Using a diagnostic indicator assessment to understand sustainability transitions towards Water Sensitive Urban Design in the City of Cape Town

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Abstract

Cities globally are progressively becoming hotspots for water related risk and disaster mainly as a result of the cumulative effects of rapid urbanisation, population growth and the impacts of climate change. South African cities in particular are faced with the dual challenges of meeting demand for scarce water resources, as well as mitigating urban flooding. A shift towards adaptive and sustainable approaches has been proposed in order to address these complexities whilst ensuring the satisfactory delivery of water services to citizens. To support this change, local authorities are tasked with restructuring policy to include climate change adaptation strategies in order to adapt more adequately and proactively. In this regard, Water Sensitive Urban Design (WSUD) has gained importance in terms of guiding cities around the world in transitioning towards becoming water sensitive. WSUD aims to ensure that urban planning and design is undertaken in an interdisciplinary way and minimises the hydrological impacts of development on the surrounding environment. Sustainability transitions literature recognises that infrastructure and technologies are highly intertwined with institutional structures, regulations and social practices. For this reason, transitions towards sustainability-oriented technologies typically involve significant changes along assorted dimensions of the socio-technical system. Accordingly, this project aims to understand and identify the fundamental institutional conditions necessary to support a transition towards WSUD, using the City of Cape Town (CoCT) as a case study site. In order to achieve this aim, the City Blueprint Approach (CBA) was applied to the CoCT based on in-depth interviews and publicly available data. The CBA was developed by the KWR Watercycle Research Institute in cooperation with Utrecht University, The Netherlands and has been tested on various cities globally. It is a set of diagnostic indicator tools comprising the Trends and Pressures Framework, the City Blueprint Framework and the Governance Capacity Framework. The CBA assessment was followed by a thematic analysis to understand the context of transitions to a WSUD approach in Cape Town. The results of the research indicate that the CoCT has had some success in its efforts related to the sustainable management of water resources through the implementation of policy, action plans and a range of learning opportunities for city officials and local stakeholders. Despite these efforts however, issues of financial viability, implementing capacity and political will have hindered progression towards WSUD in the City. In conclusion, the research has emphasised that sustainable water management and a transition towards a WSUD approach requires more than just redesigned infrastructure; it has also highlighted the different institutional aspects that make transitioning towards WSUD possible both in Cape Town, as well as for other cities in developing countries with similar socio-economic contexts to South Africa.

Acronyms

BCI	Blue City Index
CBA	City Blueprint Approach
CBF	City Blueprint Framework
CoCT	City of Cape Town
CoP	Communities of Practice
DMA	District Metered Area
DRMC	Disaster Risk Management Centre
DWS	Department of Water and Sanitation
FPRCMP	Flood Plain and River Corridor Management Policy
GCF	Governance Capacity Framework
GoSP	Genius of Space Project
IDP	Integrated Development Plan
IWA	International Water Association
IWRM	Integrated Water Resources Management
MIR	Market Intelligence Report
MLD	Mega Litres per Day
MLP	Multi-Level Perspective
MSDF	Municipal Spatial Development Framework
MUSIP	Management of Urban Stormwater Impacts Policy
NWRS	National Water Resources Strategy
NWSA	National Water Services Act
SA	South Africa
SuDS	Sustainable Drainage Systems
SNM	Strategic Niche Management
SUWM	Sustainable Urban Water Management
TM	Transitions Management
TPF	Trends and Pressures Framework
UCT	University of Cape Town
UNCED	United Nations Conference on Environmental Development
UWMTF	Urban Water Management Transitions Framework
WC	Western Cape
WCG	Western Cape Government
WC/WDM	Water Conservation Water Demand Management
WCWSS	Western Cape Water Supply System
WSA	Water Services Authority
WSC	Water Sensitive Cities
WSDP	Water Services Development Plan
WSP	Water Services Provider
WSUD	Water Sensitive Urban Design
WWT	Waste Water Treatment
100RC	100 Resilient Cities

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Chapter 1 - Introduction

1 Background and purpose

Cities globally are progressively becoming hotspots for water related risk and disaster mainly as a result of the cumulative effects of rapid urbanisation, population growth and the impacts of climate change (Wamsler *et al*. 2013). The global demand for water has been increasing at a rate of 1% per year as a function of various factors including population growth, changing consumption patterns and economic development (United Nations 2018). At the same time, climate change has caused the global water cycle to intensify resulting in some regions experiencing drier conditions whilst others experience wetter conditions (United Nations 2018). As a consequence, almost half the global population is currently living in regions that experience water scarcity approximately once per month (United Nations 2018). On the other hand, approximately 15% of the global population is currently (2018) at risk from floods. Over and above the issues of water scarcity and flood risk, water pollution has also worsened globally. Approximately 23% of the global population use poor quality drinking water that is potentially contaminated by human faeces (United Nations 2018). The implications of the global water crisis are also visible in the challenges governments (especially in developing countries) face to equitably deliver water and sanitation services to people.

Water has thus become a critical societal and geopolitical issue in many regions (Guppy & Anderson 2017). South African (SA) cities in particular are faced with the dual challenges of meeting demand for scarce water resources, as well as mitigating urban flooding. SA is a semi-arid country, with seasonal rainfall that is distributed unevenly throughout the country (Friedrich *et al*. 2009). SA experiences a rainfall average of less than 500 mm/year (compared to a global average of 869 mm), making it the thirtieth driest country in the world (Friedrich *et al*. 2009; Department of Water Affairs [DWA] 2013). Therefore, increasing water demand is putting pressure on the allocation and management of water resources in SA cities (DWA 2013). In particular, climate change research has projected a decrease in annual rainfall for the City of Cape Town (CoCT) (Abiodun *et al*. 2017). This is evident in the severe drought conditions experienced in Cape Town from 2015 to 2018, resulting in a limited supply of water resources. Even though it is estimated that rainfall will decrease in Cape Town over the medium to long term, flood risk and drainage are also a significant area of concern for the City. These issues pose a threat to various aspects of human life such as food security, quality of human health and livelihoods.

United Nations agencies, governments and civil societies have stressed the necessity for new approaches to water management to be adopted by governments in order to *"reverse these sobering water trends"* (Guppy & Anderson 2017 p.1). *"'Business as usual' will mean the world will miss water-related SDGs by a wide margin; up to forty percent of the world's population will be living in seriously water-stressed areas by 2035; and the ability of ecosystems to provide fresh water supplies will become increasingly compromised"* (Guppy & Anderson 2017 p.1). Proponents have identified various characteristics of new water management approaches that will promote

sustainable water management in cities. These include utilising a diversity of water supply options; treating and reusing wastewater; improving the health and quality of waterways; designing and installing adaptive, resilient infrastructure; incorporating urban planning and design with water planning, as well as managing the interactions between water, waste, energy, food and amenity (De Haan *et al*. 2015). A critical challenge of water management issues in many cities is their design and the use of conventional infrastructure which is not suitable to address sustainability issues (Wong & Brown 2009). As a result new technological and infrastructural innovations are being developed to support the vision and goal to achieve sustainable water management in cities. These include, rainwater harvesting systems and Sustainable Drainage Systems (SuDS) technologies such as permeable paving and swales (De Haan *et al*. 2015). Nature-based solutions have also been recognised for their potential to contribute towards achieving sustainable water management in cities (United Nations 2018). Nature-based solutions are technologies and design ideas that are *"Inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water"* (United Nations 2018 p.22). These include dry toilets, at micro scale and constructed wetlands at a landscape scale (United Nations 2018). These technological innovations can often be integrated with existing water infrastructure in order to enhance the management of water (United Nations 2018).

In addition to adaptive and resilience-focused technologies and infrastructure, a transition towards sustainable water management in cities requires a shift in the institutional arrangements and regulatory frameworks that influence decision-making at a range of scales (policy-making to day-to-day management) and shape the governance of urban water resources (Brown *et al*. 2008; Wong & Brown 2009; Dobbie *et al*. 2017). Local authorities are increasingly being tasked with restructuring policy to include climate change adaptation strategies to deal more adequately and proactively with these new challenges.

The Water Sensitive Urban Design (WSUD) approach provides a framework for holistic management of the urban water cycle and its integration into urban design (Brown *et al*. 2008). WSUD encompasses all aspects of the urban water cycle including stormwater management, water treatment and water supply, and *"represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities…"* (Fletcher *et al*. 2014 p.4). The principles of WSUD aim to ensure that water is given prominence within urban design processes through the integration of urban design with various other disciplines such as environmental science and engineering that are associated with the provision of water services and the protection of aquatic environments in urban areas (Wong & Brown 2009). WSUD therefore represents an interdisciplinary approach which encompasses the concepts of both social and physical science (Brown *et al*. 2008). The WSUD approach has gained importance in terms of guiding cities around the world in the socio-technical transformations of conventional approaches needed to aid transitions towards becoming Water Sensitive Cities (WSC) (Wong & Brown 2009; Rijke *et al*. 2013; Fletcher *et al*. 2014).

Much focus has been placed on innovation and development of sustainable technologies rather than on the institutional changes required for successful transitions towards Sustainable Urban Water Management (SUWM) approaches (Loorbach 2010; Rijke *et al*. 2013). This is further evident in the plethora of research focused on the technical aspects of WSUD (Beecham *et al*. 2010; Beecham & Chowdhury 2012; Ahammed *et al*. 2012; Fryd *et al*. 2013). Moreover, much of the existing research on the social and governance aspect of WSUD transitions mainly considers transitions in the context of developed cities (Poustie *et al*. 2016; Wong & Brown 2009; Brown & Farrelly 2009; Floyd *et al*. 2014). While the WSUD Framework, presented by Brown *et al.* (2009), is relevant in terms of informing transitions to a WSUD approach in developing countries, it will be more useful to adapt the framework to the developing country context (Fisher-Jeffes *et al*. 2012; Armitage *et al*. 2014). The beginnings of this work have explored SuDS transitions in SA and Tanzania (Mguni 2015).

This research aims to contribute towards a better understanding of the institutional factors which are favourable to orienting towards a WSUD approach in SA, using Cape Town as a case study. While doing this, the significant factors hindering progression towards a WSUD approach will be revealed, thus allowing for recommendations to be made to the CoCT and for contributions towards future research. By using the CoCT as a case study, this research contributes towards understanding transitions towards sustainable water management approaches in other SA and developing cities which share similar contexts.

The methods and analysis tools for this research have been guided by, and deemed appropriate to achieve, the objectives of this research. A combination of qualitative and quantitative research methods has been applied to achieve the objectives of this research. Figure 1 presents a summary of the research process followed in this study.

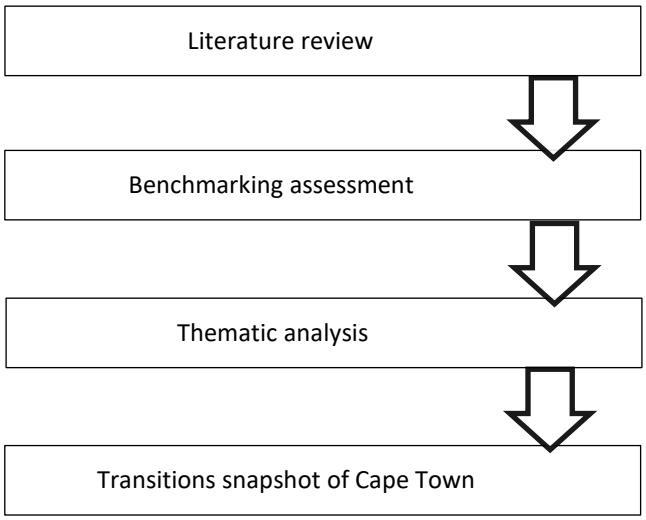

Figure 1: Research process

To help achieve the aim of this study, the following research objectives were developed:

1. To understand how Cape Town's urban water cycle is managed
2. To understand the governance of water scarcity, flood risk and wastewater treatment in Cape Town
3. To identify the fundamental institutional conditions within the CoCT that could support a transition towards a WSUD approach
4. To provide a snapshot of transitions towards WSUD in Cape Town

This dissertation consists of six chapters including the introduction chapter. The dissertation layout and description of each chapter is presented below:

Chapter 2 provides a review of literature focused on sustainability transitions towards a water sensitive future. This includes literature on sustainability assessment tools.

Chapter 3 presents an in-depth contextual analysis for the CoCT with the aim of understanding the state of water management in the City.

Chapter 4 provides an in-depth description and justification of the methods employed in this research.

Chapter 5 describes and discusses the current state of transitions towards a WSUD approach in Cape Town.

Chapter 6 synthesises the findings and conclusions drawn from this research. Secondly, this chapter presents recommendations for the CoCT's transition towards a WSUD approach, as well as recommendations for future research.

Chapter 2 – Literature review

2 Introduction

Over the past few decades environmental issues such as climate change and resource depletion have gained prominence on the urban management agenda (Geels 2010). Responses to such issues will require substantive transitions towards sustainable urban infrastructures and technologies over time. Consequently, literature focused on sustainability oriented innovation and technology has received much attention and is increasingly being explored in many sectors such as energy, water and transport (Markard *et al*. 2012). This chapter provides a review of literature focused on sustainability transitions towards a water sensitive future. This will include literature on sustainability assessment tools, as well as methods used to measure and assess sustainability transitions in various fields, contexts and scales.

Firstly a review of literature on Water Sensitive Urban Design (WSUD) is presented. This is followed by a review of sustainability transitions literature. The last section offers a review of sustainability assessment tools.

2.1 Water management in cities

In cities globally, water services are delivered through networks of buried pipelines (Marlow *et al*. 2013). These pipelines typically connect customers to the potable water supply, to sewage and wastewater services and to stormwater infrastructure to solve issues of flood risk (Marlow *et al*. 2013). The development of conventional urban water management systems followed a stepwise process mainly aimed at meeting a broad range of societal needs (Ferguson *et al*. 2013; Marlow *et al*. 2013). Firstly, the system was developed to meet the needs of water access and security which was achieved by developing water supply piping systems. Secondly, the development of sewer networks to manage the pollution and contamination of urban areas by faecal pollution and thirdly, the development of the stormwater system to manage urban floods. Conventional urban water management has thus been developed to achieve public health and safety, and the protection of urban infrastructure and property without necessarily taking environmental impacts into consideration (Winz *et al*. 2014). This poses serious threats on the environment such as pollution of water-ways (Keath & Brown 2009; Winz *et al*. 2014). Despite the benefits of conventional urban water management, this approach is increasingly becoming insufficient to ensure that water-related services are adequately delivered to citizens while simultaneously achieving environmental protection (Keath & Brown 2009; Marlow *et al*. 2013; Ferguson *et al*. 2013). There are several reasons for this including socio-political drivers such as increasing social expectations regarding levels of service (Belmeziti *et al*. 2015). Other factors include climate change, population growth, resource limitations, and the prioritisation of urban amenities and ecological health which place pressure on urban water systems, thus affecting their ability to deliver adequate levels of water services (Ferguson *et al*. 2013; Winz *et al*. 2014). Urban water managers are therefore being tasked

with the challenge of addressing these increasingly complex and multifaceted challenges related to urban water management (Brown *et al*. 2008).

There is a need to manage urban water resources in a more sustainable manner that integrates social, environmental, economic and cultural aspects (Keath & Brown 2009; Winz *et al*. 2014), to ensure that urban water management adapts to the changes and developments of the city (Belmeziti *et al*. 2015). This will involve transitioning the entire conventional urban water management system (societal and institutional systems as well as infrastructure), which rely on a centralised, top-down and fragmented management of extensively engineered infrastructure, to more sustainable states (Ferguson *et al*. 2013; Winz *et al*. 2014).

Sustainable Urban Water Management (SUWM) is a concept used to represent a management paradigm that offers alternative water management approaches, as shown in table 1 (Marlow *et al*. 2013). SUWM *"reflects a general goal to manage the urban water cycle to produce more benefits than traditional approaches have delivered"* (Marlow *et al*. 2013 p.7151). The SUWM concept refers to an urban water management approach where the management of the components of the water-cycle is interconnected in order to deliver and protect multiple benefits (Keath & Brown 2009). In addition to this, SUWM regimes should be adaptive and be able to react readily to various unexpected challenges (Keath & Brown 2009). According to Marlow *et al*. (2013), there are four central benefits of SUWM:

1. A more natural water cycle: refers to the restoration of degraded urban waterways by implementing a range of decentralised solutions and disconnecting waterways from impervious surfaces. This is to achieve flow regimes that are closer to natural ones in terms of quality, quantity and frequency of flow, while still alleviating flood risk and supporting healthy aquatic ecosystems.
2. Enhanced water security through local source diversification: refers to diversifying urban water sources by using alternative sources such as rainwater and stormwater harvesting, desalination, water recycling and reclamation of wastewater. A diverse supply helps satisfy varied urban demands through the 'fit-for-purpose'[1] (Rathnayaka *et al*. 2017) use of water of non-potable quality (e.g. irrigation, industrial application and ground water recharge). This reduces pressure placed on natural water sources like dams and groundwater.
3. Resource efficiency: SUWM promotes the efficient use of resources by minimising the use of water, energy and other resources to save costs and to minimise the ecological footprint of the water sector. This includes water demand and conservation strategies that involve consumers and reclaiming elements such as energy, nutrients and water. Resource efficiency is best achieved by integrating all aspects of the urban water cycle.
4. Decentralised solutions: Decentralised solutions are those that are complementary to existing centralised urban water systems. Decentralised solutions can be matched to the

[1] *"Matching water demands with specific quality requirements to sources of appropriate quality and quantity"* (Rathnayaka et al. 2017 p.85)

local context based on social, economic and environmental factors. Proponents of SUWM state that these solutions encourage the continuous innovation of technology which aims to improve efficient use of resources. Another benefit of decentralised solutions is that they may help defer the augmentation of existing supply infrastructure.

Table 1: Attributes of traditional and SUWM regimes (Source: Keath & Brown 2009 p.1272)

Attributes	Traditional Regime	Sustainable Regime
System boundary	Water supply, sewerage and flood control for economic and population growth and public health protection	Multiple purposes for water considered over long-term timeframes including waterway health and other sectoral needs i.e. transport, recreation/amenity, micro-climate, energy etc.
Management approach	Compartmentalisation and optimisation of single components of the water cycle	Adaptive, integrated, sustainable management of the total water cycle (including land-use)
Expertise	Narrow technical and economic focussed disciples	Interdisciplinary, multi-stakeholder learning across social, technical, economic, design, ecological spheres etc.
Service delivery	Centralised, linear and predominantly technologically and economically based	Alternative, flexible solutions at multiples scales via a suite of approaches (technical, social, economic, ecological etc)
Role of public	Water managed by government on behalf of communities	Co-management of water between government, business and communities
Risk	Risk regulated and controlled by government	Risk shared and diversified via private and public instruments

Transitioning to SUWM practices requires a shift from the conventional and linear approach to urban water management towards an adaptive, participatory and integrated approach (Brown & Farrelly 2009).

These sustainability transitions are often delayed and met with resistance and implementation barriers (Keath & Brown 2009; Winz *et al*. 2014). These include technological, social and institutional barriers. The institutional dynamics of conventional urban water management regimes pose significant barriers for transitions towards SUWM (Keath & Brown 2009; Marlow *et al*. 2013; Winz *et al*. 2014) in particular, rigid government structures and mechanisms which "*reinforce the compartmentalisation of infrastructure and service provision, leaving the sector ill equipped for responding and adapting to complex, sustainability challenges"* (Keath & Brown 2009 p.1271; Pahl-wostl *et al*. 2007). Thus urban water managers are not only confronted with the challenge of addressing increasingly complex urban water management challenges, they are also faced with the difficult experience of failing or ineffective implementation of alternative approaches (Winz *et al*. 2014). Marlow *et al*. (2013) note key issues that hamper successful transitions to SUWM approaches.

Firstly, it is often difficult for water managers to predict the impact that new technological innovations will have on urban water systems, which may lead to a lack of institutional capacity to manage uncertainties and risks across multiple scales (Marlow *et al*. 2013). In these cases, attempts to achieve one SUWM objective may hamper the attempts to achieve another; or the contribution of alternative solutions can also be overestimated. For example wastewater reclamation can lead to undesired and unintended consequences such as the presence of trace contaminants in potable water (Rygaard *et al.* 2011; Marlow *et al.* 2013). Significant reductions in water usage can also have undesired and unintended consequences on the sedimentation and degradation processes of sewer systems and may also have an impact on wastewater treatment (WWT) processes(Marleni *et al.* 2012; Marlow *et al.* 2013). These uncertainties highlight that rigorous assessment of alternative technologies is imperative before they are fully introduced into the urban water system. This can be achieved by running experimentation and pilot studies that allow empirical results to inform transitions (Rijke *et al*. 2013).

Secondly, Marlow *et al*. (2013) note that other SUWM adoption issues are related to diffusion responsibilities and community resistance to change. For instance, community acceptance of alternative water solutions can be a complex process. Risk perception, personal values, trust in the water services provider (WSP) and perception of fairness are some of the various factors which contribute to community acceptance of alternative water solutions (Mankad 2012; Marlow *et al*. 2013; Smith *et al*. 2018). Thirdly, the introduction of alternative decentralised solutions has significant financial implications for WSPs (Marlow *et al*. 2013). WSPs get a large percentage of their revenue from the volume of potable water consumed by customers. This revenue is important as it is utilised by WSPs to cover capital costs of infrastructure. Therefore, decreasing reliance on centralised water provision systems can represent a cost saving to residents, but puts strain on the revenue stream for the WSP (Listowski *et al*. 2013; Stavenhagen *et al.* 2018). For this reason, there is limited incentive for urban water managers to introduce decentralised solutions. *"The challenge is to value externalities in a way that is rigorous and reflects community values, and then to set appropriate tariffs to achieve the best outcome for the community whilst maintaining the financial viability and sustainability of WSPs"* (Marlow *et al*. 2013 p.7154).

There are various other alternative water management approaches which underpin the overarching principles of the SUWM paradigm including Integrated Water Resource Management (IWRM) and Water Sensitive Urban Design (WSUD). IWRM was introduced as an alternative water management approach which aims to address the fragmented and top-down approach of the traditional urban water management paradigm (Giordano & Shah 2014). The IWRM approach aims to regulate water-use between different water demanding sectors while taking ecological, economic and social issues into consideration (Ludwig *et al*. 2014). Thomas & Durham (2003) identify the three important aspects of the IWRM approach as:

1. The development of alternative water sources
2. The protection of water ways to improve their quality and quantity
3. Demand management implemented at river basin scale

The IWRM approach recognises that water management is multidimensional and that sustainable water management needs to holistically embrace these various dimensions (Thomas & Durham 2003; Giordano & Shah 2014). Time is an important dimension as water management decisions should always consider the long term goals to protect water resources for future generations (Thomas & Durham 2003). In conjunction with time, IWRM strongly emphasises that sustainable water management efforts should be focused at the river basin/water-shed scale, and that this management should consider a range of parameters and be multidisciplinary. These parameters include legislation and health, technological, political, institutional, historic and cultural issues, as well as environmental, social and economic factors (Thomas & Durham 2003; Giordano & Shah 2014). Stakeholder involvement in decision-making is also noted by IWRM as an important dimension for sustainable water management (Thomas & Durham 2003). Thomas & Durham (2003) emphasise that owing to the interrelated nature of the different dimensions of water management, any decision made anywhere in the system has the potential to impact on other aspects of the system. Therefore, poor understanding of the whole water system prior to decisions being taken, may lead to undesirable implications for a water management system (Thomas & Durham 2003).

Ludwig *et al*. (2014) note two defining notions of IWRM to achieve holistic multi-dimensional sustainable management of water. The first presents IWRM as a planning and decision-making approach used by experts. The aim of the approach is to reduce the uncertainties of water problem through the integration of scientific and stakeholder knowledge (Stålnacke & Gooch 2010; Ludwig *et al*. 2014). The second notion refers to the political and value driven nature of water issues; *"Water problems are understood as the product of human constructs and planning and decision making must consider different framings of the problem situation by different actors"* (Ludwig *et al*. 2014 p.236). These varied framings are influenced by differences in perspective, histories, experiences and knowledge assuming that both knowledge and politics need to be addressed in water-related research and that scientific knowledge has to involve the positions of actors (Ludwig *et al*. 2014).

The WSUD approach provides a framework for holistic management of the urban water cycle and its integration into urban design (Brown *et al*. 2008). The principles of WSUD are to ensure that water is given prominence within urban design processes. This is achieved by integrating urban design with various other disciplines, that are associated with water services provision and the protection of aquatic environments, such as environmental science and engineering (Wong & Brown 2009). In addition, the water management practices informed by urban design should be guided by community values and aspirations for urban places (Brown *et al*. 2008). WSUD encompasses all aspects of the urban water cycle including stormwater management, water treatment and water supply, and *"represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities…"* (Fletcher *et al*. 2014 p.4). At the inaugural conference on WSUD in Melbourne, which took place in 2000, four major inter-related elements were identified as being essential to underpinning the effective adoption of WSUD principles in cities; regulatory frameworks, assessment and costing, technology and design, and community acceptance (Wong 2006).

WSUD represents an interdisciplinary approach which encompasses the concepts of both social and physical science (Brown *et al*. 2008). The principles of WSUD have gained importance in terms of guiding cities around the world in the socio-technical transformations of conventional approaches needed to aid transitions towards becoming Water Sensitive Cities (WSC) (Wong & Brown 2009; Rijke *et al*. 2013; Fletcher *et al*. 2014). Despite there being no examples of a city that has fully transformed to a WSC (Rijke *et al*. 2013; Wong & Brown 2009), scholars and practitioners worldwide are showing increased interest in envisioning what this significant departure from conventional urban water management approaches will look like (Brown *et al*. 2008). This is particularly owing to the recognition that transitions to SUWM approaches are necessary to safeguard natural resources from reaching the limits of sustainable exploitation (Brown *et al*. 2008; Floyd *et al*. 2014). Wong & Brown (2009) propose three fundamental pillars of practice to underpin a WSC:

1. Cities as Catchments: this refers to cities having access to a diversity of water sources characterised by centralised and decentralised infrastructure
2. Cities providing Ecosystem Services: the provision of ecosystem services in both natural and built environments
3. Cities comprising Water Sensitive Communities: socio-political capital for sustainability and water sensitive decision making and behaviours

The concepts of SUWM, WSUD and IWRM offer alternative philosophical approaches to the conventional urban water paradigm. These approaches all represent comprehensive systems approaches to urban water management that involve multiple disciplines and stakeholder groups (Brown *et al*. 2008; Rijke *et al*. 2013; Fletcher *et al*. 2014). In addition, these approaches propose that urban water management must take complexity, uncertainty and long-term change into account in order for urban water systems to be resilient (Rijke *et al*. 2013). Resilience provides capacity to: absorb shocks to the system while maintaining function; reorganise following a disruption, and capacity for learning and adaptation (Wong & Brown 2009; Rijke *et al*. 2013). However, guidance for transitions of governance approaches that enhance resilient urban water systems is lacking (Stålnacke & Gooch 2010; Rijke *et al*. 2013). In addition to this, urban water managers still lack a clear vision or goal for the attributes of a sustainable and resilient urban water system (Brown *et al*. 2008; Rijke *et al*. 2013). The following section describes the different aspects within an urban water system where change must occur to enhance resilient urban water systems.

To successfully transition towards SUWM approaches, it is imperative that technical changes are accompanied by social, institutional and governance changes (Dobbie *et al*. 2017). This includes a change in the pervading implicit and explicit agreements between governments, businesses and citizens about how water should be managed in a city (Lundqvist 2001; Dobbie *et al*. 2017). These agreements have been termed the 'hydro-social' contract and are based on the historically embedded social and cultural context of a city which shapes urban water values. The hydro-social contract is expressed through institutional arrangements, regulatory frameworks as well as physically through water system infrastructure (Brown *et al*. 2008). These institutional

arrangements and regulatory frameworks are the main tools which influence decision-making at a range of scales (policy-making to day-to-day management) as well as structuring the governance of urban water (Dobbie *et al*. 2017). Thus, transitions towards SUWM in cities require an overhaul of the hydro-social contract (Wong & Brown 2009). However, it is important to note that such an overhaul is made difficult by the fact that the components making up the hydro-social contract have co-evolved over a long period of time (Pahl-wostl *et al*. 2007). Therefore, these systems have developed path dependencies or system 'lock-ins' that potentially resist change (Pahl-wostl *et al*. 2007).

To understand the processes involved in institutional change, an analytical approach termed 'New Institutionalism' has been actively used in the field of social research. Institutions comprise of hard and soft components (Healey 1997). The hard represents the regulatory frameworks, formal organisational structures and government, and the soft represents informal social networks and relations, professional cultures and administrative routines. Scott (1995) recognises three mutually reinforcing pillars that influence patterns of practice within institutions:

1. Cognitive: refers to dominant knowledge, thinking and skills
2. Normative: relates to values and leadership
3. Regulative: represents the laws, systems and administration which are designed to protect the cognitive and normative aspects

Brown *et al*. (2008) note that in transitions toward SUWM an example of change in the cognitive dimension can be a growing dialogue and thinking around SUWM approaches such as WSUD which challenge the conventional philosophies of water management. An example of changes to values in water management provided by Brown *et al*. (2008) is the growing focus on the value and importance of environmental protection and remediation of waterways. Therefore in order for institutions to successfully transform, change has to take place within each of these mutually reinforcing pillars (Brown *et al*. 2008).

2.1.1 Transitioning towards a Water Sensitive Urban Design (WSUD) approach – The Urban Water Management Transitions Framework

The Urban Water Management Transitions Framework (UWMTF) (figure 2) developed by Brown *et al*. (2009 p.850) illustrates *"a typology of different states that cities transition through when pursuing change towards more sustainable futures"*. The socio-political drivers represent changes in the normative and regulative dimensions whilst the service delivery functions represent the cognitive response (Brown *et al*. 2009). Wong & Brown (2009) present the hydro-social contract required for underpinning the notion of a WSC based on the Urban Water Management Transitions Framework. Due to the fact that the transition states represent a nested continuum, the hydro-social contract of a preceding city state influences and shapes the hydro-social contract of succeeding transition states (Brown *et al*. 2009). Although the transition states are represented as a model of linear progression, Brown *et al* (2009) note that cities can move in both directions across the continuum, and can straddle or leapfrog between stages based on varying circumstances. The

Urban Water Management Transitions Framework is therefore also a useful tool to benchmark a city's progress at a macro scale (Brown *et al*. 2009).

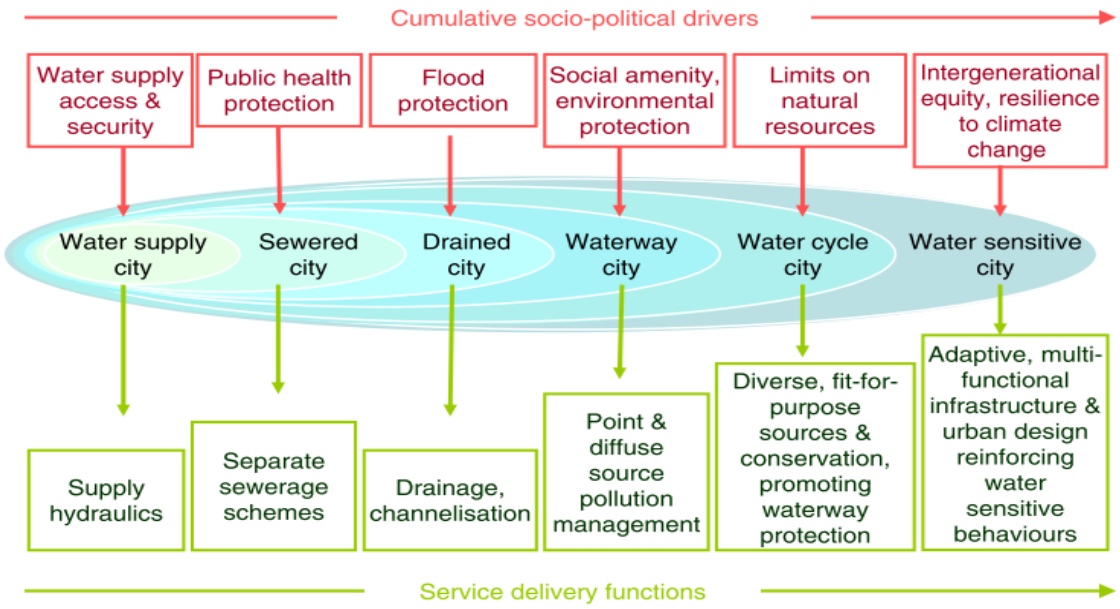

Figure 2: UWMTF (Source: Brown *et al*. 2009)

The first three states of this continuum represent the conventional development of urban water management systems, described in section 2.1, as a stepwise process predominantly aimed at meeting a broad range of societal needs (Ferguson *et al*. 2013; Marlow *et al*. 2013). Research conducted by Wong & Brown (2009) revealed that while transitioning through these first three states the hydro-social contract remains largely unaffected, as it is based on the implicit agreement for governments to provide affordable and reliable basic services (Wong & Brown 2009). The hydro-social contracts of cities start to be challenged with the advent of the 'water ways' and 'water cycle' city states as these are characterised by the realisation that urban water management needs to be expanded to encompass environmental protection; e.g. protection of water quality, ecosystems and biodiversity of urban water ways (Wong & Brown 2009).

For a city to achieve water conservation through using diverse, fit-for-purpose water sources, the distribution of functions and responsibilities within the hydro-social contract needs to be fundamentally restructured compared to the incremental structural changes associated with the transitions between the first three transition states (Wong & Brown 2009). This challenges and demonstrates a shift from a purely service delivery driven urban water management approach to one that considers ecological, environmental and social factors (Brown *et al*. 2009). The hydro-social contract in a WSC is *"adaptive and underpinned by a flexible institutional regime, and co-existing and diverse infrastructure"* (Wong & Brown 2009 p.676); achieving a WSC requires a major socio-technical overhaul of conventional urban water management approaches.

2.1.2 Transitioning to Water Sensitive Urban Design in South Africa

Armitage *et al*. (2014) note that while the UWMTF presented by Brown *et al*. (2009) is relevant for transitions to a WSUD approach in developing countries, it needs to be adapted for the developing context. This is mainly owing to the fact that the transitions framework and vision for WSC has been envisaged mostly for developed cities and does not take the context of the developing world into account (Binz *et al*. 2012; Armitage *et al*. 2014).

South African (SA) cities, for example, have been shaped by the legacy of apartheid and are thus characterised by both formal and highly dense informal areas. Whilst the formal areas have adequate water and sanitation services, informal areas in SA remain poorly serviced, with significant backlogs in infrastructure and development that still need to be addressed by the SA government. The City of Johannesburg *"faces both a leapfrogging challenge to address infrastructure deficits in informal areas and a retrofitting challenge to shift existing water infrastructure towards sustainable configurations"* (Mguni 2015 p.29). For this reason, social support and service delivery (particularly to informal areas) are high on SA's political agenda.

Transitions towards a WSUD approach in SA therefore require that both formal and informal contexts are considered (Fisher-Jeffes *et al*. 2012; Armitage *et al*. 2014). This means that whilst promoting economic and social equity, the SA government will need to promote environmental sustainability in urban areas, which can be a challenging task (Armitage *et al*. 2014). Mguni (2015) indicates that even though these transitions may be challenging for developing cities, they still have the potential to implement WSUD equitably by simultaneously moving through the stages of the UWMTF. In order to ensure that the UWMTF presented by Brown *et al*. (2009) is applicable to SA cities, Armitage *et al*. (2014) adapted it to depict the dual transition challenge facing SA cities (figure 3).

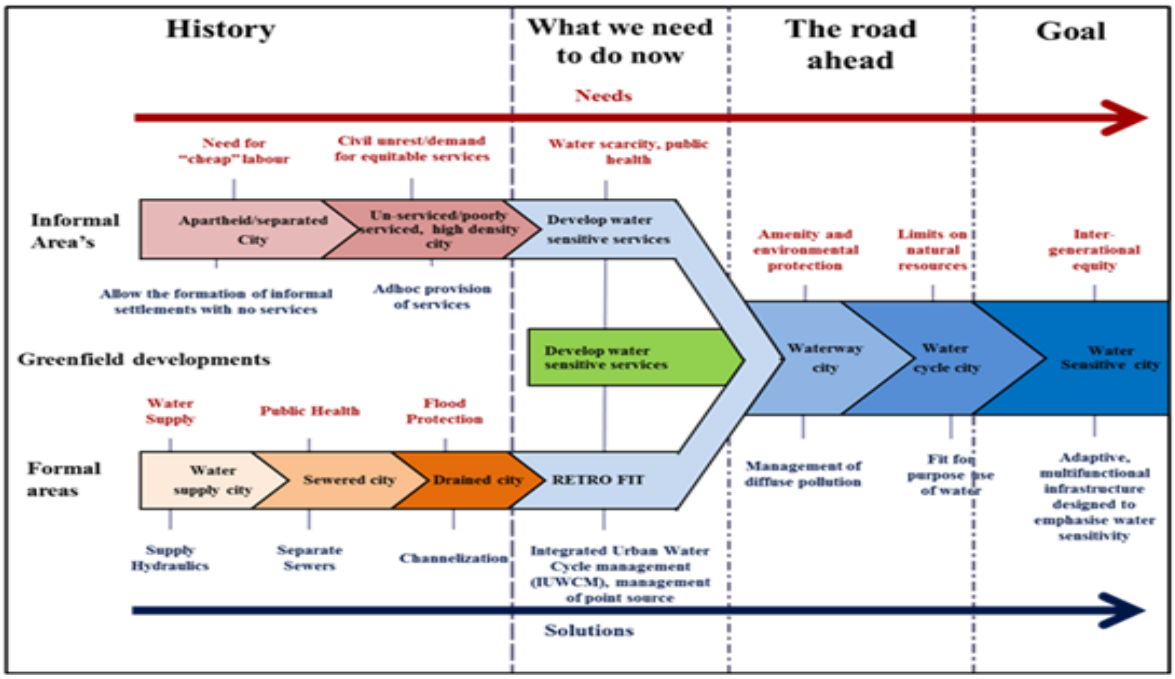

Figure 3: Framework for WSUD in SA (adapted from Brown *et al*. 2009)
(Source: Armitage *et al*. 2014)

Applying a WSUD approach that aims at specifically addressing water challenges in the SA context could provide specific benefits including the potential to connect spatially divided communities through linking open spaces between settlements using blue-green infrastructure, thus creating more liveable cities (Armitage *et al*. 2014). Secondly, the WSUD concept encourages the development of new innovations, technologies and techniques that can be commercialised thus increasing the potential to enhance job creation in SA cities and further contribute to the green economy (Armitage *et al*. 2014).

In addition to recognising both the formal and informal contexts, a transition towards WSUD also needs to recognise the way water is managed in SA. The four aspects of the urban water cycle (stormwater, wastewater, ground water and water supply) are intricately interconnected; WSUD principles call for the holistic management of these aspects (Brown *et al.* 2008). However, in SA, these aspects of the urban water cycle are mostly managed separately (in-silos) by different departments as a result of the allocation of specific mandates to each municipal department (Armitage *et al*. 2014). This results in poor communication and poor integration of the different aspects of the urban water cycle. Furthermore, it is important that transitions to a WSUD approach in SA take into account limited human and financial resources available in Government (Armitage *et al*. 2014). Table 2 highlights other issues to be considered for implementing WSUD in SA.

