers can facilitate information sharing among the local community (Crabbe and Robin, 2006); different research organisations can improve the scientific basis of policy (Meretsky et al., 2006); and community-based watershed management organisations and government agencies can improve access to technical assistance (Lurie and Hibbard, 2008). Linkages between organisations on different institutional levels (vertical links) and the same level (horizontal links) also promote information sharing, building of technical capacity and better integration of different SUWM components (de Loë and Lukovich, 2004; Brown and Head, 2005).

Shared qualities such as common goals, norms of cooperation and reciprocity are important when establishing a sound basis for cooperation and collaboration (Meijers and Romein, 2003; Suarez-Balcazar et al., 2006; Pahl-Wostl et al., 2007). These qualities may be present before the relationship is established. If not present, the partnership should work to establish these qualities through regular face-to-face meetings, negotiation strategies and cost sharing arrangements and possibly enable one organisation to lead (de Loë and Lukovich, 2004; Ivey et al., 2004; Suarez-Balcazar et al., 2006; Pahl-Wostl et al., 2007; Lehmann and Fryd, 2008).

The member characteristics that each organisation brings to the relationship influence both the qualities that the organisations share and also how the relationship is structured (Meijers and Romein, 2003). For example the organisation may have a strong commitment to the objective and be willing to share power with other organisations (Suarez-Balcazar et al., 2006). This may mean that a leadership position is permanently assigned to one organisation or it is regularly transferred from one organisation to another (Ivey et al., 2004). If there are numerous shared qualities, then operation is likely to be undertaken easily, whereas if there are few shared qualities, operation of the relationship may face numerous obstacles (Meijers and Romein, 2003).

The relationship structure affects the operation of the inter-organisational relationship by defining the processes used. Selection of team members (both organisational and individuals representing organisations) with openness to others' perspectives and willingness to cooperate and engage can ensure shared qualities are developed (Suarez-Balcazar et al., 2006). Each inter-organisational relationship should discuss and agree upon the rules for partnership operation, such as rules of interaction and formalised roles or sub-committees (Crabbe and Robin, 2006; Williams, 2006; Pahl-Wostl et al., 2007). This should maintain and further develop shared qualities.

Intra-organisational Attributes

The intra-organisational characteristics (Table 5) were the third largest group of attributes identified from 22 papers. They were drawn from the practice areas of: water (8 publications), NRM (7 publications) and urban (5 publications), and urban water (2 publications). Attributes were reasonably coherent, with the largest number of attributes grouped under the traditional organisational focus of resources. The second most frequent attribute group was the stakeholder and community engagement attributes, which relate to how organisations approach relationships with other organisations and community members. This grouping of attributes was retained in this regime sphere as these issues are under the control of the organisation. Remaining attributes were grouped into categories of structure, culture and operation.

Table 5. Sustainable Management Regime Attributes for the Intra-organisational Sphere

Attribute	**No. Times Identified in Publications**
Resources Human, information, technical and financial resources are available and/or accessible. Past experience is used to inform current plans and practice.	73
Community and stakeholders Organisation proactively develops education and communication strategies to build trust and community ownership of the problem.	46
Internal structure and administration Organisational structure is clear and transparent and feasible strategies, plans and procedures in place, including clear communication and decision-making processes.	31
Leadership and commitment Organisational leaders are effective and enable organisational commitment, and leadership if suitable, to the objective.	18
Culture Organisations are flexible, adaptive, innovative, creative, opportunistic and accountable.	16

Intra-organisational resources can be under the direct control of the organisation or accessible by the organisation. As there is likely to be uncertainty in sustainable urban water management (e.g. from the implications of climate change), consideration should be given to providing adequate,

stable and long-term financial resources (de Loë et al., 2002; Ivey et al., 2006b; Timmer et al., 2007; Lurie and Hibbard, 2008). Access to adequate human resources can be achieved either within the organisation or from consultants or other organisations (de Loë et al., 2002; de Loë and Lukovich, 2004; Ivey et al., 2006b). Human resources can be developed through, recruitment and career progression policies to retain staff (Meretsky et al., 2006; Timmer et al., 2007), which has been identified as a particular challenge facing the urban water sector (Grigg, 2006). The ability to address technical issues through access to scientific studies and data were identified as important factors. Additionally the organisation should also contribute to the broader scientific knowledge base through its operations (de Loë and Lukovich, 2004; Ivey et al., 2004; Ivey et al., 2006b; Meretsky et al., 2006; Lurie and Hibbard, 2008) and disseminate information to the community and stakeholders (Ivey et al., 2004; Crabbe and Robin, 2006; Macgillivray et al., 2007). Accessing and further developing these resources forms a solid foundation for the organisation to undertake required tasks. Variability in the size and jurisdiction of water authorities can affect their ability to access all types of resources (Ivey et al., 2002) and therefore this should be considered when evaluating organisational capacity, designing institutional arrangements and distributing resources.

The grouping of factors related to community and stakeholders is externally focused and aligned with the stakeholder engagement processes and mechanisms identified in the administrative and regulatory sphere (Table 3). In the intra-organisational sphere these attributes revolved around the priority and approach organisations use when interacting with their stakeholders and the community (e.g. de Loë et al., 2002; Ivey et al., 2002; Ivey et al., 2006b; Timmer et al., 2007). By prioritising stakeholder and community engagement, organisations can achieve greater community ownership of the local area and the problems it faces (Davenport et al., 2007; Lurie and Hibbard, 2008). The emergence of these attributes may also reflect the types of organisations studied in the publications, which were primarily local government or public authorities, typically readily focused on interactions with their constituents.

The remaining three core elements in the intra-organisational regime sphere, internal structure and administration, leadership and commitment, and culture (Table 5), consist of both structural and non-structural organisational attributes. Organisational structure and operation should connect the outcomes of organisational processes with it's the organisation's objectives (Meretsky et al., 2006). Organisational structure should facilitate integrated decision-making across the organisation (Habron, 2003). For example, in an organisation that supplies water and treats wastewater, these two sections should consider the remit of the other. Leadership of an organisation is closely related to organisational commitment (de Loë et al., 2002; Ivey et al., 2002). Without commitment of the organisation's leaders to the objective, enthusiasm and perseverance throughout the organisation is likely to falter. Leadership may need to be political, in that leaders may need to participate in committees and make their commitment public (Lawton Smith, 2003). Leadership is also influential in organisational culture. An ideal culture is one that is flexible, innovative, creative and

adaptive (Ivey et al., 2006b; Macgillivray et al., 2007). Effective leadership results in organisations developing new ideas and trialling them (Macgillivray et al., 2007).

Human Resources Management Regime Attributes

Overall, the human resources sphere had the smallest number of characteristics identified from the literature review (Table 6). Publications identifying attributes were located in the water (5 publications) and NRM (4 publications) practice areas with one publication in the urban practice area. The attributes identified in this sphere were largely coherent, with themes of knowledge and information, and personal qualities being prominent.

Table 6. Sustainable Management Regime Attributes for Human Resources Sphere

Attribute	**No. Times Identified in Publications**
Knowledge and Information Individuals have knowledge required to undertake tasks to achieve the objective and are able to understand relevant knowledge. Relevant qualifications are held where appropriate.	14
Internal Qualities These are the inherent qualities of an individual that structure or guide how they behave in their role and towards others.	6
Resilience Individuals are resilient with a history or experience of change, ability to plan, and an understanding of factors influencing change.	5
Interest in Organisation's Role Individuals have an interest in and possibly expanding the organisation's role.	4
Approaches to Engagement Individuals have an awareness of and be respectful of others when they engage and they should communicate consistently with this.	2

The most frequent human resources characteristic of knowledge and information reveals the importance of an employee's capacity to undertake their job (Table 6) (de Loë et al., 2002; Ivey et al., 2002; de Loë and Lukovich, 2004). Staff should be able to undertake the requisite tasks, including understanding and using information from consultants (de Loë and Lukovich, 2004; Timmer et al., 2007). Knowledge gained at one organisation can be transferable to other organisations however the first organisation loses this capacity when the employee leaves.

The internal qualities group of factors emphasises an individual's traits that they bring to their employment. Ideally staff are ethical, demonstrated by individuals making and implementing ethical decisions, being respectful of others, and aware of their own assumptions, biases and judgements (Tippett et al., 2005; Suchet-Pearson and Howitt, 2006). These traits are unlikely to be easily changed by traditional capacity building approaches such as attending a short training course.

An individual's resilience influences their response to change or disturbance which is affected by their ability to plan, learn and their experience with past change (Marshall and Marshall, 2007). The attributes of resilience and approaches to engagement can be developed through traditional training and experience. An individual's interest in the organisation's role can affect their motivation (Ivey et al., 2002). If interest is lacking, it could be positively influenced through internal communication emphasising the importance of the job role to the organisation's core objective and the broader societal objective of SUWM. Finally, individuals should actively engage with other professionals and stakeholders regularly during their work (Suchet-Pearson and Howitt, 2006).

5.2.7 Discussion

Implications for Advancing Sustainable Urban Water Management

Comparison between the traditional management regime attributes and those of a more sustainable regime identified through the literature review revealed some striking differences and some similarities.

In the administrative and regulatory sphere, the institutional arrangements of the traditional regime were hierarchical and centralised. This is significantly different to the sustainable regime institutional arrangements that are likely to be flexible, adaptive and transparent. The adaptive approach, with its inclusion of broad stakeholder engagement, is different to the traditional approach which had limited stakeholder engagement (Pahl-Wostl et al., 2007). Local context is also likely to be more important in a sustainable regime which emphasises consideration of developing suitable solutions for each location, rather than the traditional approach which promoted application of similar technical solutions across different locations. The observed emphasis on resources is similar to traditional urban water management, particularly the technical and financial resources. However in a SUWM regime, the resource focus is likely to shift towards political support due to the greater interaction of stakeholders and increased community awareness of water management issues.

The emphasis on collaboration, cooperation and partnership in the inter-organisational sphere is significantly different from the traditional urban water management approach, with its organisational separation of urban water components and little interaction (Niemczynowicz, 1999). Responsibility for urban water management is likely to be more distributed across stakeholder organisations in a sustainable regime given the increased emphasis on participation; this will result in greater inter-organisational interaction. Coordination and cooperation is easier if organisations have responsibilities for multiple water services (Mandarano et al., 2008), indicating that organisational roles and responsibilities may be broadened to comprise multiple components of the urban water system. The substantial difference between these attributes and those of the traditional urban water management regime indicates that significant amounts of effort and resources are

likely to be required to enable cooperative and collaborative inter-organisational relationships. As in the past, inter-organisational relationships may vary, at times characterised by conflict and at other times, harmony. However, ideally inter-organisational conflict will decrease as collaborative and cooperative relationships become the norm.

At the intra-organisational sphere, the literature review results did not reveal whether the traditional regime approach of separate organisations focusing on separate water service components will remain in a more sustainable regime. However as identified above organisational roles may expand. Organisational culture and the manner in which organisations engage with external stakeholders are the main differences between the traditional and more sustainable regimes. Given the traditional administrative and regulatory emphasis on efficiency of technical solutions, the traditional organisation is likely to also have had a culture focused on efficiency and stability. This differs considerably when compared to the more sustainable organisational culture which is flexible, adaptable and creative. The intra-organisational regime attributes also follow the administrative and regulatory sphere emphasis on stakeholder engagement, which is significantly different from the traditional regime, as stated above.

The small number of publications that focus on the human resources regime sphere make comparisons between the traditional and sustainable human resources elements difficult. However there are some similarities between the two in the emphasis on knowledge and skills. Separate consideration of the urban water management literature revealed the emphasis on technical professions, such as engineers, will remain although other disciplines from natural sciences and planning are likely to become more important (de Loë et al., 2002; Brown et al., 2009). Additionally, individuals will be required to work with other professions and this is the clearest difference between the traditional and sustainable attributes of individuals (Brown, 2005).

Overall comparison of the traditional and sustainable urban water management regime characteristics reveals salient differences for each regime sphere. The traditional urban water management system was characterised by the social values of supply security, flood protection, protection of public health and efficiency of service provision (Brown et al., 2009) and large, centralised infrastructure systems (Newman, 2001). The management regime arrangements follow this centralised nature and generally could be considered to be part of a steering governance paradigm with top-down, command and control approaches and formal rules and regulations (Elzen and Wieczorek, 2005).

Over approximately the last 20 years, market based approaches have become prevalent in the urban water sector with financial incentives introduced for improved organisational performance and increased privatisation and corporatisation of previously public water authorities (Gunningham et al., 1998; Bakker, 2005). Increased efficiency and competition have become more prominent through introduction of economic or market mechanisms into water management (Saleth and Dinar,

2004). Adjustments in the institutional arrangements to accompany these changing values have also occurred, for example in Australia independent economic regulatory organisations have been established in the states of New South Wales (Independent and Regulatory Pricing Tribunal) and Victoria (Essential Services Commission) which set urban water prices. These changes could be interpreted as a modification of the command and control governance approach to one that includes some attributes of a more market based approach, such as that described by Elzen and Wieczorek (2005). Elzen and Wiezcorek's (2005) market based approach focuses on market based instruments, with individual, autonomous actors making independent decisions and responding to market based incentives.

When compared to the recently expanded expectations placed on the urban water management system and associated underpinning social values, it could be expected that the sustainable urban water governance style and arrangements are likely to be significantly different from the command and control and market based models. In fact, Elzen and Wieczorek (2005) propose a third governance model, that of policy networks. Further detail and application of this approach can be found in publications such as Kickert et al. (1997), Rhodes (1997), van Beuren et al. (2003) and Betsill and Bulkeley (2006). This model is characterised by networks of actors that are mutually dependent, with numerous, regular interactions where information and resources are exchanged. The policy tools utilised in this model emphasise learning and network management through mechanisms such as demonstration projects, seminars and conferences. The management regime attributes identified through this literature review, such as a guiding adaptive and learning approach characterised by broad stakeholder engagement, inter-organisational collaboration and partnership, flexibility and innovation, broadly correspond to the attributes of the network governance model.

Based on the changing underpinning values of a more sustainable urban water management system, comparison with the traditional urban water management values and reflection on the literature review, it can be concluded that from the synthesis presented, the current research, when considered collectively, is implicitly calling for an overhaul of the governance approach, to one similar to the policy network approach proposed by Elzen and Wieczorek (2005). Similarly, in analysing adaptive watershed management, Allan et al. (2008) contend that a "radical departure" from the traditional, reductionist approach is required if adaptive management is to be successfully adopted. This shift in governance approach is likely to have implications for capacity building programs to overcome the current market based and hierarchical command and control governance approaches, to enable the policy network governance approach, and therefore a more sustainable urban water management regime.

Insights for Capacity Building

Institutional capacity building programs in the urban water industry in more developed countries have involved conducting training, workshops and site visits to increase knowledge among

practitioners and facilitate intra-organisational communication by organising design competitions requiring inter-disciplinary teams. For example in the Australian context, a number of formal, government sponsored capacity building programs for the urban water sector have emerged over the last five years (for example Clearwater: http://www.clearwater.asn.au/index.cfm and Water By Design: http://www.healthywaterways.org/wbd_project_overview.html, both accessed August 6, 2008). The results of the literature review and the highlighted differences between the traditional and sustainable regime attributes support the activities of these programs in working to develop the capacity qualities of the human resources and intra-organisational spheres. The emphasis of the literature review attributes on the administrative and regulatory framework and inter-organisational spheres indicate the substantial challenges in these areas and that these spheres need particular attention and development. Capacity building across all spheres is needed so as to avoid haphazard or incomplete institutional change (Wakely, 1997; Enemark and Williamson, 2004; Brown, 2008a). The existing capacity building programs are vulnerable to reduced funding and variable support from senior government administrators. Therefore the authors recommend that capacity building across all four regime spheres becomes an explicit policy intervention with the associated government and financial support required.

Additionally, the results presented provide the basis for developing a benchmark for assessment of capacity deficits and inform the development of an institutional capacity assessment framework which has been identified as an important problem facing capacity building research and practitioners (Honadle, 1981). Such an assessment would enable demand driven and focused capacity building programs to be developed (Grindle, 1997; Peltenburg et al., 2000). In assessing capacity, practitioners and policy makers should use a participatory approach (Brown et al., 2006; Brown, 2008b), followed by independent evaluation (Cortner and Marsh, 1987). Data for the capacity assessment should be collected from a range of sources (statistics, interviews and surveys), in depth consideration of organisations and mapping of stakeholder relations and the policy framework (Brown, 2008b).

Further research is required in both validation of these attributes and possibly expansion into other practice areas. Application of these factors in the field (i.e. using social research methods) would enable testing of their adequacy and scope, and provide contextual insight into their suitability for application to SUWM. This may reveal that some frequently discussed attributes are not the most important attributes and focusing on specific locations will enable examination of them in greater detail. The analytical framework of Brown et al. (2006) indicates that the management regime spheres are nested but does not expand on the relationships between the spheres or attributes further. The future empirical testing of these attributes should also involve investigation into the nature of these relationships. Expansion of these attributes could be undertaken by reviewing a broader body of literature, such as complexity theory, technology and innovation studies. The

general nature of the attributes and drawing them from a range of literature fields could enable them to be used for other socio-technical systems such as energy or transport.

5.2.8 Conclusion

There has been significant progress in identifying the technical ingredients of solutions to address the challenge of sustainable urban water management. However, in such a socio-technical system such as urban water, the social component, or the management regime, also needs to be considered. This paper has explored tentative attributes of a sustainable urban water management regime, through a systematic review of empirical research identified in 81 publications. The analytical framework of the nested regime spheres, the administrative and regulatory framework, inter-organisational, intra-organisational and human resources, was used to organise and analyse the results. Significant differences between the traditional and sustainable management regime attributes were identified, leading to the conclusion that a shift in governance paradigm to a more interactive, participatory and adaptive network based approach is likely to be required. This significant shift in urban water governance means that capacity building programs should be an explicitly supported policy intervention and existing programs should expand their focus to encompass all four nested regime spheres to achieve the sustained social change required to enable sustainable urban water management.

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5.3 SUMMARY

Publication 3 mapped scholarly perspectives of SUWM regime attributes and revealed these attributes will likely be substantially different from the traditional regime. Scholars suggested the regime would be characterised by an adaptive approach, with collaborative inter-organisational relationships, coordinated policy, a range of policy tools and organisations willing to engage with other stakeholders, and knowledgeable professionals. These findings confirmed the outcomes of Chapter 4 (Publications 1 and 2), thus building confidence in the projected SUWM regime attributes, that they will likely be substantially different from the traditional regime.