Table 2: Various aspects to consider when implementing WSUD in SA
(Source: Armitage *et al*. 2014)

1. Institutional Structures	Different aspects of the urban water cycle are managed separately 'silo-management' instead of in an integrated fashion because of the allocation of specific mandates to different municipal departments.
2. Champions	Identifying champions that support the introduction and embedding of the WSUD approach in SA.
3. Equity	Service delivery to disadvantaged communities is a challenging area for SA. Implementing 'green' projects while basic services do not exist does not promote social justice. Accomplishing these simultaneously adds a layer of complexity for service delivery in SA.
4. Health aspects:	Potential health risks such as water borne diseases must considered.
5. Adaptability & uncertainty:	SA has technical capacity and skills constraints at local and national level so complex technologies should be avoided. In addition uncertainties relating to climate change, politics and water demand patterns result in policy makers being risk averse.
6. Mitigation:	SA needs to manage its environmental impacts, especially in terms of CO2 outputs resulting from energy usage
7. Ecosystem goods and services:	Whilst the economic valuation of ecosystem services is recognised worldwide as a means of motivating for the adoption of the WSUD approach, it is unlikely to have as much impact in SA given the widespread poverty and inequality in the country. For example, politicians are more likely to consider job creation opportunities and the ability of WSUD to deliver services quickly, while city officials would be more interested in issues of cost and maintenance requirements, appropriateness. It is thus necessary to consider the likely areas of interest / opportunities for the various target audiences and stakeholders in SA.

Owing to the range of issues and contexts which need to be considered for the implementation of WSUD in SA, Armitage *et al.* (2014) note the importance of piloting WSUD implementations both at catchment and site-scale. The authors highlight the critical value of embedding WSUD principles at

catchment scale by incorporating the principles into catchment management plans and stormwater master plans so that local water management planning is holistic and supports a transition towards WSUD at site-scale. Experimentation should acknowledge the economic and environmental costs of centralised systems and should also validate and accept local community initiatives by businesses, NGOs and households (Mguni 2015). Pilot implementations will help to build a case for transitions towards a WSUD approach by creating learning opportunities about how, when and where to implement the principles of WSUD both in informal and formal areas. Building a stronger case for WSUD implementation in SA can help influence regulatory, professional practice and institutional changes in urban water management.

2.2 Sustainability transitions

Infrastructure and technologies are highly intertwined with institutional structures, regulations and social practices at large (Markard *et al*. 2012). For this reason, transitions towards sustainability-oriented technologies are regarded as socio-technical transitions. These transitions typically involve significant changes along assorted dimensions of the socio-technical system which result in an emergence of new products/services replacing old ones as well as institutional structures changing considerably (Markard *et al*. 2012). As a result, socio-technical transitions towards sustainability tend to undergo a change which is gradual in nature vs one which is drastic.

The Multilevel Perspective, Strategic Niche Management and Transitions Management are three fundamental frameworks, amongst many others, that can be used to analyse and describe traits of transitions (Markard *et al*. 2012). This section will explore literature on these three frameworks.

2.2.1 Strategic Niche Management (SNM)

A key concept in transitions literature is the concept of the niche. A niche refers to a protected space where alternative technological innovations, user practices as well as appropriate regulatory structures for these innovations can be developed without succumbing to the pressures of existing dominant socio-technical regimes (Caniëls & Romijn 2008; Smith & Raven 2012). The niche consists of various experiments which inspire social learning processes as well as cross-sector networking. Such experiments allow for niche innovations to gain enough momentum to be able to compete with established technologies and trigger the transitions process once introduced to formal markets (Schot & Geels 2008; Smith & Raven 2012; Markard *et al*. 2012). Therefore, SNM was developed as *"a way forward to trigger off regime shift"* (Markard *et al*. 2012 p.958). SNM scholars do however note that many of the innovations with a sustainability promise tend to differ radically from prevailing sets of technologies, and thus user demand and institutional acceptance of these innovations is not immediately available (Schot & Geels 2008).

The idea behind SNM is that new sustainable technologies developed in niches can eventually lead to the replacement of a prevailing socio-technical regime (Caniëls & Romijn 2008; Schot & Geels 2008). SNM suggests that sustainability transitions are created in a bottom-up fashion, from the niche up to larger institutions and eventually the socio-technical regime (Schot & Geels 2008). This is due to the fact that the niche is assumed to emerge through collective enactment between a

wide range of actors who facilitate learning processes or a set of demonstration projects which constantly steer the transitions towards the desired path (Caniëls & Romijn 2008). Accordingly, much of the early research effort in SNM focused on understanding the various internal processes and contexts within niches which are favourable to allow socio-technical transitions to be effective (Schot & Geels 2008). Three internal niche processes are notable for the successful development of a technological niche (Caniëls & Romijn 2008), namely:

1. The articulation of expectations and visions which plays a fundamental role in directing learning processes, providing continued protection of niche innovation and attracting relevant attention
2. The building of social networks which will facilitate interactions between relevant stakeholders to also provide relevant resources
3. The process of learning at multiple dimensions such as regulations and policy, infrastructure and maintenance networks, societal and environmental effects etc.

Schot & Geels (2008) note that although internal niche processes play a fundamental role in promoting sustainability transitions, niches alone cannot make this happen without linkages and interaction with external niche processes (Schot & Geels 2008).

A second critique of SNM put forth by Caniëls & Romijn (2008) suggests that while SNM places significant value on networks of actors for the success of socio-technical transitions, *"it has remained rather unclear how the incubation of new technologies relates to different characteristics of the structure and functioning of networks"* (Caniëls & Romijn 2008 p.2). Caniëls & Romijn (2008), critique SNM literature for placing much emphasis on the intensive nature of networking activities and the number of actors being directly proportional to the amount of experimentation and learning which will occur and result in successful socio-technical transitions. Caniëls & Romijn (2008) suggest that it may be worthwhile to take into consideration other aspects such as the nature and the quality of the interactions as well as the morphology of the relationships in different parts of the network. The suggestion is that exploring new dimensions and gaining more in-depth understanding of the determinants of the proper functioning of actor networks will make SNM more effective as an analytical tool for socio-technical transitions (Caniëls & Romijn 2008). These authors suggest Social Network Theory to analyse different aspects of network functioning as a contribution to the SNM framework.

Caniels and Romijn's (2008) use of Social Network Theory describes social networks in terms of nodes and ties. The nodes represent individual actors within networks while the ties represent the actual relationships between the actors (Caniëls & Romijn 2008). The theory places emphasis on the structure of the network and the quality of the relations between actors being useful to the individuals in the network (Caniëls & Romijn 2008). Caniëls & Romijn (2008) state that there is evidence of networking being largely responsible for the development and the implementation of innovations. For instance, research conducted by Farrelly & Brown (2011) examines how alternative local-scale water experiments in Australia (such as water saving devices, passive onsite sewage treatment [through reed-bed filters] for public open space irrigation and onsite greywater

treatment and reuse for toilet flushing and garden irrigation) were initiated. The findings of this study identify the success factors of these experiments to be *"early engagement of critical stakeholders, sustained involvement of dedicated individuals, mechanisms for defining key roles/responsibilities, and risk-sharing"* (Farrelly & Brown 2011 p.726).

2.2.2 Multi-Level Perspective (MLP)

Given the first critique of SNM, i.e. that SNM fails to consider external niche processes; sustainability transitions scholars suggest the use of Mulit-Level Perspective (MLP) frameworks as a complementary to SNM. MLP aims to provide a total view of the multi-dimensional complexity of the changes which take place in socio-technical systems (Geels 2010). MLP recognises three analytical layers in which socio-technical transitions occur (figure 4) (Rauschmayer *et al*. 2015):

1. The Niche at the micro level (where radical novelties emerge)
2. The socio-technical regime which forms the meso-level. This level accounts for the stability of existing large-scale systems such as transport, energy etc
3. The socio-technical landscape at the macro level. An environment beyond the direct influence of niche and regime actors.

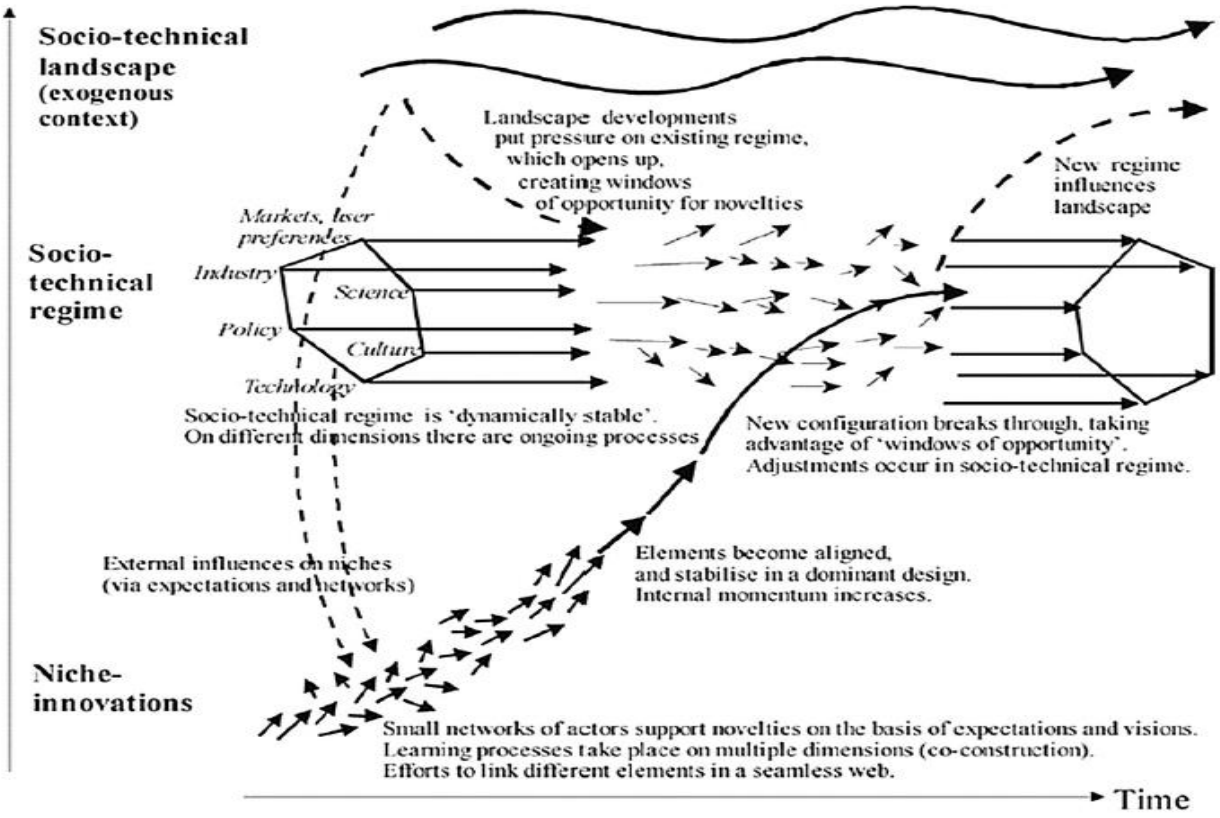

Figure 4: MLP processes at macro, market and micro levels (Source: Geels 2012)

At its core, MLP maintains that socio-technical transitions come about through interactions between and within the three analytical levels described. Contrary the SNM, MLP suggests that internal niche processes are meant to build up internal momentum while changes at a landscape level put pressure on the socio-technical regime. The destabilisation of the regime by landscape

pressures is then able to create windows of opportunity for niche innovations to emerge. Consequently, MLP is used to conceptualise the SNM Framework by exposing the larger terrain in which it functions (Schot & Geels 2008).

Equally important, MLP corrects the assumption of SNM literature which suggests that regime shifts take place through a bottom-up process of niche expansion (Schot & Geels 2008). MLP emphasises that socio-technical transitions require alignments of processes at multiple levels. The framework does not discredit niche innovations, but rather shows that niche innovations will be able to diffuse more widely if they link up with ongoing processes at the landscape and regime levels (Schot & Geels 2008). As Shove & Walker (2007 p.764) state, *"the key idea is that change takes place through processes of co-evolution and mutual adaptation within and between the layers"*.

A study conducted by Acheampong *et al*. (2016) uses the MLP to analyse urban water management transitions through management reforms in Accra (Ghana). The study shows how landscape factors such as droughts, a global economic crisis and loans from landscape actors like the World Bank and the International Monetary Fund influenced policy changes at regime level, which in-fact hinder the city to achieve desired SUWM goals. Acheampong *et al*. (2016) further show the effects of the landscape on the niche level such as triggered experimentation and the rise of social groups. The study suggests that *"urban water policy reforms must be informed by knowledge of social, economic, and political realities rather than imported generic best policies and practices that often conflict with local realities"* (Acheampong *et al.* 2016 p.1835). In addition, the study illustrates that crisis in the urban water socio-technical regime often create opportunities for change and innovation that can support transitions to SUWM practices in cities (Acheampong *et al*. 2016).

The MLP framework has been critiqued for not paying enough attention to the role of power and agency in socio-technical transitions (Geels 2010; Rauschmayer *et al*. 2015). In the same light as in the SNM framework, Social Network Theory has been suggested to be incorporated into the MLP (Geels 2010).

2.2.3 Transitions Management (TM)

Transitions Management is one of the most prevalent approaches which aims to scientifically ground the governance of sustainability transitions (Rauschmayer *et al*. 2015). It has been described by Kemp *et al*. (2007, p.78) as *"a multilevel model of governance which shapes processes of co-evolution using visions, transition experiments and cycles of learning and adaptation"*. Transitions management emphasises *"a deliberate attempt to bring about structural change in a stepwise manner"* (Kemp & Rotmans 2005 p.42).

TM places significant emphasis on the fact that multiple visions for the future, which collectively define an end goal, are to be defined by key stakeholders in a specific sector (Meadowcroft 2009; Rauschmayer *et al*. 2015). The theory suggests that by defining multiple visions for the future, transition experiments can be organised in such a way that they try out different pathways to the desirable futures. Accordingly, TM theory as with SNM, values the notion of gradual evolutionary change in socio-technical transitions (Meadowcroft 2009). However, with this evolution TM

encourages having a variation of experimental technologies, as well as to use selective market and political pressures to determine the best suited technologies to fulfil the needs of the society and influence future development trajectories (Meadowcroft 2009). To influence future development trajectories, it is essential to break out of socio-technical 'lock-ins' (Meadowcroft 2009; Rauschmayer *et al*. 2015). Equally important, TM emphasises ensuring that current decisions are always made to contribute towards future goals. This can be done through constantly exploring alternatives, encouraging system innovation as well as implementing longer time frames (Loorbach 2007; Meadowcroft 2009).

This theory suggests two objectives that policy makers should pursue to address breaking out of socio-technical lock-ins. Firstly, system improvement, which refers to addressing a perceived problem by making gradual adjustments to existing societal and institutional practices. Secondly, system innovation, which refers to developing technologies which will make necessary modifications to dominant designs. The rationale behind these two objectives is that incremental changes and improvements to a system may be enough to address an issue at hand (Meadowcroft 2009). This is either because the perceived problem may be less serious or because the existing technology has greater adaptive potential than expected. The result of this can be advantageous in helping society to benefit immediately from gradual improvements, and possibly the difficulties of system change can be avoided momentarily while alternative approaches and technologies are nurtured and gain strength (Meadowcroft 2009).

Loorbach (2007) distinguish three different types of governance in the TM framework. Firstly, strategic governance, which is linked to the structuring of issues and envisioning. Secondly, tactical governance, which refers to the negotiating and network building. Thirdly, operation, which links to implementation. Loorbach (2007) makes it clear that there is no hierarchical relationship between these three different types of governance, instead they operate simultaneously at different levels. As a result, each type of governance can be linked to particular types of actors and instruments in the transition process.

Research conducted by Poustie *et al.* (2016) and Mguni (2015) illustrates the application of TM for promoting transitions towards sustainable urban water futures in developing cities, by using Port Vila (Vanuata) as a case study. The results of the study revealed the degree of potential and appeal for SUWM transitions in the city. Moreover, the study provides insights into how developing cities can leapfrog through the different stages of the UWMTF. The study highlights *"the importance of targeted institutional capacity development, the role of purchaser–provider relationships between governments and international development banks, and the potential for visions to stimulate leapfrogging trajectories"* (Poustie *et al*. 2016 p.129).

Although this may be the case, scholars have expressed concern over the true possibility of being able to 'manage' large scale transitions (Meadowcroft 2009). In the same light, questions have been brought forth about whether it is possible to consciously shape the course of future societal evolution (Meadowcroft 2009). Another critique of transition management is that the theory is not concerned with *"political interactions through which societal goals are determined and revised,*

collective decisions are enforced, and resources are authoritatively allocated" (Meadowcroft 2009 p. 335). Furthermore, TM has been critiqued for its ignorance of issues of power, democratic legitimacy as well as politics (Rauschmayer *et al*. 2015). Not only this, TM has also been critiqued for not considering individuals engaging in transitions and their agency (Rauschmayer *et al*. 2015); and for not defining the roles and drivers of the actors as well as how and why individuals engage in experiments (Scholz, 2011; Raushmayer *et al*. 2015). Raushmayer *et al*. (2015 p.214) suggest that TM *"should embrace a more encompassing conceptualisation of the individual"*. These authors either suggest or imply that the conceptualisation should include people's values and motivations, both as individuals and when they act within a collective.

2.2.4 Social networks and learning

Caniëls & Romijn (2008) suggest that more in-depth understanding of the functions of actor networks and the quality of relations required to maintain effective social learning in these networks will be a valuable contribution to transitions analytical frameworks such as SNM, MLP and TM. This section highlights the role that social relations and networks play in facilitating social learning systems within the context of larger systems, and their potential to support transitions.

As described in section 2.1, the management and governance of water resources comprises various integrated aspects and therefore management requires the bringing together of knowledge from diverse sources (Berkes 2009; Giordano & Shah 2014; Ludwig *et al*. 2014). For this reason, relations between the public and private sectors and civil society play a key role in developing the social capacity to manage water resources and to support sustainability transitions (Pahl-wostl *et al*. 2007; Berkes 2009). An important component of this social capacity is collaboration, generating knowledge and experiences, and learning (Berkes 2009). Such collaboration helps drive the building and maintenance of coalitions of actors between and within institutions, which is often a delicate process as it involves sensitive issues between actors including conflicts and power relations (Pahl-wostl *et al*. 2007; Huitema & Meijerink 2010). For instance, in the study conducted by Poustie et al. (2016) on transitions to SUWM approaches in Port Vila (Vanuatu) the participants (comprising governments officials and private consultants from various backgrounds) recognise that *"not only will community engagement and education result in behaviour change regarding local water management, but additionally increased community interest in urban water sustainability will lead to the government taking these issues seriously"* (Poustie *et al*. 2016 p.134).

In the formation and maintenance of coalitions Pahl-wostl *et al*. (2007) and Leck & Roberts (2015) recognise the importance of both formal and informal processes of social learning. Informal coalitions, which are also referred to as shadow systems, are identified as playing a key role in social-learning practices that develop the social capacity to address sustainability transitions (Pelling *et al*. 2008; Huitema & Meijerink 2010; Leck & Roberts 2015). The term 'shadow systems' was coined by Stacey (1996) and refers to *"The space of informal interaction that lies outside of but interacts with formal institutions and relationships"* (Pelling *et al*. 2008). Owing to their informal nature, shadow systems develop into shadow networks of actors from various institutions that can transcend organisational structures and regulations (Leck & Roberts 2015). This allows actors to

exchange knowledge and experiences without the pressures of scrutiny, monitoring and regulatory control that are characteristic of formal institutions (Pelling *et al*. 2008; Leck & Roberts 2015). This affords actors within shadow systems the freedom to be creative and take risks that support innovation and experimentation which has been recognised as an important tool to facilitating sustainability transitions in socio-technical systems that are difficult to change (Bos *et al*. 2013; Leck & Roberts 2015). Shadow systems operating in 'niches' support the incubation and maturation of ideas and innovations before they are introduced into formal structures. Moreover, the personal values, ideologies, norms and capabilities that significantly characterise shadow systems are *"key determinants in making bureaucracies more permeable to new ideas, providing a back door through which conceptual change can be introduced in a way that is not initially disruptive"* (Leck & Roberts 2015 p.62).

Pelling *et al*. (2008) draw from the work of Wenger (2000) on Communities of Practice (CoP) to conceptualise the notion of shadow systems. The term CoP refers to *"structures that are often not officially recognised by the organisations they permeate"* (Pelling *et al*. 2008 p.7). According to Pelling *et al*. (2008) the 'official invisibility' of a CoP relegates them to shadow systems which can effectively be viewed as comprising a 'constellation' of interrelated CoPs (Wenger 2000). Wenger (2000 p.229) notes *"since the beginning of history, human beings have formed communities that share cultural practices reflecting their collective learning…"* thus participating as basic building blocks of social learning systems. CoP can aid in defining what constitutes competence in a given context by combining these three elements identified by Wenger (2000):

1. Joint enterprise: refers to the collective understanding amongst actors about what their community is about and how actors hold each other accountable to their joint enterprise
2. Mutuality: refers to the mutual engagement on which communities are built, which emanates from the establishment of mutual norms and relationships that build trust
3. Shared repertoire: refers to the shared inventory of communal resources which actors can use to be competent in a given context

Shadow systems are presented and recognised as intangible, complex and self-organising systems that are inherently characterised by a degree of chaos (Shaw 1997; Leck & Roberts 2015). As a result, shadow systems have been critiqued for supporting behaviours such as corruption, nepotism and resistance to change (High *et al*. 2006; Pelling *et al*. 2008). To avoid susceptibility to such behaviours Wenger (2000) strongly highlights the need for order and organisation within a CoP. Organising and legitimising CoPs can thus aid in maintaining social learning among members and ensure that the community's focus is not diffused so that experiments and new ideas can continue to influence decision-making in formal structures (Wenger 2000; Leck & Roberts 2015).

The value of social networks as a learning tool is also shown through the SUWM transitions studies conducted by Poustie *et al.* (2016) and Acheampong *et al.* (2016). Both studies utilise social network platforms such as multi-actor learning alliance platforms and workshop as a method to gain an understanding of the context specific SUWM transitions in the case study cities (Port Vila and Accra). By applying TM and MLP, respectively, both studies recognise the importance of multi-

actor engagement to encourage learning and knowledge sharing in order to improve water sector engagement in these cities (Poustie *et al.* 2016; Acheampong *et al*. 2016). This is to allow actors to understand and define complex urban water management problems that hinder the success of SUWM transitions in their local context. This equips actors to be able to consider long-term perspectives; to explore ways of strengthening local niche innovations and to consider various strategic pathways that can guide SUWM transitions in the local context (Poustie *et al.* 2016; Acheampong *et al.* 2016).

2.3 Sustainability assessments

A critical barrier to progress towards adopting approaches such as WSUD in cities is the absence of benchmarking tools that can aid in informing long-term policy development for sustainable water management (Gleick 2003; Brown *et al*. 2008). Benchmarking tools have been deemed useful to enable water managers and policy makers to identify specific urban water management challenges that are hampering WSUD transitions (Wong & Brown 2009; Beck *et al*. 2016). This section of the literature review explores the utility and the critiques of sustainability assessment and benchmarking.

The concept of sustainable development was derived from Our Common Futures[2], commonly known as the Brundtland Report of 1987. The report defined sustainable development as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (WCED 1987). The premise of the report was to call for a strategy which united social equity and economic development with environmental protection by providing guiding principles for sustainable development. Prompted by the release of the Brundtland Report, in 1992 the United Nations Conference on Environment and Development (UNCED) (held in Rio de Janeiro, Brazil) further emphasised this through the development of Agenda 21 which was adopted by 178 governments. Agenda 21 is a non-binding action plan for individual governments, the United Nations and multilateral organisations to execute at local, regional, national and international scales. Agenda 21 has since evolved into 17 additional goals, subsequent to the Millennium Development Goals, termed Sustainable Development Goals, which were added at the UNCED 2015 (UNDP 2015). Even though implementation of Agenda 21 and the Sustainable Development Goals by member states remains voluntary and its adoption has been varied, sustainability has emerged as an important planning concept (Adinyira *et al*. 2007). This has resulted in policy and legislation at various scales being underpinned by the principles of sustainable development and being utilised as a tool to implement these principles (Adinyira *et al*. 2007; Hiremath *et al*. 2013). Michael *et al*. (2014) recognise that the three pillars of sustainable development (figure 5) are supported by a fourth dimension (Figure 6) which encompasses the institutional and governance structures responsible for ensuring that sustainability is implemented and that it works.

[2] Our Common Futures is a World Commission on Environment and Development (WCED) published report.

Just as the task of defining sustainability through the Brundtland Report and the UNCED has progressed, so has the task of measuring or assessing sustainability (Hiremath *et al*. 2013). Hiremath *et al*. (2013) emphasise this by stating that if sustainability is a coherent policy goal then nation states and other organisations should be able to measure whether they are moving towards it. This has led to the prevalence of sustainability impact assessments Bond *et al*. (2012) however express concern that the prevalence of sustainability impact assessments implies that there are inadequacies in the practice. These inadequacies are seen as a potential driver for the emergence of a different type of practice to measure sustainability, the sustainability assessment practice (Adinyira *et al*. 2007; Bond *et al*. 2012).

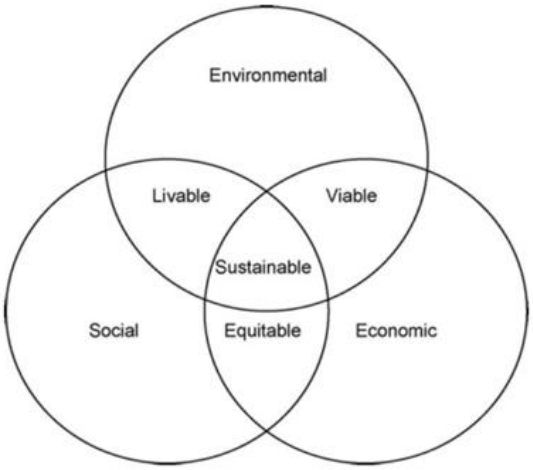

Figure 5: Three pillars of sustainable development (Source: Tanguay *et al*. 2010)

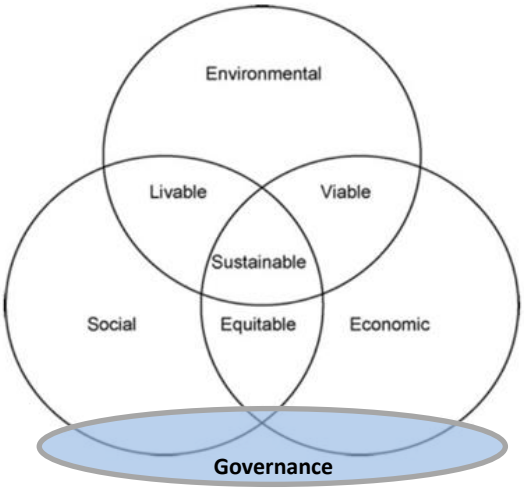

Figure 6: Fourth dimension (governance) of sustainable development (Source: Adapted from Tanguay *et al*. 2010)

Sustainability assessment has been defined as *"simply applying the broad principles of sustainability to ascertain whether, and to what extent, various actions might advance the cause of sustainability"* (Adinyira *et al*. 2007 p.2). The term 'sustainability assessment' is used in two different contexts in literature and in practice (Adinyira *et al*. 2007). Firstly, it serves as an auditing and performance measurement testing system by checking how an organisation or system is progressing towards sustainability. Secondly, in practice it serves as an impact assessment process as it is utilised to assess the sustainability of proposed projects, plans, policies or legislation pre-implementation (Adinyira *et al*. 2007). Sustainability assessments typically encompass a set of indicators that are used to measure different aspects of the performance of social, environmental and economic aspects of sustainability. Together the combined score of the individual indicators is used to provide a 'measure' of sustainability. An example of this is the Sustainability Index for Integrated Urban Water Management, developed by Carden (2013), which aims to provide a measure for sustainable urban water management potential in the SA context. Its application to several SA cities helped to highlight the strengths and weaknesses in the urban water management of these cities.

The World Bank defines indicators as *"performance measures that aggregate information into a usable form, highlighting, however, the unresolved issues of fluctuation, intertemporal variations and uncertainty"* (Hiremath *et al*. 2013 p556). Indicators are *"simplifications of complex phenomena and provide only an indication of conditions or problems"* (Hiremath *et al*. 2013). There are various ways in which sustainability indicators, that are chosen correctly, can contribute to sustainability debates. Firstly, by reducing the amount of data required to describe a situation extensively and by facilitating communication with a diverse group of audiences. Secondly, sustainability indicators can be useful tools to quantify sustainability performance; this is predominantly due to the fact that sustainability indicator types can be either qualitative or quantitative meaning they can serve well in different political or research contexts (Hiremath *et al*. 2013; Michael *et al*. 2014). The third advantage of using sustainability indicators to show how well a system is working is that, should there be a problem in a system, a single indicator is able to highlight the problem and help determine how the problem can be addressed (Hiremath *et al*. 2013; Michael *et al*. 2014). When put side by side, sustainability indicators can reveal the aspects in which a system is performing well, hence being an important tool for comparison and evaluation (Hiremath *et al*. 2013). Sustainability indicators are therefore an important aspect of public administration as they assist in supporting sustainable development strategies by enabling tangible assessment and monitoring systems (Tanguay *et al*. 2010).

Sustainability assessment is increasingly being recognised as a powerful tool for policy making (prospective) and assessing policy implementation (retrospective) (Singh *et al*. 2012; Hiremath *et al*. 2013). In addition, sustainability assessments enhance decision making at different levels as they contribute to developing data banks with relevant information, thus providing information on countries, organisations and other systems (Singh *et al*. 2012; Hiremath *et al*. 2013). Information banks help to conceptualise complex phenomena by highlighting trends on social, economic and environmental dimensions and quantifying information (Singh *et al*. 2012). This aids in providing transparency in decision making processes which can stimulate communication among policy makers, experts and the public (Shen *et al*. 2011; Bond *et al*. 2012; Hiremath *et al*. 2013). Lynch *et al*. (2011) further explain that sustainability assessments help bring different meaning to different scales (Michael *et al*. 2014). At a local scale they are used mainly as a decision-making tool for urban development by local authorities. At regional level they can be useful in comparing information for project management and regional development programmes; this is done through various institutions and service agents as reiterated by Ness *et al*. (2007 p.499), stating that *"the purpose of sustainability assessment is to provide decision makers with an evaluation of global to local integrated nature-society systems in short and long term perspectives in order to assist them to determine which actions should or should not be taken in an attempt to make society sustainable"*.

Equally beneficial and important is the fact that sustainability assessments are often not generic, therefore a set of indicators will be selected to make up an assessment which will be useful in a specific context, as highlighted by the Sustainability Index for Integrated Urban Water Management, which was developed specifically for the SA context (Carden 2013). Numerous

studies have compiled extensive lists of sustainability indicators from which various sustainability assessment methods have been put together, mainly in an attempt to simplify the holistic assessment of sustainability (Adinyira *et al*. 2007). For this reason, countries and organisations are able to develop sustainability assessment methods by adopting sustainability indicators which are useful for providing manageable amounts of meaningful data without producing extra 'unnecessary' information (Singh *et al*. 2012). Simply put, *"indicators arise from values (we measure what we care about), and they create values (we care about what we measure)"* (Meadows 1998 p.viii). In view of the benefits of sustainability assessments Michael *et al*. (2014) states that sustainability assessments seem to be *"the best way to move human activities towards the direction of sustainability"*.

Despite the popularity and praise of sustainability assessments, they have also been critiqued. Firstly, as with many other practices which measure sustainability, such as impact assessments, the main challenge for sustainability assessments is to ensure that the indicators making up an assessment successfully balance the environmental, economic, social technical and governance aspects of sustainability (Shen *et al*. 2011; Michael *et al*. 2014). This is important as indicators which are poorly constructed may provide misleading results as they do not capture the interlinkages of the dynamics in the system (Singh *et al*. 2012). According to Singh *et al*. (2012 p.297) *"only a few sustainability assessment tools have an integral approach into taking the three aspects of sustainability into consideration"*. Most tools tend to focus more on one of the three aspects. Correspondingly, the results produced using qualitative indicators are prone to being misleading as the scoring or rating of these indicators is subject to the views and interpretations of the person scoring or rating the indicators (Singh *et al*. 2012). This is unlike quantitative indicators which are based on statistical and scientific methods.

Secondly, Tanguay *et al*. (2010) link a critique of sustainability assessments to the general and universal definition of sustainability. Due to the generalised definition, the term has become normative, giving rise to multiple interpretations and triggering an explosion of sustainability indicators (Tanguay *et al*. 2010). Not only has the very broad definition lead to this explosion of indicators, it has also led to difficulties in developing and applying sustainability indicators successfully (Tanguay *et al*. 2010). Levett (1998 p.291) expresses this problem by stating that *"the struggle to find and use indicators of sustainable development is intimately bound up with the process of deciding what we mean by (the term) and what we shall do about it"*. Exacerbating this challenge is a finding revealed by a study undertaken by Tanguay *et al*. (2010 p.140) that *"there are as many possible interpretations or approaches to creation of sustainability indicators as there are definitions of sustainable development"*. It is argued that this limits the comparative potential of different practices and thus hinders the identification of best practices which could aid in the generation of benchmarks to be used for the assessment of existing practices (Shen *et al*. 2011). This is especially true for a developing country like SA that is characterised by a range of different contexts (Carden 2013). As such the Sustainability Index for Integrated Urban Water Management was developed *"based on a vision of what sustainable urban water management means in SA"* (Carden 2013 p.3-1).

2.3.1 Sustainability Assessments in urban water management

Despite sustainability assessments being applied in various fields at multiple scales, there are few benchmarking tools which inform long-term policy development for sustainable water management (Brown *et al*. 2009; Beck *et al*. 2016). However, a wide range of indicators to assess and measure water-related issues at multiple scales have been developed (Beck *et al*. 2016). This shortfall has led to the emergence of sustainable urban water management assessment frameworks such as the *Water Sensitive Cities (WSC) Index* by the Cooperative Research Centre for Water Sensitive Cities; The *Principles for Water Sensitive Cities* by the International Water Association (IWA) and the *City Blueprint Approach (CBA)* by Utrecht University (Beck *et al*. 2016; Koop & Van Leeuwen 2015a; IWA 2016). The formulation of these assessment frameworks is primarily aimed at enhancing cities' transitions towards being water sensitive cities (Koop & Van Leeuwen 2015a).

The WSC Index and the CBA both aim to achieve this by developing an assessment framework with results that provide policy-makers, decision-makers and other relevant stakeholders in the city with context specific information and insight. This is important as the results generated from these assessments are intended to be useful in guiding the envisioning and implementation of strategic initiatives which will support and enable a shift towards transitions to water sensitive practices in cities (Koop & Van Leeuwen 2015a; Beck *et al*. 2016). Equally important in the development of the WSC Index and the CBA is ensuring that information is presented in outputs such as spider diagrams and bar graphs to ensure that indicator results are easily understood and relevant for the intended end users as well as the general public (Koop & Van Leeuwen 2015a; Beck *et al*. 2016). In addition to this the development of both assessments was aimed at simultaneously facilitating inter-city learning for improving implementation capacity (Koop & Van Leeuwen 2015a; Beck *et al*. 2016). In a nutshell, inter-city learning involves the sharing of information and results obtained from the application of the assessments in other cities around the globe to foster learning and awareness among city officials from actions, practices and experiences of water management in other cities (Koop & Van Leeuwen 2015a; Beck *et al*. 2016). On a national scale, these assessments can be useful for national governments to assess and compare the state of sustainable water management of cities within the country (Beck *et al*. 2016). This may provide especially useful comparisons between cities which operate in very similar contexts, thus eliminating discrepancies in comparing and learning.

The IWA *Principles for Water Wise Cities,* on the other hand, aim to provide support for transitioning to water sensitive practices to city officials. Unlike the WSC Index and the CBA, the IWA Principles do not provide a sustainable water management assessment for cities, instead the principles provide a framework which is intended to guide city officials to implement and develop their urban water visions and strategies for the transition towards water sensitivity in their cities (IWA 2016). The fundamental goal of the IWA principles is to facilitate/encourage stakeholders within cities to have a shared vision which will result in collaborative action between local governments, urban professionals as well as the general public in addressing and searching for sustainable solutions to urban water management challenges (IWA 2016). The IWA framework

provides city officials and stakeholders with five principles to support and enable transitions to water sensitivity: vision, governance, knowledge and capacities, planning tools and implementation tools (IWA 2016).

In addition to enhancing cities' transitions towards being WSCs, these frameworks also aim to address gaps and inadequacies in sustainability assessment practice in the water sector (Koop & Van Leeuwen 2015a; Beck *et al*. 2016). For this reason, pilot applications and reviews of water-related indicator assessments are imperative. For instance, a revision of the CBA was conducted based on the learning experiences of its application in 45 cities in 27 countries (Koop & Leeuwen 2015b). This review included: (1) the updating of existing indicators; (2) ensuring that individual indicators make an equal contribution to the final score (sustainability measurement); (3) ensuring that indicator results are easy to understand by the end-user; (4) developing a separate supplementary framework which supports the undertaking of the main framework. The development of the WSC Index involved multiple development phases aimed at improving its functionality, including the prototype of the Index being applied to two councils located in Melbourne, Australia. The feedback from the two pilot studies was used to improve the functionality, usability, benefits and reliability of the WSC Index (Beck *et al*. 2016). The review and piloting process of identifying and addressing inadequacies improves the accuracy and credibility of sustainability assessment tools. This improvement is beneficial in accurately providing useful information which can be used to support sustainability transitions.

2.4 Conclusion

This chapter has provided a review of the relevant literature for this study. Section 2.1 of this chapter has provided an understanding of the conventional water management paradigm in cities and presents the alternative water management paradigms that cities need to adopt in order to adequately address the changing socio-economic and environmental demands of society. This section further highlights that, as much as transitions towards sustainable water management approaches such as WSUD require technological innovation, an overhaul of the hydro-social contract is a crucial part of ensuring successful transitions from conventional management paradigms. Finally, section 2.1 highlights that although the WSUD framework is relevant to inform transitions in developing countries, it is crucial to adapt the framework to the developing context. Section 2.2 of the chapter presents three fundamental frameworks that are used to analyse and describe traits of transitions, the MLP, SNM and TM frameworks. Lastly, section 2.3 of this chapter explores the utility of sustainability assessments and benchmarking tools in assessing the progress towards adopting SUWM approaches such as WSUD in cities. This chapter has thus provided a basis for a fuller understanding of sustainability transitions towards WSUD in the SA context.

Chapter 3 – Contextual Analysis

3 Introduction

This chapter provides an in-depth contextual analysis for the City of Cape Town (CoCT) with the aim of understanding the state of water management in the City. A desktop analysis has been undertaken of the relevant national, provincial and local laws and policies underpinning the management and governance of water in the CoCT to provide some insight into the City's potential to transition towards a Water Sensitive Urban Design (WSUD) approach.

3.1 Water management in the City of Cape Town

The CoCT is located on South Africa's (SA) South West coast in the Western Cape (WC) Province (figure 7). Cape Town is home to ± four million people and has a Gini Coefficient[3] of 0.57, which illustrates the inequalities of income levels that exist in the City (CoCT 2016a). Approximately 16% of housing in Cape Town is informal, therefore access to basic housing, sanitation and water services to informal areas remains a major challenge in the municipality (CoCT 2016a).