When considering future governance for sustainable urban water management, the secondary empirical studies results presented in Publication 3 suggest that overall, a fundamental shift in governance approach towards a network approach is required to enable SUWM. However, scholars such as Hill and Hupe (2002) and Meuleman (2008) propose that ideal modes, including network governance approaches, are unlikely to be observed in reality, but rather hybrid approaches will be detected. Furthermore, recent environmental governance literature (e.g. Lemos and Agrawal, 2006; Kooiman and Jentoft, 2009; Pahl-Wostl, 2009), supports a hybrid or mixed mode of governance, but little guidance is available on the governance approach most appropriate for supporting SUWM practices. Therefore, additional investigation is required to extend current SUWM scholarship and provide more detailed insight into governance approaches for SUWM. The governance analysis of SUWM regime attributes is presented in Chapter 6.

CHAPTER 6 GOVERNANCE ANALYSIS OF SUSTAINABLE URBAN WATER MANAGEMENT REGIME ATTRIBUTES

6.1 INTRODUCTION

This Chapter addresses the final two research objectives: to compare expert and scholarly perspectives on sustainable urban water management in relation to sustainable urban water governance; and to identify key governance characteristics of a sustainable urban water management regime. These objectives will be achieved through analysing the practitioner perspectives of SUWM regime attributes generated from the Sydney and Melbourne case studies (Chapter 4). A governance analytical framework will be used and the results of the analysis will then be compared with scholarly perspectives of SUWM governance (from Chapter 5 and from the urban water literature). A governance lens focuses on processes and holistic regime operation and therefore is considered to provide greater insight into regime change compared to an institutional perspective (Kjær, 2004). The results of the governance analysis are presented in Publication 4 (Section 6.2), "Towards Understanding Governance for Sustainable Urban Water Management: A Practice-Oriented Perspective", submitted to *Global Environmental Change: Human and Policy Dimensions*, (van de Meene *et al.*, submitted).

6.2 PUBLICATION 4 - TOWARDS UNDERSTANDING GOVERNANCE FOR SUSTAINABLE URBAN WATER MANAGEMENT: A PRACTICE-ORIENTED PERSPECTIVE

Submitted to *Global Environmental Change: Human and Policy Dimensions* at the time of thesis submission.

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6.2.1 Abstract

Despite technical advances in sustainable urban water management over recent decades, implementation remains slow. The current research on socio-institutional barriers suggests poor implementation of sustainable urban water management practices is related to the limited understanding of governance approaches. While some governance scholars express preferences for ideal hierarchical, market or network governance modes across the regime, others suggest a hybrid of these modes is more appropriate for sustainability. Currently, there is limited commentary about the potential characteristics of a sustainable urban water governance approach. Therefore, to extend the current scholarship, this paper systematically draws on tacit knowledge of expert sustainability practitioners to identify likely governance characteristics of a sustainable urban water management regime. In comparison with current urban water scholarship, which is supportive of a network-oriented governance approach at a conceptual level, the results suggest practitioners support hybrid governance arrangements at a practical and operational level. These hybrid governance arrangements comprise network and hierarchical modes and market governance instruments. These insights are used to identify future research questions which focus on examining interaction among governance modes at a variety of scales and locations.

Key words: sustainable urban water management; governance modes; regime; hybrid governance; Australia.

6.2.2 Introduction

Sustainable urban water management (SUWM) is an alternative to the traditional way in which urban water systems are managed. While traditional schemes comprise large, centralised infrastructure, SUWM is characterised by integrated infrastructure and biophysical systems, which require consideration of social, economic, environmental and political contexts, provision of water for ecological and human uses, and a long term perspective (Brown and Keath, 2008; Mitchell, 2006; Mostert, 2006; Serageldin, 1995; Vlachos and Braga, 2001). SUWM is proposed as a strategy to overcome the challenges facing our urban water systems, which include addressing the implications of population growth, climate change and environmental impacts of traditional urban water management. In 2009, urban residents comprised fifty percent of the world's population (UNPF, 2009) and as the population grows, demand for urban water services also increases. Climate change forecasts indicate extreme events (such as droughts, high intensity rainfall and heat waves) are likely to increase and freshwater systems will be adversely affected (IPCC, 2008). Over-allocated water systems are vulnerable to decreasing water availability and increasing rainfall variability, which will likely reduce the water security of both urban and non-urban areas (IPCC, 2008). Additionally, environmental impacts from traditional urban water management are observed within and outside of most cities, resulting from damming rivers for water supply and discharging pollution into downstream waterways (Niemczynowicz, 1999). Furthermore, the

challenge of addressing aging urban water infrastructure confronts numerous countries (Vlachos and Braga, 2001).

Many tools and technologies such as stormwater treatment technologies, models and assessment methods have been developed, facilitating implementation of improved practices at the project scale (see for e.g. Chocat et al., 2001; Harremoës, 2002), yet widespread SUWM across the regime remains unrealised. Scholars have identified numerous systemic and interrelated socio-institutional barriers impeding SUWM implementation at the regime scale (Harremoës, 2002; Mitchell, 2006). Barriers include, among others, institutional fragmentation, poor political leadership, unproductive intergovernmental relations, limited long-term strategic planning, and inadequate community participation (see for e.g. Brown, 2005; Brown and Farrelly, 2009; Hatton MacDonald and Dyack, 2004; Niemczynowicz, 1999; Vlachos and Braga, 2001).

Based on these systemic and inter-related barriers (Brown and Farrelly, 2009), it can be surmised that there is a lack of insight into governance approaches and solutions required to support SUWM practices. Urban water governance, discussed further in Section 2, has generally shifted from the historical, hierarchical governance approach towards a market governance approach over the last century (Bakker, 2002). However, governance for addressing the systemic and interrelated challenges facing urban water management is not readily apparent beyond the explication of regime attributes and governance approaches which are suggestive of network governance (see for e.g. Brown et al., 2009; Pahl-Wostl, 2007; 2008; van de Meene and Brown, 2009). Therefore, there is a need for further scholarly guidance as to what governance for SUWM should entail.

Derived from extensive qualitative research in the Australian water sector which is facing significant challenges, this paper extends the scholarship by developing a new, hybrid governance arrangement for SUWM. Drawing on the accounts of expert urban water sustainability practitioners, attributes of the hybrid governance approach are revealed and explained. This paper continues by discussing governance modes and urban water governance and explaining the practical use of the regime concept. The exploratory research design and methods are described, including the integrated regime and governance analytical framework. The likely SUWM regime attributes identified from practitioners are presented and the overarching hybrid governance approach for SUWM is discussed in relation to environmental governance literature. Finally, key questions and challenges arising from this research are identified.

6.2.3 Governance and Sustainable Urban Water Management

Governance describes the management of collective issues, the stakeholders involved and processes used (Kjær, 2004; Pierre and Peters, 2000; Stoker, 1998). Governance studies emphasise interactions among structures and processes, which are important when examining change (Kjær, 2004). The three ideal governance modes often identified are hierarchical, market and network modes; these approaches are briefly discussed focusing on urban water management.

Hierarchical governance consists of formal arrangements and representative democratic accountability mechanisms (Kjær, 2004). This approach characterised early urban water management and was observed in large, centralised public authorities for wastewater, water supply and drainage services (Vlachos and Braga, 2001), with vertical accountability and little stakeholder participation (Pahl-Wostl, 2007). However, hierarchical governance was criticised by scholars as being, among other issues, inefficient, and market governance was promoted as delivering efficiency by applying private sector management principles in the public sector (Hood, 1991).

Market governance aims to allocate resources efficiently and empower citizens (Pierre and Peters, 2000). This approach became popular in practice during the 1990s and was observed in urban water management through full cost pricing, introduction of competition and privatisation (Bakker, 2002). Market governance was adopted in different ways, for example water authorities in England and Wales were privatised (Bakker, 2005) and corporatised in Australia (Colebatch, 2006), while in France, the private sector delivered water supply services (Renzetti and Dupont, 2004). Recent water reforms demonstrate continued support for market governance (Saleth and Dinar, 2005). However, market governance has also been criticised for causing institutional fragmentation, highlighting decreased state control over policy implementation and increased influence of other actors through networks (see for e.g. Kjær, 2004).

Network governance acknowledges public, private and civil actor participation is required for effective public policy development and implementation (Klijn and Koppenjan, 2000). Although a network governance approach has not been formally identified in urban water management, scholars implicitly advocate a network governance approach for SUWM, identified from SUWM regime attribute projections (see Brown et al., 2009; Pahl-Wostl, 2007; 2008). Van de Meene and Brown (2009) attempted to extend the projected SUWM regime attributes by analysing published empirical studies. These results substantiated the earlier commentary supporting a network approach and provided greater detail about likely SUWM regime attributes across the individual, intra- and inter-organisation and the administrative and regulatory framework spheres.

Although, each governance mode has been promoted as a solution to public policy challenges, some scholars (e.g. Hill and Hupe, 2002; Meuleman, 2008; Pierre and Peters, 2000) argue that the three ideal governance modes will rarely be observed in reality, but rather mixed or hybrid forms will be detected in practice due to the complexity of real world situations. Indeed, environmental governance scholars (e.g. Kooiman and Jentoft, 2009; Lemos and Agrawal, 2006; Pahl-Wostl, 2009) contend hybrid governance approaches will likely deliver more sustainable outcomes. However, the challenge to understand governance in practice and develop governance solutions to facilitate SUWM implementation remains.

One approach to understanding governance and urban water governance from a practical perspective is to focus on the regime scale, in contrast to global or local scales. A useful regime

conceptualisation is van der Brugge's (2009) framework, which comprises four elements: actors, processes, structures (including physical systems) and influences. These elements are important components of governance theory (Kjær, 2004) and therefore understanding regime characteristics will likely provide insight into governance. In van der Brugge's (2009) framework, actors use processes to modify structures, which in turn influence the strategies or actions available to actors. To improve environmental governance, regime attributes will likely comprise the following: actors are likely to be interdisciplinary (Dovers, 2005; Harding et al., 2009), structures would reflect polycentric organisation which provides some resilience and improves the system's response to change (Huitema et al., 2009), and processes are likely to involve greater stakeholder deliberation and participation in decision-making (Harding et al., 2009). Additionally, scholars strongly support market governance instruments to efficiently deliver improved environmental outcomes (Bakker, 2005; Castree, 2008). However, there remains a lack of detailed knowledge regarding regime attributes and governance approaches for supporting improved urban water management practices. Based on the importance of observing governance in practice, this grounded social research study draws upon tacit (experiential and implicit) knowledge from practitioners to identify likely SUWM regime attributes and key sustainable urban water governance features.

6.2.4 Research Approach

An inductive research design (Blaikie, 2000), grounded in qualitative data from expert Australian urban water sustainability practitioners (from Sydney and Melbourne) was used to identify likely SUWM regime attributes. The inductively generated attributes were analysed using the ideal governance modes to identify the practitioners' perspectives on sustainable urban water governance approaches. The governance analysis results were then compared with environmental governance literature. This paper draws on data collected as part of a larger research project focused on institutional capacity; earlier critical insights are published elsewhere (see van de Meene et al., 2009; and van de Meene et al., in press).

The case study approach was selected for data collection because of the close relationship between the phenomenon investigated (SUWM regime) and the physical, historical and social context (Blaikie, 2000). Sydney and Melbourne were selected for investigation because they face challenges enabling SUWM which are similar to other large urban areas. Additionally, the urban water governance arrangements in both cities have followed international trends, evolving from hierarchical and centralised management structures to market governance structures (Bakker, 2002; Brown and Clarke, 2007; Colebatch, 2006; Jane and Dollery, 2006). Data collection and analysis for Sydney was undertaken prior to Melbourne and when concluded, the coding categories were saturated, suggesting additional data collection would not provide significantly greater insight (Strauss and Corbin, 1998); the two datasets were then combined because of numerous similarities between the cities' data.

Urban water sustainability practitioners were targeted as they provide access to tacit information regarding urban water system operation, which is normally unavailable but important when undertaking strategic urban water management research (Lienert et al., 2006). Interview participants were identified using the snowball method, which involved the referral of potential interviewees by senior organisational managers and identification through industry and academic (e.g. conference proceedings) publications. Additionally, informal processes seeking individuals to be identified by at least two independent sources were also used. The selected interviewees represented stakeholders from across the urban water sector: state government, local government, water authorities, land development and consulting organisations, non-government organisations, professional associations, liaison (bridging) organisations and research institutions.

To help structure the interview questions, the institutional capacity assessment framework (see Brown et al., 2006) was used. The framework is actor-focused and divides the regime into four components, which are easy for interviewees to understand: individual, intra-organisational, inter-organisational and the administrative and regulatory factors. One hundred and twenty-seven participants described their perceptions of future SUWM attributes for each component, 10 – 15 years into the future. The projections were confined to this timeframe as pilot testing of the interview questions highlighted interviewees' difficulty projecting further into the future.

Data analysis occurred in two stages: 1) coding interview transcripts (see for e.g. Kitchin and Tate, 2000), and 2) comparing the interview outcomes against the ideal governance modes. The regime framework of van der Brugge (2009), including definitions of regime elements, was used to organise and clarify the interview codes. Van der Brugge (2009) focuses on actor functions and their associated processes. However, the research presented here identified core features of a SUWM regime and instead employed a less functionalist interpretation of the framework. Strong themes for each regime element emerged from the interview coding and when saturated, were determined to be core regime features.

The second data analysis stage involved relating the projected attributes to the ideal governance modes. An analytical framework integrating van der Brugge's (2009) regime framework and the three well-established ideal governance modes was developed to analyse the SUWM regime attributes projected by practitioners (Table 1). Using the ideal governance modes provides a relatively complete analytical tool for understanding conflicts and synergies of governance modes (Meuleman, 2008), while the regime framework facilitates empirical observations (van der Brugge, 2009). Each core regime feature was evaluated against the governance modes and the number of interviewees who supported each governance mode was recorded. An NVivo 8 (QSR International) database comprising the raw data, core regime features, mode of governance, representative quotes and notes made during analysis provided a chain of evidence connecting the codes with raw data (Yin, 2003). Finally, the governance mode assessment results were compared with scholarly SUWM regime projections and relevant environmental governance literature.

Table 1 Integrated Regime and Governance Analytical Framework

Regime Element	**Mode of Governance**		
	Hierarchical	**Market**	**Network**
Actors	- Little autonomy, follow predefined orders - Dependent relationships - Rational - Considered as 'subjects' - Subordinate actors are motivated by fear of punishment - Superordinate actors are motivated by career advancement, bureaucratic stability - Common motivation is to minimise risk	- Exercise self choice - Independent relationships - Rational - Considered as 'customers' or 'consumers' - Subordinate actors motivated by material benefit - Superordinate actors motivated by profit - Common motivation is to maximise advantage	- Depend on others; trust others, empathetic - Interdependent relationships - Considered as 'partners' - Subordinate actors motivated by belonging to a group - Superordinate actors motivated by the esteem of followers - Common motivation is to satisfy identity
Processes	- Clearly defined and applied across locations - Decisions based on authoritative formal adjudication - Accountability exercised through political system	- Emphasis on private sector management practices – efficiency, competition - Decisions based on consumer preference - Accountability exercised through consumer choice	- Context dependent - Emphasis on cooperation and negotiation - Decisions based on general consent, unanimous agreement - Accountability and transparency difficult to identify
Structures	- Strong vertically, formalised, static - Low flexibility - Establishes clear actor roles and responsibilities	- Provide guidance to actors - Establish explicit standards for performance - High flexibility - Establishes principal with local actors	- Strong horizontally, informal - Moderate flexibility - Context dependent
Influences	- Centralised power - Power exercised through coercion, administrative and legal expertise, procedural correctness - Collective goods are produced and distributed	- Centralised power with autonomous actors - Resource allocation linked to performance - Power is exercised through entrepreneurship - Private goods are produced and distributed	- Distributed power and resources - Power is exercised through respect and trust - Solidaristic goods are produced and distributed

(Adapted from: Streek and Schmitter, 1985; Powell, 1990; Hood, 1991; Pierre and Peters, 2000; Elzen and Wieczorek, 2005; Meuleman, 2008)

6.2.5 Results

As a whole, the SUWM regime attributes identified from expert urban water sustainability practitioners do not precisely match with any of the ideal modes of governance; instead, support for the governance modes varies across the regime, within regime elements and also within the core regime features. The SUWM regime attributes are discussed using van der Brugge's (2009) framework, with sections assigned to the actors, processes, structures and influences regime elements. Each results table presents the core regime features, an overview and selected key words to convey how the interviewees expressed each regime element and governance mode.

Actors

SUWM regime actors (Table 2) are likely to have a holistic problem frame which involves understanding links among biophysical and infrastructural system components, connections among technical and social strategies, and the potential implications of SUWM solutions for other sectors. This actor attribute reflects the debate surrounding environmental management which calls for integrated rather than reductionist approaches (Functowicz and Ravetz, 1993). A holistic problem frame is considerably different to the traditional regime where separate organisations manage water supply, sewerage and drainage services, and give little consideration to potential impacts on other sectors (Pahl-Wostl, 2007).

Participants also proposed that both individuals and organisations would view SUWM as a core societal objective. Contributing to society through SUWM would motivate urban water professionals and encourage them to overcome challenges faced when implementing SUWM practices. Organisational commitment to SUWM, facilitated by organisational leaders, would be demonstrated through public statements of commitment, setting objectives, policies, programs or actions.

Table 2 Actor Attributes of a Sustainable Urban Water Regime and Mode of Governance

Core Regime Feature	Overview	Hierarchical Governance		Market Governance		Network Governance	
		%[a]	Description & Key Words	%[a]	Description & Key Words	%[a]	Description & Key Words
Problem Frame	Holistic approach, understanding links between water cycle elements, broader sustainability considerations & regime actors	13	System viewed as separate components which can be controlled, looking to authority for direction. *"systems management process", "track progress"*	11	Economic approaches are used to analyse the system and decide how to deliver services. *"efficiency", "ecological economics", "commercial"*	76	System viewed holistically, including examining impacts beyond the water cycle. *"conscious of sustainability", "sense of connection", "system thinkers"*
Purpose	Value sustainability, contributing to society though SUWM	12	Motivated by a clear objective which is then followed precisely. *"sound decision making", "long term vision"*	21	Efficient delivery of water services to customers. *"outcome focused", "commercially aware"*	67	Taking responsibility, working together to achieve outcomes. *"openness", "work collaboratively", "prepared to take risks"*
Knowledge & Skills	Diverse knowledge & skills, inter-disciplinary operation	13	Knowledge & skills to ensure control, e.g. through use of technology. *"better abilities to measure change", "security and risk management"*	16	Knowledge & skills to provide economic valuation. *"costing the environment", "key externalities", "market oriented people"*	71	Knowledge & skills to understand links between physical & social systems. *"ability to work across disciplines", "diversity"*
Approach towards relationships	Willing to engage with others, open minded, respectful of different perspectives	14	Directive and formal approach to relationships *"push it as much as you can", "impartial advice", "formal relationships".*	18	Focus on responding to customers' needs. *"customer focused", "authorisation to be flexible"*	68	Focus on genuine engagement & connection with others. *"involved upfront", "trusting", "respectful"*

[a] number of interviewees supporting this mode of governance expressed as a percentage to emphasise relative support

Interviewees emphasised actors would likely have diverse knowledge and skills and a positive approach to relationships, both within and between organisations. This perspective highlights the need for actors to understand and appreciate the interconnected physical and socio-institutional elements of a SUWM system. Interviewees underscored the need for technical knowledge and skills, similar to the traditional regime, and also mentioned a range of professional roles including ecologists, landscape architects, planners, economists, community engagement professionals, and policy makers. Importantly, interviewees also highlighted the need for their knowledge to be integrated across disciplinary boundaries, which has also been identified as important in environmental management more broadly (Dovers, 2005; Harding et al., 2009). Considered together, these four attributes (Table 2) show actors within a SUWM regime are likely to perceive themselves within multiple, varied and mutually dependent relationships.