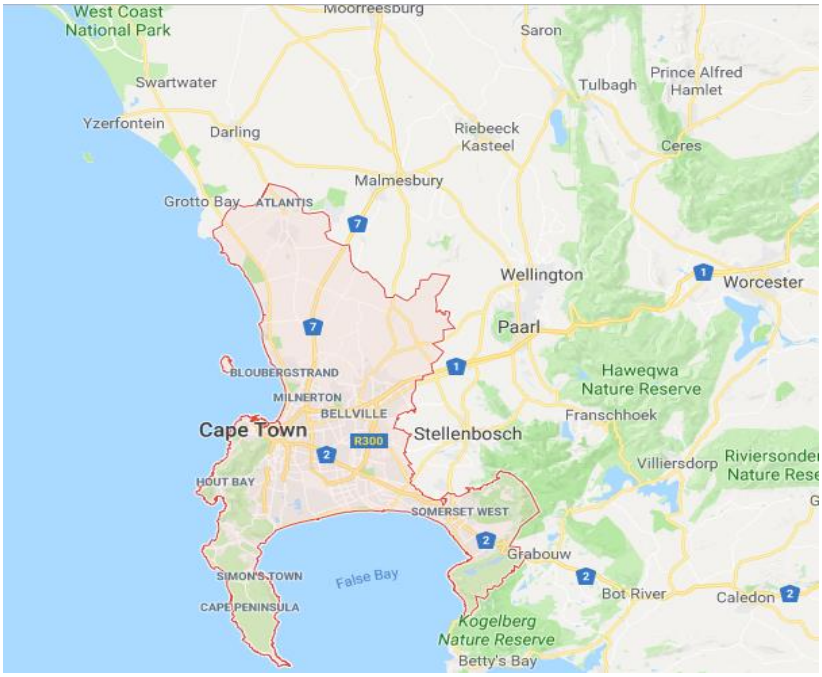

Figure 7: CoCT Map (Source: Google Maps)

The WC Province has a Mediterranean-type climate causing it to experience hot dry summers and cold wet winters. The City relies heavily on winter rainfall as 98% of Cape Town's water supply is currently supplied by surface water sources from six major dams[4] and the remaining 2% from groundwater sources (CoCT 2012; CoCT 2017a). The hot dry summer period results in the highest demand for water when water supply is most limited (CoCT 2012). The issue has become increasingly serious due to climate change effects and continued growth of the City's population (CoCT 2012). Climate change in the WC region is predicted to result in increased temperatures, drying in many areas and long periods

[3] Measurement of inequality in levels of income; the higher the value between 0 and 1, the greater the level of income inequality

[4] The six main dams that supply water to The CoCT are the Steenbras Dams (Upper and Lower), the Wemmershoek Dam, the Voelvlei Dam, the Berg River dam and the biggest, the Theewaterskloof Dam (CoCT 2017a).

between intense rainfall events (Western Cape Government [WCG] 2014). It has been estimated that by the year 2050 rainfall in the WC region will have decreased by approximately 30% (WCG 2012). The significantly decreased availability of water will result in the region being more vulnerable to droughts, fires and floods. It is feared that many of these changes will amplify existing vulnerabilities entrenched within the socio-economic inequality in the WC Province, and could cripple major sectors – agriculture and energy – which play a crucial role in the region's economy (Department of Water Affairs [DWA] 2013). As a result a major challenge faced by the CoCT is to ensure that while water services are provided to all residents, water use is reduced and conserved and the supply is augmented to ensure a sustainable future supply of water in the region (WCG 2012; CoCT 2012).

Even though it is estimated that rainfall will decrease in Cape Town over the medium to long term, flood risk and drainage are also a significant area of concern during wet winter months. Although flood risk is a concern for the City as a whole it is particularly severe in the informal settlements and expansive low-lying areas such as the Cape Flats. The CoCT has therefore developed two policies, The Management of Urban Stormwater Impacts Policy (MUSIP) (CoCT 2009a) and the Flood Plain and River Corridor Management Policy (FPRCMP) (CoCT 2009b) along with a winter programme which aim to address issues of flooding in the city. Another important aspect of Cape Town's water management is the treatment of wastewater produced from the City. These will be discussed further in the results and discussion chapter of this thesis.

3.2 City of Cape Town water crisis, 2015 - 2018

Since the year 2000 the WC region has experienced several years of below average rainfall, which has put pressure on the regions water resources. In 2000 following below average rainfall, water demand exceeded supply resulting in the introduction of water restrictions, which helped reduce demand (Department of Water Affairs and Forestry [DWAF] 2007). Similarly, in 2003 and 2004 the City experienced severe drought conditions, resulting in water restrictions. At the same time, forecasted economic and population growth rates indicated that water demand levels will continue to increase for Cape Town, over the years. As such, in early 2005 the Department of Water Affairs and Forestry and the CoCT initiated a study for the development of a reconciliation strategy for the Western Cape Water Supply System (WCWSS) (DWAF 2007). The projections from the study illustrated the need for augmentation interventions to ensure that supply meets demand till 2030. In 2007, the Berg Water Project[5] was constructed in order to increase the WCWSS yield from 475 million m^3/year to 556 million m^3/year ensuring that supply continues meets demand (DWAF 2007). However, projections in 2007 were already showing that by 2011 the WCWSS water requirements will exceed supply (as illustrated in figure 8), making 2011 a marked date to implement the next intervention. The implementation of water conservation and water demand management (WC/WDM) strategies by the CoCT delayed the need for intervention in 2011. As such the WC

[5] The Berg Water Project comprises the construction of the Berg River Dam and the Supplement Scheme.

Reconciliation Strategy Study identified the need for the WCWSS to be augmented by 2019 (DWA 2012). However, from 2015 to 2017 the CoCT experienced severe drought conditions, decreasing storage levels of the six major dams responsible for storing and supplying the City with water. Figure (9) illustrates the accumulated daily rainfall for the City at Tygerberg for years 2012 to 2018.

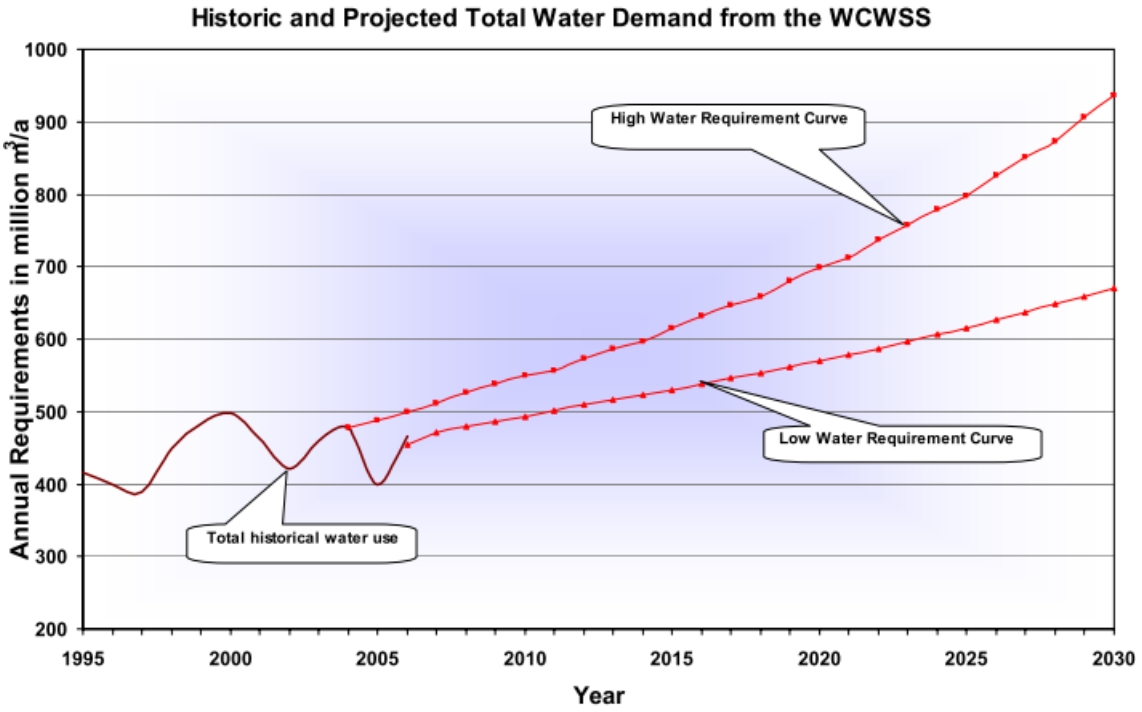

Figure 8: Projected (2007) high and low water requirement scenarios for the WCWSS
(Source: DWAF 2007)

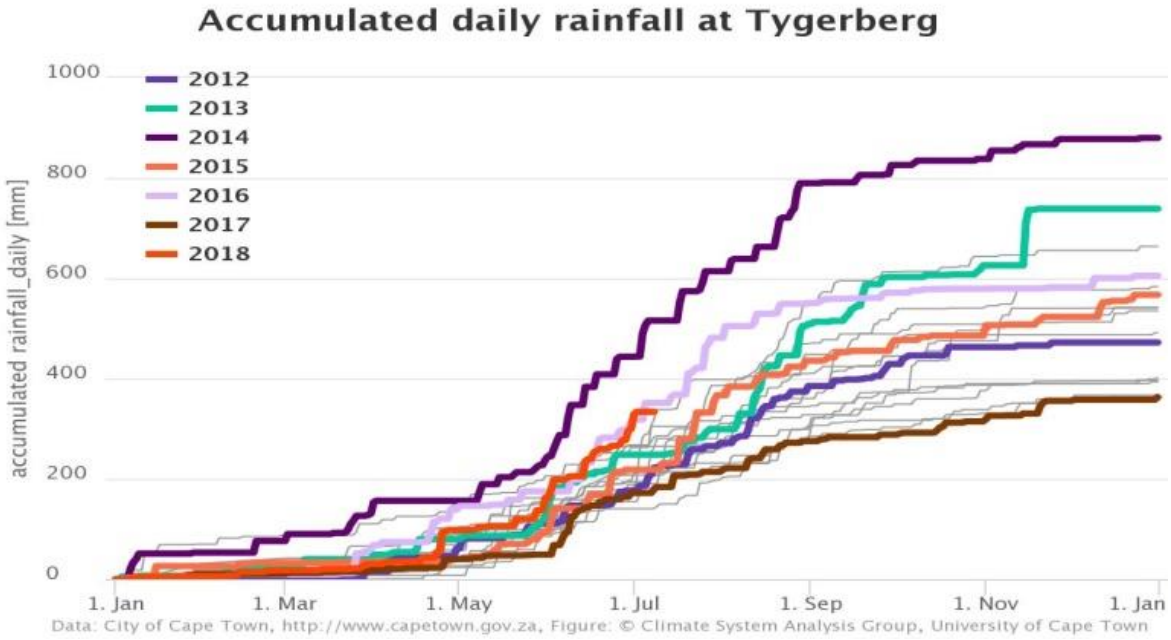

Figure 9: Accumulated daily rainfall (mm) at Tygerberg (Cape Town) for years 2012-2018
(Source: Climate System Analysis Group, University of Cape Town. Available at: http://www.csag.uct.ac.za/current-seasons-rainfall-in-cape-town/)

The critical drought conditions in Cape Town have resulted in local government enforcing strict water restrictions, in order to reduce water consumption significantly. This is to ensure that the water contained in the City's dams is able to supply the city with water throughout the current rainy season (May – August 2018). In February 2018 the City enforced Level 6B water restrictions limiting usage to 50 litres/person/day to achieve a total target of 450 Mega litres/day across the City. The City has had to devise short, medium and long term solutions to augment water supply in the event that the drought persists. The contingency measures include reducing water pressure in the reticulation network and implementing water restrictions (CoCT 2018a). Another short term solution being implemented by the City includes the commissioning of three temporary desalination plants. The first plant (V&A Waterfront) has been in full production since March 2018 and is producing 2 Mega litres of water per day (MLD). The other two plants (Strandfontein and Monwabisi) have been in full production since May 2018 and are producing 7MLD for supply to the CoCT (GreenCape 2018). Furthermore, 4 MLD is supplied from the Newlands and Oranjezicht springs and another 10MLD is expected to be supplied from the Cape Flats aquifer in September 2018. Other groundwater augmentation sources include the Atlantis aquifer and Table Mountain Group aquifer. Figure 10 illustrates the City's provisional two year augmentation plan, as published in February 2018.

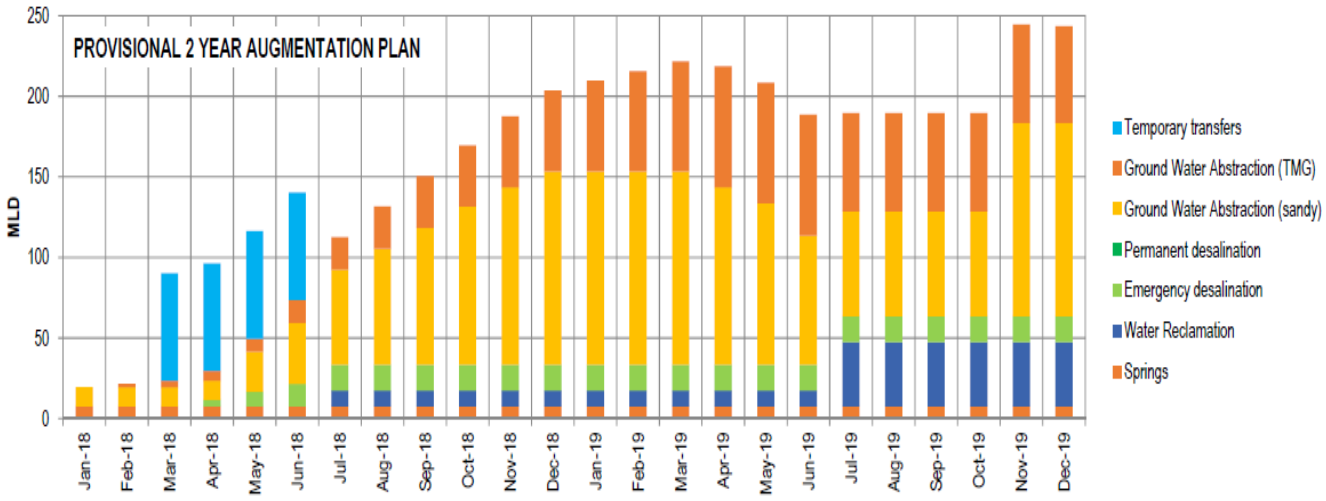

Figure 10: Two year provisional augmentation plan for the CoCT (Source: CoCT 2018a)

Despite the interventions employed by the CoCT, the uncertainty associated with the water crisis has not only resulted in the exploration and consideration of short to long term augmentations schemes. The uncertainty seems to be causing a shift in the governance and management of water resources in the City. The City has adopted a new management scenario which has been termed the 'new normal' where the city is classified as a permanent drought region. In addition, the City is in the process of developing a new water strategy. Consequently, the City plans to no longer rely exclusively on surface water sources and to consider the uncertainty of climate change in its future planning.

3.3 Policy, legislation and strategies underpinning water management in the City of Cape Town

The management and governance of water resources in the CoCT is underpinned by a guiding framework of national, provincial and local legislation, policy and strategies. It is important to consider legislation from all three spheres of government as national legislation is the formative legislation to which all subsequent provincial and local policies, strategies and plans must adhere. This section of the contextual analysis presents the common themes and guiding principles, highlighted in the analysed legislation, which inform the management and governance of water in Cape Town. The key pieces of legislation which have been analysed are presented in Table 3.

SA's Constitution is *"the supreme law of the republic; law or conduct inconsistent with it is invalid and the obligation imposed by it must be fulfilled"* (Republic of South Africa [RSA] 1996). The constitution therefore sets out the main themes used to guide water governance and management which are replicated through all subsequent laws and policy in SA, including those analysed for purposes of this research. Chapter 2 of the Constitution includes the Bill of Rights which serves to protect the rights of all people in SA by affirming, amongst other things, human dignity and equality. Sections 24a and 27 of the Bill of Rights are critical for consideration in the management of water in SA and are thus reflected in other laws, policies and strategies guiding the governance of water. Section 24a states that every human has the right to a safe and non-harmful environment which is protected through legislative measures while promoting economic and social development; this includes the protection of water resources (RSA 1996). In conjunction with this, section 27 of the Bill of Rights states that everyone has the right to access to sufficient water, food and social security and it is the responsibility of the state to ensure that *"legislative and other measures, within its available resources, achieves the progressive realisation of these rights…"*(RSA 1996).

Table 3: Key national, provincial and local legislation analysed in this section

National	• The Constitution of the Republic of South Africa Act No. 108 of 1996 • National Water Act No. 36 of 1998 • Water Services Act No. 108 of 1997	• National Environmental Management Act No. 107 of 1998 • National Water Resources Strategy 2
Provincial	• Western Cape Sustainable Water Management Plan • Western Cape Water Reconciliation Strategy	• Western Cape Climate Change Response Strategy
Local	• City of Cape Town Environmental Strategy • City of Cape Town Climate Change Policy	• City of Cape Town Integrated Development Plan • The City of Cape Town Water By-law

The National Water Services Act (NWSA) serves as a legislative measure to realise these rights (RSA 1997). Section 3 of the NWSA states that everyone has the right to basic water supply and sanitation services and that it is the role of every water services institution in the country to take reasonable measures to ensure that these rights are realised (RSA 1997). The Act further mandates all Water Services Authorities (WSA) to provide and stipulate measures to realise these rights in a Water Services Development Plan (WSDP).

The CoCT WSDP (2017/18) stipulates that the first 6kl of water supplied and the first 4.2kl of sewage removed from dwellings is free (CoCT 2017b). In addition to this, an indigent[6] grant was provided to qualifying households which afforded these an additional free 4.5kl of water and 3.15kl of discharged wastewater per month. However, owing to the water crisis, the need for additional water infrastructure investment, maintenance, and operation to enhance water security in the City has challenged the City's affordability to provide free basic water and sanitation services to all households. Consequently, as of the 1st of July 2017 the City's water and sanitation tariff structure was amended to ensure that only indigent households receive free basic water and sanitation services; this has also influenced an increase in water and sanitation tariffs for non-indigent households. The municipality states that this amendment was also strongly influenced by a statement from National Treasury appealing that municipalities reconsider the affordability of providing free basic water and sanitation services to all households. Sustainability, equity and cooperative governance are identified as central to the use, conservation, protection, development, management and the control of water resources in SA (RSA 1998a; DWA 2013). Sustainability and equity in water resource use and management are also identified as important principles as they recognise the importance of protecting water resources for present and future generations as well as the need to promote social and economic development through the use of these resources (RSA 1998a). This is especially important as water resources have an effect on large scale industries such as mining, agriculture and energy (DWA 2013). Not only are large industries affected by water resource management, but food security, human health, employment rates and ecosystem services depend largely on the equitable and sustainable management of water resources in SA.

The analysed policies acknowledge that equitable and sustainable water management cannot be achieved by one government department alone (at any sphere), rather it requires cooperative governance. Furthermore, there is recognition that cooperative governance goes beyond the three spheres of government and should include cooperation between business and industry, civil society, academia and research institutions.

The National Water Resources Strategy (NWRS) along with provincial and local policies emphasise the new found importance of considering alternative methods to sourcing water resources, to ensure continued sustainability of, and sufficient access to water resources. This is due to the fact that, despite SA having well-developed water resource infrastructure with more than 4 395 registered dams, steady population increases, increasing urbanisation rates and increasing standards of living are leading to the full utilisation of available surface water sources (DWA 2013). This is further exacerbated by the fact that there are limited sites for the development of new dams, both nationally and in the WC Province. Moreover, the effects of climate change are causing altered rainfall patterns and temperatures which are seen to be having a negative effect on surface

[6] Indigent Criteria: (a) Property values of less than or equal to R400 000; (b) The monthly household income is less than R4000; or (c) Pensioners (CoCT 2017b).

water storage (DWA 2013; WCG 2014). These policies and strategies therefore emphasise the need to reduce water demand while increasing the availability of water sources.

Achieving a sustainable water balance can only be accomplished by transitioning from traditional water supply methods towards more sustainable options such as groundwater utilisation, desalination, rain and stormwater harvesting as well as water re-use. Equally important is ensuring that water use practices which reduce supply, such as pollution, inefficient water management practices, lack of infrastructure management, unaccounted-for-water and poor governance are averted (DWA 2013). In order to ensure that SA's water resource base is not compromised the national Department of Water and Sanitation (DWS) introduced a Green Drop and Blue Drop certification program for wastewater and water treatment works nationwide. The Green and Blue Drop systems are an incentive-based method which grants Green or Blue Drop Status to WSA based on their level of compliance with water legislation and other best practices as required by the DWS. In order to further improve water management, the analysed legislation and policy recognises that monitoring and evaluation are imperative. Monitoring is beneficial as it helps improve the planning and policy formulation processes ensuring that there is effective detection and on-going adaptation strategies to help ensure water resources are protected and sustainable for future use. At local level this is achieved through the WSDP. Monitoring of policy implementation and compliance, and enforcement is also crucial in ensuring that progress against objectives and targets is made and tracked. Monitoring and implementation should ultimately contribute to review and revision processes of water management and governance plans.

As much as undertaking monitoring processes is imperative for improving water management, it is important that there are clear roles and responsibilities for institutions to successfully execute these processes. Legislation acknowledges the importance of setting up the appropriate legislated institutional arrangements and governance structures with specific roles and responsibilities (RSA 1998a; RSA 1997).

The DWS is the 'public trustee of the nation's water resources' (RSA 1998a). The role of national government is therefore to formulate, plan and implement laws and policies governing the water sector. This includes setting out the national objectives for protecting water resources and implementing water resource schemes to meet water demand for cities, agriculture, mining and other sectors (DWA 2013). Furthermore as the custodian of the national water resource base the DWS operates and maintains the dams used to store raw water. Any institution (or person) may construct and operate a dam provided the institution has a licence or authorisation to do so. However it is the role of the municipality to develop, operate and maintain the abstraction networks and infrastructure to supply water services to consumers.

Both the National Water Act and the NWSA make provision for the establishment of institutions to assist the DWS in carrying out its mandate to develop, protect, conserve and allocate water resources, and regulate water services and water use. With this intention, the DWS has divided the country into nine Water Management Areas (figure 11) of which each is to have a Catchment Management Agency that is responsible for water resource management at a catchment level. This

institutional arrangement is set in place to ensure that water resources are managed in accordance with nation legislation, policies and guidelines. It is also the role of Catchment Management Agency to establish closer links with stakeholder groups within their Water Management Areas through active participation to empower different stakeholder groups to be a part of structures such as catchment forums, water user associations and catchment committees.

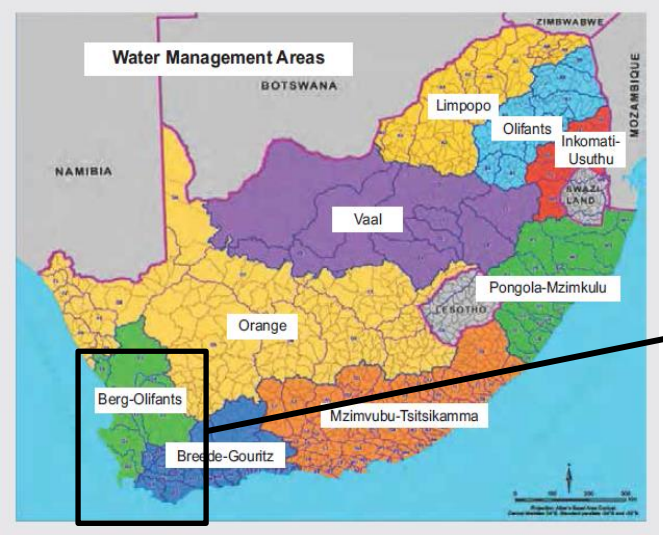

Figure 11: Water Management Areas (Source: DWA 2013)

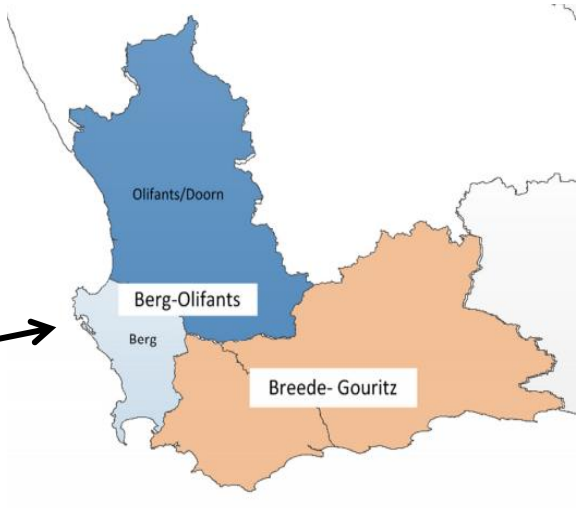

Figure 12: Berg-Olifants Water Management Area (Source: DWS 2015)

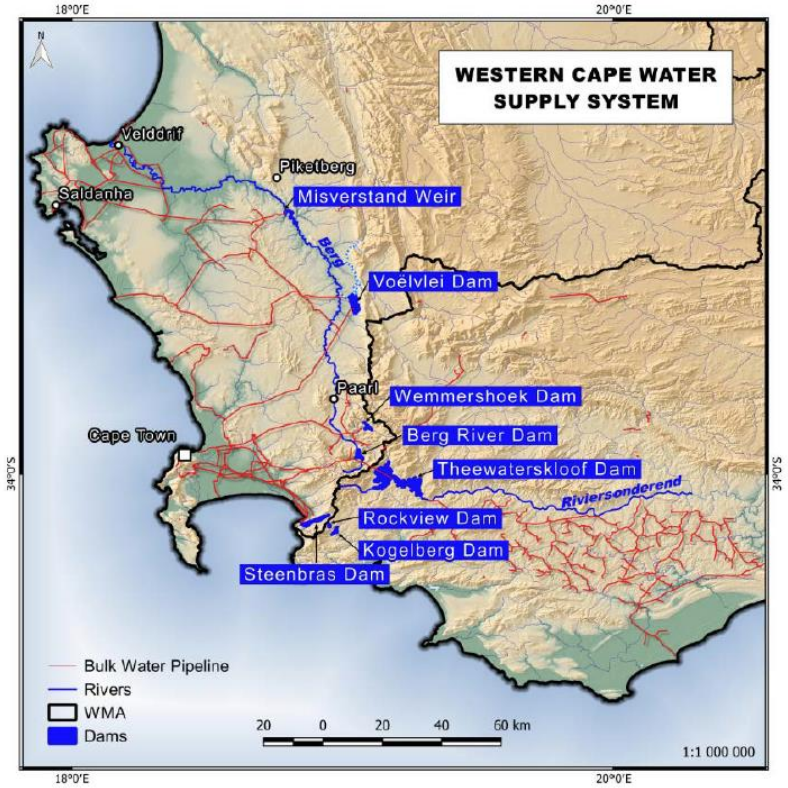

Figure 13: WCWSS (Source: http://www.dwa.gov.za/Projects/RS_WC_WSS/sa.aspx)

The CoCT falls within the Berg River Catchment of the Berg-Olifants Water Management Area (figure 12) which is the amalgamation of the Olifants River Catchment in the north and the Berg

River Catchment in the South (DWS 2015). The Western Cape Water Supply System (WCWSS) supplies water to several municipalities within the Berg-Olifants Water Management Areas. The WCWSS is an intricate network of dams, pipelines and distribution networks as shown in figure 13. The WCWSS is co-operatively managed and operated by the CoCT and the DWS' WC Regional Office. The total water allocation for the WCWSS is 609 million m^3 /year; figure 14 illustrates an overview of the WCWSS allocations by type (during the drought).

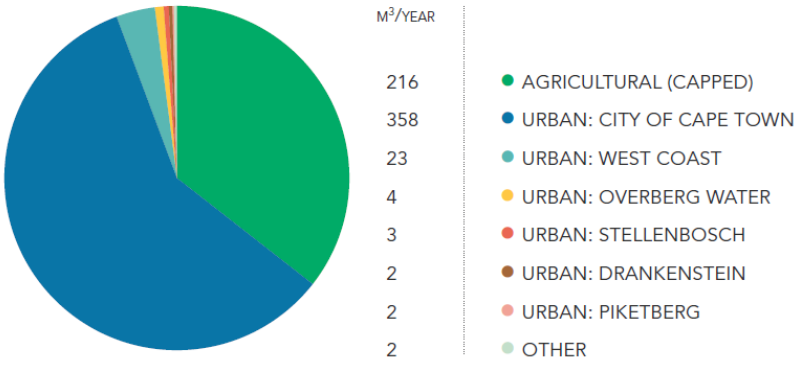

Figure 14: Overview of WCWSS allocations by type (Source: GreenCape 2018)

At the Municipal level, water is managed by Water Services Providers (WSP) as well as Water Service Authorities (WSA). A WSA is a municipality which has executive authority for water services within its jurisdiction. The role of a WSA is to provide affordable, equitable and sustainable access to water services in accordance with section 78 of the Municipal Systems Act and section 11 of the NWSA (RSA 2000; RSA 1997). This includes distribution and reticulation of water for domestic, industrial and agricultural use; considering alternative ways of providing access to water services; impose reasonable limitations on the use of water services. Importantly, section 21 of the NWSA stipulates that every WSA *"must make bylaws which contain conditions for the provision of water services"*. The NWSA makes provision for a WSA to either carry out the functions of a WSP itself or to enter into a service delivery agreement with another WSP. The role of WSPs is to physically provide the services to supply water as well as collect and treat wastewater and effluent before it is released back into the natural environment (DWA 2013).

The CoCT Municipality is responsible for both the roles of WSA and WSP. The CoCT Municipality is the WSA and the City's department of Water and Sanitation is the WSP for the CoCT. The performance of these water services institutions is monitored by the Minister and the provincial authority, as mandated by the NWSA. This is to ensure that water service institutions are complying with the provisions of the NWSA. The role of the province is also to intervene, as per request from the Minister, in the event that a WSA has not effectively performed the functions imposed by section 63 of the NWSA (RSA 1997). These legislated institutional structures aim to provide an enabling environment for roles, responsibilities and mandates to be well defined and understood for each institution so that accountability and efficiency is maintained.

3.4 Conclusion

This analysis has presented the status of water management and governance in Cape Town. The various national, provincial and local legislation, policies and strategies have shed light on the fact that it is a top priority that SA's water resources are used, managed and governed in an equitable and sustainable way. Accordingly, this analysis shows that in order to achieve sustainability and equity in water management the three spheres of government ought to exercise the mandate of cooperative governance by working together on matters of common interest. Equally important is that water is managed and governed within legislated institutional structures at national, regional and municipal level. This is so that roles and responsibilities within institutions are allocated accordingly without overlap and so that transparency and accountability may be fostered.

The analysis illustrates that the effects that climate change have or are predicted to have on SA, and the WC especially, are being considered in future plans for the management of water resources. The WC region is expected to experience less rain and higher temperatures, which will increasingly put pressure on existing water resources. This will consequently have an effect on major economic sectors and will also affect social development. It is for this reason that national, regional and local policy and strategies recognises that there is a dire need to consider alternative water sources in order to use water resources in a sustainable and equitable manner.

Chapter 4 – Research Methods

4 Introduction

This chapter provides an in-depth description and justification of the methods employed in this research. The chapter first provides a description of the overall research design. Secondly, the context, limitations and ethical considerations of this research are described. Lastly, the chapter explains the methods employed to gather, organise and analyse the data used to achieve each of the research objectives.

4.1 Research design

It is imperative that all research involves an explicit and methodical approach to finding the relevant information required to fulfil the aim and objectives of the research (Hancock *et al*. 2007). The methods and analysis tools for this research have therefore been guided by, and deemed appropriate to achieve, the objectives of this research. The objectives of this research are:

1. To understand Cape Town's urban water cycle is managed
2. To understand the governance of water scarcity, flood risk and wastewater treatment (WWT) in Cape Town
3. To identify the fundamental institutional conditions within the City of Cape Town (CoCT) that could support a transition towards a Water Sensitive Urban Design (WSUD) approach
4. To provide a snapshot of transitions towards WSUD in Cape Town

A combination of qualitative and quantitative research methods has been applied to achieve the objectives of this research.

Qualitative research methods are used to gain insight into social phenomena which cannot be understood through measuring and quantifying variables (Hancock *et al*. 2007). The qualitative research method has therefore been used to broaden and deepen the understanding of social phenomena in the real world which have not yet been fully understood (Hancock *et al*. 2007). This is achieved by collecting qualitative data in two most common ways, firstly by focusing on people's verbal reports and understanding of experiences of situations through various tools such as interviews, questionnaires and discussions (Hancock *et al*. 2007). Secondly, qualitative information can be produced from secondary data sources such as policy documents, reports and legal documents. For this reason, analysed and interpreted data from qualitative research methods has been used for purposes such as understanding the philosophy of an organisation, and understanding the perceptions and values which influence the behaviour of people in specific situations (Hancock *et al*. 2007). On the other hand, quantitative research attempts to describe measurable phenomena through statistical, mathematical or computational techniques (Hancock *et al*. 2007).

Hancock *et al*. (2007) recognise that proponents of quantitative research methods have previously criticised the distinguishing features of qualitative research methods and vice versa. This was mainly owing to the fact that it was also perceived that one research method is better than the other. Although this may be the case, recent research which integrates quantitative and qualitative research methods in the same research enquiry has become increasingly common (Bryman 2006; Zachariadis *et al*. 2013). This integration of qualitative and quantitative research has been termed '*mixed methodology research'* (Bryman 2006; Zachariadis *et al*. 2013). Employing mixed methodology research has been useful in allowing researchers to gain in-depth insights into phenomena of interest which cannot be fully understood by employing only quantitative or qualitative research methods (Bryman 2006; Zachariadis *et al*. 2013). Mixed methods research is beneficial because, depending on the nature of the research enquiry, it offers flexibility to research in terms of the way in which the qualitative and quantitative research method is combined and to what degree each method is used in the research. Therefore in order to understand the phenomena of interest, qualitative and quantitative research methods could either be used concurrently so that they are independent of each other or they can be used sequentially, where the findings from one approach inform the findings of the other.

Four major types of mixed methods designs have been suggested by Creswell & Clark (2007):

1. Triangulation: the data produced from the qualitative and quantitative research methods are merged to understand the research problem
2. Embedded: either qualitative or quantitative data is used to answer a research question within a largely quantitative or qualitative study
3. Explanatory: use qualitative data to help explain or elaborate quantitative results
4. Explanatory: collect quantitative data to test and explain a relationship found in qualitative data

In this research, embedded mixed methods research design was employed by using quantitative data to answer a research question within a largely qualitative study. The City Blueprint Approach (CBA), a diagnostic indicator tool which integrates quantitative and qualitative research to understand the sustainability of water management in a municipality was applied to Cape Town. The CBA is an indicator assessment tool comprising the Trends and Pressures Framework (TPF), the City Blueprint Framework (CBF) and the Governance Capacity Framework (GCF), as shown in figure 15 (Koop & Van Leeuwen 2015a; Koop & Van Leeuwen 2017). The CBA was developed by the KWR Watercycle Research Institute in cooperation with Utrecht University, The Netherlands and acknowledges that every city has its own social, financial and environmental setting in which water managers have to operate (Koop & Van Leeuwen 2017). The CBA was first applied to 45 cities in 27 countries before undergoing a critical revision based on the learning experiences obtained during the assessment in these cities (Koop & Van Leeuwen 2015b). The improved tool which emanated from the revision has been applied to the CoCT and forms part of a larger study to further inspect the feasibility of this approach. Part of this research process has therefore been the 'testing' of this tool on the CoCT.

The CBA was applied to provide a quick, insightful and context-specific understanding of the current water management and governance capacity of three water challenges in Cape Town.

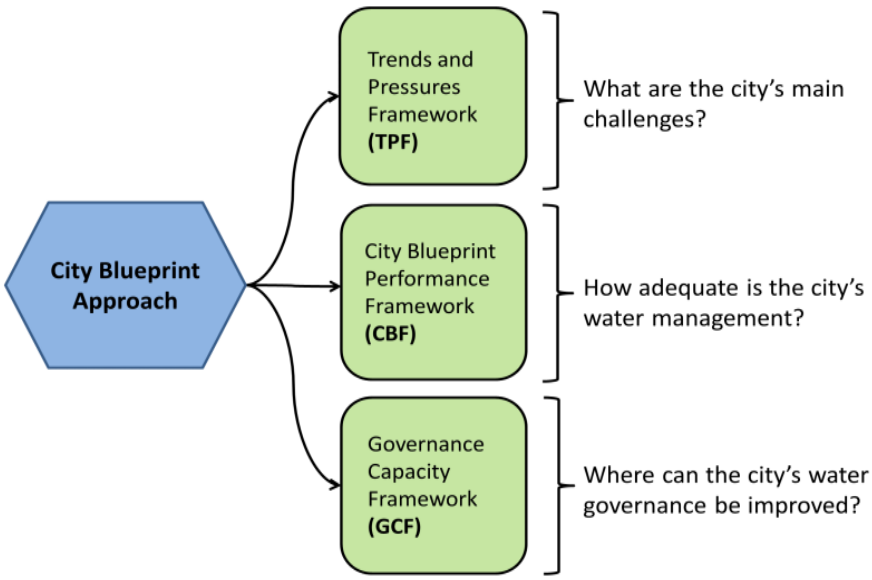

Figure 15: CBA (Source: Koop & Van Leeuwen 2017)

The TPF was used to understand the social, environmental and economic environments in Cape Town, over which the city has limited direct influence, but which provide the context within which the water officials in the city are operating. This helped the researcher to be more informed in the analysis of the CBF and the GCF. As will be discussed in more detail in section 4.3, the CBF aided in understanding the management of Cape Town's urban water cycle (Objective 1) and the GCF helped in developing an understanding the governance of water scarcity, flood risk and WWT in Cape Town (Objective 2). A complementary qualitative analysis method, the thematic analysis method, was used to analyse the data of the GCF in order to further identify the important institutional aspects which are important in considering a transition towards a WSUD approach in Cape Town (Objective 3). The results obtained from the CBA and the thematic analysis were used together to develop a snapshot of transitions towards WSUD in Cape Town (Objective 4). In order to achieve this, the International Water Association (IWA): Principles for Water-Wise Cities framework was applied to these results.

Figure 16 presents the overall research process that was adopted for this research.

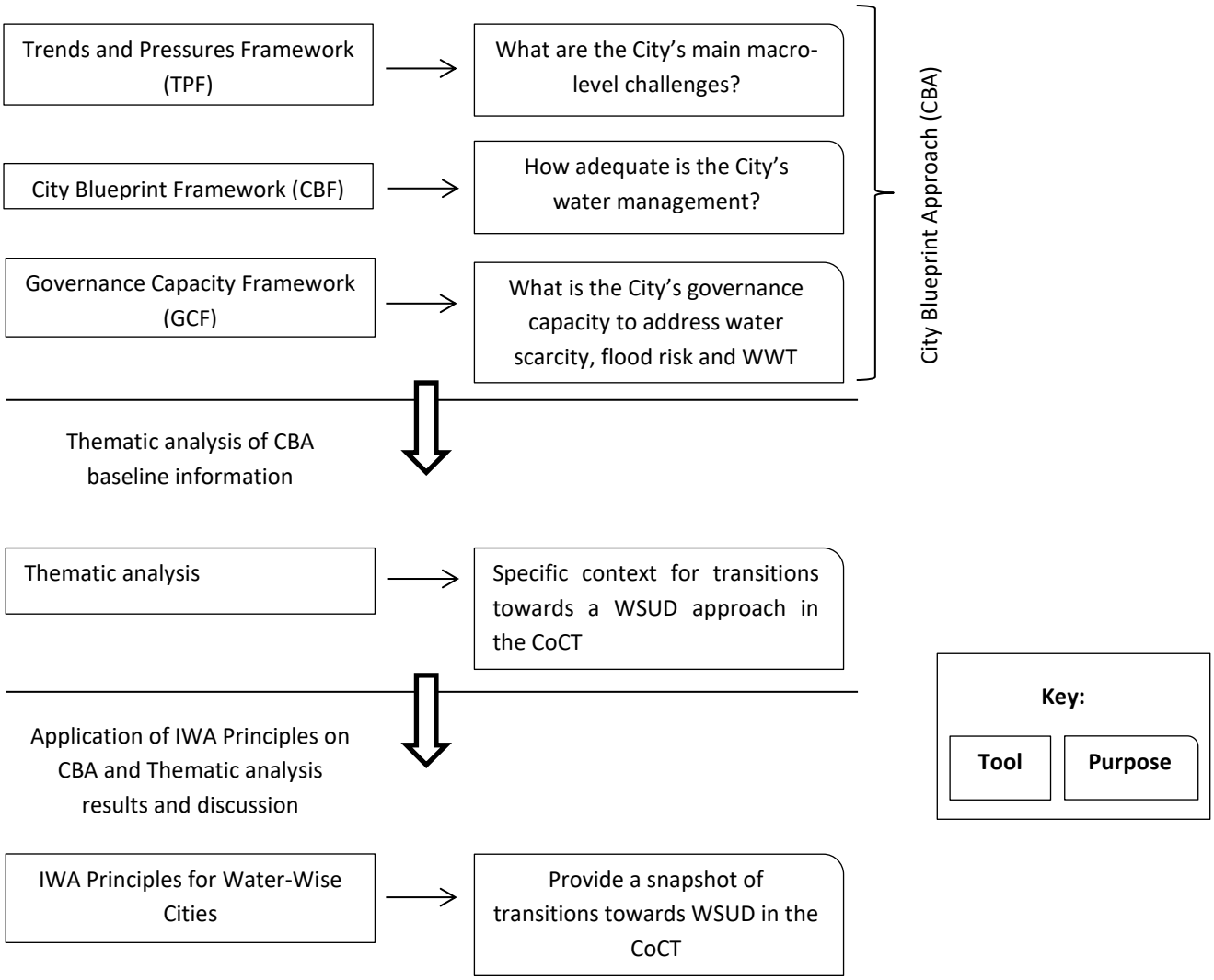

Figure 16: Research Process

4.2 Limitations and context of research

Although the methods employed have helped to fulfil the research aim and objectives, there were still unavoidable limitations to the research. Firstly, the data for this research was gathered during the time when the CoCT was experiencing a severe water crisis (2017). For this reason, organising and scheduling interviews with city officials proved to be a challenging task. Scheduling interviews depended on the availability of respondents and their willingness to participate in the study. During the data collection period, city officials were especially busy and therefore only a small number were able to participate in this study. Even so, city officials were often only able to set aside a limited amount of time for an interview (most interviews lasted 30 minutes to an hour). For this reason, secondary data sources, other interviewees and follow up emails were relied on for information more than was originally anticipated. In such cases, only a select number of questions from the GCF were asked of respondents. In addition, the interview responses may have been influenced in some way by the ongoing water crisis. Despite this being the case, all responses from the respondents offered an extremely valuable contribution to this research.