Processes

Overall, the processes in a SUWM regime (Table 3) will likely have similarities and differences to the traditional urban water management approach. Interviewees considered accountability and transparency, which are principles of good governance (Kjær, 2004; Rhodes, 1997), important for informing stakeholders and enabling them to effectively contribute to SUWM. While critical for all three ideal governance modes, including sustainable development, accountability and transparency are often associated with representative democracy and hierarchical governance (Pierre and Peters, 2000), and therefore they may be more easily observed or explicit within the traditional water management approach.

Table 3 Process Attributes of a Sustainable Urban Water Regime and Ideal Modes of Governance

Core Regime Feature	Overview	Hierarchical Governance		Market Governance		Network Governance	
		%[a]	Description & Key Words	% [a]	Description & Key Words	% [a]	Description & Key Words
Accountability & Transparency	Clear accountability mechanisms & information provision facilitate stakeholder scrutiny & participation	48	Formal processes to ensure accountability & transparency. "see decision making processes occur in front of you", "independent scrutiny"	21	Transparency & accountability ensured by consumer choice & informed consumers. *"customer protection", "competitive neutrality"*	31	Accountability & transparency facilitated by communicating openly & debating issues. *"start some of the debate", "sharing information"*
Continual Improvement	Experiential learning, evaluation & ongoing innovation	22	One-way education & learning with formal evaluation. "community education", "evaluation"	22	Change through market innovation & incentives. *"innovation fund", "markets will drive innovation"*	56	Learning through experience & questioning current approach. *"reflective time", "show and demonstrate"*
Risk Management	Addressing risks associated with uncertainty of SUWM solutions	28	Risk is controlled, often underwritten by government. *"the risks are very high and you cannot accept failure in those areas", "certain amount of responsibility"*	26	Some risk is shared between private & public organisations where appropriate. *"preparedness to take risks", "consider risk management more openly"*	46	Risk is shared & reduced through information & communication. *"sharing risk", "risk communication"*
Leadership	Clear & strong leadership to set the direction & engage others to participate	45	Strong, formal leaders, directing others. *"leadership from the top", "clear consistent message"*	16	Leadership by innovating or doing things first. *"leading the way", "assertive"*	39	Leadership through influencing, encouraging & supporting others. *"facilitate", "influencing and guiding"*
Cooperation & Collaboration	Working together to achieve common goals	25	Formal partnerships & structured cooperation procedures. *"partnerships that are more formalised"*	13	Partnerships for specific purposes which involve generating profit. *"joint venture", "partner in service delivery"*	62	Partnerships which consider members' needs, founded on trust. *"interactive", "community deliberation"*

[a] number of interviewees supporting this mode of governance expressed as a percentage to emphasise relative support

The continual improvement and risk management regime features were different to the traditional urban water management regime, which used standard solutions applied in different locations (Harremoës, 2002; Pahl-Wostl, 2007). However, SUWM solutions will need to consider each location's unique context (Mitchell, 2006; Mostert, 2006). Interviewees associated SUWM solutions with continually innovating new or adapting existing solutions, which brought high uncertainty and high risk. Risk management strategies included sharing risk among stakeholders and undertaking trials to learn and improve confidence. These interviewee projections correspond with those of Blackmore and Plant (2008) who support dynamic risk management and reducing risk through learning. According to Folke et al. (2002) learning builds system-wide adaptive capacity.

In a SUWM regime, cooperative and collaborative relationships, between or within organisations, will likely be facilitated by actors positively engaging with others (refer Section 4.1). Interviewees typically used the terms cooperation and collaboration interchangeably, although collaboration was often considered a closer and longer-term relationship than cooperation. This reflects similar concepts in integrated environmental management (see for e.g. Briassoulis, 2004; Cortner and Moote, 1994; Margerum and Born, 1995). Key features of successful actor relationships were generating shared understanding and objectives, and initiating relationships early to develop trust.

Leadership is considered a key factor in emerging (Heikkila and Gerlak, 2005) and successful collaborative and cooperative natural resource management relationships (Leach and Pelkey, 2001). Interviewees identified leadership at the organisational, inter-organisational and political levels as important for setting the direction and vision of SUWM and encouraging stakeholders to support the vision. Organisations nominated as water sector leaders by participants often used facilitative leadership strategies, including information provision, influencing through a client-consultant relationship or leading by example. These informal strategies contrast with the traditional urban water regime, where power and therefore leadership is formalised and centralised (Pahl-Wostl, 2007). The support for directive and facilitative leadership within one regime feature highlights the likely complexity of sustainable urban water governance.

Structures

Overall, SUWM regime structures (Table 4) comprise a formal guiding administrative framework, with a variety of roles and responsibilities and policy tools, together with a culture and infrastructure emphasising integration and flexibility. Interviewees described a sustainable urban water sector culture as one focused on integrating knowledge and policy and being responsive to challenges; these cultural characteristics are similar to the actor attributes of a holistic problem frame and interdisciplinary knowledge (Table 2). Focusing on integration also reflects integrated environmental management literature (Briassoulis, 2004; Cortner and Moote, 1994; Margerum and

Born, 1995), while flexibility or resilience corresponds with adaptive governance principles (Gunderson and Holling, 2002; Walker et al., 2004).

Integration and flexibility are also evident in SUWM infrastructure, reflecting the co-evolution of the management regime and technical system (Elzen and Wieczorek, 2005). Interviewees described integrated infrastructure as providing fit-for-purpose water and adapting to local constraints and opportunities, which reflects total water cycle management and integrated water management literature (e.g. Chocat et al., 2007; Harremoës, 2002; Mitchell, 2006). However, these attributes differ from traditional urban water infrastructure which is founded on stationary design principles (Milly et al., 2008) and focuses on control and prediction (Pahl-Wostl, 2007).

Interviewees supported using a range of policy instruments and associated different policy instruments with different stakeholders and outcomes, which is similar to Schneider and Ingram (1990) who support targeting stakeholder groups with appropriate policy instruments to achieve desired results. For example, interview participants related regulation to ensuring low performing actors achieved minimum water management standards, while incentives (i.e. financial) were considered to encourage innovation and more rapid implementation of SUWM practices.

Table 4 Structures Attributes of a Sustainable Urban Water Regime and Mode of Governance

Core Regime Feature	Overview	Hierarchical Governance		Market Governance		Network Governance	
		%[a]	Description & Key Words	%[a]	Description & Key Words	%[a]	Description & Key Words
SUWM Culture	Focused on integration with biophysical context & other sectors, underpinned by equity & flexibility principles	27	Focused on control, directed from the top. *"greater control", "mandated"*	16	Focused on economic efficiency & incorporating externalities into the economic evaluation framework. *"consumer paying", "economies of scale"*	57	Focused on unique solutions integrated with other sectors & contexts. *"not one solution that fits everybody", "fully integrated"*
Infrastructure	Infrastructure is integrated, enabling fit for purpose use, valuing ecosystem health	7	Large scale, centralised infrastructure. *"dam infrastructure", "desalination", "water grid"*	17	Infrastructure evaluated on economic efficiency, enables water trading. *"economic order of merit", "economical on a dollars per kilolitre basis"*	76	Decentralised infrastructure tailored for site requirements, enabling fit for purpose use. *"site specific", "cascading water cycles"*
Policy Instruments	Use a variety of policy instruments	45	Regulation, legislation and minimum standards are used. *"legislation is needed", "minimum standards"*	39	Full cost pricing policies & incentives are used. *"pricing", "rebates", "third party access"*	1316	Learning & capacity building are used. "building the capacity of *everyone", "demonstration project"*
Administrative Arrangements	Roles & responsibilities are clear & facilitate effective actor interaction	41	Responsibilities are clear & centralised; primarily public sector management. *"clear responsibilities", "take over the whole lot"*	31	Responsibilities are focused on service provision & independent regulation; private sector involvement. *"more private sector involvement", "independent regulator"*	28	Responsibilities facilitate cooperation at the local level; some community management. *"working closer together", "local level"*

[a] number of interviewees supporting this mode of governance expressed as a percentage to emphasise relative support

Similar to the policy instruments, interviewees identified a variety of roles, responsibilities and administrative arrangements, ranging from centralised through to decentralised, and public through to private arrangements. Although participants agreed that pursuing SUWM was important, the diverse interviewee opinions about roles and responsibilities and policy tools demonstrate SUWM implementation remains contested and will likely require further discussion and debate. This is typical of the broader sustainability policy implementation (Jordan, 2008; Meadowcroft, 2007).

Influences

Generally, the mechanisms through which structures influence actors in a SUWM regime (Table 5) will be mixed. Participants identified the authority of individuals (e.g. politicians) and organisations (e.g. regulators, government departments) as important because the distribution of authority affects each actor's ability to take control or have control exerted over them. A range of perspectives was expressed by interviewees including, on the one hand, centralisation of power with government and on the other, decentralisation, enabling actors greater scope to influence SUWM. Interviewee support for both centralised and decentralised authority highlights the complexity of sustainable urban water governance, similar to directive and facilitative leadership styles in the processes regime element (Section 4.2).

Interviewees identified a number of different resource types and allocation mechanisms. In particular, securing adequate financial and technical resources was perceived as critical to enabling SUWM, and policy instruments, such as government grants, incentives or subsidies, could be used to allocate resources. Strategies for accessing human resources, which were also identified as important, included ensuring the organisation has adequate staff employed, using consultancies or undertaking training or capacity building. Financial, technical and human resources are also often considered important in facilitating effective natural resource management (c.f. Ivey et al., 2006; Lurie and Hibbard, 2008).

Table 5 Influences Attributes of a Sustainable Urban Water Regime and Mode of Governance

Core Regime Feature	Overview	Hierarchical Governance		Market Governance		Network Governance	
		%[a]	Description & Key Words	%[a]	Description & Key Words	%[a]	Description & Key Words
Authority	Power should be shared & strategic considerations be at the forefront of the political process	40	Power centralised with government & enforced through top-down mechanisms. *"determined from the top", "government has got to decide"*	16	Power decentralised with consumers but centralised regulation with clear separation between government & implementation. *"structural separation", "consumers to choose"*	44	Power decentralised & actors integrated by norms, individual responsibility is emphasised. *"empowering some of the staff", "because they should"*
Resources	A variety of resources are allocated using a range of mechanisms	46	Funding secured through formal & stable mechanisms, human resources brought into organisation. *"in house", "security of funding"*	24	Funding secured through incentives, human resources through consultants *"create the right incentives", "outsourcing"*	30	Human resources developed within the organisation & informal human resources are important (e.g. fit with organisational culture); autonomous financial resources. *"about getting the right people", "encouraging people"*

[a] number of interviewees supporting this mode of governance expressed as a percentage to emphasise relative support

6.2.6 Discussion

Mode of Governance

The governance assessment of the SUWM regime attributes projected by practitioners (Tables 2 – 5) supports a hybrid governance approach for SUWM, which corresponds with scholars who contend a hybrid approach is more realistic (e.g. Hill and Hupe, 2002; Meuleman, 2008) and more likely to deliver sustainable environmental outcomes (Lemos and Agrawal, 2006). The hybrid approach for SUWM (Figure 1) would likely comprise primarily network governance in the actors and processes elements (Tables 2 and 3), while hierarchical governance would provide a counterpoint in the formal structures (administrative arrangements and policy instruments) and influences elements (Tables 4 and 5). The relatively strong support for market governance was predominantly identified in the administrative arrangements and policy instruments of the structures regime element.

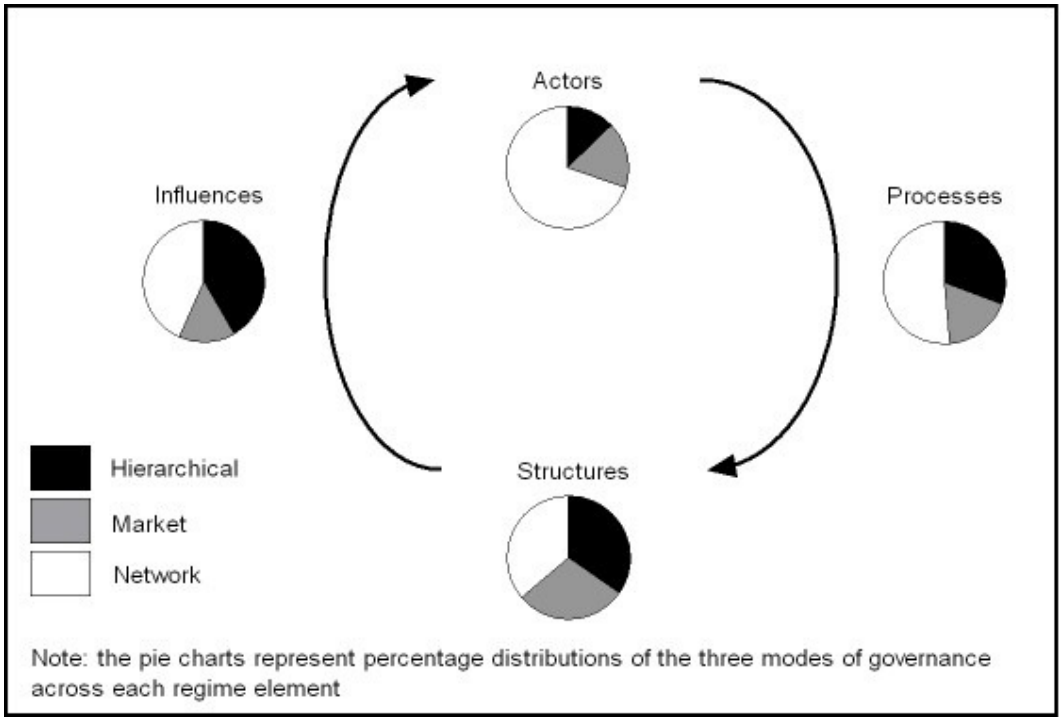

Figure 1 Summary of SUWM regime mode of governance assessment (modified from van der Brugge, 2009).

While the ideal governance modes may be expected to operate under tension given their different underpinning principles, practitioners did not perceive this as problematic, but rather explained how the hybrid governance approach would facilitate SUWM. The hierarchical mode would provide certainty across the water sector through the formal administrative framework (Table 4), political leadership and authority (Table 3, Section 4.4) and also by ensuring sanctions could be enacted if required. At the same time, the network mode would provide flexibility for implementation, enabling actors to employ less formal strategies such as collaboration, continual

learning and innovation (Table 3) and inter-disciplinary interaction (Table 2) for developing context specific SUWM solutions. Based on these observations, it appears the hierarchical and network governance interaction is an expression of formal institutions (e.g. legislation, policies) overlapping with informal institutions (e.g. norms, preferences). The market governance mode was considered to primarily facilitate efficient resource use and achieve SUWM outcomes through incentives and stimulating some industry competition (Table 4).

There are some similarities between the hierarchical governance mode, which characterised traditional urban water management (Pahl-Wostl, 2007), and the hybrid approach for SUWM, particularly in the structures and influences regime elements (Tables 4 and 5, Figure 1). However, as a whole, the hybrid governance mode differs considerably from the traditional approach, with its emphasis on connections between actors, professional disciplines and biophysical and infrastructure systems, and also continual improvement. These differences represent the network governance approach, and correspond with the SUWM regime attributes in the literature (Brown et al., 2009; Pahl-Wostl, 2007; 2008; van de Meene and Brown, 2009). In comparison with the scholarly SUWM regime attributes, which are largely conceptual, it appears the practitioner-informed hybrid governance approach provides greater clarity for applying network governance approaches in practice. The hybrid approach improves our understanding of how to successfully integrate the three ideal governance modes and offers potential solutions for resolving tensions among the governance modes.

However, the strong support of network governance within the hybrid governance approach for SUWM contrasts with scholarly support for market governance approaches for managing natural resources, including water (see for e.g. Bakker, 2002; 2005; Castree, 2008). An explanation for this may be found in the research context. This research was conducted in the Australian urban water sector which adopted market governance principles during the 1990s. Market governance principles were expressed through the efficiency agenda and largely corporatised governmental institutional arrangements (Colebatch, 2006). Market governance adoption differed across nations (Bakker, 2002) (see Section 2.1) which would likely expose practitioners to varied regulation of private companies and understanding how private and public organisations interact. This diverse experience may influence practitioners' support for market governance approaches. To ascertain if and how governance context influences practitioners' projected SUWM regime attributes, similar research in other locations, with a varied governance context is required.

Towards Understanding Sustainable Urban Water Governance

This exploratory research has provided insight into potential governance for SUWM. However, due to the emergent status of sustainable urban water governance research, these findings have raised some interesting questions, and identified tensions and challenges to be addressed in future research.

First, the debate within the literature surrounding the most appropriate governance mode for sustainable natural resource management is often divided between network, market or hybrid approaches, with some tensions identified within the hybrid perspective (Lemos and Agrawal, 2006). While the hybrid governance approach for SUWM derived from practitioners is underpinned by the network governance mode, it has not significantly clarified this debate; rather, additional evidence is required to contribute towards resolving the debate. For example, investigating practitioner perspectives from locations which differ from the Australian urban water sector would test the support for a network governance approach, possibly validating this research or providing alternative perspectives and insight. Additionally, by undertaking these investigations, contextual factors strongly influencing practitioner perspectives could be identified (as outlined in Section 5.1), and thus extend this research to develop a substantive theory for sustainable urban water governance.

Second, combining the three ideal modes of governance into a hybrid approach, can potentially lead to tensions among the governance modes which may be detrimental to effective regime operation. While the modes of governance were successfully integrated in this research, the issue of mixing governance approaches has raised some key questions which focus on improving our understanding of the interaction of governance modes at different scales. Key questions include: what role do tensions among governance modes play - do they always need to be resolved or are some tensions beneficial, and if so, how are they beneficial? How can different mixes of the three ideal governance approaches be integrated (or the tension managed) at the regime, project scale or macro scale? And how do hybrid governance approaches change in the short, medium and long term?

Finally, a key challenge facing sustainable urban water governance scholars is how to inform and advance SUWM implementation. Using the insights developed in this paper as a starting point, key questions focusing on integrating sustainable urban water governance research and practice have been identified: how can the projected SUWM regime attributes be developed across the regime? How do stakeholders across the water sector influence the development of these SUWM regime attributes? Lastly, what tools are available to evaluate governance capacity for SUWM?