In addition, the scoring of the qualitative indicators of the GCF by the researcher was to some degree subjective, thus increasing the potential danger of the indicators not being scored

accurately. With the intention of ensuring that this process was carried out as objectively as possible, the justification for each indicator score as well as the sources used to score the indicator was recorded by the researcher (Appendix A). This information was reviewed by the supervisor of this research as well as an academic from the KWR Watercycle Research Institute. Furthermore, a limitation to this research related to the data collection for the CBF. Some information required to complete the CBF was not accessible, and in instances where local data was not available, national or regional data was used as proxies. Therefore a few of the indicators of the CBF do not purely depict local information. This limits the accuracy to some degree, especially in a large and diverse country like South Africa (SA) with a great deal of regional variations.

4.2.1 Ethical considerations

When contacting the respondents, the purpose of the study was explained to them in writing. Furthermore, a consent form which outlined the purpose and procedure of the study was given to respondents to read before the interview was conducted (Appendix B). The consent form clearly stated that the respondents' participation in the study was voluntary and that at any time the respondents were allowed to withdraw from the study. Equally important, the respondents were asked for permission for the interview to be recorded. Lastly, the fact that the data for this research was gathered during the time when the CoCT was experiencing the water crisis also meant that the identities of the interviewed respondents were kept anonymous. This was owing to the sensitivity and controversy surrounding the water crisis. The severity of the crisis resulted in multiple actors (all government spheres, politicians, high income and low income consumers, and tourists) being 'blamed', for various reasons, for the crisis (Eberhard 2018). Owing to the fact that the role of the national Department of Water and Sanitation (DWS) is to formulate, plan and implement schemes to supply water to urban areas (as discussed in section 3.3 of the contextual analysis chapter), some of the blame was placed on the national government for not adequately planning for the crisis. The local government on the other hand, was accused of responding too late to the crisis. Further complicating the situation was the fact that the 'blame game' was also at play between the three spheres of government. Therefore with the intention of protecting respondents and to ensure that respondents felt comfortable to express their views without worrying that they may cause controversy or negatively impact their jobs, the identities of all respondents were protected.

4.3 Objective 1 – To understand how Cape Town's urban water cycle is managed

In order to understand how Cape Town's urban water cycle is managed the CBF was applied to the CoCT.

4.3.1 City Blueprint Framework (CBF)

The CBF consists of 25 indicators which are divided into seven comprehensive categories as shown in table 4. Each indicator is scored on a scale from 0 (low performance) to 10 (high performance). A short explanation of the scoring and analysis method for the CBF is provided in the section that follows. Appendix C, provided by Koop & Van Leeuwen (2015a,b), presents detailed information on the scoring methods for the CBF. Data for the Cape Town assessment was sourced online, predominantly from publicly available reports, local policy documents sourced from the city's

website, as well as through interviews with city officials. In order to ensure that the results of the CBF fulfilled the objectives of this research, the most recent available data was used to score the indicators for the CBF; the date range of the data was 2011 – 2018. CBF scores and sources are presented in Appendix D.

Table 4: CBF indicators

Category	Indicators	Category	Indicators
1.Water quality	1. Secondary WWT	5.Infrastructure	14. Stormwater separation
	2. Tertiary WWT		15. Average age sewer
	3. Groundwater quality		16. Water system leakages
2.Solid waste	4. Solid waste collected		17. Operation cost recovery
	5. Solid waste recycled	6.Climate robustness	18. Green space
	6. Solid waste energy recovered		19. Climate adaptation
3.Basic water services	7. Access to drinking water		20.Drinking water consumption
	8. Access to sanitation		21. Climate-robust buildings
	9. Drinking water quality	7.Governance	22. Management and action plans
4.Wastewater treatment	10. Nutrient recovery		23. Public participation
	11. Energy recovery		24. Water efficiency measures
	12. Sewage sludge recycling		25. Attractiveness
	13. WWT energy efficiency		

The indicator scores for the CBF were exported into an excel spreadsheet and a radar chart representing the scores of all 25 indicators was created. The chart presents a snapshot of water management in Cape Town during 2017. The radar chart was used to analyse the CBF results as it helped to highlight the water management areas in which Cape Town is doing well as well as those areas of concern. The geometric[7] mean of all 25 indicators, the Blue City Index (BCI) was also calculated. The BCI score is used to determine in which category of sustainable Integrated Water Resource Management (IWRM), as defined by Koop & Van Leeuwen (2015a), Cape Town falls (see table 5). The snapshot provided by the radar chart and the BCI score thus aided in illustrating where Cape Town could improve its current (2017/18) water management based on IWRM approaches which closely mirror those of WSUD (as described in section 2.1 of the literature review chapter).

[7] The geometric aggregation method for the 25 indicators aims to "equalise the number of indicators per category, to make sure that all categories equally contribute to the BCI." The geometric aggregation method has been selected as it "penalises unbalanced scores in order to emphasise the need to improve the lowest indicator scores" (Koop and Van Leeuwen 2015 p.5654). The arithmetic mean on the other hand "gives no penalty to unbalanced scores, and consequently does not address the urgent need to improve achievements for the lowest scores" (Koop and Van Leeuwen 2015 p.5661).

Table 5: BCI score categories based on IWRM in cities (Source: Koop & Van Leeuwen 2015a)

BCI	Categories of IWRM in Cities
0 - 2	Cities lacking basic water services
	Access to potable drinking water of sufficient quality and access to sanitation facilities are insufficient. Typically, water pollution is high due to a lack of WWT. Solid waste production is relatively low but is only partially collected and, if collected, almost exclusively put in landfills. Water consumption is low, but water system leakages are high due to serious infrastructure investment deficits. Basic water services cannot be expanded or improved due to rapid urbanisation. Improvements are hindered due to insufficient governance capacity and funding gaps
2 - 4	Wasteful Cities
	Basic water services are largely met but flood risk can be high and WWT is insufficiently covered. Often, only primary and a small portion of secondary WWT is applied, leading to large-scale pollution. Water consumption and infrastructure leakages are high due to a lack of environmental awareness and infrastructure maintenance. Solid waste production is high, and waste is almost completely dumped in landfills. In many cases, community involvement is relatively low
4 - 6	Water Efficient Cities
	Cities are implementing centralised, well-known, technological solutions to increase water efficiency and to control pollution. Secondary WWT coverage is high, and tertiary WWT is rising. Water-efficient technologies are partially applied, infrastructure leakages are substantially reduced but water consumption is still high. Energy recovery from WWT is relatively high, while nutrient recovery is limited. Both solid waste recycling and energy recovery are partially applied. These cities are often vulnerable to climate change, e.g. urban heat islands and drainage flooding, due to poor adaptation strategies, limited storm water separation and low green surface ratios. Governance community involvement has improved
6 - 8	Resource Efficient and Adaptive Cities
	WWT techniques to recover energy and nutrients are often applied. Solid waste recycling and energy recovery are largely covered, whereas solid waste production has not yet been reduced. Water-efficient techniques are widely applied, and water consumption has been reduced. Climate adaptation in urban planning is applied, e.g. incorporation of green infrastructures and storm water separation. Integrative, centralised and decentralised as well as long-term planning, community involvement, and sustainability initiatives are established to cope with limited resources and climate change
8 – 10	Water Wise Cities
	There is no BCI score that is within this category so far. These cities apply full resource and energy recovery in their WWT and solid waste treatment, fully integrate water into urban planning, have multi-functional and adaptive infrastructures, and local communities promote sustainable integrated decision-making and behaviour. Cities are largely water self-sufficient, attractive, innovative and circular by applying multiple centralised and decentralised solutions

4.4 Objective 2 - Understanding the governance of water scarcity, flood risk and wastewater treatment in the City of Cape Town

The GCF was applied to Cape Town in order to understand the governance of water scarcity, flood risk and WWT in the city. The results of the TPF were used to understand the social, environmental and economic aspects of Cape Town over which the city has limited direct influence, but provide the context within which the water officials in the city are operating.

4.4.1 Trends and Pressures Framework (TPF)

The TPF comprises 12 descriptive indicators and six additional sub-indicators divided over social, environmental and financial categories (see table 6). Each indicator is scaled from 0 to 4 points, where a higher score represents a higher urban pressure or concern. For seven indicators and sub-indicators a scoring method is applied based on international quantitative standards such as the World Bank, World Health Organization and the Food and Agricultural Organization (Koop & Van

Leeuwen 2015a). The scores are determined using the ranking of the city amongst all available country scores. These scores are thus not normative and only provide an indication of the urban pressures with respect to global trends. A scoring method as well as a short explanation of the significance of each indicator is provided in the section that follows. Appendix E, provided by KWR Watercycle Research Institute, presents the detailed assessment and scoring method for the TPF. The results for the TPF assessment of Cape Town (Appendix F) were provided by the KWR Watercyle Institute (but with data provided by the researcher) owing to the Institutes familiarity with the data base used for the TPF assessment. The scores are divided into classes expressed as 'degree of concern': 0 – 0.5 no concern; 0.5 – 1.5 little concern; 1.5 – 2.5 medium concern; 2.5 – 3.5 concern; 3.5 -4 great concern.

Table 6: TPF indicators

Category	Indicators
1. Social pressures	1. Urbanisation rate
	2. Burden of disease
	3. Education rate
	4. Political instability
2. Environmental pressures	5. Water scarcity
	6. Flood risk
	7. Water quality
	8. Heat risk
3. Financial pressures	9. Economic pressure
	10. Unemployment rate
	11. Poverty rate
	12. Inflation rate

The indicator scores representing the trends and pressures for Cape Town were exported to an excel spreadsheet. The data was then presented in the form of a bar graph, which was used to illustrate the degree of concern for each indicator. Not only this, the bar graph presents the scores for each indicator alongside one another, and is therefore a useful feature to help compare the degree of concern between the indicators when analysing the data.

4.4.2 Governance Capacity Framework (GCF)

The GCF consists of nine categories each with three indicators, which together were used to determine the governance capacity required to address three selected water challenges: water scarcity, flood risk and WWT (table 7). The selection of these three challenges was based on the principles of WSUD which "*represents a significant shift in the way water and related environmental resources and water infrastructure are considered in the planning and design of cities…"*(Fletcher *et al*. 2014 p.4) by encompassing all aspects of the urban water cycle including stormwater management, water treatment and water supply. The analysis of the TPF and CBF for Cape Town therefore provided a basis for the selection of the three water challenges that were analysed in depth using the GCF. Each of the 27 indicators was scored according to a Likert scale[8] to gauge the

[8] A scale used to scale responses in survey research.

subjective opinions and values of respondents and the analysis of the publicly available documents (Koop et al. 2017a). The scale ranges from very encouraging (++) to very limiting (--). GCF indicators and scoring information is provided in Appendix G.

Table 7: GCF indicators

Category	Indicators	Category	Indicators
1. Awareness	1.1 Community knowledge	6. Agents of change	6.1 Entrepreneurial agents
	1.2 Local sense of urgency		6.2 Collaborative agents
	1.3 Behavioral internalization		6.3 Visionary agents
2.Useful knowledge	2.1 Information availability	7. Multi-level network potential	7.1 Room to maneuver
	2.2 Information transparency		7.2 Clear division of responsibilities
	2.3 Knowledge cohesion		7.3 Authority
3.Continuous learning	3.1 Smart monitoring	8. Financial viability	8.1 Affordability
	3.2 Evaluation		8.2 Consumer willingness to pay
	3.3 Cross-stakeholder learning		8.3 Financial continuation
4.Stakeholder engagement processes	4.1 Stakeholder inclusiveness	9.Implementing capacity	9.1 Policy instruments
	4.2 Protection of core values		9.2 Statutory compliance
	4.3 Progress and variety of options		9.3 Preparedness
5.Management ambition	5.1 Ambitious and realistic management		
	5.2 Discourse embedding		
	5.3 Management cohesion		

4.4.2.1 Sampling for the GCF

A combination of criterion-based and snowball sampling methods was used to sample respondents who were interviewed for this research. The criterion-based sampling method refers to selecting interview respondents based on particular roles, experiences and features which provide the relevant insights to the research (Ritchie & Lewis 2003). A list of potential interview respondents was compiled for each water challenge; i.e. water scarcity, flood risk and WWT. The list included potential respondents from various sectors, including academics, city officials as well as professionals who work in the respective fields. Producing a broader list of potential respondents aided in assisting with the identification of an alternative respondent in the event that a contacted respondent was unable to participate in the research. The snowball sampling method was used to support the criterion-based sampling method. Snowball sampling is an informal technique where one research respondent suggests another respondent who could provide important information, and so on (Atkinson & Flint 2001). This method was useful as it helped the researcher take advantage of the social and professional networks of the selected respondents in order to obtain additional data of relevance to the study (Atkinson & Flint 2001).

4.4.2.2 Data collection for GCF

Before conducting interviews, it was important for the researcher to develop a thorough understanding of the themes and topics covered in the GCF questionnaire. The questions provided

in the GCF questionnaire are designed such that they provide the required information to score the indicator. Owing to the lengthy nature of the GCF questionnaire and time constraints of the interviewees, only questions from three to four indicator categories were asked of each respondent, which resulted in interview sessions lasting for 30 minutes to an hour. For this reason, prior to each interview the researcher identified the questions from three or four indicator categories relevant to the expertise of the specific respondent. This was done to ensure that the interviews were not too lengthy, and to ensure that the information provided by the respondents was not broad and shallow, but rather in-depth and narrow.

The in-depth interviews were conducted using a 'semi-structured' interview approach, which contained open ended questions based on water scarcity, flood risk or WWT. The purpose of conducting semi-structured interviews was to create an opportunity for both the researcher and the respondents of this research to discuss some topics in further detail (Hancock *et al*. 2007). In addition to this, the semi-structured interview approach helped the researcher to control the interview by being able to provide useful prompts and additional information to respondents who sometimes had difficulty answering specific questions (Hancock *et al*. 2007). Furthermore, this approach helped the researcher to be able to probe the respondents to elaborate on a response or to follow a line of enquiry introduced by the researcher.

An audio recording of each interview was taken. This was done to allow the researcher to concentrate on the discussion during the interview process (Kitchin & Tate 2000). The audio recordings of each interview also aided in ensuring that the collected data was not weakened by failure to correctly encapsulate all the relevant information (Kitchin &Tate 2000).

The data collected from the semi-structured interviews was substantiated through the use of publicly available secondary data sources. The secondary data sources included local policy documents, local reports and strategies as well as online articles. These sources were predominantly sourced from the CoCT's website as well as other sites (list provided in Appendix A). Owing to the fact that this study aims to understand the current (2017/18) governance capacity to address flood risk, water scarcity and WWT, the most recent available secondary data sources were used.

The scoring for each indicator was based on three steps:

1. A preliminary score was given and substantiated by argumentation based on publicly available reports, local policy documents, local legislation and online articles
2. The main actors involved in each of the water challenges were selected and interviewees were selected accordingly (as will be discussed in the sections that follow). In-depth interviews were recorded and used to improve the written substantiation in order to refine each indicator score. A total of nine in-depth interviews was conducted, five of which were with city officials, two with academics and another two with local water professionals

3. The interviewees were asked to provide constructive feedback, additional arguments and information sources to further justify the indicator scores (responses presented in Appendix H)

4.4.2.3 Data analysis for the GCF

The indicator scores for the GCF were exported to an excel document where the Likert scale indicators were converted to numbers so as to create a bar graph to depict the results of the GCF. The indicator symbols were converted as follows: -- very limiting (= 0); - limiting (= 1); 0 indifferent (= 2); + encouraging (= 3); ++ very encouraging (= 4). The arithmetic mean of the indicators in each category was calculated and used as the average score for each category. The bar graphs for each water challenge were plotted on the same graph to make it easier for the patterns, similarities and differences between the governance of water scarcity, flood risk and WWT, across the nine categories to stand out for a better analysis. A graph displaying all 27 indicators is presented in Appendix I.

In addition to this, in order to compare the scores for the individual indicators of the governance of flood risk, WWT and water scarcity, a table of the scores was compiled (presented in chapter 5). The indicator scores for each of the three water challenges were presented in consecutive columns in a table to make it easy for the individual indicator scores to be compared and contrasted for the analysis of the GCF.

4.5 Objective 3 - Identifying the fundamental institutional conditions within the City of Cape Town which are needed to orient towards WSUD

4.5.1 Thematic analysis

In order to understand the institutional dynamics that are needed to support a transition towards a WSUD approach in Cape Town, the qualitative data from interviews and secondary sources used to determine the governance capacity for flood risk, WWT and water scarcity was thematically analysed. This was done in addition to the CBA analysis to provide specific context for a transition towards WSUD in Cape Town. Thematic analysis is a method used to analyse qualitative data by identifying, highlighting and reporting the significant themes that are embedded within an entire data set (Braun & Clarke 2006). The themes were identified based on their relevance to the aim, objectives and the literature reviewed for this research.

When commencing with the thematic analysis process, the whole qualitative data set which was used to determine the governance capacity for Cape Town (GCF) was revisited and organised. This was done to ensure that the researcher was familiar with the data before identifying relevant themes. During this initial step, any ideas which stood out to the researcher relating to potential themes were noted. Once the researcher was familiar with the data, the data was analysed again. This time, interesting features and information from the data set were noted and coded in a systematic fashion. The data was coded in different colours, for instance all interesting features relating to ‘social learning’ were coded in blue, and all those relating to ‘financial capacity’ were coded in red and so on. This first coding process allowed the researcher to generate initial codes in

the data set which were then collated into potential themes. For example, in this research, '*policy instruments', 'human resources' and 'financial capacity'* were identified as codes and when collated were located within the theme '*implementation capacity'.* The potential themes identified during this stage were then reviewed multiple times by the researcher to ensure that there was cohesion between the identified themes and the coded extracts from the data. Once this was done, the significant themes which would be reported on were described. After refining and reviewing the themes the final discussion and analysis of the data was developed. Below is a summarised list of the thematic analysis process that was undertaken as per (Braun & Clarke 2006):

1. Familiarise with data
2. Generate initial codes
3. Searching for themes
4. Reviewing themes
5. Defining and naming themes
6. Production of report

When employing the thematic analysis method, Braun & Clarke (2006) stress that it is important to understand that it is crucial that a theme which is identified within the data relates to the research questions. For instance, a chosen theme may have significant representation in some elements of the data, while it has limited to no representation in other elements (Braun & Clarke 2006). Not only this, a theme may have limited representation across the entire data set, but still qualifies as a key theme of the research because it captures something important to the research questions. It was therefore imperative that the researcher exercised caution when judging and determining what a theme was. This method was therefore deemed to be a suitable research tool owing to its potential to provide a detailed and rich account of qualitative data especially when used to produce a short research piece, such as a dissertation, where the entire data set cannot be described.

The thematic analysis method was also chosen as an analysis method of choice to understand and identify the fundamental institutional conditions within the CoCT which are needed to orient towards WSUD, owing to the fact that the method is a relatively simple method to learn and follow. This is especially advantageous due to the fact that this method has only been employed to answer one research question and has not been the primary analysis method for the research. Secondly, this method was useful in summarising the key points emanating from a large data set which was used to determine the governance capacity of water scarcity, flood risk and WWT. Thirdly, this method aided in highlighting the similarities and differences between the governance of water scarcity, flood risk and WWT, which contribute largely to the depth of the discussion chapter of this research. While doing this, significant gaps and aspects which hinder progression towards WSUD were revealed, allowing for recommendations to be made for future research, as well as policy development.

4.6 Objective 4 – To get a snapshot of transitions towards WSUD in Cape Town

As will be highlighted in chapter 5, the results of the CBA and those of the thematic analysis provided a quick, insightful and context specific understanding of the current water management and governance capacity of three water challenges in Cape Town and illustrated some of the barriers and opportunities in Cape Town's future transition to sustainable water management efforts respectively. The results from the CBA and thematic analysis therefore provided baseline information which presented a useful starting point for discussion about these transitions and the strategic planning and implementation processes required to support them.

It was deemed useful to compliment the CBA with another city assessment process to further understand the strategies required to support sustainable water management transitions and how advanced Cape Town is in implementing these strategies. As part of this study the IWA – Principles for Water-Wise Cities made for a useful complementary framework to the CBA. This was especially due to the fact that both the CBA and IWA principles have been formulated to enhance cities' transitions towards sustainable water management approaches, hence pointing to the same goal. The IWA principles for Water Wise cities is a framework which is intended to guide city officials to implement and develop water visions and strategies which support a transition towards water sensitive in their cities (IWA 2016), as discussed in section 2.3.1 of the literature review.

Given these points, the IWA Principles have been utilised to show the successes and areas of improvement in Cape Town's transition towards WSUD based on the baseline information provided by the CBA. The framework comprises 17 principles under four levels of action (Table 8).

Table 8: IWA Principles for Water-Wise Cities

Level of action	Principles
Level 1 – Regenerative water services for all	1.1 Replenish water bodies and their ecosystems
	1.2 Reduce the amount of water and energy used
	1.3 Reuse, recover, recycle
	1.4 Use a systematic approach integrated with other services
	1.5 Increase modularity of systems and ensure multiple options
Level 2 – Water Sensitive Urban Design (WSUD)	2.1 Enable regenerative water services
	2.2 Design urban spaces to reduce flood risk
	2.3 Enhance livability with visible water
	2.4 Modify and adapt urban materials to minimise environmental impact
Level 3 – Basin conected cities	3.1 Plan to secure water resources and mitigate drought
	3.2 Protect the quality of water resources
	3.3 Prepare for extreme events
Level 4 – Water-wise communities	4.1 Empower citizens
	4.2 Professionals aware of water co-benefits
	4.3 Transdisciplinary planning teams
	4.4 Policy makers enabling water action
	4.5 Leaders that engage and engender trust

4.7 Conclusion

This chapter has provided an in-depth description and justification of the methods employed to gather, organise and analyse the data used to answer the research questions and ultimately fulfil the aim of this research.

Chapter 5 – Results and Discussion

5 Introduction

The Multi-Level Perspective (MLP) framework recognises three analytical levels in which sustainability transitions occur; the micro-level, which consists of niches where alternative innovations emerge; the meso-level which comprises the socio-technical regime and accounts for the stability of large-scale markets and industries such as water, energy and transport; and the macro-level which refers to the social, economic and environmental factors which have an indirect influence on the dynamics of the meso and micro-levels (Schot & Geels 2008; Rauschmayer *et al*. 2015). This body of literature maintains that sustainability transitions are made possible by the interactions between and within these three levels. This chapter therefore aims to describe and discuss the current state of transitions towards a Water Sensitive Urban Design (WSUD) approach in Cape Town by evaluating the dynamics of and relations between the macro, meso and micro-level factors at play in the City.

This chapter first presents and discusses the results of each of the three components of the City Blueprint Approach (CBA): the Trends and Pressures Framework (TPF), the City Blueprint Framework (CBF) and the Governance Capacity Framework (GCF) as applied to the City of Cape Town (CoCT). Secondly this chapter presents the key institutional factors which have been identified through the research (through a thematic analysis) to support the transition towards a WSUD approach in Cape Town. Lastly, the chapter presents a snapshot of transitions towards WSUD in Cape Town against the International Water Association's (IWA) Principles for Water-Wise Cities Framework.

5.1 City Blueprint Approach

5.1.1 Trends and Pressures Framework

The results of the TPF illustrate the state of the environmental, social and economic climate of Cape Town, over which the City itself has limited direct influence. These results present a snapshot of the context of the macro-level within which the water sector of Cape Town operates at the time of the research (2017/18). Figure 17 shows the scores of each of the twelve indicators of the TPF ranging from 0 to 4 (0 indicating the lowest degree of concern and 4 the highest degree of concern), according to the key shown in table 9.

Table 9: Key for TPF indicators scores

TPF indicators score	Degree of concern
0 – 0.5	No concern
0.5 – 1.5	Little concern
1.5 – 2.5	Medium concern
2.5 – 3.5	Concern
3.5 - 4	Great concern

The City's unemployment rate scored as a significant area of concern for Cape Town and has an impact on the ability of low income citizens to afford and pay for water and sanitation services (as discussed in section 3.3 of the contextual analysis chapter), which is an important revenue stream that enables municipalities to implement projects and programmes such as infrastructure maintenance (figure 17). In addition to this, poverty and urbanisation are areas of medium concern in the CoCT. Urbanisation and poverty rates are particularly important as they have an influence on the pressure put on local government to continuously expand the City's water infrastructure.

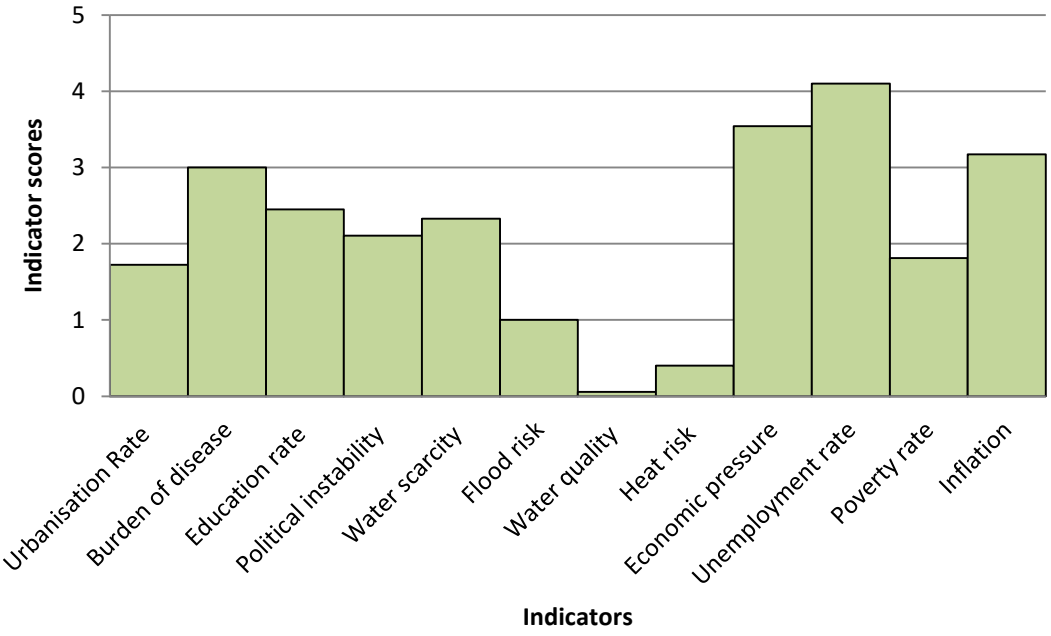

Figure 17: Indicator scores for TPF analysis for Cape Town

The indicator scores for water quality, flood risk and water scarcity depicted in figure 17 are the average scores of the sub-indicators for each of these indicators. These sub-indicators represent different aspects of their respective indicators; consequently these averages do not necessarily present an accurate representation of the individual indicators and could thus present skewed information. The indicator for water scarcity comprises three sub-indicators: *freshwater scarcity, groundwater scarcity*, as well *salination and seawater intrusion*. The flood risk sub-indicators are *urban drainage flood, river peak discharge* and *sea-level rise*. Lastly, the water scarcity sub-indicators are *surface water quality* and *Biodiversity.* Figures 18, 19 and 20 present the results for the sub-indicators of water quality, flood risk and water scarcity respectively and show a more accurate description of these indicators.

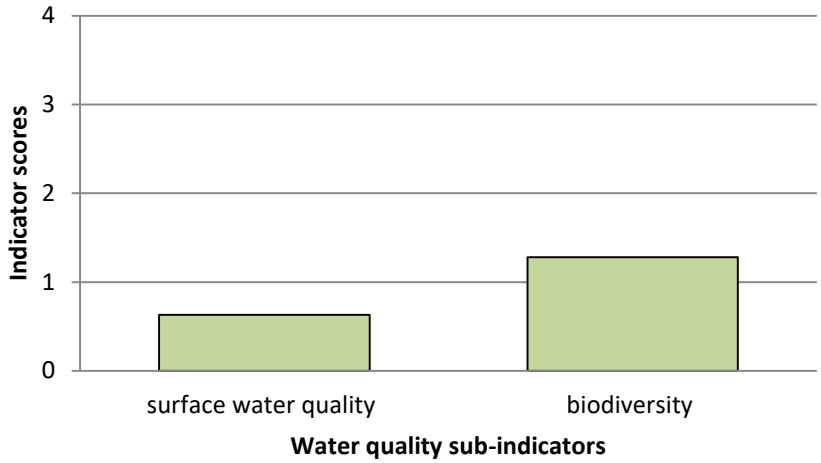

Figure 18: Indicators for water quality sub-indicators

The indicator of surface water quality scored as areas of zero concern for Cape Town. This highlights that maintaining exceptional surface water quality will require sustainable water management especially the sustainable release of treated effluent into the City's waterways.

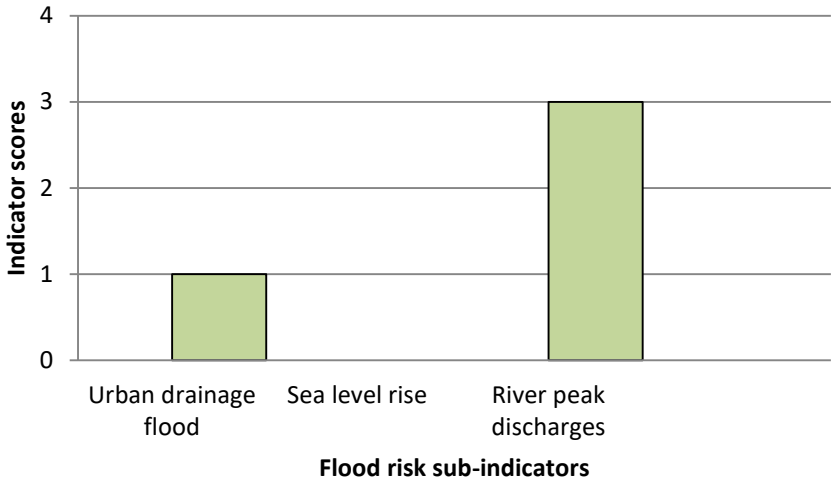

Figure 19: Indicators for flood-risk sub-indicators

The indicator scores for river peak discharge and urban drainage flooding indicate that flood risk is also an area of concern for water management in Cape Town. Floods have social, economic and environmental consequences; this includes loss of human life; increase in water-borne diseases as well as damage to infrastructure. This may result in certain economic activities coming to a halt as well as disruption of service delivery such as electricity, wastewater treatment (WWT), health care, education and the supply of clean water. The score for the sea-level rise sub-indicator is based on the percentage of the CoCT which will flood with a 1 meter sea level rise. The immediate impacts of sea-level rise are coastal flooding and erosion as well as submergence, thus increasing flooding and saltwater intrusion potential in coastal cities. Despite sea-level rise being an area of low concern

currently (2018), it is important for the City to implement adaptation strategies that address coastal risks related to climate change.

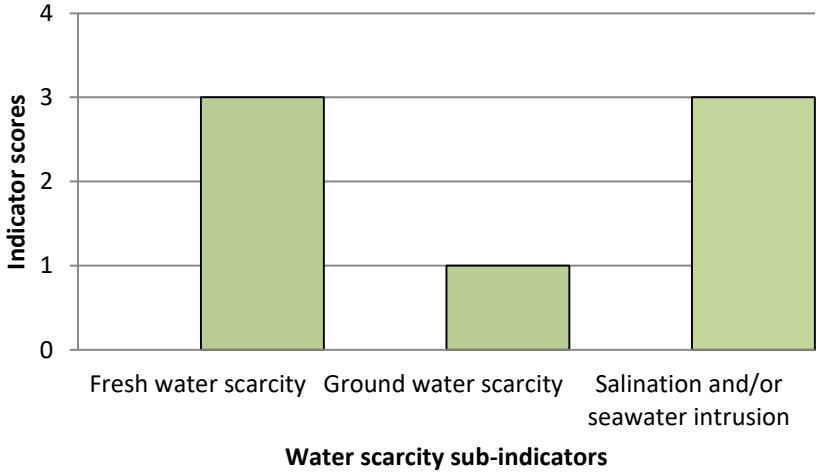

Figure 20: Indicators for water scarcity sub-indicators

The indicator of fresh water scarcity represents an area of major concern for water management in Cape Town. Fresh water scarcity is an important factor as the City is relying mainly on surface water sources and water scarcity can negatively impact the socio-economic aspects of a city (Armitage *et al*. 2014). It has the potential to affect human health by increasing the burden of disease which the TPF has shown to be an area of concern for the CoCT (figure 17). Not only this, water scarcity has the potential to hinder business productivity in various industries which may result in an increase in the poverty and unemployment rates. The TPF shows that on the contrary, groundwater scarcity is an area of little concern for Cape Town. The groundwater scarcity sub-indicator score of 1 is however useful in highlighting that groundwater could be considered as an alternative water source for the City. Although this is the case, the score of 3 for the salinization and/or seawater intrusion sub-indicator highlights that the City's groundwater sources are vulnerable to salinization. Salinization of soil and seawater intrusion can both affect the salinity of groundwater and thus the water quality of freshwater aquifers. This is especially important in the CoCT as the City's water supply augmentation plans include groundwater abstraction (as discussed in section 3.2 of the contextual analysis chapter).

5.1.2 City Blueprint Framework

The CBF scores are presented in Figure 21, which gives an indication of the current (2017/18) management of Cape Town's water cycle. The figure shows the scores for each of the 25 indicators ranging from 0 (low performance) at the centre of the circle increasing outwards to 10 (high performance). The geometric average of the 25 water management indicators is summarised in one value, the Blue City Index (BCI), which represents the overall score for sustainability of water management in the City. The BCI for Cape Town is 4.9 and reflects the fact that Cape Town is currently categorised as a water efficient city (Table 10) according to (Koop & Van Leeuwen 2015a) (described in section 4.3.1 of research methods chapter). The CBF assessment presents a snapshot

of the performance of Cape Town's water system to illustrate the strengths and weaknesses of Cape Town's water management.

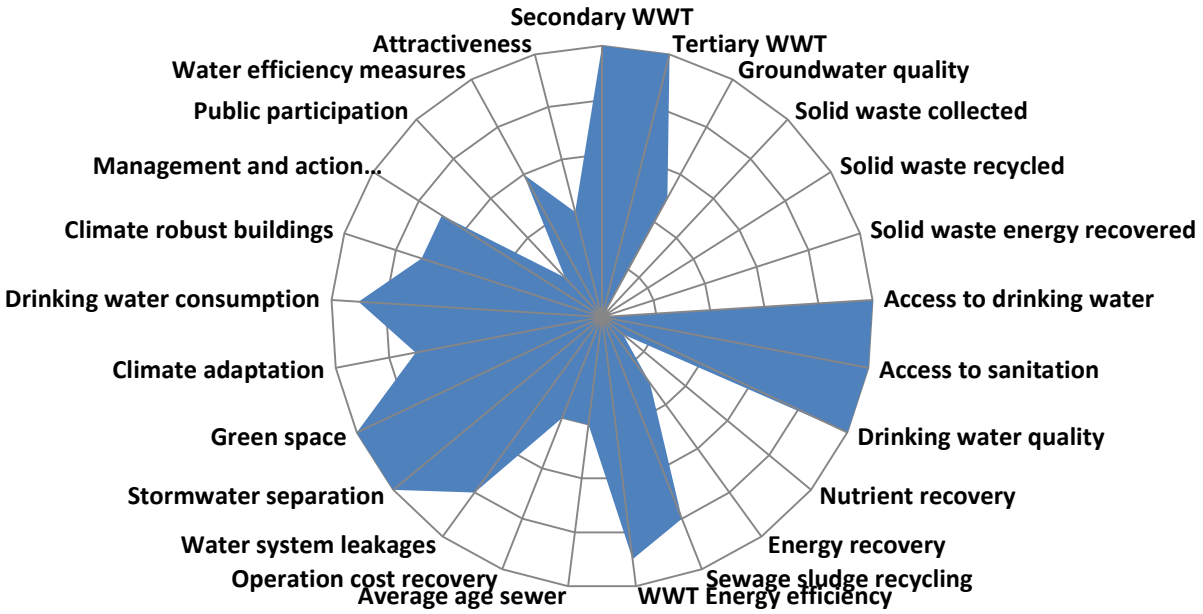

Figure 21: CBF results for Cape Town

Table 10: Cape Town's BCI score based on IWRM in cities (Source: Koop & Van Leeuwen 2015a)

BCI	Category of IWRM in Cities
4 - 6	Water Efficient Cities
	Cities are implementing centralised, well-known, technological solutions to increase water efficiency and to control pollution. Secondary WWT coverage is high, and tertiary WWT is rising. Water-efficient technologies are partially applied, infrastructure leakages are substantially reduced but water consumption is still high. Energy recovery from WWT is relatively high, while nutrient recovery is limited. Both solid waste recycling and energy recovery are partially applied. These cities are often vulnerable to climate change, e.g. urban heat islands and drainage flooding, due to poor adaptation strategies, limited storm water separation and low green surface ratios. Governance community involvement has improved

The City Blueprint results also show that Cape Town has a high standard of drinking water quality. The quality of the water produced at the City's water treatment facilities is monitored strictly on a continuous basis by the City's Bulk Water Branch. Water quality standards are required to be compliant with those set by the South African National Standard (SANS 241:2015) on drinking water quality, as per national regulations (CoCT 2017b). The National Department of Water and Sanitation (DWS) has also introduced an incentive-based method which grants Blue Drop Status to Water Services Authorities (WSA) (in this case the CoCT) based on their level of compliance (95%) with water quality legislation and other best practices as required by the DWS. The most recent Blue Drop report was published in 2014 in which the CoCT scored a Blue Drop Status of 95.86% based on compliance at all of the City's water treatment facilities (CoCT 2017b). The City also scored

relatively well on leakage control as only 9% of water is lost through system leakages compared to the national average of 25% (Mckenzie *et al*. 2012; CoCT 2017b). Cape Town also scored well on the green space indicator, as there is a 48% share of blue and green area in the City (Siemens 2011). Green space in a city contributes towards the management of surface water run-off, by aiding with infiltration. Nature-based flood protection is an important aspect of WSUD, particularly with regards to adapting to the effects of climate change in cities such as the increasing frequency of heavy rains.