6.2.7 Conclusion

Despite significant advances in developing technical solutions to address the challenges facing urban water management, widespread implementation of SUWM remains slow. Investigations into SUWM implementation have revealed systemic socio-institutional barriers at the regime level which suggests there is limited insight into governance approaches to support SUWM practices. Governance literature typically identifies three ideal governance modes: hierarchical, market and network. However, there is scholarly debate about applying these ideal modes to complex challenges such as environmental governance, and scholars suggest hybrid approaches will more

likely be observed in practice. Current scholarship in urban water governance outlines SUWM regime attributes which implicitly support a network governance approach for facilitating SUWM. However, there remains little detailed knowledge regarding governance approaches and solutions for supporting SUWM practices. Therefore, this paper aimed to extend current scholarship by systematically drawing on experiential knowledge from expert urban water sustainability practitioners to identify likely attributes of a SUWM regime and examine the attributes for insights into sustainable urban water governance.

The projected SUWM regime attributes generated from practitioners were analysed using an integrated regime and governance framework, and the governance analysis outcomes were then compared with environmental governance literature. The results suggest practitioners are supportive of hybrid governance arrangements, which comprise network and hierarchical modes and also include market governance instruments. Practitioners suggested the hierarchical mode would provide certainty for the water sector through a clear administrative framework and leadership, while the network mode would facilitate development and implementation of SUWM solutions tailored to each location. In comparison with the current urban water management scholarship, which is supportive of a network governance approach, it appears that the practitioners' hybrid governance approach provides detailed information about SUWM regime attributes and interaction of ideal governance modes which may facilitate the practical application of network governance approaches.

Based on the emergent status of sustainable urban water governance scholarship, this research was primarily exploratory leading to the identification of future research questions, debates and critical challenges that need to be addressed. For example, new research should aim to understand how context influences practitioner projections of SUWM regime attributes. Additionally, questions regarding interaction among modes of governance at different spatial and temporal scales were posed to understand the role of tensions and synergies between governance approaches. Finally a critical challenge facing sustainable urban water governance scholars is how to effectively inform SUWM practice and transform research insights into practical guidance to improve SUWM outcomes.

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6.3 SUMMARY

In comparison with the scholarly perspectives of sustainable urban water governance, which support a network approach, the results of the governance analysis of practitioners' SUWM regime attributes supported a hybrid approach for sustainable urban water governance. The hybrid governance approach confirms the position of environmental and governance scholars (e.g. Hill and Hupe, 2002; Meuleman, 2008; Kooiman and Jentoft, 2009; Pahl-Wostl, 2009). The practitioners provided detailed information of regime operation and integration of the three ideal

governance modes; these findings offer insights into the practical application of a network governance approach. Based on the comparison between scholarly and practitioner perspectives, the key governance characteristics of a SUWM regime are likely to be the hierarchical and network modes of governance, with some market governance instruments. The hierarchical mode would provide certainty for the water sector through a clear administrative framework and leadership, while the network mode would facilitate flexible development and implementation of SUWM solutions which are context specific.

The integration of van der Brugge's (2009) regime framework and governance analysis (Publication 4, Figure 1) forms the guiding framework for sustainable urban water governance and the overarching aim of the thesis. The following chapter, Chapter 7, summarises the results from the three research stages, identifies the contributions and limitations of the research, and finally outlines opportunities for further research.

CHAPTER 7 CONCLUSION

7.1 RESEARCH SUMMARY

The aim of this thesis was to contribute to advancing sustainable urban water management implementation by developing a guiding framework for sustainable urban water governance. Implementation of SUWM remains slow despite innovation of numerous technologies, methods and analytical tools (see for e.g. Niemczynowicz, 1999; Chocat *et al.*, 2001; Vlachos and Braga, 2001; Harremoës, 2002). Systemic socio-institutional barriers hamper widespread realisation of on-ground SUWM practices (Brown and Farrelly, 2009) and indicate that understanding the regime is critical to advancing SUWM.

A governance perspective was used to investigate regime change. Compared to other approaches, such as an institutional approach which emphasises formal and informal rules and structures, governance explicitly focuses on actors and processes and therefore provides insight into regime operation and change (Kjær, 2004). Examining the regime attributes projected by scholars and governance literature revealed there was substantial debate surrounding the most appropriate governance styles for environmental management, with some scholars advocating network governance (e.g. Gunderson and Holling, 2002; Walker *et al.*, 2004; Folke *et al.*, 2005; Gunderson and Light, 2006), others supporting market governance (e.g. Bakker, 2003b; Nickson and Franceys, 2003; Bakker, 2005; Saleth and Dinar, 2005; Bailey, 2007; Castree, 2008), and another group supporting a mixed or hybrid approach (e.g. Lemos and Agrawal, 2006; Kooiman and Jentoft, 2009; Pahl-Wostl, 2009). Within this debate, knowledge about likely attributes of a SUWM regime and the most appropriate mode of governance for SUWM is lacking.

An emergent research design was used to investigate these SUWM knowledge gaps, drawing on practitioner and scholarly perspectives, which were explored separately and then compared. The first phase of the research aimed to identify practitioner perspectives of SUWM regime capacity attributes (Chapter 4). This part of the research revealed that new capacity attributes across the individual, intra-organisational, inter-organisational, and administrative and regulatory framework spheres would need to be developed to enable SUWM. Overall, these capacity attributes revealed that a SUWM regime would be more complex than the traditional regime. The knowledge held by urban water professionals would be diverse, and interdisciplinary interaction would be required; there would be a wide range of collaborative relationships among individuals and organisations, and also within organisations; and finally, the institutional arrangements would employ a variety of policy tools which are coordinated across the water sector.

The investigation of 81 empirical studies, which comprised the second phase of the research, provided scholarly perspectives of SUWM regime attributes. These attributes confirmed the findings of the first research phase (Chapter 4), highlighting the need for systemic change across the urban water regime, or in other words, a shift in governance is required. Based on the scholarly

perspectives (Chapter 5), a change from the traditional hierarchical governance mode to a network governance mode was proposed to advance SUWM. Support for a network governance approach corresponded with the implicit governance style of projected SUWM regime attributes (Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). However, given the observation that the ideal modes of governance do not exist in practice (Hill and Hupe, 2002; Meuleman, 2008), further investigation was required to determine which governance mode expert urban water sustainability practitioners considered most appropriate for SUWM.

The practitioner capacity attributes of a SUWM regime were analysed using an analytical framework integrating the three ideal modes of governance and van der Brugge's (2009) regime framework (refer Chapter 6). The outcomes of the governance analysis were then compared with scholarly perspectives of a SUWM regime, including the scholars' perspective presented in Chapter 5. This analysis revealed that while there is support from both the scholarly and practitioner perspectives for a network governance approach, the practitioner view provides insight into the practical application of SUWM by advocating a hybrid mode of governance. The hybrid governance approach would likely comprise strong network and hierarchical modes, with some market governance policy instruments. Overall, the hybrid governance mode comprises a dominant hierarchical administrative framework which is delivered through network governance mechanisms. The integration of hierarchical, network and market governance modes across the regime provides insight into how tensions among the governance modes can be addressed and also points to the likely complexity of sustainable urban water governance. Integrating the governance mode assessment findings with van der Brugge's (2009) regime framework resulted in the development of a guiding framework for sustainable urban water governance, thereby achieving the overarching aim of this thesis.

7.2 RESEARCH CONTRIBUTIONS

The guiding framework for sustainable urban water governance, developed in this thesis, extends the field of SUWM. By identifying likely attributes of a SUWM regime, the framework maps a set of desirable attributes which water practitioners can aim to develop. Using the framework of van der Brugge (2009) (Section 2.5.2) in the context of SUWM enabled mechanisms for change among the regime elements to be identified, which also contributes to an improved understanding of regime operation. The improved knowledge of regime operation will likely inform the development of specific strategies for advancing regime change towards SUWM.

The guiding framework for sustainable urban water governance revealed that a SUWM regime will likely be characterised by strong hierarchical and network modes, with some market components. The combination of the different governance modes across the regime revealed that there are complementarities among the governance approaches. For example, where network governance is preferred but hierarchical governance is considered an important mechanism for instigating

sanctions (Chapter 6). Identifying interaction among the modes of governance at different levels is a key knowledge gap in both governance literature (van Kersbergen and van Waarden, 2004), and more recently in sustainable water resources management (Pahl-Wostl, 2009). This research has identified how the three governance modes interact at the regime level for SUWM.

Current thinking in urban water management literature, drawing on adaptive management theory and transition management, advocates a network governance approach to advance SUWM (see Pahl-Wostl, 2007; 2008; Brown *et al.*, 2009). The findings of this research support a mixed network and hierarchical hybrid governance approach, which broadly confirm network governance trends within the adaptive governance and transition management approaches. However, the research findings provide some insights which could contribute to the future development of these theories, particularly relating to the inclusion of hierarchical governance approaches within the network governance mode. These insights may be used to inform strategies to overcome criticisms of network governance (lack of accountability and transparency (Klijn and Koppenjan, 2000; Kjær, 2004) and slow decision-making (Jessop, 2003)). For example, interviewees recommended establishing independent urban water organisations to advise government thereby improving transparency of decision-making and opening the decision-making within the urban water network to public scrutiny.

Mitchell (2006) suggested the lack of conceptual frameworks to link SUWM principles with practice was hampering implementation. The guiding sustainable urban water governance framework contributes to this knowledge gap by linking SUWM principles with the operation of a SUWM regime. The framework was developed using qualitative data from expert urban water sustainability practitioners from Sydney and Melbourne. These locations were selected due to their similarities with other large urban areas, both in the challenges facing their urban water management systems and also the evolution of their governance regimes. Therefore, although tentative, the framework for sustainable urban water governance and the regime attributes could provide guidance to urban water practitioners in similar locations.

More specifically, the combination of governance modes within the framework could guide policy makers developing mixed governance policy programs by informing policy instrument selection and other strategies for advancing SUWM and additionally facilitate understanding of actor relationships and motivations. Furthermore, the SUWM regime attributes could inform capacity building program development by providing a benchmark against which existing regime capacity could be assessed, which is critical to addressing underlying problems (Grindle and Hilderbrand, 1995). Where possible, the capacity building programs could be built on existing programs such as Clearwater in Melbourne and the Water Sensitive Urban Design Program in Sydney. It is recommended that policy and capacity building programs which focus on developing network governance characteristics be prioritised to provide a solid foundation for future interactive and

integrated urban water management. The following are suggested starting points for specific capacities and strategies to be developed.

- At the individual sphere, urban water professionals should be encouraged to undergo training to develop an appreciation of other disciplines and their role in enabling SUWM. Combining this socio-institutional content with technical training would potentially maintain high attendance rates given the perceived importance of technical training to professional development.

- At the intra-organisational sphere, strategies or projects which require inter-disciplinary interaction should be supported, together with learning and evaluation processes. Employees should be supported to engage with organisational and community stakeholders. Strategies such as internal competitions or awards may be developed to generate interest and momentum around these desired attributes.

- At the inter-organisational sphere, collaborative and cooperative projects should be sought and supported with adequate funding and human resource capacity. Managers and participants in these relationships should acknowledge that developing trust and understanding can take time and therefore stakeholders may do well to initially set expectations below the ideal (Meijers and Romein, 2003). Strategic funding tied to collaboration may be a way to stimulate collaborative and cooperative inter-organisational relationships.

- At the administrative and regulatory framework sphere, opportunities for information sharing such as conferences and seminars should be supported, together with demonstration projects, large scale exhibitions or awards (Elzen and Wieczorek, 2005). These provide opportunities for developing informal networks.

Despite these recommendations and identified contributions, there are limitations to this research. Although the practitioner data were collected from locations which share similarities with other large urban areas and the data analysis categories reached saturation (refer Sections 3.3 and 3.4), the time constraints of doctoral candidature prevented the framework being validated in other city contexts. Additionally, the identification of a hybrid mode of governance for SUWM adds complexity to the challenge of developing a substantive theory of sustainable urban water governance. The potential combinations and distribution of the three ideal governance modes across the four regime elements are numerous, and are likely to vary depending on context. Despite this, there are possibly some common attributes across the regime and across different locations which could be used to develop a substantive theory for sustainable urban water governance to facilitate understanding of the SUWM regime and its operation.

The selection of interviewees for this project was targeted at leading sustainability practitioners in the urban water sector to identify the attributes of a SUWM regime. It is acknowledged that in doing this, the regime attributes have not been generated from a representative sample of urban water practitioners across the water sector, who may have different perspectives to the expert practitioners. Another group who may have a different perspective to the participants in this study are those individuals who hold influential or leading positions within the current urban water regime, or 'power brokers' , such as politicians or political advisers. Conducting the research using a sample of practitioners representative of the whole water sector and/or focusing on key power brokers, may have provided a different perspective to that developed within this thesis. The objective of targeting expert sustainable urban water practitioners was to gain insight from leading practitioners, to try to identify the attributes of an ideal SUWM regime and therefore establish detailed attributes which function as an objective for the water industry (as well as informing development of an institutional capacity assessment framework and governance approaches for SUWM). The potential for different perspectives to be identified from other interviewee cohorts was considered during the design of the interviewee selection strategy. It was concluded that approaching a more diverse cohort of interviewees was beyond the scope of this project, but it is presented here as a suggestion for future research.

The SUWM regime attributes provide insight into practitioner perspectives from the time of the interviews. Due to the limitations of doctoral research, it was not possible to investigate if and/or how these perspectives change over time, in response to contextual influences, such as major policy decisions, or over a longer time period. From these limitations, opportunities for future research can be identified.

7.3 FUTURE RESEARCH OPPORTUNITIES

To extend this research, the guiding framework for SUWM could be validated by undertaking similar research in other locations. As a starting point, research could be conducted in cities with different socio-political contexts, for example, different experiences of market or network governance modes. Testing the framework would provide opportunities for validation and comparison, thereby providing insight into important factors which influence governance change across a regime which may have potential implications for developing a SUWM regime in practice, and for developing a substantive theory for sustainable urban water governance.

Another avenue for extending this research is investigating the perspective(s) of a broader selection of urban water practitioners and to target power brokers, which may reveal different SUWM regime attributes and/or governance perspectives. In addition, comparing the research findings presented here with the perspectives of other suggested participants may reveal capacity strengths and weakness across the three groups which could be used to develop capacity building programs which target each of these groups. To obtain the perspective of a broad range and larger number of

urban water practitioners, methods such as quantitative surveys could be undertaken, possibly with follow up interviews to investigate specific areas of interest. Practical efforts to implement a shift from largely hierarchical to a mixed hierarchical and network approach will potentially reveal power dynamics as a key difference between hierarchical and network governance is a shift from centralised to distributed power (Rhodes, 1997; Kjær, 2004); stakeholder reluctance to relinquish power may hamper implementation. The insights gained from power brokers could potentially improve understanding of and offer insight into the power dynamics and strategies to overcome them.

By drawing on van der Brugge's (2009) regime framework (Section 2.5.2), the guiding framework for sustainable urban water governance identifies mechanisms which can be used to enable regime change (e.g. actors use processes to modify structures). However, more detailed research into the mechanisms of change and how to implement these ideal processes is required to advance SUWM. A starting point for future research in this area could be similar to Margerum and Born's (1995) focus on the process of interaction in integrated environmental management and the subsequent identification of sub-processes which are prioritised to provide guidance for practitioners. Focusing on processes, such as interaction, would assist practitioners to determine how to implement SUWM across the regime, and also contribute to the development of more robust implementation theory. Developing implementation theory would enable direct comparison between locations and therefore more salient lessons to be learnt, which could result in more rapid dissemination of these lessons to practitioners and improved implementation (Margerum and Born, 1995). Understanding regime change in more detail could also contribute to refining van der Brugge's (2009) regime framework and more clearly articulating 'cause and effect' links between the regime elements.

Drawing on the concept of meta-governance, or "the governance of governance" (Jessop, 2003: 107) and Lowndes and Skelcher's (1998) observations of governance dynamics would provide greater understanding of the different roles stakeholders play within the urban water management regime and governance dynamics more broadly. Such insights may contribute to understanding regime power dynamics, possible refinement of the guiding framework for sustainable urban water governance and development of more targeted strategies to facilitate regime change.

By developing a guiding framework for sustainable urban water governance, this research has contributed to improving knowledge of likely SUWM regime attributes and regime operation, thereby contributing to extending the field of sustainable urban water management.

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Note: this list contains references from Chapters 1 to 3 and 7, and Appendix A, and the introduction and summary for each of Chapters 4 to 6. Complete reference lists for Publications 1 to 4 are contained within each manuscript.

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Appendix A – Additional Context Information for Sydney and Melbourne Cases

List of Appendix A Abbreviations

CMA	Catchment Management Authority
CRSWS	Central Region Sustainable Water Strategy
DECC	Department of Environment and Climate Change (NSW)
DSE	Department of Sustainability and Environment (Victoria)
DWE	Department of Water and Energy (NSW)
EPA	Environment Protection Authority (Victoria)
ESC	Essential Services Commission (Victoria)
IPART	Independent Pricing and Regulatory Tribunal (NSW)
MMBW	Melbourne and Metropolitan Board of Works
MWP	Metropolitan Water Plan (Sydney) (NSW Government, 2006a)
MWSDB	Metropolitan Water, Sewerage and Drainage Board
NGO	Non-government Organisation
NSW	New South Wales
OWOF	*Our Water Our Future* policy document (2004) (Victoria) (DSE, 2004)
OWOF2	Our Water Our Future: The Next Stage of the Government's Water Plan policy document (2007) (Victoria) (DSE, 2007)
PPWCMA	Port Phillip and Westernport Catchment Management Authority
SCA	Sydney Catchment Authority
SEPP	State Environment Protection Policy (Vic) or State Environment Planning Policy (NSW)
SMCMA	Sydney Metropolitan Catchment Management Authority
SWC	Sydney Water Corporation
WICA	Water Industry Competition Act 2006 (NSW)

A.1 SYDNEY CONTEXT INFORMATION

A.1.1 Overview

This section provides a description of the Sydney urban water regime and key infrastructure developments to supplement the description provided in Section 3.3.1. Refer to references such as Aird (1961), Beasley (1988) and Beder (1989) for more in depth historical information.

A.1.2 Geographical Setting

Sydney, the state capital of New South Wales, is located on the east coast of Australia (Figure A1). The urban area is located on relatively the flat land east of the Great Dividing Range and is surrounded by three large national parks with a number of smaller national parks within the urban area, particularly near waterways. Major waterways include Port Jackson (Sydney Harbour), Botany Bay, and the Parramatta, Lane Cove, Georges, Cooks, Hawkesbury and Nepean Rivers (Figure A2).

Sydney is classified as having a temperate and humid climate. Rainfall varies across the metropolitan area; eastern Sydney has higher average annual rainfall (1 216 mm) than western Sydney (822 mm). January through to May are the wettest months in both east and west Sydney (BOM, 2008b; BOM, 2008a) and average daily temperatures range from 16.3°C in July to 25.9°C in January in eastern Sydney, with western Sydney a few degrees lower during winter and higher during summer (BOM, 2008b; BOM, 2008a).

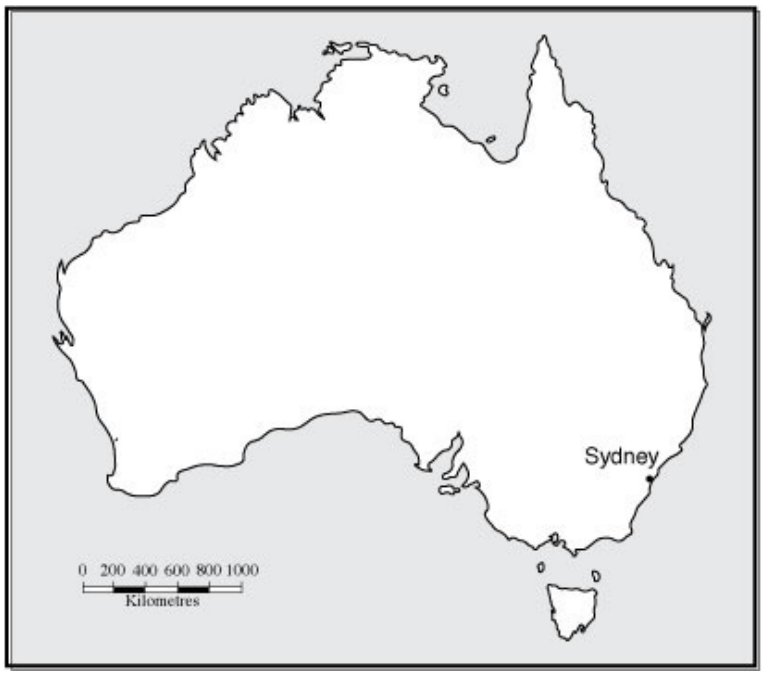


Figure A1 Location of Metropolitan Sydney
Source: School of Geography and Environmental Science, Monash University.

Metropolitan Sydney comprises 38 local government areas which cover an area of 6 385 km^2 (DLG, 2008). Sydney is the largest Australian city, with a population of 4.3 million (July 2006) (ABS, 2007). The populated area surrounds Port Jackson and Botany Bay and extends west to the Hawkesbury-Nepean River system and south to the Georges River (Figure A2). Major water storages are located to the west and south of the urban area, while the largest sewage treatment plants, which discharge effluent to the ocean, are located in the eastern suburbs.

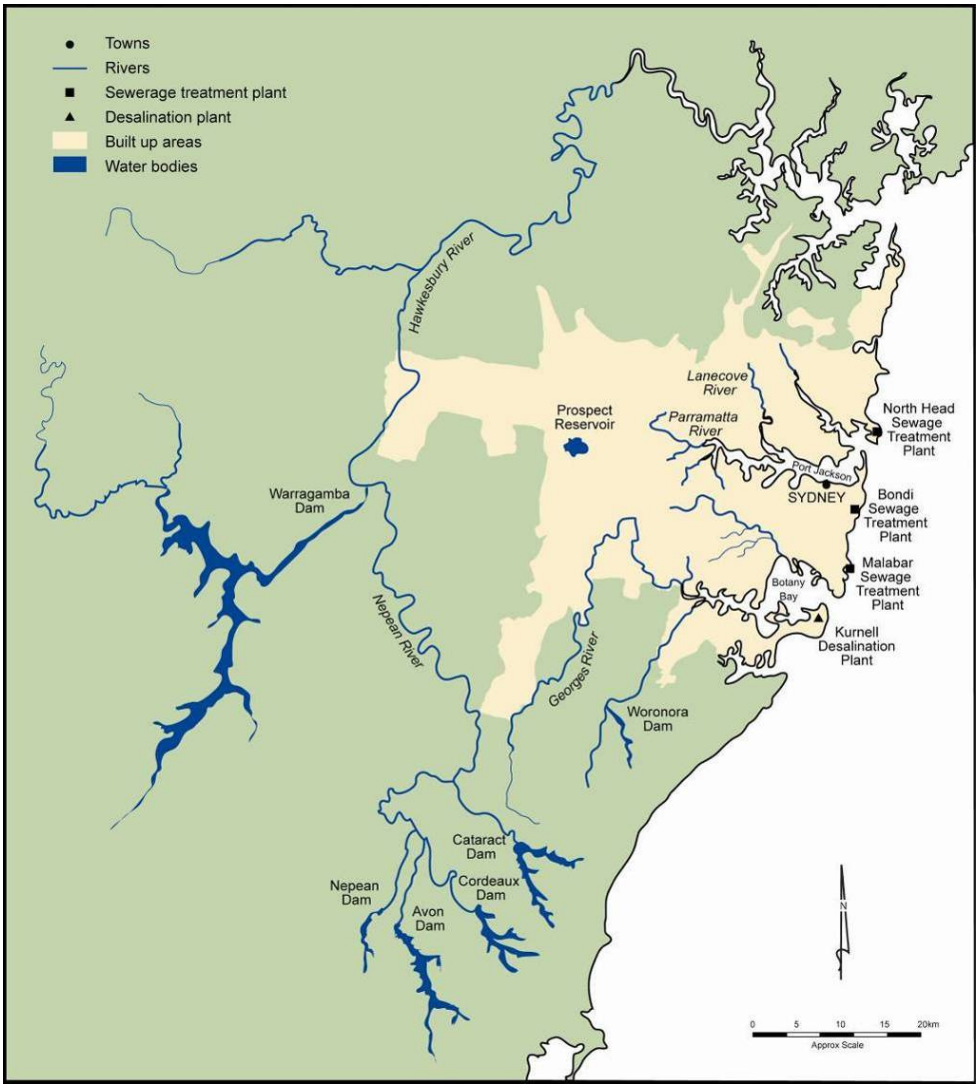


Figure A2 Sydney Metropolitan Area and Major Urban Water Infrastructure
Source: School of Geography and Environmental Science

A.1.3 Settlement

Sydney was settled as a penal colony in 1788 by the British on the shores of Port Jackson, which comprises the better known Sydney Harbour. Water supply was an important issue and the first regular water supply source was the Tank Stream, a small stream that flowed through the

settlement and into Sydney Harbour (Aird, 1961). Additional water sources were soon sought due to population growth and associated water demand, variability in rainfall and pollution from settlement activities (Aird, 1961; Boughton, 1999). Over time, the colonial government sourced the water from locations further from the city centre, for example, the Lachlan and Botany Swamps and Nepean River via canal to the Prospect Reservoir (Pigram, 2006). Separate systems water supply systems (e.g. Manly and Parramatta) were absorbed into the main metropolitan system during the early 1900s (Aird, 1961).

The first sewerage systems in central Sydney were constructed in between 1842 and 1859 (Aird, 1961). The early sewers carried combined sewer and stormwater flows and flowed to Sydney Harbour, following the European tradition of combined sewers until 1880 when they were then constructed to carry the stormwater and sewage flows separately (Aird, 1961). The sewerage system was diverted from Sydney Harbour and extended to discharge to Bondi Beach and also Botany Bay. These two sewer systems, completed in 1889, form the basis of the current sewerage system south of the Harbour (Aird, 1961).

Political and administrative delays in construction of the early sewer systems were caused by the colonial government doubting the ability of the Sydney Municipal Council to undertake the construction. This situation was resolved by dissolving the Sydney Municipal Council which was replaced by three appointed City Commissioners and sewer construction proceeded (Aird, 1961). The community supported public control of the water supply and sewerage and hence, once constructed, the sewers were transferred from the Commissioners to the Sydney Municipal Council (Aird, 1961).

Due to the growing city, water and sewerage needed to be managed by an organisation larger than the Sydney Municipal Council (Beasley, 1988) and so the Metropolitan Board of Water Supply and Sewerage (the Board) was established in 1888. With a membership of eight representing local government and the president being appointed by the Governor, the Board was responsible for making decisions about water supply and sewerage. Construction of infrastructure was divided between the Board which constructed smaller works (e.g. service reservoirs) and the Department of Public Works was responsible for the larger projects (Aird, 1961). The Board and its organisation functioned in a similar manner to a government department with the minister required to approve its budgets (Aird, 1961). This separation of responsibilities for asset construction caused conflict between the two organisations due to a lack of communication about asset handover and maintenance (Aird, 1961). The split responsibility between the organisations continued until 1924 when the Board was restructured to become the Metropolitan Water, Sewerage and Drainage Board.

A.1.4 Expansion

The Metropolitan Water, Sewerage and Drainage Board (MWSDB) was allocated sole responsibility for future construction of water supply, sewerage and drainage works and services,

and had greater independence from state government than the Board. During the passage of the restructure bill, debate arose around the MWSDB membership, with some politicians advocating representative membership and others supporting membership based on technical expertise. A large representative model was approved; although with 17 members, it was cumbersome and awkward (Aird, 1961). Following 1924, the drainage system assets were divided between local government and the MWSDB; the MWSDB constructed new main stormwater drains serving more than one municipality or shire and large works which were beyond the financial resources of the local authority and also ensured the local authorities constructed the minor drainage system (Aird, 1961).

The composition of the MWSDB changed during the 19th century in response to perceived poor performance by the state government. First, the number of representatives was reduced from 17 to seven with two appointed and five elected from local councils, maintaining the close relationship with local government (Aird, 1961; Beasley, 1988). Second, technical experts were introduced between 1972 and 1989 and the membership changed to comprise five members appointed by the minister and three chosen from a panel recommended by the Local Government Association, further separating the MWSDB from the representative model (Beasley, 1988). In 1983, the MWSDB members were sacked amidst allegations of inefficiency and mismanagement and the structure was changed to have small part time board and a general manager and a decentralised corporate structure (Beasley, 1988). Distributed offices were established to improve public relations and reduce bureaucracy (MWSDB, 1986).

Infrastructure construction for water supply continued during this period (refer Table A1), including the Shoalhaven Scheme, which coincided with the rise of environmentalism and changing social norms in Australia (Boughton, 1999). The environment movement challenged the pro-development paradigm of water resources management in Australia and increased the focus on preventing environmental degradation (Beasley, 1988).

Table A1 Summary of Major Sydney Water Sources

Reservoir	**Capacity (ML)**	**Year Completed**	**Approximate Sydney Population**
Prospect Reservoir	33 300	1888	300 000
Cataract Dam	94 300	1907	559 800
Cordeaux Dam	93 640	1926	1 019 900
Avon Dam	214 360	1928	1 066 400
Nepean Dam	70 170	1935	1 245 600
Woronora Dam	71 790	1941	1 331 300
Warragamba Dam	2 031 000	1960	2 132 700
Fitzroy Falls Reservoir#	23 500	1974	3 063 300
Wingecarribee Dam#	25 900	1974	3 063 300
Tallowa Dam#	90 000	1976	3 143 800
Sydney Olympic Park Recycling	1 132 /year	2006	4 254 900
Rouse Hill Recycling	4 600 /year	2009	4 400 000*
Kurnell Desalination Plant	250 /year	2009/2010	4 400 000*
Hoxton Park Recycled Water Scheme	2 000 /year	2013	4 500 000*

Population data is sourced from (ABS, 2006).
Capacity information is from SCA (2008).
* indicates forecasts are estimates.
# Part of Shoalhaven Scheme.

A prominent environmental event in Sydney related to water is the public outcry over the sewage pollution at Sydney's eastern beaches, high levels of pesticide contamination in fish, and also the response of the MWSDB and the State Pollution Control Commission (established 1970, DoC, 2009) in 1989. The outcry was exacerbated by publicisation that the extent of pollution was withheld by the authorities and in response, authorities were pressured to make changes which included increasing service fees, increasing trade waste staff, introducing an environmental levy and phasing out ocean sludge dumping (Beder, 1989). However these changes were viewed cynically by the community and were considered to be a response to publicity rather than proactively addressing the underlying problem (Beder, 1989). The Clean Waterways Program was established to address community anger and the problems of beach and ocean pollution. Environmental non-government organisations (NGOs) were invited to undertake an evaluation of the Clean Waterways Program and MWSDB's activities (later Sydney Water Corporation), which became known was the Sydney Water Project (Dowsett *et al.*, 1995). The NGOs were strong

critics of the MWSDB's activities and having them evaluate the MWSDB was considered to improve transparency and legitimacy (Dowsett *et al.*, 1995). The outcome of the Sydney Water Project was a series of strategic recommendations for Sydney Water Corporation, aimed at addressing the problems of the community and leading to more sustainable operations (Dowsett *et al.*, 1995).

Overall, the environmental impacts of traditional urban water activities have been identified upstream and downstream of the Sydney metropolitan area. The Hawkesbury-Nepean River system is heavily regulated for water supply and the fish communities have exhibited the impacts of these reduced flows (Gehrke *et al.*, 1999). Receiving waters have been negatively affected by stormwater runoff (Courtenay *et al.*, 2005) and sewer overflows (Bickford *et al.*, 1999), while long-term industrial pollution has resulted in widespread and difficult to remediate sediment pollution in Port Jackson (Taylor *et al.*, 2004).

A.1.5 Corporatisation

In 1990-91, the MWSDB was restructured to have separate operation and planning policy sections (DoC, 2007). Staff levels were reduced prior to the establishment of Sydney Water Corporation (Sydney Water), a state government owned corporation, on 1 January 1995. This followed a trend of market governance internationally (Bakker, 2002) and in Australia (Colebatch, 2006) (also see Chapter 2). At this time, Sydney Water had responsibility for management of the water supply catchments, dams and reservoirs, water supply distribution, sewerage collection and treatment, trunk stormwater drainage and approvals for developments. Public health, environmental protection and economic regulatory functions were established, held by: the NSW Department of Health, NSW Environment Protection Authority (EPA)[5], and the Independent Pricing and Regulatory Tribunal (IPART) respectively. Also refer to Table A2 for specific legislation and organisational responsibilities.

The formal institutional arrangements of the Sydney urban sector remained unchanged until the Sydney 'water quality incident' between July and September 1998 when high levels of *Cryptosporidium* and *Giardia* pathogens were recorded in raw and treated water supplied. 'Boil water' alerts were issued to the community although no illnesses associated with the incident were recorded (McClellan, 1998a). An inquiry into the incident undertaken by Peter McClellan (Queen's Counsel) concluded the event was caused by factors including *Cryptosporidium* and *Giardia* in the water supply catchments being washed into the reservoirs during heavy rain, uncertainty about the operation of Prospect Filtration Plant and poor diagnostic laboratory techniques. The inquiry recommendations included improving incident management and communication by Sydney Water and the NSW Department of Health, separating the catchment management and bulk water supply functions from Sydney Water and the subsequently

[5] NSW EPA was established in 1990, adopting responsibilities from the State Pollution Control Commission. The EPA is now part of the Department of Environment and Climate Change (DECC).

establishing the Sydney Catchment Authority (SCA) to perform these functions (McClellan, 1998b), an arrangement which continues today.

The overall structure of the sewerage system in metropolitan Sydney has not changed, the ocean outfalls are still the main discharge points with minimal treatment (Sydney Water, 2008a). Inland sewage treatment plants also discharge treated effluent to major rivers and have a higher level of treatment, up to tertiary level (Sydney Water, 2009b). The inland treatment plants were upgraded as part of the *WaterPlan 21*, a policy document issued by Sydney Water, which supported water recycling and community education to reduce water demand (Department of Land and Water Conservation, 1999). The changing institutional arrangements, negative community sentiment regarding urban water management and the Sydney Water Project also appear to have contributed to this change in approach. While responsibility for the drainage system has remained with Sydney Water and local government, new initiatives have been trialled. For example, in the Rouse Hill development area (western Sydney) which commenced in 2001, Sydney Water is responsible for flooding, waterway health and water supply including recycled water (Sydney Water, 2009c). This is a unique example of holistic urban water management in metropolitan Sydney to date.

Waterway health became a focus of government policy during the 1990s which was motivated by the realisation that stormwater was significantly degrading urban waterway health (Courtenay *et al.*, 2005). To improve stormwater quality management, the Urban Stormwater Program, managed by the EPA, required organisations responsible for stormwater, primarily local government, to prepare stormwater management plans based on catchment boundaries (Sharpin et al., 1999 cited in Brown, 2005). The resulting plans raised administrative awareness of the issue of stormwater quality management in local government but were varied in achieving on-ground outcomes (Brown, 2005).

Another initiative aimed at improving natural resource management across New South Wales was the establishment of regional catchment management authorities (CMAs) in 2003. The Sydney metropolitan region has two CMAs: Hawkesbury-Nepean to the west and north, and the Sydney Metropolitan CMA covering the remaining area. The Hawkesbury-Nepean is typical of most CMAs, as it has significant operational capabilities and works with landholders (mostly private landholders) to improve natural resource management. The Sydney Metropolitan CMA has a different role, providing a coordinating and leadership function to the community and other stakeholders (e.g. local government) and limited operational capability (SMCMA, 2008). The Sydney Metropolitan CMA has hosted the Water Sensitive Urban Design in Sydney capacity building program since 2006, which aims to build capacity across local government (Dahlenburg and Lees, 2004).

A.1.6 Water Shortage and Involvement of the Private Sector

Climate change scenario modelling predicts temperatures in New South Wales are likely to increase, with a tendency for dry periods to be accompanied by warmer temperatures than in the

past (Hennessy *et al.*, 2004). Higher temperatures increase evaporation which leads to decreased soil moisture and runoff (Chiew and McMahon, 2002), which will likely negatively impact waterway health (Hennessy *et al.*, 2004; Preston and Jones, 2006). Forecast impacts on reduced runoff range from no change (Jones and Preston, 2006) to a 15% decrease (Chiew and McMahon, 2002). However, extreme rainfall events (defined as the 1 in 40 year rainfall 1 day rainfall total) are predicted to change for the Sydney region by -3% - +12% in 2030 (CSIRO, 2007a; CSIRO, 2007b) and larger flood events have been estimated to become approximately twice as frequent for the Hawkesbury-Nepean and Upper Parramatta River catchments (Schreider *et al.*, 2000).

Sydney's water storages dropped from approximately 80% to 42% of capacity between January 2001 and July 2004 (SCA, 2009). With water storage levels remaining approximately half full between 2004 and 2007 (SCA, 2009), a number of state government policy initiatives were developed. One, in 2004 was BASIX (Building and Sustainability Index), initiated through a specific State Environment Planning Policy (NSW Government, 2006b). BASIX set mandatory water and energy efficiency and thermal comfort targets for residential buildings (new and larger renovations), which could be achieved by using water efficient devices or installing alternative water sources such as a rainwater tank or grey water system (NSW Government, 2006b).