Cape Town performs well on the delivery of services, scoring 100% for access to sanitation and drinking water, as well as on the percentage of wastewater/sewage that is treated. Both formal and informal settlements in Cape Town receive potable water service levels to the minimum standards[9] as required by the Water Services Act 108 0f 1997 (NWSA). All sewage generated in the city is treated to some level at one of 23 WWT works delivered either through the formal sewage networks, or through alternative collection systems for informal settlements, such as chemical, portable and container toilets. Notwithstanding these high levels of WWT, the fact that Cape Town has low energy and nutrient recovery levels from these treatment processes highlights a major area for improvement. At present there is energy recovery at only one of the City's WWT plants, with methane biogas from the anaerobic digesters used on site. Currently there is no nutrient recovery as a separate item from WWT processes; nutrients are contained in the sludge which is used for agricultural processes or taken to landfill. The recovery of nutrients from wastewater is important as it helps to prevent the pollution of surface water sources (Koop & Leeuwen 2015b). Nutrient recovery is also important as it reduces dependence on non-renewable energy sources and promotes energy efficiency in WWT plants. This is particularly important in South Africa (SA), where coal-generated electricity is a critical input for delivering municipal water and wastewater services. WWT processes use 55% of the energy consumed by the SA water sector, therefore the recent sharp increases in national electricity rates mean that energy is increasingly becoming a significant operation cost which requires additional funding for WWT in SA municipalities (Musvoto & Ikumi 2016). Accordingly, the CoCT's Wastewater Branch has received Environmental Authorisation by the national Department of Environmental Affairs for the development of a Biosolids Beneficiation Facility where energy (biogas), which could account for 45% of the electricity consumption at 9 of the City's WWTWs, will be recovered and used onsite. In addition, nutrients such as struvite, nitrate and biosolids will be recovered for agricultural and industrial use in the City (GreenCape 2016).

Additionally, there is considerable room to improve the city's solid waste collection and treatment, as only ~10% of the city's waste is recycled (Department of Environmental Affairs 2012). Proper management of solid waste is important as inappropriate dumping increases the potential for solid waste to find its way into the city's waterways and stormwater drains, thus affecting water quality, the effectiveness of water infrastructure and increasing the chances of flooding.

[9] The City has set its own service provision targets of ensuring a minimum of one tap per 25 households, provided within at least a 100m distance from the dwelling. In terms of sanitation provision, the City aims to provide one toilet per five households.

Another potential area of concern is the fact that sewer and water networks in Cape Town are 40 years old on average (Department of Water Affairs [DWA] 2013; Respondent 5 pers.comm 2017). This increases the probability for blockages and leakages in sewers and substantially increases the costs to refurbish and replace the extensive underground network over the next decade. The City's Water and Sanitation department has allocated a budget of R22.5 million over the next five years to roll out city-wide projects which aim to reduce overloading in the sewer system caused by stormwater ingress and sewer blockages (CoCT 2017b). This is in order to ensure that the integrity of the infrastructure is prolonged. The CBF results show that Cape Town performs well on stormwater separation as stormwater and sewage are conveyed in separate infrastructure. This separation is particularly important owing to the fact that in instances of extreme rain events, combined sewer overflows result in significant surface water pollution (Van Leeuwen *et al*. 2016). Having said that, the fact that there is poor drainage/sanitation provision in informal settlements (contrary to what figure 21 depicts), means that extreme rain events also result in significant surface water pollution from contaminated runoff.

5.1.3 Governance Capacity Framework

Despite Cape Town performing well on drinking water consumption and access to drinking water in the CBF assessment, the TPF and the current water crisis draw attention to the specific need to analyse and understand the governance of water scarcity in Cape Town. Similarly, in spite of adequate access to water and sanitation services in informal settlements, the TPF draws attention to the fact that issues of drainage and flood risk remain serious issues of concern. It was therefore deemed important to further analyse the governance of flood risk in Cape Town. Furthermore, the CBF results show that there is room for improvement in institutionalising energy recovery from WWT. Given these points an in-depth analysis of the governance of water scarcity, flood risk and WWT is important as these challenges have an effect on the varying needs of society including human and environmental health and water resources.

The results of the GCF analysis illustrate the CoCT's governance capacity to address the main water challenges in the City. Governance capacity refers to *"the ability to coordinate the aggregation of diverging interests and thus promote policy that can credibly be taken to represent public interest"* (Frischtak 1994 p.vii). The GCF consists of nine categories each with three indicators, which together were used to determine the governance capacity required to address three selected water challenges: water scarcity, flood risk and WWT. Each of the 27 indicators was scored according to a Likert scale to gauge the subjective opinions and values of respondents and aid in the analysis of publicly available documents (Koop *et al*. 2017a). The scale ranges from very encouraging (++) to very limiting (--), as highlighted in table 11.

The findings of the GCF assessment for Cape Town for the three selected water management challenges (water scarcity, flood risk and WWT) are shown in table 12, which is explained and discussed in the sections that follow.

Table 11: GCF indicator scoring Likert scale

GCF indicators scoring scale	
--	Very limiting
-	Limiting
0	Indifferent
+	Encouraging
++	Very encouraging

Table 12: GCF assessment for Cape Town

Category	Indicators	Water scarcity	Flood risk	Wastewater treatment
1. Awareness	1.1 Community knowledge	0	++	0
	1.2 Local sense of urgency	+	+	++
	1.3 Behavioral internalization	0	+	-
2.Useful knowledge	2.1 Information availability	+	+	++
	2.2 Information transparency	0	+	+
	2.3 Knowledge cohesion	0	+	+
3.Continuous learning	3.1 Smart monitoring	+	0	+
	3.2 Evaluation	-	0	0
	3.3 Cross-stakeholder learning	+	+	+
4.Stakeholder engagement processes	4.1 Stakeholder inclusiveness	-	0	0
	4.2 Protection of core values	0	0	0
	4.3 Progress and variety of options	+	0	+
5.Management ambition	5.1 Ambitious and realistic management	0	+	++
	5.2 Discourse embedding	-	+	+
	5.3 Management cohesion	+	+	+
6.Agents of change	6.1 Entrepreneurial agents	0	+	+
	6.2 Collaborative agents	++	++	++
	6.3 Visionary agents	0	+	+
7.Multi-level network potential	7.1 Room to manoeuver	+	+	0
	7.2 Clear division of responsibilities	0	0	0
	7.3 Authority	+	+	+
8.Financial viability	8.1 Affordability	0	-	-
	8.2 Consumer willingness to pay	+	++	++
	8.3 Financial continuation	0	-	+
9.Implementing capacity	9.1 Policy instruments	0	0	+
	9.2 Statutory compliance	0	-	+
	9.3 Preparedness	0	++	+

5.1.3.1 Governance of water scarcity

The water crisis experienced in the Western Cape (WC) during 2015 to 2018 resulted in most governance processes related to water scarcity in the City being in a constant state of change, particularly during the latter part of 2017 and early 2018 when the City was strongly focused on averting 'Day Zero'[10].For this reason, the results of the governance assessment of water scarcity in Cape Town reveal the situation at the time of writing, and may not be representative of a typical year – even though it provides a useful 'worst case' scenario assessment and reflects long term issues of water scarcity.

[10] The day when the dams supplying the City with water reached 13.5% capacity and most taps would be turned off

The GCF shows that the main challenge for Cape Town currently is on reducing water consumption levels to ensure that the city does not completely run out of water during this drought period. At the time of assessment (2017), the City was encouraging citizens to limit their water use to 87 litres of water per person per day, equating to a total usage across the city of 500 Mega litres per day[11], so as to ensure that the water in the dams lasted till the next rainy season. Consumption levels however were averaging 600 Mega litres per day[12]. Despite total usage not reaching the required 500 Mega litres per day, there was an overall drop in consumption over the period of the crisis from an average usage of 1200 Mega litres per day (summer usage) before the crisis. Consequently, at that time Cape Town scored as 0 (indifferent) on indicator *1.3 behavioural internalisation*. Respondents stated however that they were witnessing behavioural change around water usage from both citizens and business[12]. Although this may be the case, respondents were concerned that Cape Town runs the risk of citizens defaulting to original behaviours in the event of the drought ending.

The 2015 - 2018 water crisis has given rise to an increasing local sense of urgency for the municipality to educate the public on water scarcity. Information on various water saving measures for citizens and information on the city's plans during the drought have been disseminated on social media platforms, on the city's website and on posters in various public spaces. The City also has a special website feature: a weekly 'Water Dashboard' which provides comprehensive information on dam storage levels, water-use levels, rainfall patterns and water quality results. The City therefore scored as + (encouraging) on indicator *1.2 local sense of urgency*. However, despite the concerted efforts to educate the public on water scarcity, community knowledge on water scarcity remained low at the time of data collection (although this has changed subsequently). Cape Town scored 0 (indifferent) on indicator *1.1 Community knowledge*, owing to the fact that although respondents agree that awareness on the issue of water scarcity has increased significantly due to the drought, there is limited community knowledge regarding the causes, uncertainties and long-term impacts of water scarcity in Cape Town. However, owing to increasing information availability relating to the Cape Town water crisis this may have shifted. This was further prompted by impact of the City Mayor's proclamation of 'Day Zero'. Furthermore there is a limited understanding on the value and importance of different management approaches such as WSUD.

A respondent who is a former employee of the CoCT noted that water scarcity was not sufficiently high on the city's agenda before the 2017/18 water crisis. This is despite the fact that climate change research has consistently placed emphasis on the possibilities of changing rainfall patterns in the WC region with likely adverse impacts on water resource availability for the region (Mukheibir & Ziervogel 2007; Ziervogel *et al*. 2010). The City's management ambitions before the drought were largely focused on service delivery objectives such as providing water service points

[11] This is based on an assumption that 70% of daily demand is residential, i.e. 350 ml/d and the City's population of four million people.

[12] Under the current (June 2018) Level 6B restrictions, water use is limited to 50 litres/person/day and a total usage across the city of 450 Ml/d. Consumption has been steadily decreasing but is still higher than desired at around 500 Ml/d.

(taps) in informal settlements and maintenance of infrastructure, as reflected in the Water Services Development Plan (WSDP) (CoCT 2016b). In addition, a respondent who is a city official stated that planning for water supply management for the year 2017 was based on a best-case climate prediction scenario of receiving optimal rainfall. This indicates that the City was relying on conventional climate prediction models and therefore planning for severe drought conditions was limited. Cape Town therefore scored as 0 (indifferent) for indicator *5.1 ambitious and realistic management* of water scarcity. This is also due to the fact that long-term goals to augment the city's water supply by using groundwater, methods of desalination and water reclamation for potable use have been part of water resources planning processes since June 2007 as part of the Western Cape Water Reconciliation Strategy (Department of Water Affairs and Forestry [DWAF] 2007); however there are no signs that these long-term plans were being supported by intermittent targets.

The Western Cape Water Reconciliation Strategy is chaired by the DWS, as such (as discussed in section 3.3 of the contextual analysis) it is the responsibility of the DWS to implement water resource schemes to meet demand for cities and other sectors. As a result the CoCT was hamstrung in its disability to implement augmentation schemes. This has resulted in the City being forced to implement plans for short-term augmentation in a time span of six to eighteen months in the face of the current crisis. This has however proven to be a learning opportunity as evidenced by the fact that Cape Town has recently adopted a new water management scenario termed the 'New Normal' in which the city has been classified as a permanent drought region. Consequently, the City will no longer exclusively rely on surface water sources, and resilience to climatic uncertainty is being pursued in its future planning.

5.1.3.2 Governance of Flood risk

Together with water scarcity, flooding is a common phenomenon in Cape Town, especially during Cape Town's rainy season. This is particularly the case in informal settlements and expansive low-lying areas such as the Cape Flats which are prone to extreme flooding events. For this reason, there is a great sense of urgency to address flood risk in Cape Town. Enhancing community knowledge and including local communities in addressing flood risk is high on the agenda for the local authority. An annual multi-departmental 'Winter Readiness Programme' led by the City's Disaster Risk Management Centre (DRMC) is run before the onset of each rainy season. The programme aims to implement various measures to mitigate flood risk during the season whilst raising awareness and increasing community involvement. Practical tips such as how to raise flooring in homes and diverting flood water away from shacks are shared with residents of informal settlements. For example, while planning for the 2016 rainy season, 34 high flood risk areas including informal settlements were identified for running the programme. A component of the programme focuses on clearing stormwater infrastructure of solid waste to ensure its functionality. Community members are employed to litter-pick and remove sand from drainage systems and the banks of channels. In 2017, 1805 temporary jobs were created and R35 million was spent on these cleaning programmes. Information regarding flood risk is also distributed on the City's website. The City's DRMC compiled a series of educational pamphlets named the 'Flood-wise pamphlets' which

are also made available on the website. These address issues such as understanding the causes of flooding, practical solutions to prevent flooding and health issues related to flooding. Hence Cape Town scored as + (encouraging) on the indicators belonging to the category 'awareness'.

In addition to the CoCT making strides in addressing flood risk in informal settlements, the city's Stormwater Department has also devised two policies which aim to address the challenge of flood risk in formal developments and quality of stormwater runoff from developments: The Management of Urban Stormwater Impacts Policy (MUSIP) (CoCT 2009a) and the Flood Plain and River Corridor Management Policy (FPRCMP) (CoCT 2009b). For this reason, Cape Town scores as + (encouraging) on indicator *5.2 Discourse embedding,* as the city uses different methods to address flood risk in different contexts. The MUSIP aims to *"minimise the undesirable impacts of stormwater runoff from developed areas by introducing WSUD principles to urban planning..."* (CoCT 2009a p.3). The objective of the policy is for all Greenfield and Brownfield development sites > 50 000m2 and Brownfield development sites < 50 000m^2 with a total impervious surface > 15% of site to include a Sustainable Drainage Systems (SuDS) component which achieves the objectives set out by the policy to maintain pre-development runoff and improve water quality. The FPRCMP aims to *"manage development adjacent to watercourse and wetlands taking cognisance of the flood regime…"* (CoCT 2009b p.4). The policy objective is to set back developments beyond floodplain zones, geomorphological buffers and ecological zones as per the conditions and requirements of the policy. The development of the MUSIP and the FPRCMP illustrates that there is a growing understanding of the complexity and uncertainty related to flood risk and awareness and that the development of innovative approaches such as WSUD is crucial. Hence Cape Town also scores as + (encouraging) on indicators *5.1 Ambitious and Realistic Management* and *5.3 Management Cohesion.*

The MUSIP provides a degree of freedom to agents of change to explore new alternatives and to seize more high-risk opportunities. This is revealed by the City's score for *Category 6 Agents of change as + (encouraging)*. Entrepreneurial agents, i.e. consultants who design and implement SuDS technologies in new developments are essentially given the freedom to experiment with alternative technologies when implementing these, as the policy does not prescribe what technologies are to be installed. The policy only requires effective technologies which adhere to the policy's SuDS objectives, thereby creating an enabling environment for implementation. This will aid in driving change as respondents emphasise that experimentation is crucial in legitimising alternative technologies which may be otherwise doubted. Despite the fact that the MUSIP and the FPRCMP have been developed to stimulate desired behaviour and discourage undesired behaviour, the implementation of these policies (indicator 9.2 *statutory compliance)* remains difficult for various reasons. For instance, local government lacks the human resources to check compliance to policy on the ground. Also, in developments where SuDS are successfully installed maintenance of technologies proves to be difficult resulting in ineffective performance.

5.1.3.3 Governance of wastewater treatment

66% of the water used in Cape Town ends up at 23 WWT works from where the final treated effluent is discharged back into the environment (CoCT 2017a). The wastewater undergoes treatment processes to ensure that the effluent released into rivers, the ocean and other water bodies meets prescribed standards. Ensuring that the quality of the effluent is of acceptable quality to be discharged requires rigorous monitoring of the process and functioning of the WWT systems. The city scored as ++ (very encouraging) on indicator *3.1 smart monitoring* with regard to the governance of WWT. The GCF reveals that smart monitoring is essential in ensuring that other governance aspects such as statutory compliance (indicator 9.2), preparedness for risk and adequate service delivery (indicator 9.3) are carried out successfully.

The quality of the effluent being discharged from the WWT works in Cape Town is monitored by the City on a continuous basis and the results are provided in the WSDP. Effluent quality is also reported in accordance with the DWS license requirements by way of the Green Drop certification program for WWT works nationwide (as described in section 3.3 of contextual analysis chapter). The most recent Green Drop report was published in 2014 in which Cape Town scored a Green Drop status of 89.7% (Good) based on compliance to criteria at all of the City's WWT facilities (CoCT 2017b). Not only is smart monitoring applied to wastewater effluent quality, but a register of non-compliance incidents at WWT facilities is also included in the WSDP (CoCT 2016b; CoCT 2017b). The register provides a clear definition of the problem, the cause of the problem and remedial actions taken. The precautionary principle is adopted for dealing with risks such as non-compliance incidents, as a departmental Risk Management Register is compiled for the local Water and Sanitation department where action plans are provided for potential risks. This has resulted in Cape Town scoring as + (encouraging) on indicator *9.3 Preparedness*. Continuous monitoring of wastewater effluent quality and monitoring of non-compliance incidents enhances the city's preparedness in dealing with both sudden and gradual deviations in WWT processes.

Continuous monitoring of effluent is also important as effluent is not only being discharged into the environment, but it also being reused. Approximately 8% (and steadily increasing) of the total volumes of treated wastewater are currently re-used by more than 160 industrial and commercial customers (CoCT 2017b). The CoCT has been promoting the re-use of treated effluent by using an incentive-based method of selling treated water at a price lower than that of potable water. The treated effluent is used for industrial purposes and irrigation of schools, golf courses, city parks, construction companies and agricultural land. The water crisis has prompted the city to plan to increase the percentage of treated effluent being used. An estimated budget of R210 million has been allocated to expand the City's treated effluent network over the next five years (CoCT 2017b). Another important area of focus for the city is reclamation of potable water from treated effluent in order to augment drinking water supplies, as discussed in the contextual analysis. WWT processes are therefore also being used to promote conservation of the City's limited potable water supply. Hence Cape Town scores as encouraging (+) for indicator *7.1 Room to manoeuvre* as the city has the opportunity to develop alternatives to address water scarcity in the city.

5.2 City Blueprint Approach: intra and inter-city learning

In addition to providing useful information on the current state of water management and governance in Cape Town the analysis of the CBA provides an opportunity to compare and contrast the governance capacity of different water challenges within the City as well as with other cities where the CBA has been applied. This is useful as it promotes intra and inter-city learning. The intra and inter-city assessment of the CBA is provided in this section.

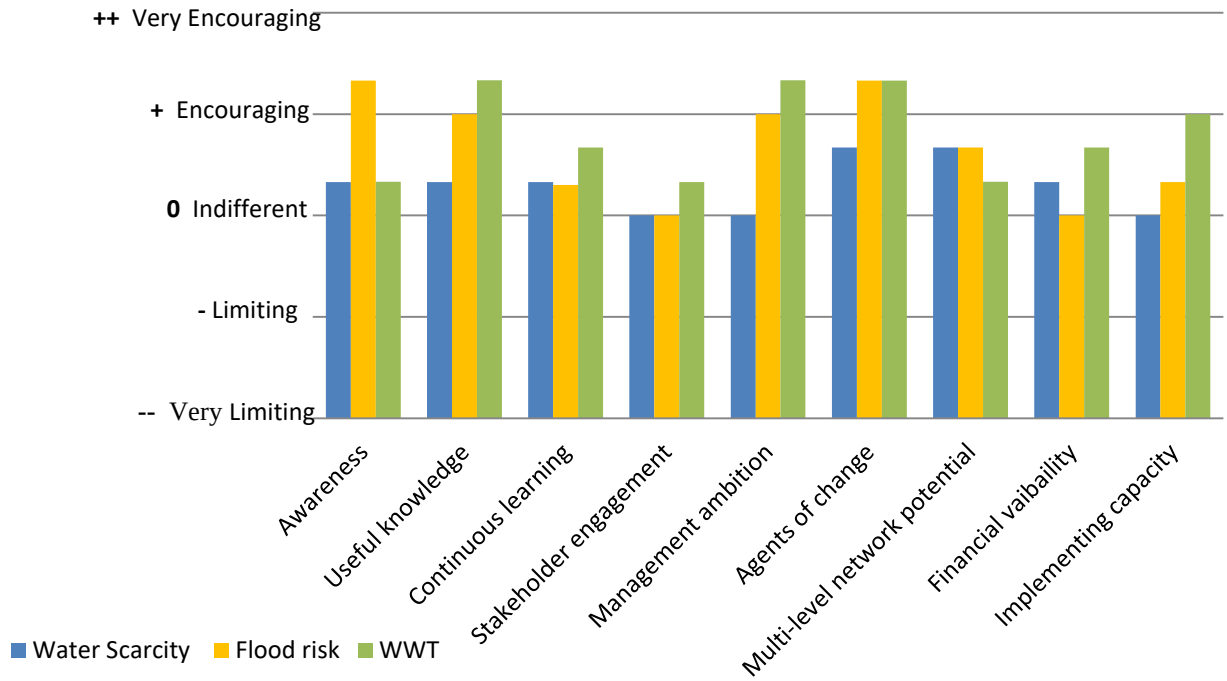

Figure 22: GCF for Cape Town

Figure 22 shows Cape Town's Governance Capacity for water scarcity, flood risk and WWT for each of the indicator categories. The general trend illustrates that the current governance capacity to address WWT and flood risk is higher than the governance capacity for water scarcity. This is mainly owing to the fact that the challenge of water scarcity is fairly new for Cape Town as compared to flood risk and WWT which have been at the fore for a significantly longer period of time and in which the governance capacity has generally strengthened. This is especially indicated by the categories of *management ambition, awareness* and *useful knowledge.* However, the scores for the categories of *financial viability* and *implementing capacity* illustrate that there are some similarities in certain aspects related to the governance of water scarcity, flood risk and WWT. For instance, the City has relevant policy and legislative instruments which promote implementing capacity to addressing issues of flood risk, WWT and water scarcity; however one of the main factors hampering implementation across these three water challenges is limited and financial human resources which limit work on the ground such as monitoring of compliance. Although this is the case, the annual budget allocated to each City department provides a degree of financial continuation to address the challenges of water scarcity, WWT and flood risk (although the stormwater branch is comparatively chronically underfunded) (CoCT 2017c).

The analysis of the CBA has provided a snapshot of the actual state of the City's water management and is therefore useful in comparing the status of Cape Town's water management to that of other cities where the CBA has been applied, thereby promoting inter-city learning. Figure 23 presents the BCI (overall score for sustainability of water management in the City) for 57 selected municipalities around the world (Koop *et al.* 2017b).

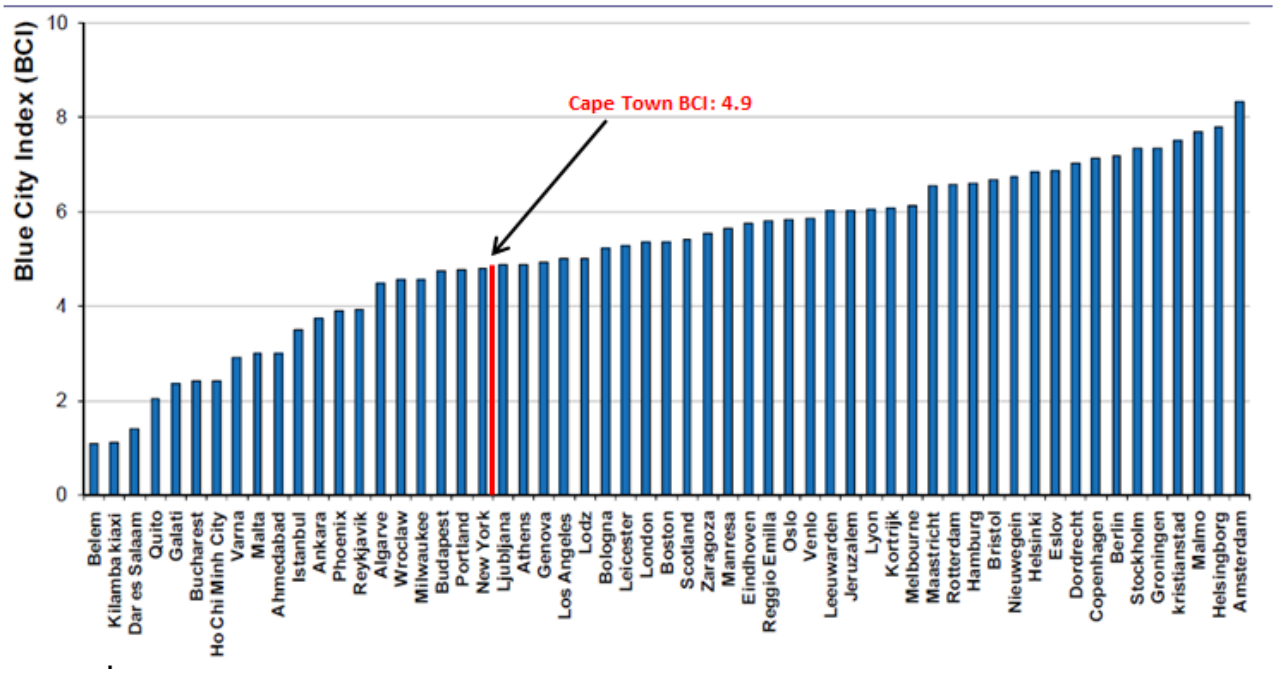

Figure 23: BCI of 57 municipalities and regions in 30 different countries
(Source: Koop *et al*. 2017b)

Thus far, the CBA has been applied in over 45 municipalities and regions internationally, but mostly in European countries. The results of the CBA from other cities in developing countries such as Tanzania (Dar es Salaam), Vietnam (Ho Chi Minh City) and Turkey (Istanbul), as well as eastern European cities highlight that Cape Town is performing relatively well in water and WWT services as compared to these cities (Koop & Van Leeuwen 2015b). The general CBF results for the 45 cities show that the coverage of secondary and tertiary WWT services is less than 30% and 50% respectively. Similarly, approximately half of the 45 cities do not apply any nutrient recovery techniques in WWT because of factors such as a lack of awareness regarding nutrient recovery; a limited market for the application of struvite or sewage sludge; and legislative limitations which prohibit the use of sewage sludge such as in the Netherlands (Koop & Van Leeuwen 2015b). Furthermore, the average infrastructure leakage rate for the 45 cities is 21% (with the lowest leakage rate of 2% (Berlin) and the highest 60 % (Varna)), compared to Cape Town's leakage rate of 9%. Although this highlights that Cape Town is performing well in infrastructural leakage control, Berlin's leakage rate highlights that Cape Town can still improve its water efficiency in this regard. Cape Town also scores well with respect to the full separation of stormwater and sewage infrastructure compared to many of the other CBF cities which still have combined sewers. For instance only about 12% of Copenhagen's stormwater and sewer system is separated, and as a

result a thunderstorm experienced in the city in 2011 resulted in sewers overflowing into streets and buildings resulting in significant surface water pollution and risks to human health (Van Leeuwen *et al*. 2016).

The CBF results further highlight that, similar to Cape Town, many of the 45 cities are faced with the challenge of securing water supply; this is especially the case for the developing cities and countries such as Dar es Salaam and Malta (Van Leeuwen *et al*. 2016). However, even developed cities which have 'sufficient' water resources, such as Oslo, are currently faced with the task of either reducing water demand or increasing water supply owing to future urbanisation rates and effects of climate change which will stress water resources. These results provide evidence that water-scarce cities need to use water resources more efficiently and consider the use of alternative water sources which promote water security. Although this is true, the TPF results for these 45 cities highlights that a lack of awareness and readiness, limited financial resources, limited government effectiveness and the lack of ambition as some of the challenges that are hindering transitions towards sustainable and efficient water resource management in cities worldwide (Van Leeuwen *et al*. 2016).

The score for the *economic pressure* indicator for Cape Town's TPF suggests that limited financial resources may be a challenge for Cape Town. Nevertheless, Cape Town and other water-scarce cities can learn from a city such as Melbourne which was successful in managing changing urban water systems in the face of Australia's 'Millennium Drought'[13]. A transparent governance structure comprising various organisations in the city working towards the same vision was set up and there was significant public response to the drought, e.g. approximately 32% of houses in Melbourne have installed rainwater tanks for non-potable use, in an effort to reduce the use of municipal potable water (Van Leeuwen *et al*. 2016; Chubaka *et al*. 2018). Accordingly, Melbourne scored high in the areas of water efficiency and climate adaptation for the CBF.

5.3 Transitions to WSUD approach in the City of Cape Town

The previous section has pointed out that issues related to water governance and management are often not unique to a single city. In addition, the GCF results for the three water challenges in Cape Town highlight that water management involves various actors from various institutions who play different roles in ensuring the sustainable management of water resources. It is therefore imperative to understand the different institutional dynamics that support or hinder transitions towards sustainable water management approaches in cities. In order to understand the context specific institutional dynamics that are needed to support a transition towards a WSUD approach, the results of the governance capacity for flood risk, WWT and water scarcity were thematically analysed (see section 4.5.1 in methodology chapter).

[13] From the late 1990s to 2010 southern Australia experienced a severe prolonged period of dry conditions, termed the 'Millennium Drought'.

The Transitions Management (TM) Framework distinguishes three types of governance which are essential to supporting a sustainability transition in a socio-technical system (Loorbach 2007). The first type is strategic governance, which refers to the structuring and envisioning of issues; secondly, tactical governance, which refers to negotiating and network building; and thirdly, operational governance, which refers to implementation of projects, regulatory frameworks and programmes. These governance types are not hierarchical and instead operate simultaneously and at different levels within a socio-technical system. Therefore each type of governance can be linked to particular actors and instruments in the sustainability transition process (Loorbach 2007).

This section describes the strategic, tactical and operational governance of sustainability transitions that are required to support a WSUD approach in the CoCT, as well as the different actors and instruments involved. The aim of this research is to understand the institutional conditions that affect the governance of sustainable management of water resources in the City. Hence, this section presents the salient themes which were identified as playing a key role in supporting a transition towards a WSUD approach in the overall management and governance of water challenges in the City.

5.3.1 Knowledge and learning

5.3.1.1 Knowledge sharing and bridging the knowledge gap

Participants in this research highlighted the importance of 'useful knowledge' in supporting a transition towards sustainable urban water management (SUWM). This refers to factual and reliable information related to different aspects of water resources in Cape Town as well as other topics which have an effect on the management of water resources such as climate change. This is knowledge and information which is based on multiple sources, methods and experiences that can be used to enhance well-informed decision-making. Useful knowledge can therefore emanate from various stakeholders within the City such as research from academics; practical experiences gained by consultants and city officials; and lived experiences of citizens. Useful knowledge is deemed important as a tool to influence and improve water-related policies and strategies in the city. For this reason, knowledge sharing between academics, city officials, consultants and citizens has been recognised as an important aspect of transitioning towards a SUWM approach in the City. In particular, responses from city officials and academics highlighted the significance of formalised knowledge sharing between these parties to support transitions in the CoCT.

There is much emphasis on the fact that knowledge produced in academia is expected to be useful to local government officials during decision making, policy reviewing and planning processes. Similarly, the knowledge and experiences acquired by local government officials is expected to be useful in aiding and informing research agendas in academia. In essence, the expectation is that there is a formalised two-way knowledge transfer between local government and academia that is effective in addressing water management challenges in Cape Town. Notwithstanding this expectation, the respondents express that the knowledge transfer is weak. The result of this is that decisions and policy in local government are predominantly informed by the day-to-day experiences and knowledge of city officials and that academic research is often not considered

useful and hardly used in addressing water management challenges in the city. A knowledge sharing gap between academia and local in the City is revealed in this study.

Several respondents suggested that the main reason for this knowledge sharing gap is the difficulty experienced by academics in translating and contextualising scientific knowledge for audiences such as city officials. For instance, respondents communicated that when addressing issues of climate change adaptation and resilience, city officials and politicians expect fine scaled and sophisticated information from scientists. This is due to the fact that the CoCT is required to develop water management plans for climate events predicted to happen in specific years. As a result, scientists find it difficult to downscale global climate models to smaller scales, such as the city scale, due to the fact that downscaling increases the uncertainties of these models and makes it difficult to estimate the impacts of climate change on water resources (Chen *et al*. 2011). According to Chen *et al*. (2011), despite the fact that downscaling methods have been developed to meet the requirements for regional modelling, the computational costs for these methods are said to be high, resulting in these methods only being available in a few regions around the world. This sheds light on the need for a middle ground where academic knowledge can be translated in a way that is valuable to local authorities who are making decisions on urban water management.

In an attempt to bridge the knowledge sharing gap in the CoCT, two research initiatives between the CoCT Municipality and University of Cape Town (UCT) have recently been undertaken to facilitate a better understanding of issues of climate change and sustainability at the city scale between city officials and academics. 'Mistra Urban Futures' and 'Climate Change Think Tank' are cross-stakeholder learning initiatives which involve a two-way learning system through innovative knowledge sharing practices (Patel *et al*. 2015; Cartwright *et al*. 2012). Furthermore, these initiatives were aimed at including politicians in discussions in order for them to understand climate change and recognise it as a key issue in decision making and planning in Cape Town. A respondent who participated briefly in these initiatives, confirmed that the Mistra Urban Futures Programme contributed to the knowledge and social networks that made it possible to create a receptive environment in the City to develop the Cape Town's Climate Change Policy, which was drafted at the tail end of the programme (CoCT 2017d). Despite the fact that such programmes are not continuing indefinitely due to issues such as lack of funding, the knowledge from research-based initiatives such as these is nevertheless useful to enhance decision-making on urban sustainability issues such as water scarcity in Cape Town and could be applied to other cities in the country.

5.3.1.2 Social learning

Social learning has been referred to as the *"process by which societal actors interact and develop alternative perspectives on a societal issue"* (Bos *et al*. 2013 p.399). As highlighted in the previous section, the interviewed participants shared a common view that in order to achieve effective management of water resources in the CoCT, knowledge and expertise regarding water management should not reside in one place. For this reason, it is imperative that social relationships are fostered between and within city departments in order to facilitate the sharing of knowledge and expertise possessed by individuals and groups within the municipality. Social

learning, however, is not limited to city officials. A respondent mentioned that social learning occurs even during 'business as usual' processes, such as when consultants (mainly engineers) who are contracted by the CoCT to render a service to the City are a great source of information and learning in that service, e.g. WWT. He stated that WWT technologies are constantly evolving and often consultants impart knowledge and ideas about different technologies which may be fit-for-use in the context of the CoCT. In the same light city officials who work in the stormwater branch have acknowledged that consultants who are implementing the CoCT's MUSIP in new developments have played a crucial role in providing knowledge to city officials about policy implementation. This type of interactive learning reflects the shared values and social relations between actors, which over time develop into communities of practice (CoP) that are sustained by the common interests shared by individuals (Wenger 2000). Some CoP are informal, such as the ones referred to above between city officials and consultants, while some take on a formal nature (Wenger 2000). For example, in 2014 a Water Sensitive Design Community of Practice (WSD CoP) Programme, commissioned by the South African Water Research Commission, was established by the Urban Water Management research unit at the UCT (Carden *et al*. 2016). The 5-year programme is aimed at *"advancing a water sensitive design vision for the country"* (Carden *et al*. 2016 p.53) through cross-stakeholder interdisciplinary interaction that encourages sharing of knowledge and expertise. One such activity of the WSD CoP is the Liesbeek Life Plan which involves the collaboration of city officials, researchers, members of the public and practitioners in the development of a framework plan which aims to guide the building of ecological and social resilience in the degraded Liesbeek River Catchment in Cape Town (Carden *et al*. 2016).

Social learning has also been indicated as a vehicle to facilitate knowledge sharing in formal and informal ways. Although participants recognised the importance of social learning to facilitate a transition towards a SUWM approach such as WSUD, they also noted the difficulty of successfully engaging in social learning. The underlying idea of social learning is that actors possess shared values and understandings through interaction, which ultimately provides the basis for joint venture (Bos *et al*. 2013). One of the main aspects identified as a hindrance to social learning is conflicting relationships between individuals. Individuals also tend to have busy schedules and do not to have the time to make a concerted effort to forge and foster social learning relationships. For example, it has been indicated that over and above the lack of continuous funding to keep initiatives such as the Climate Change Think Tank sustained, the combination of individuals driving the initiative did not work well together, thus leading to the ending of the project.

This illustrates that the strength of relations between individuals is important for successful social learning (Pahl-wostl *et al*. 2007; Huitema & Meijerink 2010). As such, social learning opportunities such as professional conferences and other networking platforms such as research seminars and workshops play a crucial role in strengthening relational capacities between individuals who operate within the water management field. Conferences provide a platform for academics and professionals to showcase and present the work which they have undertaken to people who operate within the same field. This provides ample opportunity for individuals to network, interact and form social relationships which can transcend the conference space. These informal social

relations that are formed between actors have been referred to as shadow systems. *"Shadow systems comprise personal relationships and alliances, formed and maintained through networks of actors with common challenges and experiences, as well as values and beliefs that transcend formal organisational structures and regulations"* (Leck & Roberts 2015 p.62). Research by Leck & Roberts (2015) identifies shadow systems as an integral and influential factor in the successful development and implementation of the eThekwini Municipality's (located on SA's east coast) climate change strategy which addresses, amongst other themes, the impacts of climate change on water management in the city. This research provides credibility to the claim that strong social relationship between actors with common challenges plays a crucial role in supporting transitions to SUWM approaches in SA cities.

5.3.1.3 Experimentation and innovation

Sustainability Transitions literature emphasises the value of innovation and experimentation to support sustainability transitions (Smith & Raven 2012). Alternative technologies and innovations are typically developed and matured in the niche level before they are pushed out into the market (Schot & Geels 2008; Smith & Raven 2012). This research has also illustrated the importance of experimentation and innovation in aiding a transition towards a WSUD approach in Cape Town. Interviewees conveyed that there is at times a need to highlight the credibility of alternative technologies or innovations that aim to address sustainability challenges in the City. An interviewee expressed that this is mainly the case due to the fact that conventional technologies have long been used and are understood to deliver services and address water challenges in the City; while alternative technologies are not embedded in the socio-technical system and may not yet have been 'tried and tested'. Not only this, but according to a respondent, the sustainability agenda as well as its technologies has not yet gained solid credibility in the City, especially in the political space. For these reasons, respondents strongly suggest that it is important that the proponents of alternative approaches are afforded the opportunity to implement their technologies in the market space in order to build credibility. Such experimentation is needed to actually demonstrate the success of new approaches in order to build momentum for sustainable technologies to be embedded in the socio-technical system. The City's stormwater branch has facilitated this through the implementation of the MUSIP (discussed in GCF section 5.1.3.2), which allows experts and professionals to install and demonstrate flood alleviation and water quality technologies in formal developments.

Interviewees further stressed the importance of ensuring that there are spaces for experimentation within the City. This is to encourage alternative or sustainable solutions not to be 'imported' from other countries, but instead to be designed for the SA context. In other words it is crucial that, despite information regarding sustainable technologies possibly originating from other countries, ideas are not just transferred but rather developed and tested for a specific context. In this way, the probability of success and uptake of technologies in the City is optimised. For instance, as shown by the results of the GCF, different areas in Cape Town are affected by a range of urban water challenges and have a different ability to adapt to the effects of climate change due to aspects such

as income level, dwelling type and topography. Hence the different governance approaches for addressing flood risk in formal vs informal areas discussed in the GCF results.