At the same time, and seeing the water shortage as a business opportunity, a private water management organisation, Services Sydney, challenged Sydney Water's monopoly over urban water supply and sewerage services by applying to Sydney Water for access to the sewerage network. Many years of protracted applications and negotiations between Services Sydney and Sydney Water, the NSW State Government, IPART, and an application to the National Competition Council followed. However, Services Sydney's idea for large scale recycling and resale was effectively stalled with the NSW State Government's announcement to construct a desalination plant, which effectively removed the potential market for recycled water that Services Sydney had identified (van de Merwe, 2007), resulting in a hiatus for Services Sydney.

Further reinforcing market governance principles, the NSW State Government also introduced the *Water Industry Competition Act (2006)* (WICA), which enables water supply and network operator licences to be granted to third parties, including private organisations. The objective of the WICA was to harness the investment and innovation potential of the private sector (IPART, 2009). At the time of writing, two licences had been successfully gained by private sector organisations to recycled water for industrial and irrigation use (NSW Government, 2009).

The most recent major policy document is the 2006 Metropolitan Water Plan (MWP) which extended the 2004 plan (NSW Government, 2006a). The MWP focuses on water supply security, outlining strategies to ensure the security of Sydney's water supply for 25 years. Strategies include: a pipeline to transfer water from regional areas, outlets and pumps to access deeper water in storages; a water recycling plant; use of groundwater during drought; and a desalination plant.

Construction of a 250 Megalitre desalination plant started in Kurnell (eastern Sydney) (Figure A2) in 2007 which has the potential to be expanded to a capacity of 500 Megalitres. When completed, the desalination plant will be owned by Sydney Water, with operation and maintenance contracts held by a private company, Veolia Water.

Sydney Water continues to establish recycled sewage schemes to reduce potable water consumption; approximately 5% of the sewage is recycled for residential, industrial and river flows, thereby reducing the quantity of poor quality effluent discharged to the environment (Sydney Water, 2009e). Sydney Water plans to increase the amount of recycled sewage to approximately 11% (approximately 70 Gigalitres/year) by 2015 (Sydney Water, 2008c). Additionally, other organisations such as local government are undertaking sewage recycling projects (e.g. Beverley Park in the Kogarah Council area (Sydney Water, 2008b)). Demand management programs such as the 'Every Drop Counts' program (Sydney Water, 2009a) aim to decrease water consumption within the Sydney metropolitan area. Water consumption in Sydney was approximately 310 L/capita/day in 2009 which decreased from approximately 420 L/capita/day in 2003 due to water restrictions and demand management initiatives (Sydney Water, 2009d).

A.1.7 Current Institutional Arrangements

To conclude this section, a map of the current institutional arrangements for the Sydney urban water sector is presented in Figure A3 which provides an overview of the current interactions and relationships, and how they are structured for the key stakeholders in the urban water sector (as at October 2007, when Sydney interviews were concluded).

Sydney Water and Sydney Catchment Authority operate under policy developed by the Department of Water and Energy. Their operations are regulated by IPART (for pricing) and also the Department of Environment and Climate Change (for environmental purposes). NSW Health regulates both organisations for drinking water quality. The leaders of these organisations regularly meet through the Metro CEOs Group to facilitate communication about issues that arise and to develop responses to these issues (source: Sydney interviewees).

Local government operates under legislation administered by the Department of Local Government and receives policy advice related to stormwater management from the CMAs. Local government and the Department of Planning have important roles in stormwater management, particularly through their authority to approve developments and changes in land use, for example through master planning. Private sector organisations operating in urban water management include consultants, development organisations and private water management organisations (e.g. Veolia Water). NGOs and professional associations lobby the water organisations and state government departments, and provide formal responses to policy. More detailed information about roles, responsibilities and governance documents is contained within Table A2.

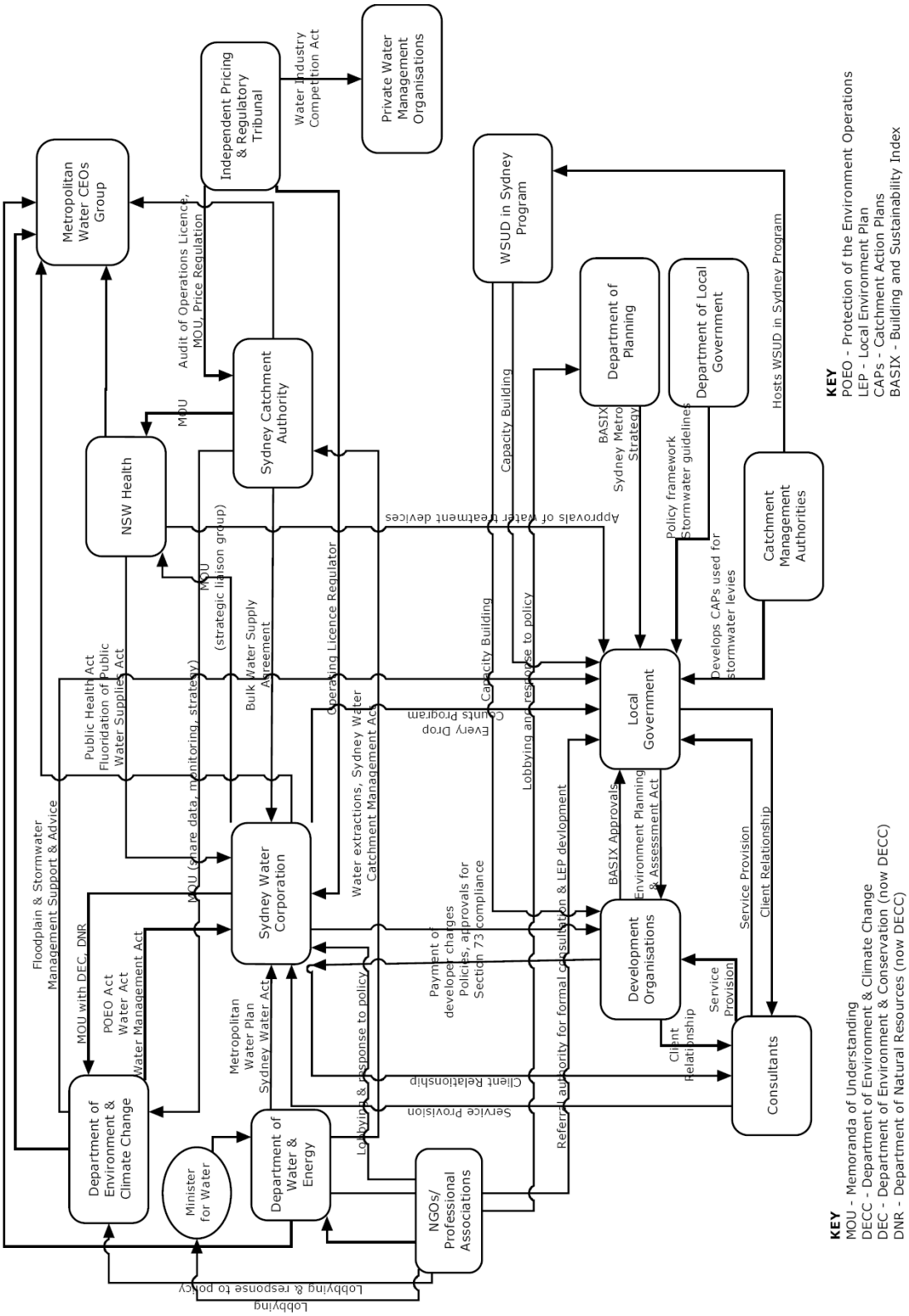


Figure A3 Schematic Diagram of Sydney Urban Water Management Institutional Arrangements

Table A2 Summary of Public Organisations in the Metropolitan Sydney Urban Water Sector

Organisation	Organisation Type	Responsibility	Formal Governance Documents
Sydney Water Corporation (SWC)	State government owned corporation	Water treatment, water supply, wastewater collection & treatment, trunk stormwater; provision of recycled water; demand management; floodplain manager in Rouse Hill development	Operating Licence; State Owned Corporations Act 1989 ; The Water Board (Corporatisation) Act 1994; Sydney Water Act 1994 ; Sydney Water Regulation 2006; Memoranda of Understanding with: NSW Health, Department of Natural Resources (now DWE), Department of Environment and Conservation (now DECC)
Sydney Catchment Authority (SCA)	State government agency	Catchment management; bulk water supply; some input into demand management	Operating Licence; Sydney Water Catchment Management Act 1998; Water Management Licence ; Memoranda of Understanding with: NSW Health, NSW Environment Protection Authority (now DECC), Water Administration Ministerial Council (now DWE)
Local Government	Democratically elected councillors, supporting administrative organisation	Stormwater; waterway health; some sewer mining & stormwater harvesting projects	Local Government Act 1993 and Regulations
Independent Pricing and Regulatory Tribunal (IPART)	Independent statutory authority	Economic regulator; administers operating licences for SWC and SCA; conducts health of the catchments audits and operational audits of SCA; administers the Water Industry Competition Act	Independent Pricing and Regulatory Tribunal Act 1993; Independent
Catchment Management Authority (Sydney Metropolitan and Hawkesbury-Nepean)	State government agency	State government natural resource manager	Catchment Management Authorities Act 2003; Catchment Action Plan (CAP) to establish objectives & strategic direction.
Department of Health (also known as NSW Health)	State government department	Public health regulator	Public Health Act 1991 (Part 2B Safety of Drinking Water); Fluoridation of Public Water Supplies Act 1957; Fluoridation of Public Water Supplies Regulation 2002; Code of Practice for the Fluoridation of Public Water Supplies

Organisation	Organisation Type	Responsibility	Formal Governance Documents
Department of Environment and Climate Change (DECC) (comprises former Environment Protection Authority, Department of Environment & Conservation)	State government department	Environmental regulator; formulates policy	Administers the following legislation: Catchment Management Authorities Act 2003; Protection of the Environment Administration Act 1991 (establishes the former EPA); Protection of the Environment Operations Act 1997
Department of Planning (formerly part of the Department of Infrastructure, Planning and Natural Resources)	State government department	State level planning policy; prepares Metropolitan Strategy; approval authority for the Drinking Water Regional Environment Plan, desalination plant; developed and implemented the Building and Sustainability Index (BASIX)	Environmental Planning and Assessment Act 1979; Metropolitan Strategy; Drinking Water Regional Environment Plan; Environmental Planning and Assessment Regulation 2000 and State Environment Protection Policy – Building and Sustainability Index , which enabled BASIX; responsible for Sydney Metro Strategy – the regional planning strategy for the metropolitan area
Department of Water and Energy (DWE) (formerly parts of Department of Energy, Utilities and Sustainability and the Department of Natural Resources)	State government department	Water authority regulator; Develops urban water policy	Administers: Sydney Water Act 1994; Water Efficiency Labelling and Standards (NSW) Act 2005; Water Industry Competition Act 2006; coordinates Metropolitan Water Plan preparation

Table A2 Summary of Public Organisations in the Metropolitan Sydney Urban Water Sector (continued)

A.2 MELBOURNE CONTEXT INFORMATION

A.2.1 Overview

This section describes the context surrounding the urban water management regime in Melbourne to supplement the description provided in Section 3.3.1. Due to the large amount of documentation available, refer to references such as Dingle and Rasmussen (1991), Powell (1989; 1999) and Brown and Clarke (2007) for further information.

A.2.2 Geographical Setting

Melbourne, the state capital of Victoria, is located on the south east coast of Australia (Figure A4). The Melbourne metropolitan urban area surrounds Port Phillip Bay and the Yarra River is the main river flowing from the eastern ranges to Port Phillip Bay (Figure A5). Other tributaries of the Yarra River flowing through the urban area include Merri Creek, Plenty River, Darebin Creek, Gardiners Creek, Diamond Creek and Mullum Mullum Creek. The other main river flowing through the urban area and discharging into Port Philip Bay is the Maribyrnong River, which flows through the western suburbs and joins the Yarra River near the central business district (Figure A5).

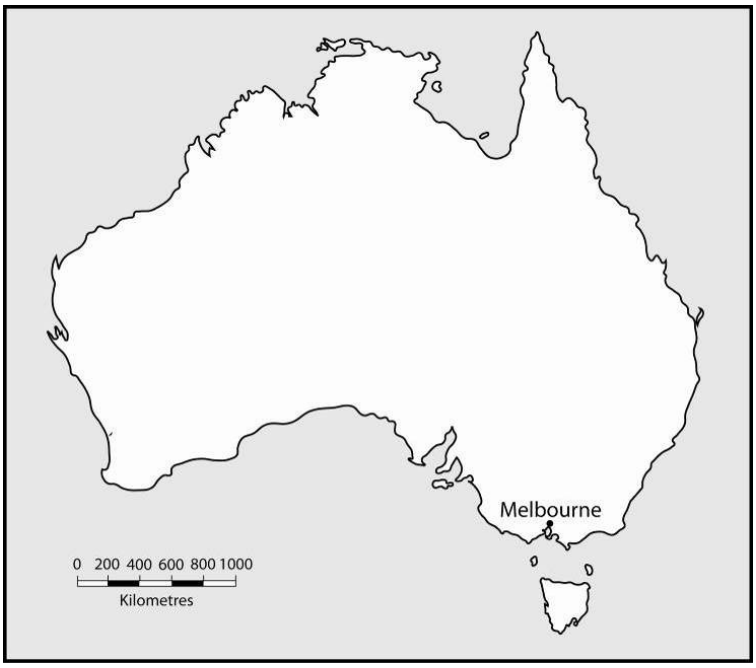


Figure A4 Location of Melbourne
Source: School of Geography and Environmental Science, Monash University.

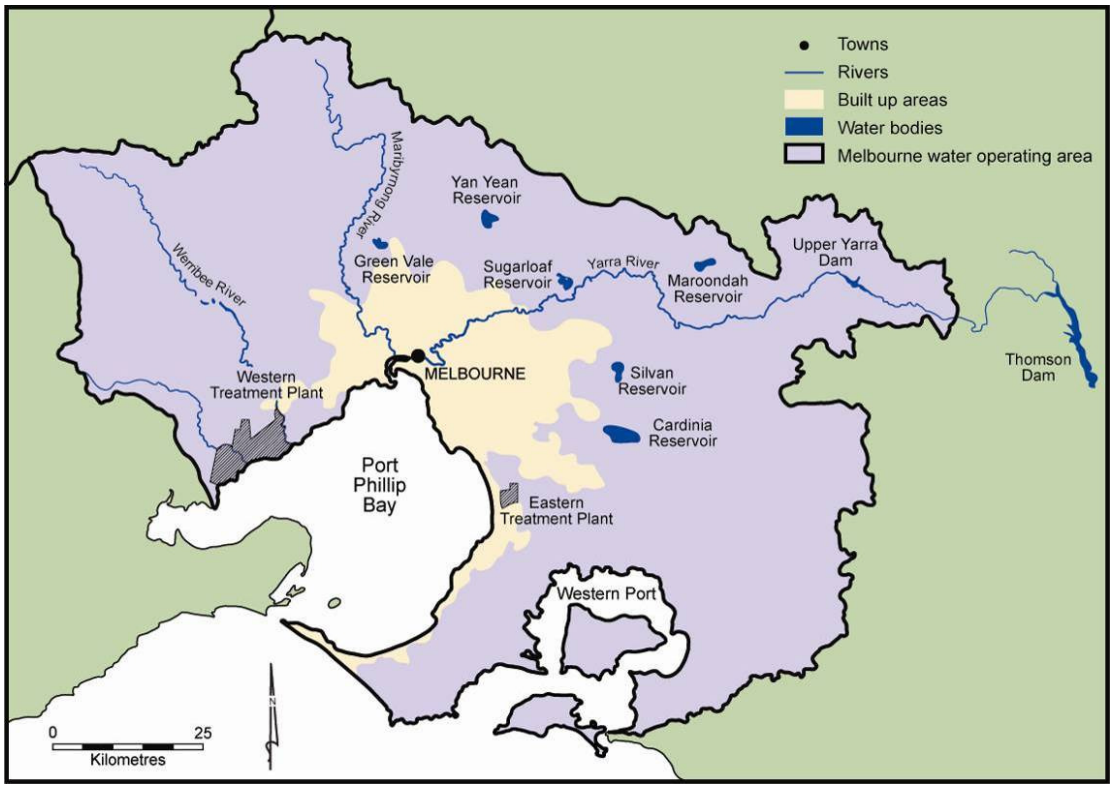


Figure A5 Melbourne Metropolitan Area and Major Urban Water Infrastructure
Source: School of Geography and Environmental Science, Monash University.

With a temperate climate, Melbourne's average annual rainfall is 651 mm, which is generally evenly distributed throughout the year although there is slightly lower rainfall between January and March (BOM, 2007). Melbourne experiences distinct summer and winter periods, separated by moderate autumn and spring seasons. Average monthly maximum temperatures range from 13.4°C in July to 25.8°C in January and February (BOM, 2007).

Metropolitan Melbourne has 38 local government areas and a population of 3.8 million in 2007, making it Australia's second largest city after Sydney (ABS, 2008b). Moderate population projections forecast the population to increase to approximately 5.0 million in 2026 and 6.8 million in 2056 and where it will retain its position as the second largest Australian city (ABS, 2008a).

A.2.3 Settlement

Europeans located their Melbourne settlement on the lower reaches of the Yarra River in 1834. The Yarra River was used as a water source from a site near the present day Queen Street Bridge in the centre of the central business district (Powell, 1989). At first there was no charge to residents accessing the river for water but private companies took advantage of the opportunity and sold water via pumps along the northern bank (Powell, 1999). A larger private operation began to exert its influence and seek to protect its business from other operators, however fear of a monopoly

operator being established caused the City Council to take action to stop the private organisation establishing a monopoly (Powell, 1989). The City Council maintained control over water supply, although this role was debated, until 1853 when the Mayor and Town Clerk were appointed to a Commission of Sewers and Water Supply which was established due the City Council lacking the requisite financial resources to manage the water supply (Dingle and Rasmussen, 1991).

As the urban development grew, pollution of the Yarra River became a more prominent problem affecting potable water supply. The first reservoir to be constructed for Melbourne's water supply was the Yan Yean Reservoir, north of the city in 1857 (Powell, 1989). Water supply was debated, particularly focusing on issues such as poor engineering and coordination, poor water quality and ingress of polluted water. Conflict between the City Council and the Commission of Sewers and Water Supply over water supply management continued until the Commission was abolished in 1860 and its powers were transferred to the newly formed Board of Land and Works (the Board) (Powell, 1989). Provision of adequate water remained a challenge with the first recorded long period of drought experienced between 1895 and 1902 (Powell, 1989).

Although there was general support for public water supply management because it was perceived as providing services at a lower cost, debate over water supply management continued within Melbourne (Powell, 1989). Typhoid outbreaks killed hundreds of people which increased the pressure on the government to construct a sewerage system; subsequently, a Royal Commission was established into the sanitary conditions of Melbourne which recommended an underground sewerage system would improve public health (Dingle and Rasmussen, 1991).