Respondents deemed it important that the Municipality seeks out a wide range of 'African' solutions from local entrepreneurs. An example of this is the Open Innovation Platform, which is run by the CoCT's New Technology Committee. The Open Innovation Platform allows businesses, innovators and residents to submit innovative ideas which can improve the city's various services such as water supply, sanitation, energy and housing. The information gathered through the platform is reviewed by the New Technology committee, which includes representatives from the CoCT and the Western Cape Government (WCG). The outcomes from the review process are then shared with the relevant WCG and CoCT Branches and Departments who are at liberty to implement successful ideas within approved procurement processes of the City, such as advertising a tender. Innovation in the CoCT is however not limited to this. Initiatives such as the Water Hub in Franschhoek have been lauded by respondents as key players in incubating innovation to address water challenges in Cape Town. The Water Hub is a partnership between the WCG, UCT and the University of Stellenbosch. It has been established at the old Franschhoek WWTW facility and intends to be a research and training centre for the innovation of solutions that address water challenges that promote liveable and healthier environments in the SA context (https://www.thewaterhub.org.za/). This includes solutions for contaminated stormwater and water reuse, and the treatment of contaminated water using natural systems and bioprocesses. Ultimately the goal is to demonstrate novel technological innovations which can contribute to addressing issues of water quality and reuse.

The Genuis of Space Project (GoSP) is another example of how context-specific innovation can aid the incorporation of WSUD principles in informal settlements. The GoSP has been implemented in the Langrug informal settlement, which is located three kilometres north-west of Franschhoek in the WC Province; it was initiated by the WCG and is a collaboration between the Langrug community, Biomimicry SA and Greenhouse Systems Development. The aim of GoSP is to incorporate a systems approach to addressing water, waste and socio-economic challenges in the Langrug informal settlement, by integrating innovative design thinking and community co-managed greywater management infrastructure in the upgrading and development of informal settlements. In addition, the GoSP aims to tackle the problem of water quality in the Berg River.

One of the main challenges identified as having a significant impact on the health of the Berg River system is the difficulty in managing the grey water which comes from informal settlements, bypassing the formal system and washing into the river untreated. The Langrug informal settlement is one of the settlements contributing to the pollution of the Berg River. However, greywater pollution has not only affected the health of the river, it has had a negative impact on the health of the Langrug community too. After struggling with the negative health effects caused by years of accumulated household greywater that was stagnant in the Langrug settlement, due to no formalised drainage infrastructure, the community decided to install their own pipes as a drainage system for greywater to alleviate pollution problems. Given that the Langrug community members

had already taken initiative to try and solve the water pollution challenges, Langrug was identified as a suitable settlement to implement the GoSP.

The GoSP involved the implementation of a greywater system in the settlement that is based on the principles of biomimicry, a methodology that applies nature based principles to solve human system challenges. The system includes greywater disposal points where the water is filtered to trap sediments, before entering into an underground wastewater pipe system. Along the way these pipes offshoot some of the greywater into interconnected tree gardens and wetlands which provide sub-surface greywater treatment through microbes in plant roots that help to breakdown pollutants and heavy nutrients. The GoSP water system also includes living drainage channels for stormwater as well as eco-machines, for treating stormwater. In addition to the technical aspects of treating and managing wastewater in the community, the GoSP also focuses strongly on community involvement in the project, facilitating human behaviour change and uplifting the community's socio-economic development. This was achieved by facilitating community engagement from the first phase of the project (scoping) through the design and implementation phases, through community meetings, workshops, and door-to-door visits as well as newspapers and pamphlets. This ensured that all voices from the different stakeholders in the project were heard and that collective decisions were made. Furthermore, the GoSP is an example of how community engagement plays a role in social learning processes (as discussed in the previous section) as the exchange of context-specific knowledge and experiences of community members and the science-based knowledge of the consultants and government officials between these two groups was essential in ensuring that the project was successfully implemented.

The GoSP demonstrates novel technological innovations which can contribute to addressing water challenges in informal settlements and importantly also demonstrates how community members play a key role in supporting transitions towards WSUD.

> *"The project sets out to create a new model for regenerative development, integrated design thinking and community co-managed infrastructure"* (Greenhouse Media 2016, 4:49).

Literature on sustainability transitions recognises that in order to influence future development trajectories, it is essential to break out of socio-technical 'lock-ins' (Meadowcroft 2009; Rauschmayer et al. 2015). An important aspect of breaking out of socio-technical 'lock-ins' is developing new sustainability technologies in niches (Schot & Geels 2008). This study shows that experimentation and innovation is indeed deemed important to aid transitioning to WSUD in Cape Town (a socio-technical regime) in which unsustainable practices may still be embedded (Meadowcroft 2009). Importantly, these findings also provide evidence that collective enactment between a wide range of actors as well as demonstration projects are important in steering a transition towards a desired path in Cape Town (Schot & Geels 2008). This is seen in the collaborative efforts in implementing policy (MUSIP), the Open Innovation Platform as well as the Franschhoek Water Hub. Moreover, government institutions also play a key role in creating platforms for niche innovations and technologies to be introduced into the market such that they stand a chance to be slowly embedded into the socio-technical regime.

5.3.2 A shared city vision

According to the IWA Principles for Water Wise Cities and the Organisation for Economic Cooperation and Development (OECD 2015; IWA 2016), a shared vision amongst stakeholders in a city is an important building block to delivering SUWM. The respondents of this study echoed this by stressing that it is important for the CoCT to have a vision of what the city aims to achieve in terms of water resource management and secondly to ensure that this is a shared vision amongst stakeholders (politicians, city officials and practitioners). This is in order to support a transition towards an alternative and sustainable approach to water management such as WSUD. According to city officials, having a vision includes understanding the reasons why a transition is necessary; establishing how the stakeholders in the city are to benefit from the transition; envisioning the circumstances and physical characteristics of a future water sensitive city (WSC), and framing the pathways and adjustments the city has to make to achieve a transition to a sustainable approach to urban water management. All of this should happen while taking the local context into consideration. Having a shared vision is said to be imperative because in most cases politicians and other urban stakeholders may not always fully understand what concepts and approaches such as WSUD entail. For this reason, respondents expressed that it tends to be difficult for city officials and proponents of these approaches to get the political buy-in to adopt such approaches. For instance, in a city like Cape Town, where approximately 16% of housing is informal (almost 600 000 people) (CoCT 2016a) there is strong political will to ensure that services are delivered to minority groups without any hindrance (Armitage *et al*. 2014).

In addition to this, the CoCT is an opposition party-led city, meaning that the City is constantly under political scrutiny. For this reason, political-will to engage and support agendas which are not deemed by politicians to be directly beneficial for service delivery may be limited. However, resistance is not limited to politicians only, as other stakeholders in the city (such as developers and consultants) who may lack an understanding or who may hold different values may also present resistance to a certain degree. An example of this can be seen in the implementation of the MUSIP. City officials who are in charge of implementing this policy have stated that they have experienced low political will to implement this policy in low-cost housing projects, as the requirements of the policy are perceived to be time and space wasting in these developments, therefore impacting on service delivery. Not only this, developers have also been resistant to implementing this policy as it is firstly not fully understood and secondly the incorporation of required stormwater technologies in developments is deemed to be a waste of money. The need for early involvement of stakeholders, a stable long-term political agenda, and awareness of the cost of inaction are crucial components to build the required level of understanding of the need for WSUD transitions (Koop & Van Leeuwen 2017).

This research shows that engaging stakeholders in visioning exercises, workshops and other platforms is key to safeguarding a common vision. Such platforms ensure that stakeholders gain knowledge and understanding of concepts and approaches such as WSUD. In addition, these platforms can be used for stakeholders to offer valuable knowledge and information which can be collated and used to enhance decision making and planning in the city. In this way a wide range of

stakeholders such as academics, politicians, professionals and city officials are able to share knowledge and experiences and work together towards a common vision. In addition, visioning exercises and workshops are said to be important to inspire a shift in what is considered best practice for professionals such as engineers and developers, as best practice informs the way in which these professionals carry out their work. Important to remember in the SA context, is the fact that the engineering and planning space has traditionally been dominated by an older generation of engineers who have been infrastructure-focused and less oriented on social and environmental aspects. As a result, such professionals have generally not been forced to deal with the social justice issues linked to water management which are incorporated in WSUD. Therefore, providing platforms which showcase new best practices to professionals is essential. For instance, when the City's MUSIP was approved by council in 2009, the City's stormwater branch held policy-learning seminars which were open to professionals who would be faced with the task of interpreting and implementing the policy. The seminars included presentations by academics and city officials on different aspects of implementing the policy, mainly focusing on sustainable urban drainage systems. This was done to ensure that the professionals implementing the policy understood the purpose for a policy of this nature in Cape Town, and most importantly for professionals and the local authority to share a common vision.

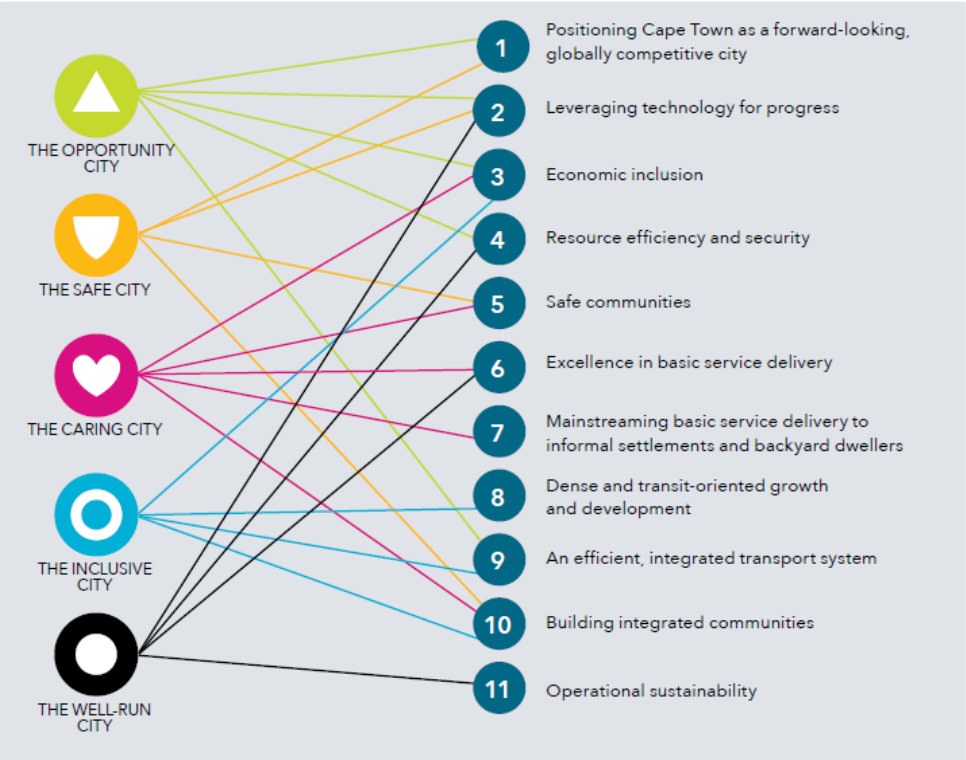

Figure 24: Relationship between the IDP's five strategic focus areas and the eleven priorities (Source: CoCT 2017g)

Over and above using policy seminars, conferences and similar platforms, the City's Integrated Development plan (IDP) has also been identified to play a key role in defining the City's vision. The Municipal Systems Act No.32 of 2000 requires that all municipalities prepare and implement an IDP (RSA 2000). The IDP identifies a municipality's key development priorities and formulates a clear

vision, mission and values for the municipality. The IDP is also required to formulate appropriate strategies, systems and structures which will support and aid in achieving the municipality's visions and missions. The CoCT's IDP has set out eleven priorities which span five strategic areas (figure 24). Not only this, but the IDP also outlines guiding principles which, along with the priorities and strategic areas, includes the planning and implementation of the City's activities over a five year period. The following section will further describe how the planning and implementation of activities in the City's Water and Sanitation department are informed by the IDP and aid in achieving the City's vision in general.

5.3.3 Planning tools

Sustainability transitions literature recognises sustainability as a long-term goal (Schot & Geels 2008). For this reason transitions towards sustainability in cities tends to be gradual in nature. Literature stresses that the adoption of sustainability approaches, such as WSUD, is better informed by long-term plans which will inform the direction of the transition. This makes it important for current decisions to contribute towards future plans (Markard *et al*. 2012). This notion was confirmed by the research participants, however they also emphasised the value of setting short and medium-term goals which contribute towards the long-term goal of sustainability.

This research identified the Municipal Spatial Development Framework (MSDF) as an important planning tool to aid in supporting transitions towards WSUD in the CoCT. The MSDF is a legislative requirement of the Spatial Planning and Land Use Management Act No.16 of 2014 to serve as a principal strategic planning tool for Municipalities (CoCT 2018b). The MSDF translates the visions and priorities of a municipality's IDP into a desired spatial form for the municipality. For the CoCT, the MSDF represents *"a framework for long-term growth and development, including a spatial vision, policy parameters and development priorities to support Cape Town achieve a reconfigured and inclusive spatial form and structure sets out the development priorities"* (CoCT, 2018b p.1). The 2017 CoCT MSDF sets out three spatial strategies (drawn from the IDP) and policies which aim to support the spatial vision of the City. These spatial strategies are important for planning in the City as they guide and direct decision-making that is binding on the City. These spatial strategies are to:

1. Build an inclusive, integrated, vibrant city
2. Manage urban growth, and create a balance between urban development and environmental protection
3. Plan for employment, and improve access to economic opportunities

Each of these strategies is accompanied by sub-strategies, policy statements and policy guidelines. The MSDF emphasises that amongst other things, spatial strategy 2 will be achieved by making efficient use of non-renewable resources such as water and energy, as well as ensuring that water resources are protected and sustainably managed to secure future water supplies. In addition to this aquatic resources and networks, biodiversity and agriculture need to be taken into account when planning new development in the City. The MSDF's spatial strategy 2 therefore mirrors the principles of WSUD (as described in section 2.1 of the literature review chapter) and highlights the importance of employing WSUD principles to achieve the City's vision of creating a balance

between urban development and environmental protection. The relevant sub-strategy and policy guidelines related to the 'appropriate management of urban development impacts on natural resources and critical biodiversity networks' further emphasise and describe the key role of applying WSUD principles to land use management decisions in the City (as illustrated in table 13). Owing to the fact that the SDF is a municipal-scale spatial planning tool, the strategies and policy statements would therefore require that WSUD principles inform decision-making at different scales within the City (CoCT 2018b). The MSDF is therefore an important planning tool to support a desired WSUD vision for the City over the long-term.

Table 13: Relevant sub-strategy and policy guidelines related to the 'appropriate management of urban development impacts on natural resources and critical biodiversity networks'
(Source: CoCT 2018b p.128)

Strategy 2: Manage urban growth, and create a balance between urban development and environmental protection		
Appropriately manage urban development impacts on natural resources and critical biodiversity networks		
Policy statement	**What this means/requires**	**Policy guidelines**
Policy 24: Reduce the impact of urban development on river systems, wetlands, aquifers, aquifer recharge areas and discharge areas	The City will ensure that the water flow regimes and quality of river systems and wetlands, as well as their ability to support their natural flora and fauna, are not unduly compromised, by: • identifying adequate flood lines and ecological buffers/setback lines to permit the full range of flow regimes and flood attenuation, and protect the integrity and functioning of adjacent aquatic ecosystems; • identifying adequate measures to reduce impacts such as quality impairment and erosion to all receiving surface and groundwater systems; • promoting the sustainable use and sourcing of water supply; • mapping all aquifer recharge areas; • policing of illegal water extraction; and • taking measures to accommodate changes in climate that predict lower water availability, extreme flood events and higher temperatures	24.1 All land use management decisions should be guided by the development guidelines in the relevant district SDF 24.2 Land use management decisions should take the following water sensitive urban design principles into account: • maintain the natural hydrological behaviours of catchments; • protect and restore water quality of surface and groundwater systems; • minimise demand on the potable water supply system; • minimise sewage discharges into the natural environment; and • integrate water with the landscape to enhance visual, social, cultural and ecological values 24.3 Development should not unduly compromise the freshwater ecosystems, especially high productivity aquifers and their ability to be utilised as water sources. 24.4 Incorporate aquifer restoration and protection requirements into spatial planning, development and landscape design strategies and policies.

In addition to the MSDF, the WSDP has been also been utilised as an important planning tool to address challenges faced by the water sector. The WSDP is based on audited information and integrates technical planning, social, financial, institutional and environmental aspects of the water sector. Apart from satisfying the legislative requirement of the NWSA (as discussed in section 3.3 of the contextual analysis chapter), the various aspects covered by the WSDP also aim to support the

strategic focus areas and priorities set out by the City's IDP. The WSDP has been identified in this study as an important planning tool as it firstly defines the principle challenges for the City as well as the approach and important aspects to consider when addressing these challenges.

The 2017/18 WSDP describes maintaining existing water and sanitation services while providing services for an increasing number of households in a sustainable way as a key challenge (CoCT 2017b). The City's Department of Water and Sanitation aims to address these challenges *"in the context of providing basic needs, ensuring economic growth, maintaining an ageing infrastructure, limiting negative environmental impact, managing water resource scarcity and consolidating a transformed metro administrative infrastructure"* (CoCT 2017b p.9). Accordingly, each annual sector plan presents detailed information on important areas such as yearly service level profiles for the city, i.e. Water and Sanitation Tariffs; Water and Sanitation department financial profile; water quality and sampling at treatment works facilities; progress and cost of Water and Sanitation department's projects. On the whole the WSDP provides a comprehensive and relevant summary of the water services development planning in the City. The WSDP is therefore a useful tool for the City to inform the direction of a transition towards the adoption of a WSUD approach.

The detailed annual reporting provides an opportunity for the DWS to compare and contrast the success of various processes and programmes from year to year so that gradual and necessary changes can be made in poor performing water management areas, thus supporting a gradual transition towards SUWM. In addition to this, the WSDP provides detailed reports and plans which integrate technical planning and social, financial, institutional and environmental aspects of the water sector based on audited information. Sustainability transitions literature states that owing to the fact that infrastructure and technologies are highly intertwined with institutional structures, regulations and social practices, transitions require significant changes along assorted dimensions of the socio-technical system (Markard *et al*. 2012). The WSDP has the potential to play a significant role in facilitating and supporting a transition towards WSUD as it plans and reports on the different dimensions of water management in the City in an integrated manner. In addition, transitions literature suggests 'system improvement' as a strategy that policy makers can pursue in order to break out of a socio-technical lock-in. System improvement refers to addressing a perceived problem by making gradual adjustments to existing societal and institutional practices. The use of this existing planning tool to facilitate a transition towards a WSUD approach can therefore be beneficial for the City as it is already embedded in the City's socio-technical regime and hydro-social contract and would cause a significant shift in the institutional planning and reporting culture of the DWS. Moreover, owing to the fact that the WSDP is a legislative requirement in SA, lessons from utilising an existing planning tool to facilitate a sustainability transition can be transferred to other municipalities or cities in the country. However, it is also important to note that, owing to a severe lack of appropriate skills and financial resources, smaller municipalities around SA are either unable to develop or pay consultants to develop WSDPs.

In addition to the WSDP, the CoCT's Water Conservation and Water Demand Management (WC/WDM) Strategy is also representative of an important planning tool for facilitating a transition

towards the adoption of WSUD approach in the City. As a result of Cape Town's water scarcity and growing population, WC/WDM is key to safeguarding a sustainable water supply to the city. The National Water Resources Strategy (NWRS) (DWA 2013) emphasises the need to find ways to ensure that multiple strategies for WC/WDM are explored and adopted in order to achieve a sustainable water balance in SA, and also puts emphasis on the fact that the greatest opportunity for WC/WDM lies in the local government sectors due to the expected growth in water demand in this sector. The City's WC/WDM strategy therefore aims to make certain that the City maintains a long-term sustainable balance between water resources and water demand. This has been achieved by implementing significant water demand management interventions in the City.

This has firstly included the installation of pressure relief valves in high-pressure areas in order to decrease the quantity of water lost through leaks and burst pipes. For example, pressure management was successfully installed in Sunningdale, Imhoff's Gift, Wynberg 3 Zone B, Vrygrond, Masiphumelele, Therina, Helderzicht and Silverboom and is reported to have saved approximately 8.24 million m^3 during the 2015/16 year (CoCT 2017b). The City aims to continue implementing pressure management across the various District Metered Areas (DMA[14]) where pressure management will be most effective based on a calculated Infrastructure Leakage Index (ILI[15]) (Lenzi *et al*. 2013). Once the delineation of the City's DMA's have been finalised and implemented, a water balance model will be developed at the zone (DMA) level. DMAs have been recognised as an active approach to accounting for water loss in the form of leakages in the reticulation system. This is achieved by having smaller sub-systems, referred to as DMAs, within the larger reticulation system (Diao *et al*. 2013). This approach is therefore beneficial as the City can better target non-revenue water reduction within these zones.

Secondly, plumbing leak and meter repair programmes have also been undertaken. In the 2015/16 financial year a notable 7131 water meters were replaced, re-fixed or relocated (CoCT 2017b). Other WC/WDM implementation measures include educational programmes, treated effluent re-use, pipe replacement, water restrictions, as well as stepped tariffs. Not only this, other key projects to be implemented as part of the WC/WDM Strategy include a large-scale roll-out of waterless urinals in City-owned facilities to replace approximately 5000 automatic flushing urinals which has the potential to save up to 20 million litres of water per year.

This research illustrates that the WC/WDM strategy makes use of a system innovation approach presented by transitions theory literature to aid a transition towards the sustainable management of urban water resources in Cape Town. System innovation refers to developing and implementing technologies which will make necessary modification to dominant designs (Meadowcroft 2009;

[14] A district metered area (DMA) is defined as a discrete area of a water distribution network. It is usually created by closing boundary valves so that it remains flexible to changing demands. However, a DMA can also be created by permanently disconnecting pipes to neighbouring areas. Water flowing into and out of the DMA is metered and flows are periodically analysed in order to monitor the level of leakage.

[15] "Infrastructure Leak Index is an operational indicator defined as the ration between the Current Annual Real Losses (CARL) and Unavoidable Annual Real Losses (UARL), defined as the reference leakage level, which is its lowest technically achievable value for a well-maintained and well-managed system" (Lenzi et al. 2013 p. 1017).

Rauschmayer *et al*. 2015). The implemented WC/WDM interventions aim to make incremental changes and improvements to the City's existing water supply infrastructure without completely altering it. This illustrates that the existing technologies and systems of the City have satisfactory adaptive potential to support a gradual transition towards a WSUD approach. This is advantageous to the City as WC/WDM interventions incorporated are immediately beneficial to the modified system. If WC/WDM is controlled to the levels expected in the WC/WDM Strategy, the City has the opportunity to consider other alternative approaches, technologies and water resource schemes for the future. Planning tools such as the WC/WDM strategy are also shown to provide unintended benefits for water management in the City. The WC/WDM Strategy is driven by two critical factors, the efficient use of scarce water resources for the City's growing needs and maximising the use of existing infrastructure. However, interventions such as minimising losses in the bulk and reticulation system have also been reported to prolong infrastructure integrity. For example at lower pressures the lifespan of the reticulation system is increased, and this postpones the need for expensive capital infrastructure projects for as long as it is economically viable.

This section of the research illustrates that it is imperative for a City to have coherent long, medium and short-term planning tools to help support the adoption of WSUD principles. Both the MSDF and the WSDP aim to support the strategic focus areas and priorities set out by the City's IDP. The MSDF has a long-term focus, whilst the annual WSDP ensures that the water-related strategic focus areas of the IDP are continuously supported on a short-term basis. The reporting of progress and challenges of the WC/WDM Strategy in the annual WSDP further supports the long-term vision and strategy to transition towards a WSUD approach in the CoCT.

5.3.4 Implementing capacity

5.3.4.1 Financial resources

Transitions Management theory has been critiqued for not considering the political interactions through which societal goals are determined and revised and how resources are authoritatively allocated accordingly (Meadowcroft 2009). This section aims to illustrate how societal goals and the financial resources allocated to local governments in SA have an effect on the ability of a city to transition towards being a more sustainable socio-technical system. Respondents of this research recognised that financial resources are thinly spread in local government institutions and thus have to be spent wisely. This, according to some respondents, is hampering a transition towards WSUD in Cape Town. This was also acknowledged in a study conducted in municipalities in the WC, which reported that financial constraints have a hand in affecting the ability of municipalities to undertake various actions such as climate change adaptation (Pasquini *et al*. 2013). The participants of this research noted that the main reason financial constraints affect climate change adaptation is that the financial resources available to each government department have to be allocated carefully to address social and service delivery issues such as housing, water supply and sanitation which are perceived to be of a higher priority than climate change adaptation and sustainability. This mind-set further illustrates that sustainability may be perceived as a separate agenda as well as a competing priority to the services delivery agenda.

In SA each municipality has a city/town council which is responsible for passing budgets for the municipality each year. The council is also responsible for deciding on development and service delivery plans. The budget is therefore approved according to these municipal plans. The council is made up of proportional representation councillors and ward councillors. Proportional representation councillors are elected members who represent a political party which is voted for by voters. The winning party then elects members to fill the councillor positions. Ward councillors are directly elected by voters from a ward to serve the people in a specific ward; ward councillors are often also representative of a political party. The work of the city council is coordinated by the mayor of the city who also oversees the work of the municipal manager and department heads. The administrative work and the implementation of the programmes approved by the city council is then done by the city officials. In light of this structure city officials argue that the chief priority of politicians (councillors) is to ensure that peoples' needs are met through service delivery. This is especially pertinent in Cape Town where the continuous growth of the informal sector is putting increasing pressure on the municipality to address these social needs. For this reason, it is important to prioritise the different aspects of service delivery in the City's water management.

Service delivery is evident in the CoCT's WSDP. The (2017/18) WSDP draws attention to the fact that a *"principal challenge for the department is to maintain an existing water and sanitation service for the city while also providing services for an ever-increasing number of households in a sustainable way. This has to be achieved in the context of providing basic needs, ensuring economic growth, maintaining an ageing infrastructure, limiting negative environmental impact, managing water resource scarcity and consolidating a transformed metro administrative infrastructure"* (CoCT 2017b p.9). The WSDP highlights key performance areas for the implementation of projects as approved by the budget allocated to the local Water and Sanitation department. These include service levels for informal settlements such as water service taps and sanitation points (toilets); socio-economic development such as bursaries and employment opportunities; and water services infrastructure management which includes the replacement and maintenance of sewer and reticulation mains.

This research suggests that priority areas such as service delivery are utilised as a vehicle to aid the transition towards a sustainable future for the CoCT. This was echoed by Pasquini *et al.* (2013) who suggested that climate change considerations should occur in parallel with service delivery priorities. Respondents suggested that this could be done through the installation of low-cost sustainable technologies in informal settlements which ensure that basic water and sanitation services are delivered whilst increasing communities' adaptive capacity to the effects of climate change. This is especially important because lower income communities often have a limited financial ability to adapt to the effects of climate change (Beg *et al*. 2002). The 2017/18 WSDP, in contrast to those from previous years, shows that the recommendations articulated by research have come to also be realised in the City's Water and Sanitation department. This is highlighted in a statement in the 2017/18 WSDP which communicates that as a result of the Cape Town water crisis *"various waterless technologies will be explored over the following 5 years. Partnerships with reputable institutions such as Tertiary institutions and the Water Research Commission amongst*

others will be included in agreements to ensure that the City remains the 'beacon in Africa through the progressive realisation of Cape Town as a water sensitive city' (CoCT 2017b p.24).

This section of the research has shown that adopting a sustainable approach to urban water management may still be perceived as a separate agenda in the CoCT. This has consequently lead to climate change adaptation measures as well as sustainability principles competing with service delivery and social issues such as water infrastructure maintenance, water and sanitation service delivery. This research therefore helps to reveal the importance of the City applying the principles of sustainability through approaches such as WSUD when implementing programmes approved by council. This is especially important in developing countries where there is a need for stringent financial resources to be stretched to allow service delivery priorities to be met, especially in the face of growing population numbers and urban growth. Furthermore, the competing 'pressures' of the ongoing challenge in delivering basic service to informal areas of the City can be used by the City as a window of opportunity to gradually implement technologies that promote WSUD principles.

5.3.4.2 Clear division of responsibilities

The participants of this study drew attention to the fact that along with the policies that encourage sustainability (as discussed in the previous section), a considerable change in actual institutional structures is necessary to ensure that transitions towards approaches such as WSUD are supported in Cape Town. This is also supported by sustainability transitions literature which emphasises that transitions typically involve significant changes along assorted dimensions of the socio-technical regime, including technological products and services as well as changes in institutional structures (Markard *et al*. 2012). A prevalent institutional aspect which has emerged as an issue for the CoCT is that government departments may still be working in silos instead of collaborating to address issues relating to urban water management.

Interviewees drew attention to the clear division of roles and responsibilities that are assigned to each department in the City and suggest that this is possibly a reason why City departments may continue to work in silos. The Local Government: Municipal Systems Act states that it is the duty of the municipal council to exercise the municipality's executive and legislative authority (SA 2000). It is therefore the responsibility of the municipal council, in accordance with national and provincial legislation, to assign clear roles and responsibilities to government departments to implement the programmes approved by council. This may be seen as being useful to ensure that each aspect of urban water management is addressed effectively by a separate branch of the department. However, respondents stressed that with the emergence of concepts and approaches such as climate change adaptation and mitigation, WSUD and sustainability, some areas of ambiguity have emerged in the management of water resources in the City. There is an increasing need to work in more interdisciplinary teams that can address the various integrated aspects of water resource management.

Literature on WSUD emphasises the importance of the integration of urban design with other disciplines such as environmental science and engineering in water management (Wong & Brown

2009). This was further echoed by the interviewees who stated that achieving collaboration and integration of expertise in the CoCT has been a challenge. Respondents stated that navigating through approaches such as WSUD requires city officials to think 'outside the box' and to work in an integrated fashion instead of working in silos. This research suggests however, that city officials are hamstrung by rules. For instance, the Local Government: Municipal Finance Management Act No.56 of 2003 places personal liability on city officials who are deemed to have deliberately conducted unlawful actions when performing a function of office. The Act states that the municipality has the right to recover any loss or damage incurred from an unlawful act by a city official from such city official (SA 2003). De Visser (2012 p.144), states that "*the prospect of personal liability for the incorrect interpretation of laws stimulates city officials to strive for strict compliance rather than for purposive interpretation".* This does not encourage innovative interpretation of the law.

The respondents of this study also referred to the fact that addressing sustainability and climate change adaptation may still be viewed as an extra function in the work of city officials and thus SUWM does not form part of their mandate. It can therefore be assumed that there is a degree of confusion in terms of who should actually address the climate change and sustainability vision of the City. This illustrates the fact that although there is a clear division of roles and responsibilities in terms of service delivery in the CoCT, there is still a sense of confusion regarding whose responsibility it is to address the climate change and sustainability agenda in the city. This issue is further stressed in the City's Environmental Strategy which states that *"environmental governance becomes an adhoc process without the appropriate structure and framework"* (CoCT 2017e). This also shown by research conducted by Pasquini *et al*. (2013) regarding the uptake of climate change policy in local governments in the WC Province. City officials from Pasquini's research stated that addressing climate change should ideally be the responsibility of only the environmental department. In accordance with these findings, the CoCT's Climate Change Policy recognises that addressing the effects of climate change on the City's water resources is not purely an environmental agenda (CoCT 2017d). The impact of climate change on water resources has the potential to have an effect on various socio-economic systems such as food-security, human health and the business sector. This means that the constitutional rights of residents, whom local governments have a responsibility to protect, will be implicated. Municipalities should thus ensure that the potential hazards and consequences of climate change on water resources are included in decision-making processes across the board and are not limited to one department in the City.

City officials in this study stated that human resources are an issue for the water sector in the CoCT, with extremely low numbers of skilled professionals, most of skilled and technical professionals such as water engineers work for the private sector. The respondent stated that for this reason, much of the technical and skilled knowledge required to solve problems in the water sector lies in the private sector. The city official identified this as one of the barriers to transitioning towards a WSUD approach in the CoCT, as there are only a few people with the relevant skills in the municipal services environment to explore and design suitable solutions for the city's context.

The research suggests that collaborative work between City departments is essential to achieving transitions towards a WSUD approach in Cape Town. In addition this section highlights that there may be a lack of understanding by city officials as to how to address sustainability and the impacts of climate change in the management of water resources in their day-to-day work activities. The following section will discuss this in further detail.

5.3.4.3 Policy instruments

Sustainability transitions literature stresses that in conjunction with the innovation of sustainable technologies regulatory practices and support play a crucial role in ensuring that a transition towards a more sustainable socio-technical regime is achieved (Schot & Geels 2008; Markard *et al*. 2012). This was further reiterated by this research's participants, who expressed that it is challenging to address issues regarding flood risk, water scarcity and WWT without an enabling legal framework. This is owing to the fact that all the laws and policies which govern urban water management at the local level are underpinned by national legislation, as discussed in chapter 4 (contextual analysis). Respondents stressed that there is a lack of a legislative framework for the sustainable management of water resources, especially legislation which aims to address issues of climate change adaptation in various sectors, at national level in SA.

Although this may be the case, section 151(3) of the Constitution states that *"a municipality has the right to govern, on its own initiative, the local government affairs of its community, subject to national and provincial legislation, as provided for in the Constitution"*. In conjunction with this, section 156(1) of the Constitution sets out that a municipality has executive authority in respect of, and has the right to administer the local government matters listed in Schedule 4B and 5B of the Constitution and any other matters assigned to it by national or provincial legislation (Table 14). This means that municipalities have the right and authority to make and administer By-laws and policies regarding these matters, on condition that the policies and By-laws are within the parameters set out by national and/or provincial laws. Accordingly Schedule 4B and 5B list the following matters, which may relate to the governance of urban water resources:

Table 14: Schedule 4B and 5B matters relating to governance of water resources
(Source: RSA 1996)

Schedule 4B matters	Schedule 5B matters
• Building regulations • Municipal planning • Stormwater management systems in built-up areas • Water and sanitation services limited to potable water supply systems and domestic waste-water and sewage disposal systems	• Public places • Local amenities

In light of this, research conducted by De Visser (2012) on cities and climate change points out that municipalities do not have to rely on and wait for legislative and executive instruction from national or provincial government. Instead, municipalities can use their own executive and administrative authority as stipulated by the Constitution. The CoCT has developed By-laws, policies and strategies

which to a certain degree provide an enabling legislative and regulatory environment for urban water resources to be managed in a sustainable way; these include:

- Floodplain and River Corridor Management Policy (2009) – Management of development adjacent to watercourses and wetland to take flood regime, aquatic and riparian ecology as well as socioeconomic factors into consideration
- Management of Urban Stormwater Impacts Policy (2009) – To minimise the undesirable impacts of stormwater runoff from developed areas by introducing SuDS principles to urban planning and stormwater management
- Treated Effluent By-law (2009) – Allows for treated effluent to be used by customers with the aim of ensuring that the demand for potable water is decreased, thus promoting significant potable water savings
- Wastewater & Industrial Effluent By-law (2006) - Enables the City to govern activities linked to the disposal of wastewater and industrial effluent which can potentially have a negative impact on the natural environment
- Water By-law (2010 amended 2017) - Enables the City to control and regulate water services in the City. The By-law encourages water-saving, regulates water use and plumbing installations, and allows for water restrictions when necessary
- Stormwater Management By-law (2005) – Enables the regulation of stormwater management and activities that negatively affect the development, operation or maintenance of the City's stormwater system

The City's Water By-law plays a key role in creating an enabling environment for the CoCT to control and regulate water services and to encourage consumers to adopt sustainable water usage practices (CoCT 2010a). The By-law was amended in 2017 to further encourage sustainable water usage practices in the City. For example, in terms of WC/WDM the amended By-law requires that the maximum holding capacity of all new or upgraded toilet cisterns is reduced from 9 litres to 6 litres. Not only this, the amended By-law also requires that all swimming pools in the City be covered to reduce evaporation which limits the need to refill swimming pools (CoCT 2017f). The By-law also requires that all new developments in the City make provision for the installation of an alternative water system for non-domestic[16] purposes and that full details of the alternative water system must accompany building plans (CoCT 2017f). The previous By-law prevented customers from using any water sources other than water sources supplied from the municipal system for domestic use. The new By-law now allows the use of water from alternative water sources, provided that users have applied for and have received permission from the municipality to do so. These amendments to the CoCT's Water By-law demonstrates the City's progress in transitioning towards a WSUD approach. Furthermore, they highlight that water use practices of citizens play an imperative role in supporting these transitions.

[16] 'Domestic purposes' in relation to the supply of water means water supplied for drinking, ablution and culinary purposes. [excluding toilets and urinals]" (CoCT 2017f p.27)

Over and above these policies and By-laws, the CoCT has developed two important strategies/policies which are meant to play an integral role in creating an enabling environment for the principles of sustainability and the consideration of climate change impacts to be woven into the day-to-day functions of city officials. The CoCT's Climate Change Policy and the Environmental Strategy for the CoCT are overarching policies which are applied across all government departments in the City (CoCT 2017d; CoCT 2017e). The Climate Change Strategy provides a guiding framework for government departments to respond to climate change by addressing the social, economic, infrastructural and environmental risks of climate change in the work they do. The Environmental Strategy outlines the environmental principles within which government departments are to operate and perform. Not only this, but it also aims to communicate the City's stance to city officials regarding sustainable urban management.

The interviewees also placed emphasis on the fact, that as much as it is important to have policies and By-laws for creating an enabling environment for a sustainability transition, it is not enough for a city to just have a collection of various policies that are not coherent. The respondents warned against the danger of a city having a cluttered and confusing 'policy landscape'. This refers to a policy landscape where the policies are not coherent, are contradictory, do not feature common themes, and have an overlap of issues which ultimately cause confusion within the City. The danger of such a policy landscape is that it increases the chances of loopholes existing in the policy sphere, where city officials are suddenly 'at liberty' to pick and choose which policies to implement and which to ignore. The CoCT's Environmental Strategy (CoCT 2017e) has been used as a key tool to ensure that a coherent environmental policy landscape that is easily navigated by city officials is achieved in Cape Town. This strategy does this in the following ways:

1. Contextualising the City's Environmental Strategy and setting out where the strategy lies in Cape Town's policy landscape (Figure 25)
2. Clearly setting out the principles of the strategy
3. Providing a comprehensive list of the By-laws, policies, planning tools which are relevant to the City's Environmental Strategy
4. Describing the four strategic areas as well as four cross-cutting themes that form the basis of the implementation of the Strategy
5. Presenting a comprehensive implementation strategy which outlines the implementation tools (By-laws, policies, strategies and planning tools) for each strategic area which gives effect to the strategy, as well as stipulating the lead and supporting departments responsible for implementation.

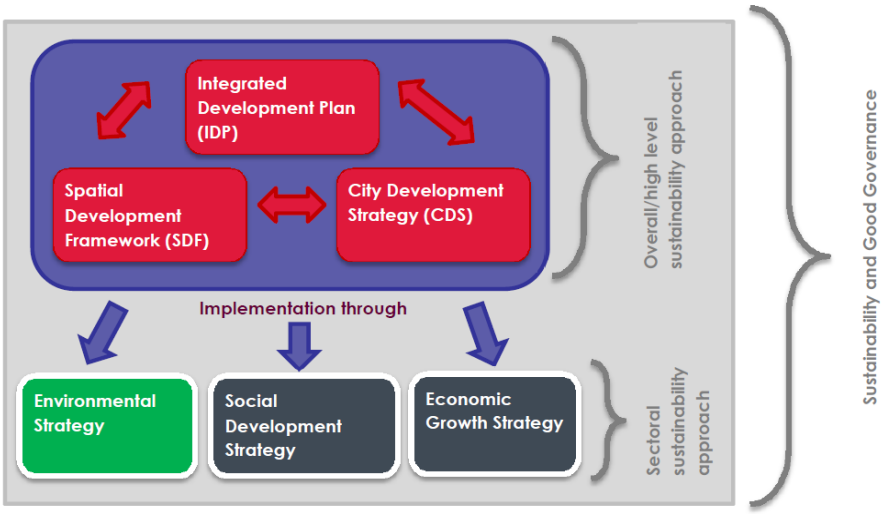

Figure 25: Contextualising the City's Environmental Strategy (Source: CoCT 2017e)

Despite the fact that the policies referred to have been presented as key implementation tools for achieving sustainable management of urban water resources, a respondent held an insightful view regarding the actual implementation of these policies. When asked about the importance of policies as implementation tools to aid a transition to WSUD, the respondent communicated that policies such as the Environmental Strategy for Cape Town and the Climate Change Policy for Cape Town have a more guiding and less prescriptive nature and aim to express the intention of the City. City officials are therefore not always necessarily obligated to perform their duties in line with the principles of these policies. This is captured by the response of another respondent: "*If there is no legal mandate for city officials, people only do as much as they are prepared to do".* Consequently, the directive that the principles of these policies are to be considered in the day-to-day responsibilities of city may not always be realised. The insights of the city official are further supported by the lenient language utilised to give directives to government departments in these policies. For instance the Environmental Strategy states that *"The identified principles aim to collectively enable the City to ultimately achieve its environmental sustainability vision and outcomes. Each principle is given effect through a corresponding directive that is intended to inform and guide ways of working across the organisation…*" (CoCT 2017e p. 13). Similarly the Climate Change Policy states: *"The policy will require the City to work differently and more collaboratively and is, therefore, designed to provide a framework to encourage and help departments to do this more effectively"* (CoCT 2017d p.8). Although this may be the case, other respondents argue that it is still important to have policies such as the Environmental Strategy and the Climate Change Policy as these help to articulate the intention of the city and may aid in allowing a more incremental change in the transition towards sustainable management of urban water resources.

While the implementation of the Environmental Strategy and Climate Change Strategy is mainly directed at city officials, the responsibility of implementation of the MUSIP and the FRCMP is shared between city officials and engineers and planners working on developments, as described in the results of the GCF (section 5.1.3). Research conducted by Madonsela (2016) on the implementation of the MUSIP showed that the implementation of the policy has proven to be a

challenge due to numerous factors. A lack of human resources inhibits city officials from going to the field once a development has been approved, to firstly ensure that the policy is being complied with in practice; and secondly to inspect the practicality of the 'as-built' design of the SuDS technology implemented. Not only this, but as with the Environmental Strategy and Climate Change Policy, there are no regulatory punitive measures which can be taken on non-compliance incidents.

This research demonstrates the important role that regulatory support plays in transitioning towards a WSUD approach in the CoCT. The guiding nature of the Environmental Strategy and Climate Change Policy illustrate that a policy framework which is not binding may continue to encourage path-dependencies in socio-technical systems. *"Without the legal basis for adjusting local environmental planning in terms of climate change, it is difficult to do so in the face of competing interests…"*(Pasquini *et al*. 2013 p.230). Furthermore these findings illustrate that, whilst policies and regulations create an enabling environment for sustainability transitions and are important implementation tools, it is just as important to have implementation capacity within the local authority itself. Lastly, this section of the research sheds light on the strides that the CoCT has made in terms of policy and legislation in the urban sustainability space.

5.3.4.4 Agents of change

The respondents of this research have placed emphasis on the role that agents of change play in facilitating and supporting sustainability transitions in the City. According to the respondents the City's mayoral office plays an important role in having an influence on what is perceived as being important on the City's agenda. The mayor of the City (as a position)[17] has therefore been identified by the research participants as an important agent of change in Cape Town's transition to SUWM approaches. It is therefore suggested that the interests of the City's mayor can easily set the tone for the visions and strategies of the city. In the CoCT, the mayor has been seen to have a vested interest in climate change resilience and adaptation. As a result the mayor has entered into various international agreements such as the C40 Cities Climate Leadership group (where the CoCT's instrumental climate change adaptation measure, the Water Conservation and Water Demand Management Programme, won the Adaptation Implementation category at the 2015 C40 cities awards in Paris) and the 100 Resilient Cities programme (100RC) pioneered by the Rockefeller Foundation. The C40 Cities Climate Leadership Group comprises 90 of the world's cities and focuses on tackling climate change and driving action that reduces the risks of the effects of climate change in these cities as well as ensuring that the socio-economic well-being of the city is improved. Similarly, the 100RC programme is dedicated to helping cities around the world become more resilient to the physical, social and economic challenges that they face. Cities in the 100RC network are thus provided with resources which are necessary to develop resilience pathways. This includes membership of a global network of member cities who can help and learn from each other, access to solutions and actors from private, public and NGO sectors that can help cities develop their

[17] This position is currently (August 2018) being contested in the CoCT, as the current mayor intends to vacate office on the 31st of October 2018.

resilience strategies as well as financial and logistical guidance for establishing an innovative new position in city government - a Chief Resilience Officer - who will lead the city's resilience efforts.

Respondents of this research highlighted that for a developing city such as Cape Town with limited financial resources to fully support sustainability transitions, the City's affiliation to the 100RC and C40 programmes presents an opportunity to secure financial resources in the form of funding to implement projects that address sustainability, climate change resilience and adaptation challenges in Cape Town. Not only this, but to also gain guidance on how to navigate the issues related to limited resources from countries with a similar context. For example, the C40 Cities Finance Facility provides access for cities to leverage private and public funding opportunities for green infrastructure, climate change mitigation and resilience projects. An example of such a project is the City of eThekwini's Sihlanzimvelo initiative which is supported by the C40 Cities Finance Facility. The project is focused on the clearing of alien vegetation and litter from the city's waterways, so that the ecosystem services provided by the waterways are analogous to the services provided by water-related built infrastructure. The project aims to help the city's infrastructure cope with the increase in storms and heavy rains caused by climate change. Equally important is the guidance provided by these programmes to facilitate climate change resilience efforts in Cape Town. In 2017 the CoCT's Mayor in partnership with 100RC appointed the CoCT's first Chief Resilience Officer. The Chief Resilience Officer will have access to various tools, expertise and other resources from the 100RC to assist in leading Cape Town's resilience efforts. The appointment of the Chief Resilience Officer occurred at a critical time when the City was facing a severe water crisis. This appointment Chief Resilience Officer can therefore be expected to have a positive impact on the resilience and adaptive capacity of Cape Town's water resources as well as their management.

In addition to the CoCT's affiliation to international programmes such as 100RC and C40, a local sector development agency, GreenCape, was recognised by respondents as an important agent for supporting the transition towards a WSUD approach in Cape Town. GreenCape is a non-profit organisation that was established in 2010 by the WCG. The agency functions as a special purpose vehicle to support the development of the green economy of the WC region, especially the adoption of economically viable green economy solutions, together with a variety of actors such as academia, businesses, investors and government. This involves the understanding and unlocking of the investment and employment potential of green technologies and services. Essentially the key is to support a transition towards a green economy by consulting with businesses in the region and removing barriers to their establishment in the green economy. This includes aspects such as helping potential investors understand the local market; providing policy and regulatory advocacy and support; as well as sharing expert knowledge through publications and information. GreenCape notes that business opportunities in the green economy may be constrained by factors such as legislation and policy, a lack of credible information, limited market awareness and demand, financial resources as well as skills. The organisation therefore aims to provide relevant information relating to the constantly shifting dynamics of specific sectors to potential and existing businesses operating in the green economy. The functions of the organisation are however not limited to assisting businesses; they are extended to assisting local, provincial and national government by

providing these government structures with support on the development of tools, policies and regulations as well as linking government to networks of key business and academic players within specific sectors in the green economy.

GreenCape performs these functions in a number of sectors such as waste, sustainable agriculture, renewable energy and water. One of the organisation's prominent instruments for facilitating a green economy in the water sector is an annual (publicly available) water economy Market Intelligence Report (MIR). The report provides a snapshot of the state of the water sector including various business opportunities for water in the green economy in the WC (Table 15). In addition to identifying gaps in the market, GreenCape runs projects which aim at understanding particular water related issues and thereafter attempts to produce practical products to address these challenges. For instance the overarching water challenges distinguished by the 2018 MIR are those of water scarcity currently (2018) facing the WC Province. The MIR therefore identifies water scarcity as a key driver for investment in the water sector in the WC region.

The MIR identifies that there are a number of opportunities for water efficiency and reuse of various types of water including greywater, sewage water or industrial effluent. Importantly, the MIR goes beyond just identifying business opportunities and also describes the opportunities, drivers and barriers related to each opportunity. For instance, the report points out that one of the main drivers for the implementation of water reuse systems in the industrial sector is the risk of insufficient water supply to operate businesses. Due to increasing water scarcity and water restrictions[18], businesses need to begin to consider reuse opportunities. However, although this may be the case, there are barriers to seizing business opportunities in water reuse. Firstly, some industrial companies are wary of the risk of negative public perception related to the reuse of effluent. Secondly, high capital costs prevent the adoption of WWT technologies in the industrial sector and this is worsened by the fact that financial incentives are fairly limited across the province. Thirdly, a lack of knowledge or awareness of water reuse technologies is common among smaller industrial companies, and acts as a barrier to adopting these technologies.

Table 15: Key opportunity areas outlined in GreenCape MIR
(Source: Adapted from GreenCape 2018)

<table>
<tr><th>Market</th><th colspan="2">Key opportunity areas</th></tr>
<tr><td>Industrial</td><td rowspan="3">• smart water metering
• water quality monitoring
• Ground water supply
• rainwater harvesting</td><td>• industrial effluent treatment
• upgrading treated effluent
• water exchange networks</td></tr>
<tr><td>Commercial</td><td rowspan="2">• Greywater reuse
• Water efficient devices</td></tr>
<tr><td>Residential</td></tr>
<tr><td>Municipal</td><td>• Non-revenue water
• Potable water reuse</td><td>• Groundwater
• Seawater desalination</td></tr>
</table>

[18] Current (June 2018) level 6B water restrictions in Cape Town require that all non-residential users reduce their consumption by 45% compared to 2015.

This research shows that special purpose vehicles such as GreenCape are crucial in assisting local government structures create an enabling environment for the transition towards the adoption of a WSUD approach. This section of the research further points to the fact that local government structures cannot facilitate transitions towards a WSUD approach on their own. The importance of GreenCape is based on the fact that the organisation views water in the green economy as a whole; in other words when liaising with governments and businesses it does not focus only on the technical aspect of water, but also plays close attention to social, economic and legal aspects. The organisation also provides useful information on issues such as how water plays a role in economic and social outcomes such as investment and growing the job market. The establishment of GreenCape by WC further illustrates the importance and the major role that the business sector plays in supporting a transition towards sustainable water management in the CoCT and the WC Province as a whole. For example, in accordance with Cape Town's Treated Effluent By-law, businesses can seize low risk opportunities in the green economy such as purchasing treated effluent from the City. The City has used an incentive-based method of selling treated effluent to these users at a price that is lower than that of potable water. This therefore creates an inter-reliant partnership between the City and industrial customers.

5.3.5 Crisis: A window of opportunity

Transitions literature points out that when landscape factors, over which cities have limited direct control, destabilise regimes, a window of opportunity for niche innovations emerge (Schot & Geels 2008). Therefore extreme events such as droughts have the potential to act as a catalyst for significant socio-technical transitions. In the case of Cape Town, the water crisis which destabilised the water industry in the City has played an important role in creating a window of opportunity and innovation for better management of water resources. Respondents of the research expressed that despite the severity of the current water crisis, it has provided an opportunity for the City to alter the way in which water is managed. This is evident in the accelerated manner in which the City now perceives the issue of water scarcity in relation to climate change and rapid urbanisation. Respondents also argued that the water crisis has drawn attention to the realisation that without adequate water supply, human and aquatic health is at risk, the City is at risk of protest, disease and at risk of the collapse of valuable water infrastructure. The water crisis has thus resulted in a shift in water governance in order to adequately address it. An example of this is the establishment of a water resilience task team which was appointed by the City to manage short to medium-term solutions that will ensure that acute water shortages are avoided. The task team involved a range of actors such as city officials, academics and experts from GreenCape. This shift in governance also resulted in the City making space for niche innovations to emerge as alternative ways to address water scarcity. The City sent out a Request For Information to the market in June 2017 for proposed solutions that would enable the temporary establishment of several small, intermediate and possibly even large desalination plants and other solutions to supply potable water. This shift in governance echoes the idea that water crises help to highlight water governance problems in cities and not only technical and resource related issues (Mguni 2015). The Cape Town water crisis thus

further highlights the importance of considering institutional and governance factors in transitions towards WSUD.

5.4 A complementary framework to the City Blueprint Approach

The analysis of the CBA provided a quick, insightful and context-specific understanding of the current water management and governance capacity of three water challenges in Cape Town. The results of the thematic analysis have further illustrated how advanced Cape Town is in its sustainable water management efforts. Together with this, the CBA was useful in comparing the governance capacity of the three water challenges in the city and in comparing Cape Town's status to other cities. Furthermore, the GCF results assisted in allowing the identification of the institutional factors which may be necessary to support a transition towards a WSUD approach in Cape Town. This baseline assessment therefore presents a useful starting point for discussions about these transitions and the strategic planning and implementation processes required to support them.

Owing to the fact that the CBA only provided some baseline information, as part of this study the IWA – Principles for Water-Wise Cities make for a useful complementary framework to the CBA. This is especially due to the fact that both the CBA and IWA principles have been formulated to enhance cities' transitions towards sustainable water management approaches, hence pointing to the same goal. The IWA principles for Water Wise cities is a framework which is intended to guide city officials in developing and implementing and water visions and strategies which support a transition towards water sensitivity in their cities (IWA 2016). Given these points the IWA Principles have been utilised to show the successes and areas of improvement in Cape Town's transition towards WSUD based on the baseline information provided by the CBA. The framework comprises 17 principles categorised into four levels of action (Table 16), to help city leaders ensure that: citizens have access to safe water and sanitation; cities are resilient to challenges of water scarcity and flood risk; and the principles of WSUD are incorporated into city planning. The Water-Wise principles are thus useful in helping Cape Town build on the City's current capacity to govern and manage water challenges.

The first level of action relates to local governments ensuring that all current water-related societal needs are met, whilst protecting the quality and quantity of water resources. This involves embedding the principles of level 1 into water and wastewater processes in the City. In Cape Town, most of the treated effluent which is released back into fresh water bodies is treated to acceptable quality standards (Cape Town Green Drop Status of 89.7%), with the exception of the three marine outfalls operated by the CoCT where largely untreated wastewater is released into the ocean. According to the CoCT the marine outfalls are designed to safely disperse wastewater deep underwater away from the shore (CoCT 2017a). Large volumes of sea water help to dilute the wastewater to concentrations that are almost undetectable and bacteria and pathogens from the wastewater die off while mixing with the sea water. However, long distance swimmers, kayakers and citizens groups from these marine outfall areas claim that the untreated effluent from the outfalls washes back to shore in specific weather conditions (Petrik *et al*. 2017).

Table 16: Successes and areas of improvement in Cape Town's transition towards WSUD

Levels of action and Principles	Progress areas	Areas for improvement
Level 1 – Regenerative water services for all 1.1 Replenish water bodies and their ecosystems 1.2 Reduce the amount of water and energy used 1.3 Reuse, recover, recycle 1.4 Use a systematic approach integrated with other services 1.5 Increase modularity of systems and ensure multiple options	• Cape Town Green Drop Status of 89.7% • City's water supply augmentation scheme • Cape Town's WC/WDM strategy • Reuse of treated effluent by commercial consumers	• Marine outfalls • Beneficiation plant to reduce energy used during water treatment processes (Integrating energy saving with water services) • Diversion of sewage slude from landfill (integrating solid waste management with water services)
Level 2 – Water Sensitive Urban Design (WSUD) 2.1Enable regenerative water services 2.2 Design urban spaces to reduce flood risk 2.3 Enhance livability with visible water 2.4 Modify and adapt urban materials to minimise environmental impact	• MUSIP and MSDF policy efforts to ensure incorporation of WSUD in urban development • Flagship developments showcasing how the principles of WSUD can be incorporated into urban design	• Maintenance of green infrastructure • Including green infrastructure in City's asset registers
Level 3 – Basin connected cities 3.1 Plan to secure water resources and mitigate drought 3.2 Protect the quality of water resources 3.3 Prepare for extreme events	• Basin-wide planning through the WCWSS Reconciliation Strategy	• Using the City as a water-supply catchment by using locally-based water resources e.g. stormwater and rainwater harvesting
Level 4 – Water-wise communities 4.1 Empower citizens 4.2 Professionals aware of water co-benefits 4.3 Transdisciplinary planning teams 4.4 Policy makers enabling water action 4.5 Leaders that engage and engender trust	• C40 and 100RC partnership – connectin the city with cities with these networks • Water and Sanition Department's annual customer satisfaction surveys • GreenCape facilitates relations between government and business actors to create water-wise communities • Interdisciplinary water resilience task team and Winter Readiness programme	• Interdisciplinary work between City Departments

Microbial tests of seawater and beach water conducted by Petrik *et al*. (2017) are consistent with these claims; i.e. that on occasion the water is indeed a health risk. This could have implications on the plans for desalination of seawater by the City, as it is possible that the toxic contaminants from the sewage being disposed into the sea could be present in the desalination plants' intake water which poses a potential health risk to the public (Petrik *et al*. 2017). It is therefore important that drinking water supplied from desalination plants is screened regularly for toxicity (Petrik *et al*. 2017). Although this may be the case, the City's desalination of seawater and other alternatives

considered for the augmentation of water supply as well as the selling of treated effluent to industrial users illustrates that the City is embedding the principles of *reuse, recover and recycling* as well as *increasing modularity* in water and wastewater processes.

The WC/WDM Strategy and the City's future beneficiation plant(s) also highlight that the City is making a concerted effort in embedding the principles of reducing the amount of water and energy used in water and WWT processes. Apart from the above-mentioned water management actions ensuring that water-related societal needs are met and that the quality of water bodies is being protected, these also have unintended benefits. For example, the selling of treated effluent is also a source of revenue for the CoCT, and therefore efforts to increase this customer base will put less pressure on potable water sources as well as increase the revenue stream for the City. Additionally, the proposed wastewater beneficiation plant will reduce the City's dependence on non-renewable power sources in WWT processes thus acting as a cost saving measure for the City, and the possible production of struvite may provide a new revenue source for the City (refer to section 5.1.2). Finally, the potential for energy recovery in WWT will result in the integration of the City's energy services into water management efforts - in a way similar to the use of sewage sludge for agricultural purposes in the City aiding the diversion of sewage sludge from landfill and thus integrating solid waste into water management.

The second level of action towards sustainable urban water management takes into account the incorporation of WSUD principles in urban planning. The CoCT's MUSIP and MSDF stand out as the City's main efforts to ensure that WSUD principles are incorporated into urban planning. Several developments in the City such as the Mitchells Plain Hospital, the Kraaifontein Integrated Waste Management Facility and Merriman Square have incorporated WSUD principles in their development. The design of these developments has incorporated flood alleviation and quality improvement infrastructure such as bio-swales, detention and retention ponds, bio-filtration basins and wetlands. In addition, the planning and design of the Merriman Square building has incorporated the principles of regenerative water services through rainwater harvesting and infiltration of water into the ground to put less pressure on the City's stormwater infrastructure. Furthermore, the design of the building also aims to enhance liveability through exposed green infrastructure and water that the public can enjoy as well as sustaining indigenous wetland plant species on an onsite wetland. Developments of this calibre can therefore be used as examples for future developments in the City in order to continue to support a transition towards WSUD approaches in urban planning and design. Although this may be the case, the City is nonetheless experiencing challenges with regards to alternative approaches to planning and design. For instance the maintenance of SuDS is a challenge in the City. This is firstly owing to the fact that there is no blueprint to managing this infrastructure, as each system requires a specific management regime. Secondly, there are often ownership issues once green infrastructure is installed. For instance, SuDS have not been included in the City's asset registers and may therefore be neglected resulting in the SuDS not being effective.

The third level of action considers proactive basin-level management as an important means to secure water resources, reduce flood risk and enhance the overall sustainability of the basin. The CoCT falls under the Berg-Olifants Water Management Area as discussed in the Contextual analysis. The Western Cape Water Supply System (WCWSS) allocates and supplies water to municipalities within the Berg-Olifants area, which is responsible for approximately 84% of the Province's GDP. In 2007 the WCWSS developed a WCWSS Reconciliation Strategy (2007) (DWAF 2007) which aims to secure future water requirements of the water supply from the WCWSS. The strategy *"details the strategic approaches to issues raised by water resource planners and includes an implementation plan to address strategic requirements. It addresses actions, programmes/ timing and responsibilities, as well as providing a decision-support tool"* (DWAF 2007 p.i). It therefore plays a key role in ensuring that future water resources are secure by providing interventions and approaches to addressing water scarcity issues for all water users of the WCWSS. The strategy also raises issues related to the impact of water quality on the water resources of the WCWSS and provides an approach to address this. Risk management is an inherent theme of the strategy and acknowledges that natural hazards such as seismic events, floods and droughts can impact the different components of the WCWSS, especially the economic, physical and environmental components. The risk management component of the strategy therefore aims to reduce the WCWSS's vulnerability to these hazards as well as increase the system's capacity to cope. The strategy recommends to municipalities that this can be achieved by having early warning systems, policies and strategies aimed at risk management as well as disaster risk management centres. The CoCT's participation in and subscription to this 'basin management' strategy ensures that the City secures sufficient water resources, which reduces the vulnerability of its socio-economic and environmental assets.

Lastly, the fourth level of action emphasises the importance of strong partnerships between various stakeholders within the City which play a key role in creating a water-wise community in the City and ultimately being responsible for building on the existing governance and management capacities of water. Most importantly, the IWA principles recognise this as the crucial level where the transition to achieve the other three levels of action starts. The CoCT's mayor's vested interest in climate change resilience and adaptation and her involvement in the C40 Cities Climate Leadership Group and the 100RC agreements allow Cape Town to form strong partnerships with other cities within these networks and create opportunities for inter-city learning. This illustrates how the actions of leaders have the potential to provide progressive vision and governance through engagement.

Cape Town has shown that the involvement and input from citizens is also valued in achieving sustainable water management in the City. The City's Water and Sanitation department conducts annual customer satisfaction surveys which aim to identify the specific issues of concern in water-related service delivery. The surveys gauge customer satisfaction level in the business, informal domestic and formal domestic sectors. In addition to this, citizens have access to a wide range of information regarding water governance and management in the City, which is made available on the City's website. Equally important is the role that GreenCape plays in providing relevant

information to business and other professionals who operate in the water sector about the various market factors and co-benefits associated with the sustainable management of urban water resources. Essentially GreenCape facilitates strong relations between the provincial and local government with actors in the business sector to create water-wise communities. Although this is the case, this research has also highlighted that despite interdisciplinary work across City departments being a key factor in facilitating transitions towards sustainable water management; this is still an important area of improvement for the City. The interdisciplinary resilience task team established to address issues of water scarcity in the City as well as the Winter Readiness Programme which addresses issues of flood risk in informal settlements serve as examples to how interdisciplinary planning and operation teams can be set up to address other water challenges in the City over the long run.

The IWA Principles and the CBA have both been useful in highlighting areas of good performance and areas of improvement in Cape Town's water management. The IWA principles have further provided insight into how Cape Town can improve in the successes and areas of improvement in Cape Town's transition towards WSUD based on the baseline information provided by the CBA (Table 16). The IWA principles for Water-Wise Cities Framework illustrates that the City of Cape Town has the potential to transition and fully adopt WSUD principles in water governance and management. This section has shown that the City has embedded the Water-Wise principles in its governance and management of urban water to a certain degree. However, this section also highlights that there are areas that the City experiences challenges in; areas where the City can improve and also efforts that the City can do more of to support a transition towards WSUD.

Chapter 6 – Conclusions and recommendations

6 Introduction

This chapter synthesises the findings and conclusions drawn from this research. Secondly, this chapter presents recommendations for the City of Cape Town's (CoCT) transition towards a Water Sensitive Urban Design (WSUD) approach, as well as recommendations for future research.

6.1 Research findings

The aim of this study was to understand the institutional contexts which are favourable to orienting towards a WSUD approach in the CoCT. To fulfil this aim the study sought to achieve the four research objectives listed below:

1. To understand how Cape Town's urban water cycle is managed
2. To understand the governance of water scarcity, flood risk and wastewater treatment (WWT) in Cape Town
3. To identify the fundamental institutional conditions within the CoCT that could support a transition towards a WSUD approach
4. To provide a snapshot of transitions towards WSUD in Cape Town

In order to achieve objective one and two, the City Blueprint Approach (CBA) was applied to the CoCT. The CBA is an indicator assessment tool comprising the Trends and Pressures Framework (TPF), the City Blueprint Framework (CBF) and the Governance Capacity Framework (GCF) (Koop & Van Leeuwen 2015a; Koop *et al*. 2017a). The results of the TPF illustrate the state of the environmental, social and economic climate of Cape Town over which the City has limited direct influence. The TPF highlighted the fact that water managers in Cape Town have to adequately and sustainably manage and govern water resources in the face of high levels of economic pressure, poverty and unemployment as well as urbanisation. In addition to this, the results of the TPF further indicated that flood risk and water scarcity are significant areas of concern for the Cape Town, and therefore water management efforts in the City need to take these water challenges into consideration. This is especially owing to the fact that the effects of water scarcity and flood risk have the potential to bear negative social, economic and environmental consequences for the City.

The TPF was an important component of this research as it revealed the broader macro-context in which the CoCT's water resources are governed and managed, and the macro factors which possibly impact WSUD transitions in the City. The CBF assessment then helped to provide a 2017 snapshot of the performance of Cape Town's water system to illustrate the areas of good performance and improvement Cape Town's water management. The results showed that Cape Town performs well in terms of water and sanitation service delivery which includes access to sanitation, drinking water, and access to WWT services. In addition, the City performs well on the

maintenance and management of water infrastructure. This assessment did however highlight that the City does not perform well in terms of nutrient and energy recovery from WWT processes, and is thus an area that the City needs to improve on. The 2017 snapshot view provided by the CBF aided in illustrating in what areas Cape Town can improve its current (2017/18) water management in order to orient towards sustainable water management approaches such as WSUD.

The GCF helped to assess the CoCT local government's governance capacity to address the challenges of flood risk, water scarcity and WWT in the City. The overall results of the GCF have illustrated that governance capacity to address water challenges such as flood risk, WWT and water scarcity has built over time in the CoCT. Despite this, the local government's governance capacity to address issues of flood risk and WWT is not faultless; although it is higher than that of addressing issues of water scarcity. Based on the analysis of interview data and secondary sources, this is mainly owing to the fact that the local government has had to manage flood risk and WWT for a much longer period of time, thus allowing governance capacity to evolve and improve. For instance the development of policies, By-laws and programmes to address issues relating to flood risk and WWT strengthen the local government's governance capacity to address these water challenges. This is in contrast to the acute challenge of water scarcity which has only recently (over the last three years) emerged.

The Multi-level perspective (MLP) emphasises that socio-technical transitions require alignments of processes at macro, meso and niche levels (Schot and Geels 2008). In summary, the analysis of the CBA has provided a quick, insightful and context-specific understanding of the current (2017/18) macro-level (TPF) and meso-level (CBF and GCF) factors that have an influence on WSUD transitions in Cape Town. This baseline assessment therefore presents a useful starting point for discussions about WSUD transitions in Cape Town and the strategic planning and implementation processes required to support them. The baseline information provided by the CBA was beneficial for this study as a thematic analysis was utilised to achieve objective three of this research: to understand the context specific institutional conditions within the CoCT which could support a transition towards a WSUD approach in the City. The following sections present the main findings drawn from the results of the thematic analysis.

Firstly, this research has, in accordance with section 2.1.2 of the literature review chapter, illustrated that the fact that the CoCT is characterised by both serviced formal and poorly serviced informal areas adds a layer of complexity to WSUD transitions in Cape Town (Armitage *et al.* 2014). A challenging aspect of transitioning towards a WSUD approach in Cape Town is thus ensuring that stringent financial resources are used to equitably deliver water and sanitation services to all whilst attempting to implement principles of WSUD. In the same vein, this research highlights that the necessity for service delivery in informal settlements may provide a window of opportunity for principles of WSUD to be incorporated in water and sanitation service delivery, thus allowing the City to simultaneously move i.e. 'leapfrog' through the different stages of the Urban Water Management Transitions Framework (UWMTF) (Brown *et al*. 2009*;* Armitage *et al*. 2014; Mguni 2015). All-in-all this research concludes that WSUD transitions in the CoCT require that both

informal and formal contexts are recognised when adopting such transitions. An important aspect of this is ensuring that services are delivered to marginal groups in order to ensure that transitions are equitable.

Relations between the public and private sectors and civil society play a key role in developing the social capacity to manage water resources and to support sustainability transitions (Pahl-wostl *et al*. 2007; Berkes 2009). An important component of this social capacity is collaboration, generating knowledge and experiences, and learning (Berkes 2009). This research also places emphasis on the important role that knowledge sharing and learning plays in transitions towards a WSUD approach in Cape Town. As mentioned, WSUD transitions need to recognise the different contexts of the City and thus have to be applied accordingly.

Context specific knowledge and learning is a key tool to ensure that selected WSUD technologies, designs and practices are well-suited for each context within the City. This research has however highlighted that a knowledge gap may exist between various stakeholders (politicians, city officials, practitioners, academia and civil society) in the City. The findings show that developing various knowledge sharing and learning platforms in the City may help bridge this knowledge gap. This is illustrated in this study through the role of cross-stakeholder learning initiatives (Climate Change Think Tank and Mistra Urban Futures) as well as formal and informal Communities of Practice (CoP) (WSUD CoP). These knowledge sharing initiatives can help to facilitate a better understanding of issues of climate change and sustainability at the city scale between stakeholders and can act as a vehicle to facilitate WSUD transitions in the City. Niche experiments are also said to inspire social learning processes as well as cross-sector networking (Smith & Raven 2012; Markard *et al*. 2012). Such experiments allow for niche innovations to gain enough momentum to be able to compete with established technologies (Smith & Raven 2012; Markard *et al*. 2012). The findings of this research provide evidence that collective involvement of a wide range of actors in demonstration projects is important in steering a transition towards a desired path in Cape Town. Moreover, government institutions also play a key role in creating platforms for niche innovations and technologies to be introduced into the market so as to stand a chance to gain credibility and be slowly embedded into the socio-technical regime. This is seen in the collaborative efforts in implementing policy (Management of Urban Stormwater Impacts Policy), the Open Innovation Platform, the Genius of Space Project (GoSP) as well as the Franschhoek Water Hub.

Along with knowledge sharing and learning transitions literature places significant emphasis on the idea that multiple visions for the future which collectively define an end goal are to be defined by key stakeholders in a specific sector (Loorbach 2007; Meadowcroft 2009; Rauschmayer *et al*. 2015). In accordance with this idea Brown *et al*. (2008) and Rijke *et al*. (2013) highlight that urban water managers still lack a clear vision for the attributes of a sustainable and resilient urban water system. This study highlights the importance of a vision of what the CoCT aims to achieve in terms of sustainable urban water management and to ensure that this is a shared vision amongst stakeholders (politicians, city officials, citizens and practitioners). This includes understanding the reasons why a transition is necessary; establishing how different stakeholders in the city are to

benefit from the transition; envisioning the circumstances and physical characteristics of a future water sensitive city, and framing the pathways and adjustments the city has to make to achieve a transition to a sustainable approach to urban water management. This research shows that decision-making, policy-making and implementation of sustainable water management approaches requires the collaboration and cooperation of various stakeholders in the City. When stakeholders do not share the same vision, such as in the implementation of the MUSIP, adoption of sustainable water management approaches can be met with resistance, lack of buy-in and lack of knowledge which hamper successful adoption of WSUD principles in the City.

Armitage *et al*. (2014) highlight the critical value of embedding WSUD principles at catchment scale by incorporating the principles into catchment management plans and stormwater master plans so that local water management planning is holistic and supports a transition towards WSUD at site-scale. This study correspondingly highlights the importance of planning tools at different scales to inform and support transitions towards WSUD in Cape Town. Legislative planning tools such as the Integrated Development Pan (IDP), Municipal Spatial Development Framework (MSDF) and Water Services Development Plan (WSDP) play an important role in informing sustainable water management approaches in Cape Town. These planning tools can be used to provide a coherent long, medium and short-term planning strategy to help support the adoption of WSUD principles.

In conjunction with planning tools, the findings of this study have highlighted the importance of local policy and By-laws to help create an enabling environment for WSUD transitions and to regulate sustainable water use practices in the City. The CoCT has developed By-laws, policies and strategies which to a certain degree provide an enabling legislative and regulatory environment for urban water resources to be managed in a sustainable way. Although this may be the case, the findings of this research point out that the capacity to successfully implement these policies and By-laws in the City is lacking. This is mainly due to a lack of human and financial resources, but another factor is the guiding nature of City policy documents, such as the Environmental Strategy and Climate Change Policy. This study highlights that a policy framework which is not binding may continue to encourage path-dependencies in socio-technical systems. Furthermore, this study shows that the 'silo-management' which exists in local government structures may also potentially encourage path-dependencies and hamper a transition to WSUD in Cape Town. The different aspects of the urban water cycle are addressed separately, which can hinder the integrated sustainable management of the urban water cycle, as described by Armitage *et al*. (2014).

In addition, the findings of this study have shown that adopting a sustainable approach to urban water management may still be perceived as a separate agenda in the CoCT, and not one that should be embedded in the City's water management paradigm. This has consequently lead to climate change adaptation measures as well as sustainability principles competing with service delivery and social issues such as water infrastructure maintenance, water and sanitation service delivery. This research therefore helps to reveal the importance of the City applying the principles of sustainability through approaches such as WSUD when implementing programmes approved by council. This is especially important in developing countries where there is a need for stringent

financial resources to be stretched to allow service delivery priorities to be met, especially in the face of growing population numbers and urban growth. Furthermore, the competing 'pressures' of the ongoing crisis for delivering basic services to informal areas of the City can be used by the City as a window of opportunity and to gradually implement technologies that promote WSUD principles.

The drought in Cape Town was crucial in highlighting the key role that crisis plays in prompting a transition towards SUWM approaches in cities. The Cape Town water crisis resulted in a shift in water governance in order to adequately address it, which created a window of opportunity for innovation and better management of water resources. Not only this, but the water crisis also created a window of opportunity for the City to employ an interdisciplinary and integrated approach to addressing the issue of water scarcity in the City. Moreover, the shift in governance that took place because of the water crisis, further advocates the value that governance and institutional factors add in facilitating and supporting transitions towards sustainable water management approaches such as WSUD.

Lastly, to achieve the fourth objective, the International Water Association's (IWA) Principles for Water-Wise Cities were applied to the results of the CBA and thematic analysis to get a snapshot of transitions towards WSUD in Cape Town. The IWA principles provide a framework which is intended to guide city officials to implement and develop water visions and strategies which support a transition towards water sensitive in their cities (IWA 2016). The application of the IWA principles to Cape Town therefore revealed areas of progress and improvement in sustainable water management practices in Cape Town.

Figure 26 (on the next page) provides a summary of the research process and findings of this research.

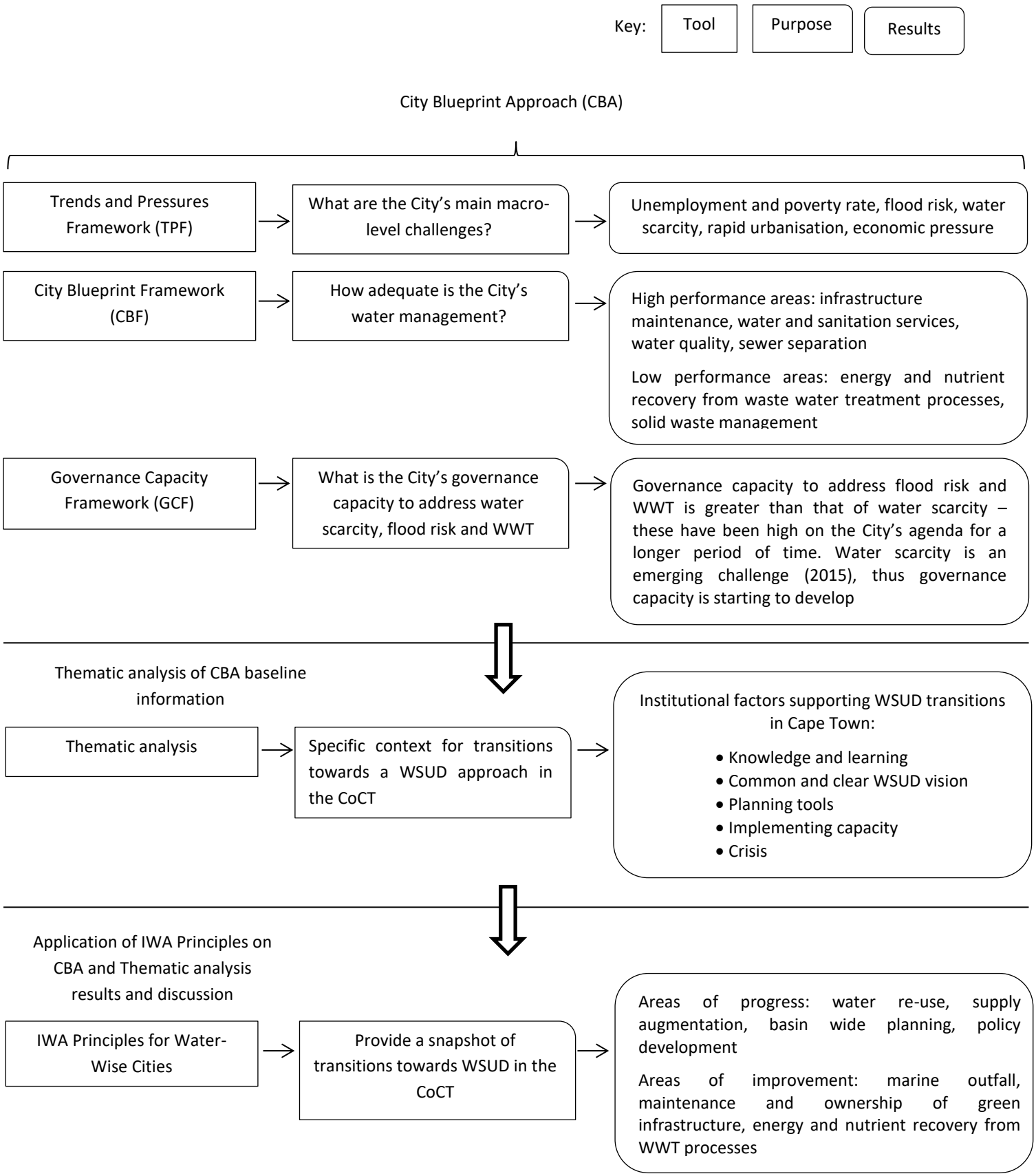

Figure 26: Research process and findings

On the whole this study has, to some degree, revealed the pervading implicit and explicit agreements between the three spheres of government, businesses and citizens about how water should be managed in the CoCT. This agreement has been referred to as the hydro-social contract of a city, which is based on the historically embedded social and cultural context of a city which shapes the urban water values. The hydro-social contract is therefore expressed through institutional arrangements, regulatory frameworks as well as physically through water system infrastructure (Brown *et al*. 2008). These institutional arrangements and regulatory frameworks are the main tools which influence decision-making at a range of scales (policy-making to day-to-day management) as well as structure the governance of urban water (Dobbie *et al*. 2017). Therefore, SUWM literature notes that transitions towards SUWM approaches in cities require an overhaul of the hydro-social contract (Wong & Brown 2009). The findings of this research have thus presented a snapshot (2017/18) of Cape Town's hydro-social contract and also provided an understanding of the institutional factors which have the potential to help orient towards a WSUD approach in the CoCT. Equally important, the findings of this study have also highlighted the factors that encourage path-dependencies and make it difficult for the CoCT to transition towards a WSUD approach.