Further debate arose about the size and membership of the Board, payment for water supply assets and representation of inner and outer municipalities. These issues were resolved with the establishment of the Melbourne and Metropolitan Board of Works (MMBW), with 39 members elected from constituent municipalities and a chairman (Dingle and Rasmussen, 1991; Powell, 1999). The MMBW was charged with the responsibility for water supply and sewerage, and began construction of the Werribee Sewage Treatment Plant (now the Western Treatment Plant), beginning in 1892 with the first homes connected in 1897 (Melbourne Water, 2006).

A.2.4 Expansion

Water supply infrastructure expanded to meet the needs of the growing Melbourne population. The MMBW held significant power during the early 1900s, through control over large areas of Melbourne and access to adequate and sustained funding from rates across its expanding operational area (Powell, 1989). The closed catchment management policy to protect water supply quality was instituted by the Public Works Department and was adopted by the MMBW during the early 1920s, although it was not without its detractors, particularly logging and recreational stakeholders (Powell, 1989). Large reservoirs were constructed (see Table A4) and sources further from the Melbourne area were sought, which caused conflict between the MMBW and the State

Rivers and Water Supply Commission which managed regional water during the mid-20th century (Powell, 1989).

The MMBW formally become the metropolitan drainage manager under the *Metropolitan Drainage and Rivers Act 1923*, to overcome uncoordinated municipal drainage management (Dingle and Rasmussen, 1991). This Act provided the MMBW with responsibility for the beds and banks of all streams in the MMBW area, together with water supply, sewerage and flood protection responsibilities (Powell, 1989).

Table A3 Summary of Melbourne's Water Major Water Storages

Reservoir	**Capacity (ML)**	**Year Completed**
Yan Yean	30 000	1888
Maroondah Reservoir	22 000	1927
O'Shannassy Reservoir	3 000	1928
Silvan Reservoir	40 000	1932
Upper Yarra Reservoir	200 000	1957
Tarago Reservoir	37 500	1969
Greenvale Reservoir	27 000	1971
Cardinia Reservoir	287 000	1973
Sugarloaf Reservoir	96 000	1981
Thomson Reservoir	1 068 000	1984

(Melbourne Water, 2007)

Drought conditions during the 1960s and early 1970s increased the awareness of Melbourne's population to the need for 'drought proofing' Melbourne (Keating, 1992). At this time, community values were also changing with the rise of environmentalism around Australia and general community dissatisfaction with the pro-development approach of the previous years (Boughton, 1999). Institutionalisation of environmental protection was strengthened with the establishment of the Environment Protection Authority (EPA) in 1970. Increased environmental and social scrutiny focused on projects such as the construction of the Thomson Dam (Powell, 1989) and an outfall from the Carrum (eastern) sewage treatment plant to the Port Phillip Bay (Dingle and Rasmussen, 1991). Scientific investigations into the health of Port Phillip Bay, which highlighted sewage effluent discharges as adversely affecting water quality, contributed to the development of the first Victorian State Environment Protection Policy (SEPP), known as the Port Phillip Bay SEPP (released in 1975) (Brown and Clarke, 2007).

The MMBW membership expanded to include municipalities on the edges of the metropolitan area in the mid-20th century, which increased the influence of the MMBW on urban planning due to the

closer relationship between urban development and expertise in managing urban water services (Powell, 1989; Dingle and Rasmussen, 1991). However, the membership was changed to be less representative; in 1978 membership was changed from 54 unpaid commissioners representing local councils to a full time appointed chairman and six part time board members. Four of these part time members were elected based on groups of municipalities and two were appointed by the State Government (Dingle and Rasmussen, 1991). In 1982 along with the government shift to improve efficiency, the chairman became part time and a full time general manager was employed who did not retain formal membership of the board (Powell, 1989).

These changes reflected the changing approach to public sector management and increased calls for adaptability, accountability and efficiency (Powell, 1989), that is, the shift towards market governance. Additionally, the strategic urban planning responsibilities of the MMBW were reallocated to the Ministry for Planning and Environment, although the MMBW retained its water supply, sewerage and drainage functions. Demand management programs were also introduced including the education campaign "Don't be a Wally with water" and demand-based pricing (Dingle and Rasmussen, 1991).

A.2.5 Corporatisation

In a further move towards a corporate management approach, the MMBW merged with other similar organisations in the region to form Melbourne Water Corporation (Melbourne Water). In 1995, Melbourne Water was disaggregated and three retail water authorities were created as state owned corporations: Yarra Valley Water, City West Water and South East Water. Melbourne Water was responsible for catchment management, bulk water supply, bulk sewerage, and bulk drainage. The retailers have fixed geographical regions and are intended to compete on the basis of comparison rather than direct, market based competition (Godden, 2008). The retailers were charged with responsibility for the water supply distribution network, the sewerage network, trade waste, and household and industrial customer interaction. The State Government Department of Sustainability and Environment (DSE) is the primary water policy department while the public health, environment and economic regulatory functions are carried out by separate organisations: Victorian Department of Human Services, Environment Protection Authority and Essential Services Commission (ESC) respectively. The ESC adopted responsibilities which were previously held by the Office of the Regulator General and it regulates the prices of urban water services and market operation for Melbourne Water and the three retailers (ESC, 2010). The Drinking Water Regulatory Unit within the Department of Human Services has responsibility for the implementation and oversight of the *Safe Drinking Water Act (2007)* (Vic) (DHS, 2007).

While the responsibility for parks, waterways and environmental operations in the lower Yarra River catchment was separated from Melbourne Water as part of the efficiency agenda, these responsibilities were re-established in Melbourne Water's operations in 1997 (Brown and Clarke,

2007). Melbourne Water retained its trunk drainage responsibilities and is responsible for the main drains and waterways that serve sub-catchments greater than 60 hectares. Local government are responsible for local street and property drainage systems that serve sub-catchments smaller than 60 hectares (EPA *et al.*, 2002).

A second major scientific study into Port Phillip Bay's environmental health was conducted between 1992 and 1996 and concluded that although the environmental health of Port Phillip Bay was good, it was threatened by nitrogen levels resulting from stormwater and sewage effluent discharges (Harris *et al.*, 1996). A recommendation to reduce the nitrogen entering the Bay by 1000 tonnes from 1993 levels (Harris *et al.*, 1996) was incorporated into the State Environment Protection Policy (SEPP) (Waters of Victoria). The SEPP (Waters of Victoria) also aimed to improve waterway degradation from reduced environmental flows (Brizga *et al.*, 1996), increased pollutant loads and the magnitude and frequency of stormwater runoff events (Walsh, 2000). Melbourne Water, responsible for waterway management and bulk sewage treatment, set ambitious targets to reduce nitrogen from Werribee Treatment Plant and from diffuse catchment loads by 500 tonnes each (Brown and Clarke, 2007). Addressing the distributed nature of nitrogen loads was advanced by the Lynbrook Estate demonstration project of a Water Sensitive Urban Design (WSUD) 'treatment train' in southeast Melbourne.

The Lynbrook Estate involved multiple industry and research organisations to develop a treatment train approach to capture and treat stormwater before it was discharged to the environment (Lloyd *et al.*, 2002). As the local government was reluctant to approve the innovative design, Melbourne Water underwrote the cost of replacing the WSUD drainage system with a conventional 'pit and pipe' system if it failed (Brown and Clarke, 2007). The Lynbrook Estate WSUD treatment train succeeded and is considered to have encouraged the adoption of other WSUD systems in Australia (Lloyd *et al.*, 2002). As the concept of WSUD evolved, it was further institutionalised by the publication of 'best practice' guidelines, such as the *Urban Stormwater: Best Practice Environmental Management Guidelines* (Stormwater Committee, 1999).

The State Government establishment of catchment management authorities (CMAs) across Victoria in 1994 needed some adjustment for the Melbourne metropolitan region to ensure the responsibilities were clearly allocated between Melbourne Water and Port Phillip and Westernport Catchment Management Authority (PPWCMA). The PPWCMA's roles are to develop policy documents including the Regional Catchment Strategy (RCS), promote cooperation in and provide advice on land and water management, report on the condition of the catchment and promote community awareness of catchment management issues (PPWCMA, 2007). The PPWCMA partners with local government, state government departments, the EPA, Melbourne Water and the three retail water authorities in the Melbourne metropolitan area to achieve its objectives.

A.2.6 Response to Water Shortage

While the institutional arrangements were stable at the turn of the 21st century, the physical situation of Melbourne's water supply was less so. Drought conditions began in 1998 and continue, leading to over a decade of low rainfall and associated low inflows into Melbourne's water storages (Melbourne Water, 2009b). Climate change impact modelling predicts there will be reduced rainfall over south eastern Australia, reducing water supply into Melbourne's reservoirs by 7% by 2020 and by 18% by 2050, while the frequency and magnitude of the heaviest rainfall events is likely to increase (Howe *et al.*, 2005). However, the current drought conditions have seen lower rainfall and stream inflows than the climate models predicted (Melbourne Water, 2009a).

Since 2000, a number of state government policy documents were developed as part of the strategic planning program for Melbourne's urban water management. These policies include:

- a 50 year strategy, *21st Century Melbourne: a WaterSmart City* (WRSMAC, 2002);
- a white paper, *Our Water Our Future: Securing Our Water Future Together* (OWOF) (DSE, 2004);
- the *Central Region Sustainable Water Strategy: Action to 2055* (CRSWS) (DSE, 2006a); and
- *Our Water Our Future: The Next Stage of the Government's Water Plan* (OWOF2) (DSE, 2007).

These policy documents demonstrated the response of state government to the challenges of increased population and decreased water supply, the need to address waterway health, and integration of the Melbourne metropolitan area within its broader regional context. Across these documents, policy initiatives varied and included demand reduction through permanent water saving rules (DSE, 2006b) and use of alternative water sources.

An implicit shift towards network governance was marked in the CRSWS which states that there is no single solution to the challenges faced and that all stakeholders will be required to contribute to achieving the benefits outlined in the plan (DSE, 2006a), which is in contrast to the traditional hydro-social contract where government provided all water services with little fro citizens to do but consume potable water (Wong and Brown, 2009). However, this direction was challenged through OWOF2 (DSE, 2007), which was developed in a hierarchical manner and emphasised Melbourne's water supply security and comprised major supply system augmentation, including a desalination plant and pipeline to draw further water from regional Victoria, thus reinforcing the government's role in large centralised water supply provision (Keath and Brown, 2008).

For residential developments, stormwater quality was incorporated into the Victorian Planning Provisions Residential Subdivision Clause 56 (herein Clause 56) in October 2006 (DSE, 2006c),

which mandated the use of WSUD technologies across Victoria. Inclusion of stormwater quality objectives in the planning provisions is significant as it enables local government to require developers to meet these objectives for residential development. The Clearwater capacity building program was also formed in 2002, which provides a range of training, networking, site visits and information sharing programs to build water industry skills and capacity (Clearwater, 2008), including helping to build local government capacity to implement Clause 56.

With the significant water supply augmentation infrastructure being constructed (desalination, regional pipelines) as part of the OWOF2 policy, water prices were forecast to rise. The Victorian Premier announced that the Victorian Competition and Efficiency Commission (VCEC) would undertake a review into the structure of the urban water sector with the objective of improving its efficiency and to ensure the forecast price increases were consistent with government predictions they would approximately double by 2012 (Brumby, 2007). The review found that there were minor efficiencies to be gained by an industry restructure but that cooperation would lead to improved savings through cost sharing and also some changes to the governance arrangements to increase transparency and reflect the complexity of the policy, regulatory and economic contexts in which the retailers operate (VCEC, 2008).

A.2.7 Current Institutional Arrangements

There have been numerous changes to the institutional arrangements described in this section; Figure A6 illustrates the key organisational stakeholders and the relationships between them (as at July 2008, at the conclusion of Melbourne interviews). Melbourne Water and the three water retailers operate under legislation administered by DSE and also their activities are regulated by the EPA. The Department of Human Services also regulates these organisations relating to water quality including use of alternative water sources. The Essential Services Commission regulates the prices that Melbourne Water and the three retailers can set for urban water services and monitors industry operation.

Local government operates under legislation administered by the Department for Local Government. Local government receives policy and technical advice and guidance from the EPA and Melbourne Water relating to stormwater management. Melbourne Water is also a referral authority for approving development applications, submitted to local government from development organisations with regards to regional drainage and waterway health management. Land development organisations also receive advice from Melbourne Water during the design phase of their projects. The Department of Planning and Community development administers the Victorian Planning Provisions, including Clause 56. The PPWCMA works with local government and Melbourne Water and the three retailers in natural resource management to implement the Regional Catchment Strategy. Consultants work with a wide range of urban water stakeholders, primarily Melbourne Water and the retailers, local government and development organisations.

These relationships have both service provision and client components. Table A4 summarises the roles, responsibilities and major legislation, formalised inter-organisational arrangements and policy documents among public sector organisations.

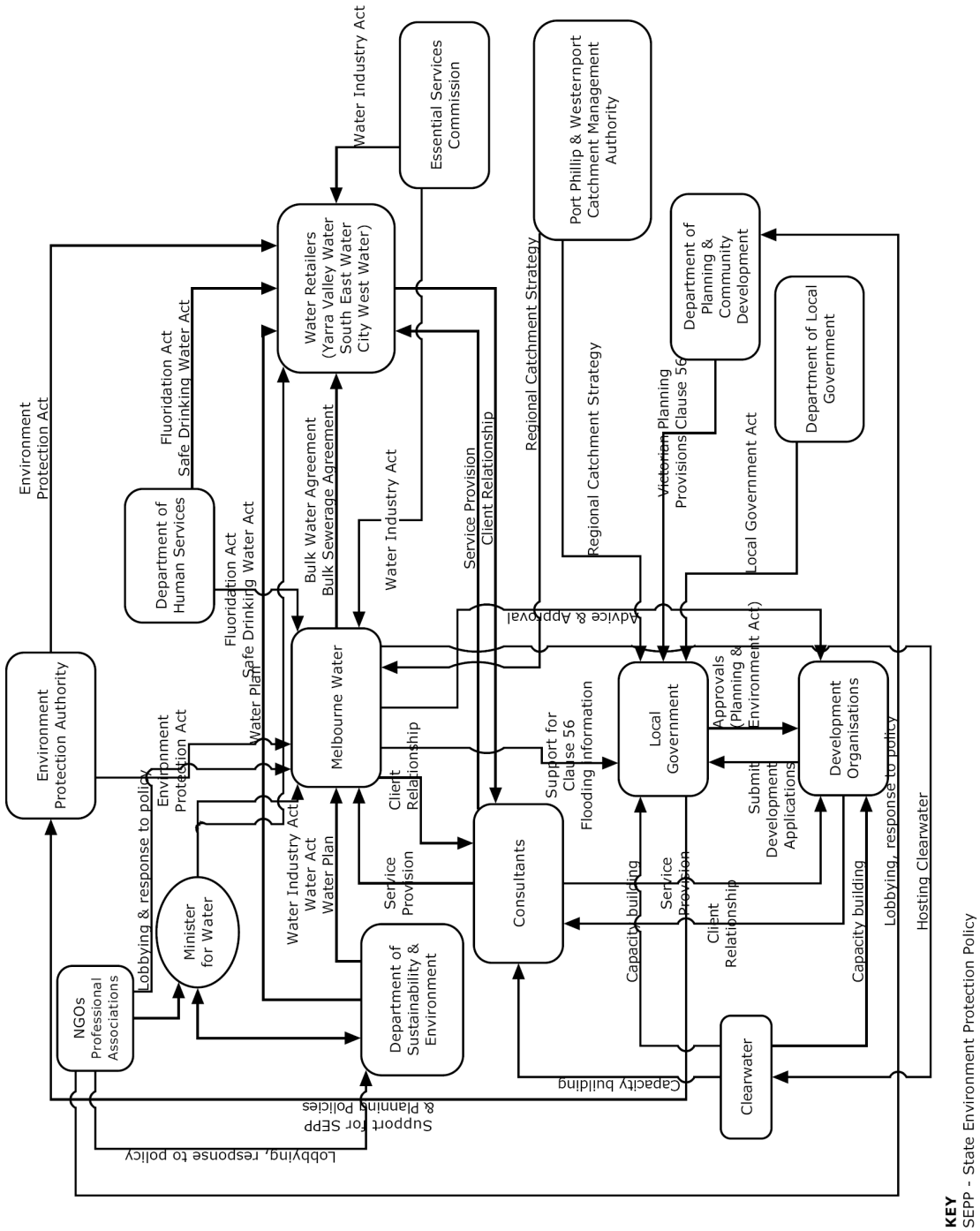


Figure A6 Schematic Diagram of Melbourne Urban Water Institutional Arrangements

Table A4 Summary of Public Organisations in the Metropolitan Melbourne Urban Water Sector

Organisation	Organisation Type	Responsibility	Formal Governance Documents
Melbourne Water Corporation	State government owned corporation	Catchment management; bulk water supply; water treatment, water supply, wastewater collection & treatment, trunk stormwater; Provision of recycled water; waterway health; regional drainage (catchments larger than 60 hectares)	Statement of Obligations; Water Industry Act 1994; Water Act 1989; Water Plan; Bulk Water Agreement & Bulk Sewerage Agreement with water retailers
City West Water South East Water Yarra Valley Water (water retailers)	State government owned corporation	Potable water distribution to customers (residential, industrial, commercial); sewage collection from customers (residential, industrial, commercial); demand management	Statement of Obligations; Bulk Water Agreement & Bulk Sewerage Agreement with Melbourne Water
Local Government	Democratically elected councillors, supporting administrative organisation	Stormwater & flooding on catchments less than 60 hectares; waterway health; some sewer mining & stormwater harvesting projects; development approvals	Planning & Environment Act 1987 (includes Victorian planning provisions); Provides support for State Environment Protection Policy (SEPP) & Planning Policies for Environment Protection Authority
Essential Services Commission	Independent statutory authority	Economic regulator which involves making price determinations, imposing consultation obligations in relation to determinations, regulate standards and conditions of service; require regulated businesses to provide information.	Essential Services Commission Act 2001; Water Industry Act 1994; Water Industry Regulation Order (part of Water Industry Act 1994)
Port Phillip & Westernport Catchment Management Authority	State government agency	State level natural resource manager; coordination & facilitation for catchment management policy	Catchment and Land Protection Act 1994; Regional Catchment Strategy
Department of Human Services	State government department	Public health regulator	Health (Fluoridation) Act 1973; Safe Drinking Water Act 2003
Environment Protection Authority	State government agency	Environmental regulator; formulates policy	Environment Protection Act 1970; State Environment Protection Policy (SEPP)

Organisation	Organisation Type	Responsibility	Formal Governance Documents
Department of Sustainability & Environment	State government department	State level water and natural resource management policy	Water Industry Act 1994; Water Act 1989; Water Plan; Central Region Sustainable Water Strategy
Department of Community Planning & Development	State government department	State level urban planning policy	Planning & Environment Act 1987 (includes Victorian planning provisions);
Department of Local Government	State government department	Administers Local Government Act	Local Government Act 1989

Table A4 Summary of Public Organisations in the Metropolitan Melbourne Urban Water Sector (continued)

Appendix B – Interview Explanatory Statement & Interview Questions

Note: The explanatory statements were identical for Sydney and Melbourne, except for changing the city names; only the Melbourne explanatory statement is included in Appendix B.

MONASH University

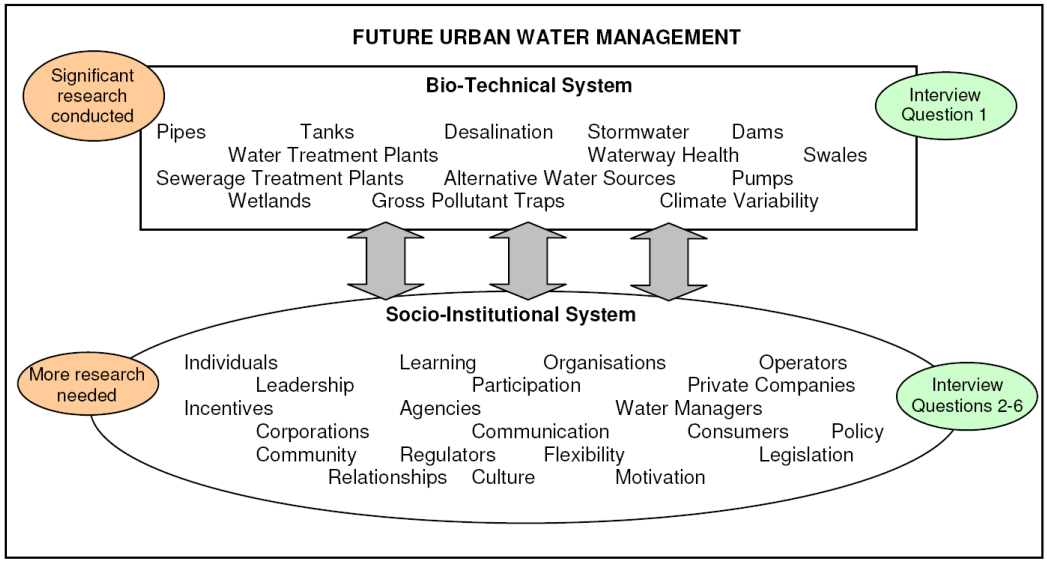
School of Geography and Environmental Science
Faculty of Arts

Explanatory Statement for Interview Participants
Sustainable Urban Water Management and Institutional Capacity

My name is Susan van de Meene and I am conducting a research project supervised by Dr. Rebekah Brown and Professor Chris Cocklin in the School of Geography and Environmental Science towards a Doctor of Philosophy degree at Monash University.

Purpose
Improved urban water management is now widely recognised as an important social and political objective. Significant research has been undertaken into water related infrastructure and technologies to improve urban water management, for example, biofiltration systems and water efficient technologies. However, the 'softer' part of a sustainable urban water system, the individual, organisational and administrative aspects are not well understood. Together, these are known as the socio-institutional capacity qualities (refer figure).

The objective of the interviews is to vision, identify or imagine, attributes or qualities of the 'softer' part of a future, more sustainable urban water management system for individuals, organisations and the administrative framework. The interview responses will be used to develop a tool to assess the existing urban water management system in relation to the qualities identified for future urban water management. Development of the tool is the overall research objective. The results of the socio-institutional assessment could then be used for planning future programs to develop these qualities. The tool could also be used for communication between people in different organisations and roles.



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Interview Questions
Semi-structured interviews with urban water management and related staff will be conducted in both Sydney and Melbourne, lasting approximately 60 minutes. The interview questions for Melbourne are:

1. In your view, what should urban water management in Melbourne look like in 10 – 15 years to ensure it is on a sustainability pathway?
2. What do you see as the new skills, knowledge and other attributes people working in the sector will need to have to realise this vision?
3. How would your organisation need to change to realise this vision?
4. Would your organisation need to interact with other organisations differently? If so, how?
5. What should the administrative arrangements for urban water management across Melbourne look like in 10 – 15 years?
6. If there was only *one* strategic action that could be implemented in Melbourne to make your vision a reality, what would that be?

Data Management
Interviewees were identified from relevant industry and academic literature with contact details obtained via the Internet or via organisational representatives. The interview is voluntary and you have the right not to answer any questions for any reason. It is anticipated that there will not be any significant risks of harm to you as a result of your participation in this research.

Permission from the interviewees will be obtained to audio-record the interview for subsequent written transcription. In reporting of the research your name will not be identified and the reporting will not include any quotes attributed to you. Any quotes used will be attributed to different stakeholder groupings: water management organisation, state or local government, consultant, developer, professional association, and non-government organisation. In addition to the Doctor of Philosophy thesis, the data may also contribute to the findings reported in a journal article or conference presentation.

The data provided by the interviewees will be available to the key researchers involved in the research but the interviewees' names and identities will not be revealed in any way. The transcripts will be securely stored by the researchers and available to no other persons, unless the researchers give permission. In accordance with Monash University policy, the transcripts will be destroyed in 5 years.

Future Interaction with Interviewees
The interview transcript will be available for you to review. Each interviewee will be sent an intermediate research report in early 2008 for comment. The report will consist of a summary of the interviews and key findings. You can choose to withdraw from the research at any time prior to having reviewed the interview transcript by contacting Susan van de Meene (details below).

If you require further information, please contact Susan van de Meene on [redacted] 03 9905 2918, fax 03 9905 2948 or susan.vandemeene@arts.monash.edu.au.

Thank you for your time. Your input into this research is very much appreciated.

If you would like to contact the researchers about any aspect of this study, please contact the Chief Investigator:	If you have a complaint concerning the manner in which this research (project 2006/1038LIR) is being conducted, please contact:
Dr. Rebekah Brown Senior Lecturer Tel: +61 3 9905 9992 Fax: +61 3 9905 2948 Email: rebekah.brown@arts.monash.edu.au	Human Ethics Officer Standing Committee on Ethics in Research Involving Humans (SCERH) Building 3e Room 111 Research Office Monash University VIC 3800 Tel: +61 3 9905 2052 Fax: +61 3 9905 1420 Email: scerh@adm.monash.edu.au

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Appendix C – Coding Structure for Governance Analysis

Figures C1 – C4 illustrate the relationship between the open and axial codes for each of the four regime elements: actors, processes, structures and influences. Refer to Section 6.2 (Publication 4) for the results and discussion of the governance analysis.

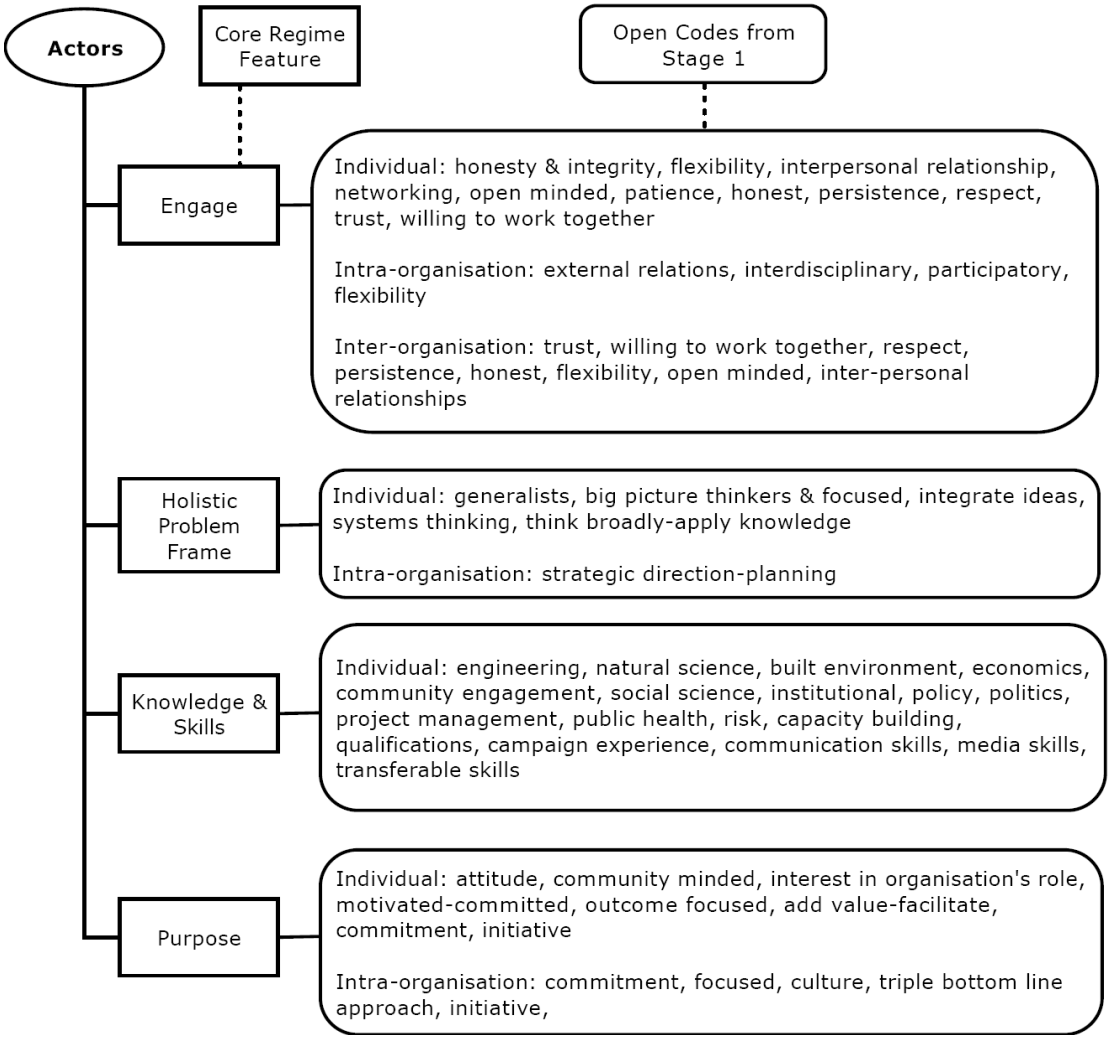
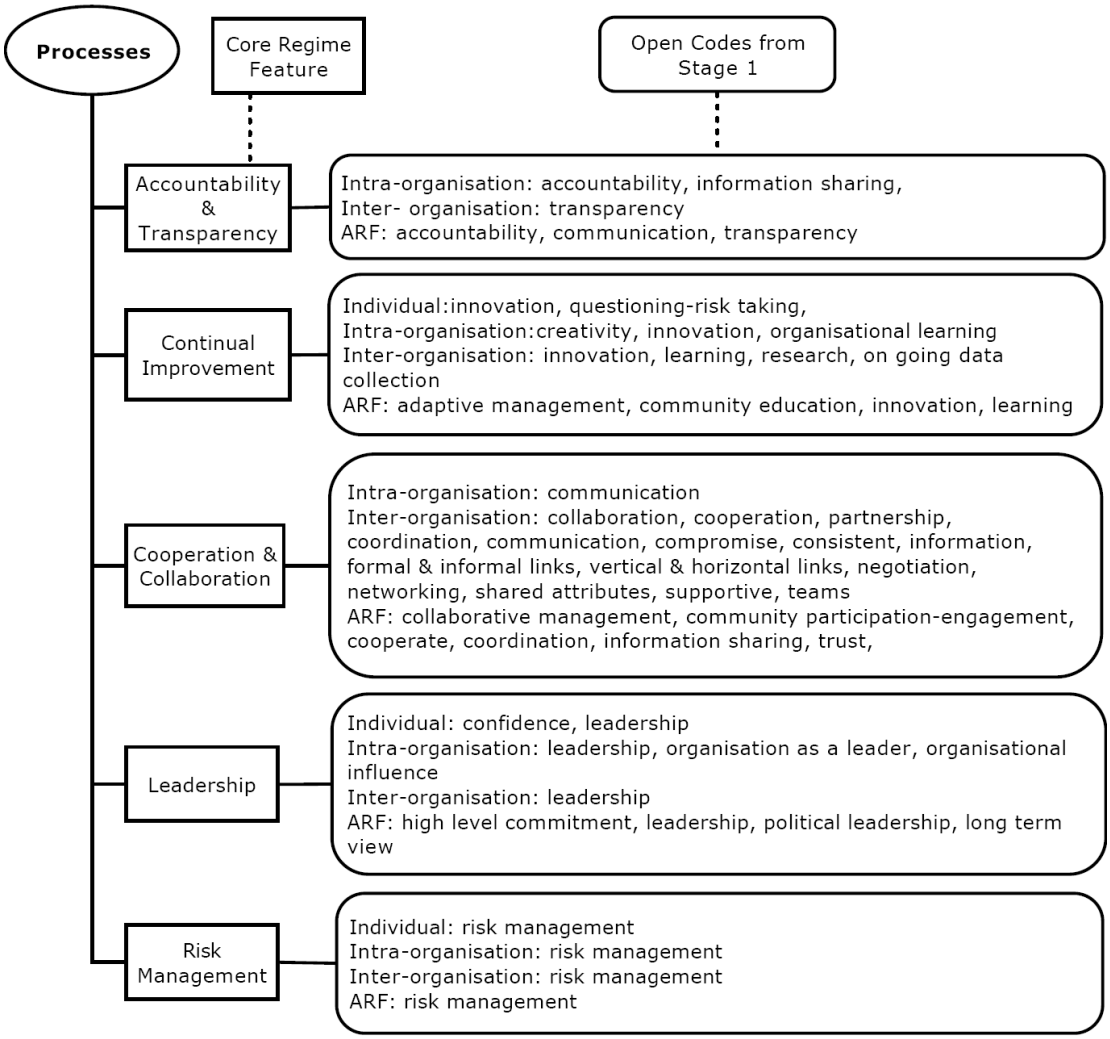
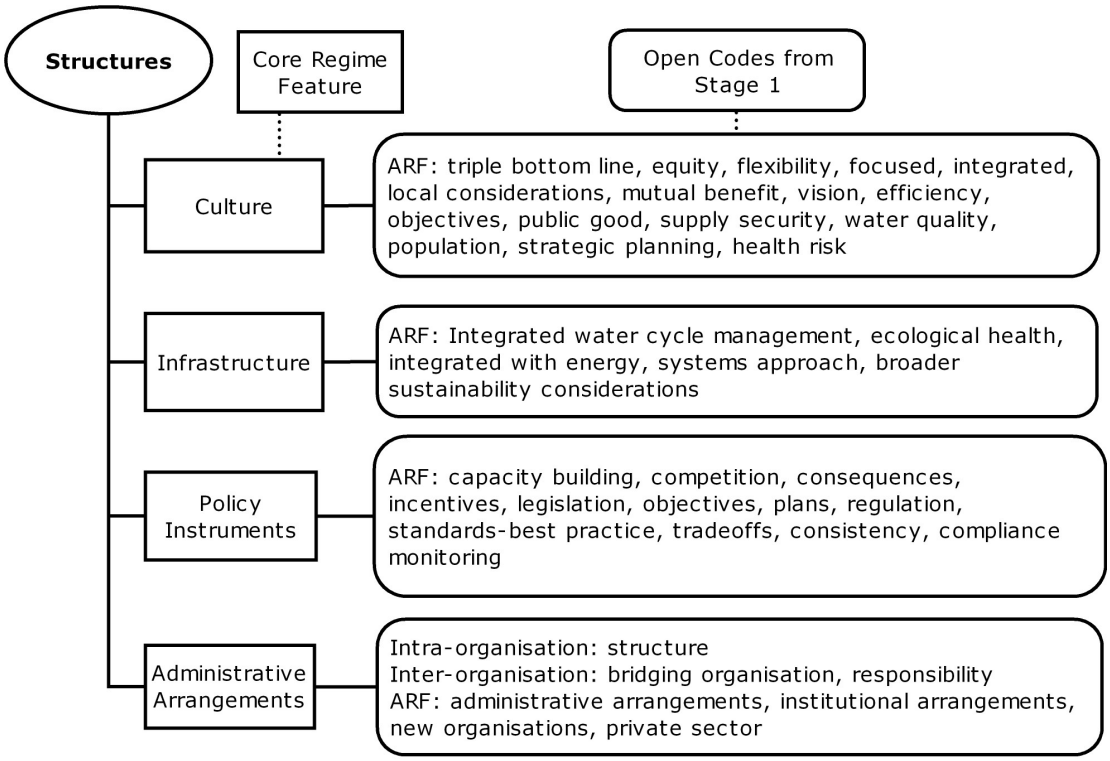


Figure C1 Relationship between Open and Axial Codes for the Actors Regime Element Governance Analysis



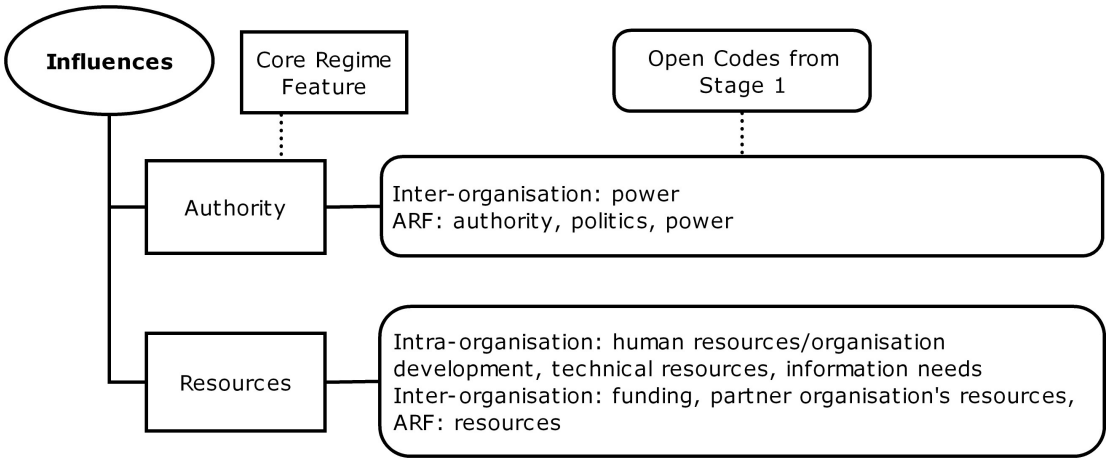
ARF - Administrative & Regulatory Framework

Figure C2 Relationship between Open and Axial Codes for the Processes Regime Element Governance Analysis



ARF - Administrative & Regulatory Framework

Figure C3 Relationship between Open and Axial Codes for the Structures Regime Element Governance Analysis



ARF - Administrative & Regulatory Framework

Figure C4 Relationship between Open and Axial Codes for the Influences Regime Element Governance Analysis