6.2 Recommendations

Based on the findings and conclusions drawn from this research, the recommendations for supporting WSUD transitions in the CoCT are provided below:

1. Given that WSUD is recognised as a specific objective in the MSDF, which aims to guide spatial planning and development in the City, it is recommended that the CoCT engages a wide range of actors in WSUD visioning and implementation exercises. This should be done with the aim of defining a shared vision of what a water-sensitive Cape Town would look like as well as to map context specific, strategic pathways characterised by short and medium-term goals that will support the achievement of a long-term WSUD goal.
2. Secondly, it is suggested that the challenge of servicing informal areas should be used as a window of opportunity to apply WSUD principles in these areas and unleash Cape Town's leapfrogging potential for transitioning to a water sensitive city - similar to the way in which the 2015 -2018 water crisis created an opportunity for a shift in the management of water scarcity in the City.
3. Lastly, it is recommended that all aspects of Cape Town's water cycle are managed in an integrated manner. This can be achieved by promoting collaboration between local government departments to address the complex challenges of urban water management in Cape Town.

Recommendations for future research are as follows:

1. This research has identified and described institutional factors that support or hinder transitions towards WSUD in Cape Town. It will be valuable for future research to focus specifically on one or two of these factors in order to provide a deeper understanding of each.

2. The research acknowledges that private consultants play a role in supporting transitions towards WSUD in Cape Town. However, no consultants were interviewed during the primary data collection process, which limited[19] the understanding of how these actors influence transitions in Cape Town. It will be valuable for this dimension to be considered and included in future research conducted on WSUD transitions in developing contexts.

[19] After identifying this limitation, an interview/conversation was conducted with a consultant. Owing to time constraints the data was not included in the dissertation. The content of this interview is presented in appendix H, for future research purposes.

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Appendix A: Governance Capacity Framework scores, justifications and sources for Cape Town:

A1: Governance Capacity Framework scores, justifications and sources for water scarcity

Conditions	Indicators	Water scarcity scores	Score justifications
1. Awareness	1.1 Community knowledge	**0**	• All interviewed respondents agree that community knowledge and awareness on the issue of water scarcity has been significantly low before Cape Town experienced a water crisis in 2015 - 2017. According to the respondents, most South Africans have been aware of the fact that South Africa is a water stressed country, but that has been taken for granted because people have always had water flowing out of their taps. • The 2017 drought experienced in Cape Town has resulted in the increase in community knowledge and awareness regarding water scarcity (Source 2). Respondent 1 who is a previous employee of the City of Cape Town confirms that before the 2017 drought, awareness regarding water scarcity was not high on the agenda, even amongst city officials. Respondent 1 is also a part of environmental lobby groups and a home owner's association, which she says did not have water scarcity on their agenda either until the 2017 drought. • There has also been increased dispersion of information regarding water scarcity on various platforms, such as posters in public spaces, social media platforms as well as the City's website. Twitter: https://twitter.com/CityofCT Facebook: https://www.facebook.com/CityofCT/ • Although the drought has increased basic community knowledge about the drought, at the time of data collection the risks, long-term impacts were not fully known.
	1.2 Local sense of urgency	**+**	• The interviewed respondents express that the local sense of urgency on the issues of water scarcity has also only increased in recent times, in the face of the drought. • There has been an increasing sense of urgency to educate the public on the issue of water scarcity and on water saving measures. • The City has also formed Ad Hoc committees such as the, water resilience task team (Source 1). • The issue of water scarcity has also been receiving much media attention. This has also resulted in an increased sense of urgency in addressing the water challenge and developing realistic action plans. The City of Cape Town Water Outlook report presents the various augmentation plans being undertaken by the City. https://resource.capetown.gov.za/documentcentre/Documents/City%20research%20reports%20and%20review/Water%20Outlook%202018%20-%20Summary.pdf
	1.3 Behavioural	**0**	• The growing knowledge and awareness on issues of water scarcity has prompted a change in behaviour patterns

	internalisation		around water. • The interviewed respondents mention that they have witnessed behavioural change both from individual persons and businesses. Although this may be the case, a few respondents share the sentiments that behaviour change, particularly for individual persons, takes a long time to achieve. Therefore the City of Cape Town runs a risk of its citizens defaulting to original behaviours in the event that the drought is overcome. For this reason, Cape Town is certainly in the exploration phase with regards to behavioural internalisation. • The Average daily consumption in the City prior to the water crisis fluctuated between 800 and 1000 Ml per day, compared to an average of 600 Ml per day during the crisis. • Despite strict water restrictions, the City of Cape Town is still reporting that water consumption is higher than it should be. This meaning that, behavioural change is limited; some citizens are actively changing their behaviour while others are not (Source 12). (See City of Cape Town reports on their Facebook page). • At the time of assessment, the City were encouraging citizens to limit their water use to 87 litres of water per person per day, equating to a total usage across the city of 500 Mega litres per day, so as to ensure that the water in the dams lasts till the next rainy season. Consumption levels however were averaging 600 Mega litres per day.
2. Useful knowledge	2.1 Information availability	**+**	• Given the realisation of the intensity of the 2017 drought, strong effort has been put into providing integrated information, from various fragmented source. • The public's knowledge has also been taken into consideration; the city sent out a Request For Information (RFI) to the public in 2017 (see Source 1). This information from the public along with various other sources of information was used to inform decision making on short, medium and long-term augmentation schemes for the City of Cape Town. • There is also much academic research which is available online that has been undertaken on water scarcity in Cape Town. Academic research is an important source of information as it often reveals information gaps which could be useful to decision makers. However, Respondent 7 who is a city official expressed that many of his colleagues do not read academic papers. (The science policy interaction needs to be improved)
	2.2 Information transparency	**0**	• Information on water scarcity is easily accessible on open source information platforms. Information is mostly accessible through the City's website in various forms. In addition to this, information is also made available on social media platforms so as to reach a wider audience. • The City's website has special features such the Water Dashboard which provides comprehensive (weekly/daily) information on the status of the City's water resource as well as information on water restriction levels. • The information is generally presented in a manner which is easily understandable by non-experts. Over and above this, there is information which is tailored specifically for non-experts in the form of brochures and summary reports. Information is also available in different languages (Source 3 -5) • Although information is available, information seems to be focused mainly on educating the public on water saving tips and vaguely telling the public what they city will be doing to address the issue. At the time of data collection there was very limited information on water scarcity itself: the causes and uncertainties.

	2.3 Knowledge cohesion	**0**	• Knowledge on water scarcity is still fragmented. As mentioned by Respondent 1, water scarcity was not very high on the agenda until the 2017 drought. • Tertiary institutions have continuously been producing knowledge on water scarcity which is shared with City. Knowledge sharing has happened through projects such as Mistra Urban Futures programme in Cape Town and FRACTAL. https://www.mistraurbanfutures.org/en/content/cape-town http://www.fractal.org.za/ • The respondents have acknowledged the importance of sectors cooperating in a multi-disciplinary way to address the challenge of water scarcity. This includes the inclusion of multiple actors and multiple methods used to support information. • Knowledge on water scarcity is however still fragmented. The 2017 drought will act as a force to bring disciplines together and encourage multi-disciplinary operation. Hopefully this should result in the production of cohesive knowledge regarding water scarcity. • Overall the water scarcity challenge is yet to be fully understood by the City. Short-term and long-term goals to address the water challenge have only recently been decided on and communicated to the public, in a non-specific manner (July/Aug 2017).
3. Continuous Learning	3.1Smart monitoring	**+**	• Annual Water and Sanitation Development Plan (WSDP) reports produced by the city require a substantial amount of monitoring to be executed (Source 6 and 7). • Underlying trends and processes are revealed in these reports and allow the city to be able to examine certain aspects as well as alter certain processes where necessary. • The water balance table presented in the WSDP provides comprehensive reporting on how water is being used in the city. The percentage of non-revenue water presented as a part of the water budget should be used to enhance maintenance regimes (fixing leaks) of the pipe network. • The continuous monitoring of dam levels over the years was however not used by the city to learn. The continuous decrease in dam levels over the years could have provided predictive value for what the situation may look like in 2017. Water restrictions could have been implemented at an earlier stage to prevent severe stress on the water resource.
	3.2 Evaluation	**-**	• Respondent 1 expresses that reporting in government is a very onerous process which is quite meaningless. Reporting focuses more on compliance rather than on evaluation. Respondent 1 stated that “it is really out of evaluation that you get learning.” • Evaluation of policy in the city is not systematic (Respondent 1; Respondent 8). Evaluation is limited regarding both frequency and quality and in most cases it takes place on an ad-hoc basis. • However, there is national legislation that requires the evaluation of processes and progress of certain aspects related to the management of water demand and conservation. E.g. Annual Water Services Development Plan (WSDP) which is a legal requirement of the Water Services Act. The WSDP is to be maintained every five years and updated annually.

			• Following the Cape Town water crisis the City's Water By-law has been evaluated and amended to ensure and encourage more sustainable water use practices in the City. Thus representing an ad-hoc evaluation process.
	3.3 Cross-stakeholder learning	+	• All interviewed respondents recognise that stakeholder interaction is valuable and useful for improving policy and implementation. • Various initiatives/projects for stakeholder learning such as the Climate Change Think Tank and Mistra Urban Futures have been set up to facilitate learning between city and academics. However such initiatives tend to come to an end due to a lack of funding and continuous commitment from stakeholders. • There is also effort to increase stakeholder interaction in ways which are not structured and registered. This stakeholder learning occurs between various parties i.e. across government departments, between government and academia as well as between government and consultants (Respondent 7, Respondent 1 and Respondent 8). • The Think Water exhibition held by the city and the Request For Information are also platforms which have created an opportunity for stakeholder learning. These also illustrate that the city does value cross-stakeholder learning (Source 8).
4. Stakeholder Engagement Process	4.1 Stakeholder inclusiveness	-	• Opportunities for stakeholder inclusiveness processes such as public participation processes are made clear by the city. The public is made aware through various platforms of opportunities for public participation. • Stakeholders who are involved do not have the mandate to make any formal arrangements or to make decisions. Decision makers are thus faced with the task of ensuring that the values of the consulted stakeholders are taken into consideration when making decisions. Not all the views of the participating stakeholders may be taken into account when making decisions. This is due to the fact that representation may not always mirror the demographic of the city. This means that minority groups may not be represented, but in the end decisions which are taken have to be beneficial for all citizens of the city (Respondent 1; Respondent 7). • Stakeholder engagement is abundantly done for overlapping issues. A public participation process was followed during the development of the City's Integrated Development Plan[20] (IDP). A total of 2780 members of the public attended the various public meetings, including meeting with the city's strategic partners. 6500 'Have your say' forms were received as the end of 2011. Source 16 indicates a schedule for the approval of the 2013/14 IDP which includes scheduled public consultation and participation. See Source 17. • In some cases, too many stakeholders who hold different values are involved. • Stakeholders are also allowed to speak on behalf of a group i.e. ward councillors and representatives of community groups are allowed to represent groups of people in public participation processes (Respondent 7). • The Water and Sanitation Department also conducts annual customer satisfaction surveys which aim to identify the specific issues of concern in water-related service delivery. The surveys gauge customer satisfaction level in

[20] "The IDP is a strategic tool that guides all the activities of local government in consultation with residents and stakeholders. Its focus is on development in the broader sense and it is a structured plan that informs budget priorities, decision making and the allocation of resources." (IDP 2017-2022 p.2)

			the business, informal domestic and formal domestic sectors
	4.2 Protection of core values	**0**	• Stakeholders are often consulted because it is believed that they will add value to a decision making process. Therefore participation opportunities are made clear to stakeholders and exit possibilities are also made clear. (Respondent 7; Respondent 1; Respondent 8). • Although stakeholders are consulted, their influence on end results is limited and decisions comply with the interests of the initiating party primarily.
	4.3 Progress and variety of options	**+**	• Due to the fact that stakeholder interaction is valued by the city officials and decision makers, there is sufficient room for consulted stakeholders to elaborate alternatives. However, even if this is the case, these stakeholders do not have an influence on the end-result. • The recent Request For Information (RFI) from the city to the citizens has illustrated that a variety of alternatives can be considered and selected from stakeholder processes. The RFI process was also a clear process where procedures, deadlines and agreements were clear. • Other opportunities include the Open Innovation Platform run by the CoCT's New Technology Committee. The Platform allows businesses, innovators and residents to submit innovative ideas that can improve the city's various services such as water supply, sanitation, energy and housing. Western Cape Government and City of Cape Town Branches and Departments are at liberty to implement successful ideas within approved procurement processes of the City, such as advertising a tender process.
5. Management ambition	5.1 Ambitious and realistic management	**0**	• The Environmental Strategy for the City of Cape Town clearly states and sets out that there is a long-term, integrated and sustainability oriented vision for addressing environmental challenges such as water scarcity in Cape Town (Source 9). • Although this may be the case, the vision for water scarcity has been confined in the City of Cape Town. Before the drought, management ambitions have been focused largely on service delivery i.e. increasing number of taps in informal settlements etc. (Source 6 and 7). Unchanging situations were assumed and therefore planning for severe drought conditions was limited (Respondent 2). • Management ambitions in the face of the drought have been focused on improving the current drought situation. The city has always had long-term ambitious goals in place to address water scarcity issues (Respondent 9 and Respondent 7). These goals were certainly not intended to be implemented in a short time span of six to eighteen months. • The long-term ambitious goals to augment the water supply by implementing desalination plants, using groundwater sources as well as treated wastewater for potable use have been in place for ± 6 years (Source 10). These long-term goals were however not supported by intermittent targets. • Interviewed respondents state that action to implement these plans is only being taken now (2017) due to the drought crisis Cape Town is experiencing. • It is anticipated that planning from here on out will incorporate a degree of uncertainty into strategies and long-term plans by adopting a scenario called the new normal (Source 11) https://www.dailymaverick.co.za/article/2017-10-04-op-ed-the-city-of-cape-towns-critical-water-shortages-

			disaster-plan/#.WdzgzGiCy01
	5.2 Discourse embedding	-	• The issue of water scarcity in Cape Town is increasingly identified, framed and interwoven into local discourse. This is seen in guiding documents such as the Environmental Strategy and the IDP (Source 9 and Source 13). • The interviewed respondents agree that adaptation is required, but substantial effort is necessary as there is little experience addressing the water scarcity challenge in a long term integrated approach. • The city has always identified as a water scarce city, but the city has never had to deal with a drought this severe (Respondent 2). There has been a disregard of uncertainty regarding water scarcity, which in-turn has resulted in very little sense of urgency to adopt adequate adaptation measures and a low sense of urgency embedded in policy. • Discourse embedding is a long-term processes – hence the score of (-) which represents poor embedding of water scarcity in the city's historical, cultural, normative and political context.
	5.3 Management cohesion	+	• Policy to address water management is coherent. • The Principles of the Environmental Strategy for the City of Cape Town are underpinned by those of the National Environmental Management Act (NEMA). The Principles of NEMA apply throughout South Africa across all organs of state which many significantly affect the environment. • The City's Environmental Strategy for the City of Cape Town is an overarching policy which aims to address the City's environmental challenges. The policy provides a strategy which is appropriate for the governance, long-term planning and the optimisation of the city's resources. The strategy sets out principles within which the City wishes to perform and operate. The strategy also sets out a framework for the regulations and mechanisms which are required to achieve the city's desired outcomes related to long-term environmental management. The environmental strategy applies to all directorates and departments within the CoCT. Therefore the principles of the policies, strategies and plans which are developed within directorates have to be underpinned by those of the Environmental Strategy. Environmental governance is therefore approached thematically rather than in a sectoral manner (Source 9). • The tools set out by the Environmental strategy to address issues of water management in Cape Town, including water scarcity are underpinned by the same principles which all only apply to the geographic and administrative boundaries of the City of Cape Town.
6. Agents of change	6.1 Entrepreneurial agents	**0**	• There is a growing need to understand the uncertainties of water scarcity. There is also a need for innovative approaches which entail a certain level of risk. • Opportunities for innovative approaches and synergies were hardly pursued before the 2017 drought, simply because there was no need. Entrepreneurship was conventional and risk-averse. • The 2017 drought has definitely opened a window for opportunity for entrepreneurial agents to seek and seize opportunities (Respondent 6). For instance, certain car washing businesses are now using grey water to wash cars. • The city had however, before the drought, created opportunities for businesses to re-use treated effluent for certain business practices instead of using potable water. This was done to decrease consumption of potable water to preserve the resource (Respondent 6).

			http://ewn.co.za/2017/05/17/level-4-water-restrictions-could-lead-to-job-losses-in-car-wash-industry
	6.2 Collaborative agents	**++**	• GreenCape is a non-profit organisation which was established by the Western Cape government in 2010 as a special purpose vehicle to support the development of the green economy in the region. GreenCape tries to work with the government in helping the government create an enabling environment for businesses to operate within the green economy (Respondent 3). • GreenCape releases an annual water economy Market Intelligence Report which highlights business opportunities for water in the green economy in the Western Cape. In addition to identify gaps in the market GreenCape runs projects which aim at understanding particular issues and thereafter attempt to produce practical products to address barriers. • See Source 15 and 14 (MIR 2017 + 2016) • GreenCape's sustainability as an agent of change is maintained by partial funding from the Western Cape government as well as considerable private funding. • The mayor of the City (as a position) acts as an important agent of change. In the City of Cape Town, the mayor has been seen to have a vested interest in climate change resilience and adaptation. As a result the mayor has entered into various international agreements such as the C40 Cities Climate Leadership group (where the CoCT's instrumental climate change adaptation measure, the Water Conservation and Water Demand Management Programme, won the Adaptation Implementation category at the 2015 C40 cities awards in Paris) and the 100 Resilient Cities programme (100RC) pioneered by the Rockefeller Foundation.
	6.3 Visionary agents	**0**	• The Environmental Strategy for the City of Cape Town clearly states and sets out that there is a long-term, integrated and sustainability oriented vision for addressing environmental challenges such as water scarcity in Cape Town (Source 9) • The visions of actors regarding water scarcity have been limited to promoting business as usual. • Before the 2017 drought, only 5% of treated effluent produced by the city was being re-used by businesses (Source 16 p.43). According to Respondent 6, the city had been promoting the re-use of treated effluent and even distributing posters to industries who qualify to use treated effluent. It was however not compulsory for businesses not to use potable water where they could avoid using it. By doing this, the city's wastewater branch has been trying to push forward the city's integrated and sustainable vision. • The current water restrictions are now forcing businesses to use recycled water. Respondent 6 expressed that city officials are hoping that the use of recycled water for businesses will become the new 'business as usual'. • Visionary agents such as GreenCape are also promoting the city's vision of addressing challenges such as water scarcity in an integrated and sustainable way.
7. Multi-level Network Potential	7.1 Room to manoeuvre	**+**	• The interviewed respondents acknowledge that a high degree of freedom is necessary to deal with complex water challenges such as water scarcity in the form of experiments and seeking unconventional approaches. Despite this acknowledgement, there are factors which limit flexibility and high degrees of freedom to deal with such complex challenges. The two main factors said to limit flexibility are money as well as the specified mandates which government officials are to follow. Although this may be the case, respondent 1 states that the drought has

			helped to bridge slightly better bridges across different mandates. It is being used to increase flexibility for new cooperative partnerships. • Flexibility is perceived to be possible when initiated by the mayor. This is due to the fact that the mayor has more financial flexibility as well as flexibility in terms of mandates to form ad hoc committees to adequately address water scarcity (Respondent 1). • i.e. A Water Resilience Task Team (WRTT) has been put together by the mayor's office (in 2017) to act as a special ad-hoc team which would adequately address the drought in the city. This is through exploring various alternatives and approaches.
	7.2 Clear division of responsibilities	**0**	• There is a clear mandate and legislation which sets out what local government can and cannot do. The different directorates and departments also have specific mandates which they have to follow. Many of the city officials are well versed in knowing what legislation stipulates and what they are mandated to do. officials often abide strictly to the set of conventional mandates in which their responsibilities are divided (Respondent 8) • The grey areas with regards to a clear division of responsibilities occurs when the work of city officials requires them to work within new integrated concepts and principles such as climate adaptation, WSUD, IWRM, sustainability etc… This calls for officials to think outside of the box and to work in an integrated fashion instead of working in silos (Respondent 8). • City officials increasingly understand the theory behind these sustainability principles, but some officials are still hamstrung by playing by the rules. There is chance for collaboration, and such chances are seized as and when possible. This mainly due to the fact that there is recognition among actors that knowledge is scattered within the local network and does not lie in individual silos.
	7.3 Authority	**+**	• There is recognition of the need for long-term and integrated strategies to address water scarcity in Cape Town. • In 2017 a Chief Resilience Officer was appointed in the mayor's office as a legitimate form of authority who would ensure that long-term, integrated and sustainable solutions for climate change and disaster resilience are implemented. • The mayoral office also plays an integral role in what is perceived as important in the city (Respondent 1). The current executive mayor of the city, Patricia de Lille is therefore also a legitimate form of power. As the head of the city her interests can easily set the tone for the city's vision and strategies. • They mayor has a vested interest in climate change adaptation and resilience. The mayor has entered into agreements such as the C40 Cities Climate Leadership Group and the 100 Resilient Cities programme which are two high profile global climate change initiatives. The mayor's involvement has changed what she sees as being important. There is therefore more anticipation for long-term integrated strategies for climate change adaptation to be seen through while the mayor is in office. https://www.iol.co.za/capeargus/news/de-lille-appoints-cape-towns-first-chief-resilience-officer-9256106 https://voices.nationalgeographic.org/2016/03/15/patricia-de-lille/ • The CoCT's instrumental climate change adaptation measure, the Water Conservation and Water Demand Management Programme, won the Adaptation Implementation category at the 2015 C40 cities awards in Paris)

			and the 100 Resilient Cities programme (100RC) pioneered by the Rockefeller Foundation.
8. Financial viability	8.1 Affordability	**0**	• Poor communities have much difficulty affording climate change adaptation measures. • Although this may be the case, there are communities who have not had abundant or easy access to water, who have intuitively devised measures to adapt over the years as they have been exposed – this is due formal infrastructure constraints, especially in informal areas.
	8.2 Consumer willingness to pay	**+**	• Due to increasing worries about water scarcity in Cape Town, there are windows of opportunity for the city to increase rates. Rates for 2017/18 have already been set and cannot be changed; therefore the public will not be facing any extra costs till the end of the financial year (Source 1). • There is a willingness to pay for measures to address water scarcity. This is especially because of severity of the drought.
	8.3 Financial continuation	**0**	• There is continuous financial support for addressing water management challenges. • Each financial year funds are allocated to the department of water and sanitation and its respective branches. The funds which are allocated are not additional funds; the funds are included into the baseline funding which the department of water and sanitation receive every financial year. • More of the budget will have to be allocated towards addressing water scarcity.
9. Implementing capacity	9.1 Policy instruments	**0**	• The water By-law (in the process of being revised) is used as a tool to discourage undesired behaviour and to encourage desired behaviour. The water By-law sets out provisions relating to various aspects of water in the city. The provisions clearly set out what is permitted and what is not permitted. • Encouraged behaviour includes: compliance with water conservation and demand management practices; adequate management of onsite alternative water sources (e.g. storage tanks) and prevention of water pollution • Discouraged behaviour includes: unauthorised use of water; interference with water supply system and wastage of water • Any person who does not comply with the provisions set out by the By-law is liable to a fine and/or a prison sentence of a term not exceeding five years (Source 18). Despite this being the case, limited human resources make policing of By-laws challenging.
	9.2 Statutory compliance	**0**	• Legislation is clear. • Since the drought, there has been much fear of some members of the public not complying with legislation such as the By-law which aims to protect the pipe networks as well the health of water users. This is because members of the public are seeking to tap into alternative water sources without receiving permission from the city. (At the time of data collection the City was developing guidelines for alternative water supply systems)
	9.3 Preparedness	**0**	• Respondents express that the risk of the severity of the drought being experienced in Cape Town in 2017 was underestimated. For this reason, the level of preparedness to address water scarcity at this degree was low. • However, the Municipal Disaster Risk Management Plan for Cape Town and the water By-law set out plans and actions which are required to be followed in cases of such disasters. There is a level of preparedness in terms of the administrative actions which need to be taken to address water scarcity E.g. water restrictions.

Source number	Source description
1	Advancing water resilience: getting to an additional 500 million litres of new water a day (Statement by the City's Executive Mayor, Patricia De Lille)
2	Drought crisis: winter water-saving awareness efforts ramped up (Published by City of Cape Town, Media Office)
3	Top ways to save water indoors pamphlet (Source: City of Cape Town)
4	Saving water in your business or organisation (Source: City of Cape Town)
5	Saving water in your business or organisation (Source: City of Cape Town) – Afrikaans version
6	Water and Sanitation Department: Annual Water Services Development Plan Performance and Water Services Audit Report (2013/14)
7	Water and Sanitation Department: Annual Water Services Development Plan Performance and Water Services Audit Report (2016)
8	City's Think Water Exhibition brings water-saving solutions closer to the people (Published by City of Cape Town, Media Office)
9	Environmental Strategy For The City of Cape Town (Policy Number 46612)
10	Climate change adaptation in a developing country context: The case of urban water supply in Cape Town (Ziervogel *et al.,* 2011)
11	The City of Cape Town's Critical Water Shortages Disaster Plan (Article published by the Daily Maverick)
12	Drought crisis warning: don't use more water just because it's raining (Published by City of Cape Town, Media Office)
13	City of Cape Town: Five-year Integrated Development Plan (IDP) – July 2017 – June 2022
14	GreenCape Market Intelligence Report (2016)
15	GreenCape Market Intelligence Report (2017)
16	Water Services and the Cape Town urban water cycle (Document source: City of Cape Town)
17	Mayor De Lille meets with informal settlements as part of City's IDP engagement (Published by City of Cape Town, Media Office)
18	City of Cape Town Water By-law (2010)

A2: Governance Capacity Framework scores, justifications and sources for flood risk

Conditions	Indicators	Flood Risk Scores	Notes
1. Awareness	1.1 Community knowledge	++	• Community knowledge and awareness on flood risk has been significantly high in Cape Town. This is due to the fact that flood risk has been troubling communities in the city for years. Flooding has mainly been affecting built-in marginal areas, typically informal settlements or places which were not intended for habitation such as the Cape Flats[21] (Respondent 1). • Nearly all members are aware of the risks, impacts and uncertainties regarding flood risk. • There has also been sufficient media coverage of flood events in Cape Town over the years, which has increased awareness (Respondent 1) http://ewn.co.za/2013/08/17/Cape-rains-cause-worst-flooding-ever http://www.news24.com/SouthAfrica/News/Over-8-000-people-affected-by-Cape-Town-floods-20140615 https://www.iol.co.za/news/south-africa/western-cape/cape-town-storm-floods-150-homes-2013421 • Some local communities are familiar with adaptation measures and have recently been involved in programmes which address flooding such as the 'winter readiness plan' (Source 1 and Source 2: A statement by the City's executive mayor, Patricia de Lille). The 'winter readiness plan' aims to help Informal settlement dwellers with flood mitigation and adaptation measures. • Winter preparedness programme: Raising awareness, increasing involvement in implementation.
	1.2 Local sense of urgency	+	• There is a general sense of importance regarding flood risk in Cape Town. This is because flooding in Cape Town occurs during winter months; this results in the degree of misery experienced being much higher as compared to areas which experience summer flooding. In addition to this, winter flooding is mainly experienced by marginalised. The effect of flooding on these communities puts flooding high on the political agenda and increases the sense of urgency in mitigating and responding to flooding (Respondent 1). • There is continuous maintenance of stormwater and sewage pipes which is performed to reduce the risk of flooding (Source 1). This is however still not enough to prevent flooding, because behaviour change is still an issue (see next indicator). • In addition to this, extra effort is put into clearing blocked stormwater inlets and outlets right before the rainy season to reduce the risk of flooding (Source 1 and 2).
	1.3 Behavioural	+	• Behavioural change is partial because every year stormwater inlets and outlets are blocked by solid waste

[21] The Cape Flats are located South-East of the Business District of Cape Town. The Cape Flats is an expansive flat low lying area. As a result it is prone to extreme flooding events.

	internalisation		which is illegally dumped. The city has made efforts to educate citizens about the consequences of illegal dumping of rubbish, however this still continues. https://www.fin24.com/Economy/Africa/blow-for-zimbabwe-as-trump-signs-sanctions-into-law-20180810 • More homes in flood prone areas are now being built with raised floors to prevent homes from being inundated during heavy rains (Respondent 1). • Green Park informal settlement is located within the Driftsand Nature Reserve near a wetland. Three levelled platforms were installed by the City of Cape Town's Informal Settlements Department to raise the homes in this informal settlement above the water table to reduce flood risk to these households (Source 10 and Source 11). – Such exploratory initiatives illustrate that awareness is evolving to a degree of action. • There is political incentive for local government actors to try and change practices and approaches regarding flooding. The CoCT Metro is an opposition-led Metropolitan Municipality; therefore progress in bettering the lives of people through addressing issues such as flood risk reduces the degree of political scrutiny the City comes under. • The 'winter readiness plan' is also an example of behaviour change amongst local stakeholders to contribute to solutions regarding flood risk. • In addition to this, it is safe to assume that people living in informal areas that experience flooding often during rainy seasons have changed their behaviour to an extent, in order to avoid the risk of their homes being flooded (Respondent 7). • The issue of flood risk in Cape Town is being incorporated into two policies the Management of Stormwater Impacts Policy and the Flood Plain and River Corridor Management Policy. These address flood risk in formal developments.
2. Useful knowledge	2.1 Information availability	+	• Strong effort is put into providing integrated information on flood risk from various sources. • Citizen's knowledge regarding flood risk is taken into consideration and is used by city officials to enhance decision making on issues of flood risk. The City's Disaster Risk Management Centre encourages citizens to report any activity, such as illegal dumping, which could possibly cause flooding (Source 12 and Source 1). This makes intervention easier when addressing flood risk. • Information on the issue of flood risk is also available in local policy documents and reports. Information on flood risk prevention is available in the City's Five Year Integrated Development Plan for 2017-2022 and the city's climate change policy (Source 13 p78, 79; Source 14). The Framework for adaptation to climate change in the City of Cape Town also provides information on the challenge of flood risk in the city (Source 15). • There is also much academic research which is available online that has been undertaken on different aspects of flood risk. Academic research is an important source of information as it often reveals information gaps which could be useful to decision makers. However, Respondent 7 who is a city official expressed that many of his colleagues do not read academic papers.
	2.2 Information transparency	+	• All interested stakeholders can access information on flood risk which is available and accessible on open source information platforms (mainly the city's website). The City's website is easy to use and provides a

			search function which makes searching for information simple. Even though all stakeholders can access information, it is still very difficult for people with lower income brackets to gain access to the internet. Only 68.5% of households in the Western Cape Province have at least one member who uses the Internet either at home, their places of work or study, or at Internet cafés (Source 25) • Educational pamphlets are also made available by the city. They are tailored to educate the general public (Non-experts) on the issues of flood risk. There is a series of educational FLOOD-WISE posters and pamphlets by the City's Disaster Risk Management Centre which is available on the City's website. (Source 3 – 9)
	2.3 Knowledge cohesion	**+**	• Sectors cooperate in a multi-disciplinary way particularly when working on big long-term projects such as the Sir Lowry's Pass River and Lourens River initiatives which are set out to be multi-disciplinary projects which will include all line functions. (See Source 16 page 78)
3. Continuous Learning	3.1 Smart monitoring	**0**	• It is recognised that the flooding which occurs on the Cape Flats is mainly as a result of its topography. However a degree of smart monitoring over the years has allowed city officials to realise that there are other factors which exacerbate flooding, this includes illegal dumping, of solid waste which blocks stormwater pipes (Source 1;Source 15). Thus creating discrepancies between assumptions and what is happening on the ground http://www.tda.gov.za/en/news-and-events/press-releases/articles/city-officials-discover-lawnmower-in-stormwater-manhole/article-copy/ • The Disaster Risk Management Centre is responsible for identifying, preventing and reducing the occurrence of disasters and also softening the impacts of disasters which cannot be prevented. This means that the Disaster Risk Management team have more on-the-ground contact when there is a flood. This constant contact with communities has led to an incremental improvement of the response to flood risk over the years (Respondent 1). • This amount of monitoring has provided the city with sufficient information for recognising underlying trends, processes and relationships. New approaches to addressing issues of flood risk can be developed and actioned. • On the ground monitoring is a difficult task owing to limited human resources.
	3.2 Evaluation	**0**	• Respondent 1 expresses that reporting in government is a very onerous process which is quite meaningless. Reporting focuses more on compliance rather than on evaluation. Respondent 1 also stated that "it is really out of evaluation that you get learning." • Evaluation of policy in the city is not systematic (Respondent 1; Respondent 8). Evaluation is limited regarding both frequency and quality. • However, there is national legislation that requires the evaluation of processes and progress of certain aspects related to the management of stormwater (links to flooding). E.g. Annual Water Services Development Plan (WSDP) which is a legal requirement of the Water Services Act. The WSDP is to be maintained every five years and updated annually.

			• The WSDP by the Water and Sanitation Department includes the evaluation of progresses of stormwater and flood risk related strategies and objectives for each year. • Despite the fact that evaluation of policy is limited, city officials are aware of the shortfalls in policy implementation (Respondent 9).
	3.3 Cross-stakeholder learning	**+**	• All five interviewed City officials (former and present) expressed that stakeholder interaction is considered valuable to most city officials and is useful for improving policy implementation (Respondent 1; Respondent 2; Respondent 6; Respondent 7) • Various initiatives for cross-stakeholder learning have been deployed. When the City of Cape Town's Management of Urban Stormwater Impacts Policy (MUSIP) was approved by council in 2009, the city's Stormwater Branch held policy learning seminars which were attended by a wide range of stakeholder. In addition to this, city officials from the Stormwater Branch acknowledge that consultants who are implementing the (MUSIP) in new developments have played a crucial role in providing knowledge to the city officials about policy implementation (Respondent 9). • Despite the fact that learning is valued and is increasingly occurring on structural and non-structural platforms, policy implementation remains difficult. This is not yet occurring everywhere and is not considered standard procedure yet.
4. Stakeholder Engagement Process	4.1 Stakeholder inclusiveness	**0**	• Stakeholders are mostly consulted and are allowed to be actively involved. The winter readiness programme is an example of a multi-stakeholder programme which also includes citizens of affected communities. Source 26 • https://www.iol.co.za/capetimes/news/citys-winter-flood-risk-assessment-completed-14454368 • Stakeholders who are involved do not have the mandate to make any formal arrangements and therefore do not influence decision making. • Decision makers are thus faced with the task of ensuring that the values of the consulted stakeholders are taken into consideration when making decisions. Not all the views of the participating stakeholders may be taken into account when taking decisions. This is due to the fact that representation may not always mirror the demographic of the city. This means that minority groups may not be represented, but in the end decisions which are taken have to be beneficial for all citizens of the city (Respondent 1; Respondent 7). • Stakeholder engagement is abundantly done for overlapping issues. A public participation process was followed during the development of the City's Integrated Development Plan[22] (IDP). A total of 2780 members of the public attended the various public meetings, including meeting with the city's strategic partners. 6500 'Have your say' forms were received as the end of 2011. Source 16 indicates a schedule for the approval of

[22] "The IDP is a strategic tool that guides all the activities of local government in consultation with residents and stakeholders. Its focus is on development in the broader sense and it is a structured plan that informs budget priorities, decision making and the allocation of resources." (IDP 2017-2022 p.2)

			the 2013/14 IDP which includes scheduled public consultation and participation. • The Water and Sanitation Department also conducts annual customer satisfaction surveys which aim to identify the specific issues of concern in water-related service delivery. The surveys gauge customer satisfaction level in the business, informal domestic and formal domestic sectors
	4.2 Protection of core values	**0**	• Stakeholders are often consulted because it is believed that they will add value to a decision making process. Therefore participation opportunities are made clear to stakeholders and exit possibilities are also made clear. (Respondent 7; Respondent 1; Respondent 8). • Although stakeholders are consulted, their influence on end results is limited and decisions comply with the interests of the initiating party primarily.
	4.3 Progress and variety of options	**0**	• Respondent 1 expresses that city officials are often encouraged to consider a variety of options and to innovate around their areas of their work which will give the city 'bragging rights'. However, they are discouraged from innovating and considering a range of alternatives which may possibly run the risk of failing. This is mainly because for many years before the 2016 election, the City of Cape Town was the only Metro which was run by the opposition party. Therefore as an apposition led city and province the local governments are risk averse and try by all means to avoid criticism from the ruling party (Respondent 1). • Consultants who implement the MUSIP are encouraged by city officials in the stormwater branch to consider a variety of options when installing SuDS systems on new developments.
5. Management ambition	5.1 Ambitious and realistic management	**+**	• There are long-term goals regarding flood risk which are ambitious and yet realistic. • Policy objectives such as that of the MUSIP are ambitious yet realistic. The objective of the MUSIP is to "minimise the undesirable impacts of stormwater runoff from developed areas (excluding informal settlements) by introducing WSUD principles to urban planning…" (MUSIP, 2009 p.3) (Source 17). The objective is for new developments to include a SuDS component in their plan. However this has not been the case (Respondent 5). This is mandated in development over a certain size – through the MUSIP. • Similarly the Flood Plain and River Corridor Management Policy's (FPRCMP) objective is to "manage development adjacent to watercourse and wetlands taking cognisance of the flood regime … as well as socio-economic factors." (FPRCMP, 2009 p.4) (Source 19) • These long-term incremental objectives are supported by other long-term goals: • The Sir Lowry's Pass River and the Lourens River initiatives are both intended to alleviate the risk of flooding in the built areas near the river. The capacity of both rivers is planned to be increased either through river widening and/or deepening. The Sir Lowry's Pass River initiative will also be aimed at freeing up land for low-cost housing and other developments. This makes these two initiatives integrated initiatives which will cut across all line functions (Source 16). • **Green infrastructure project:** The CoCT plans to develop a green infrastructure plan for the entire CoCT area in 2017/18. The plan will focus on ecosystem services such as flood attenuation. • These medium to long-term goals are also supported by short term plans such as the winter readiness programme which aims to address issues of flood risk on a more short term basis.

	5.2 Discourse embedding	+	• The local context is used smartly to accelerate policy implementation. One of the overarching policies in the City is the Environmental Strategy in which the city's context is clearly set-out and used to smartly guide policy (Source 20). • Methods to address flood risk are subdivided into suitable phases which enable sustainable practices. Policy and actions are subdivided to address flood risk in differing contexts. For instance the MUSIP and FPRCMP aim to address flood risk in a more formalised setting. Whereas flood risk is addressed differently in informal areas; it is mainly addressed through the winter readiness programme. • Flood risk is also high on the political agenda; therefore it is important that the political context of the city is interwoven into policy and action regarding flood risk.
	5.3 Management cohesion	+	• Policy to address flood risk is coherent and relevant. • The Principles of the Environmental Strategy for the City of Cape Town are underpinned by those of the National Environmental Management Act (NEMA). The Principles of NEMA apply throughout South Africa across all organs of state which many significantly affect the environment. • The Environmental Strategy for the City of Cape Town is an overarching policy which aims to address the City's environmental challenges. The policy provides a strategy which is appropriate for the governance, long term planning and the optimisation of the city's resources. The strategy sets out principles within which the City wishes to perform and operate. The strategy also sets out a framework for the regulations and mechanisms which are required to achieve the city's desired outcomes related to long-term environmental management. The environmental strategy applies to all directorates and departments within the CoCT. Therefore the principles of the policies, strategies and plans which are developed within directorates have to be underpinned by those of the Environmental Strategy. Environmental governance is therefore approached thematically rather than in a sectoral manner (Source 20). • The policy's and plans which aim to address flood risk have are therefore underpinned by the same principles which ensures that flood risk policy is coherent and clear. • The above mentioned policies all only apply to the geographic and administrative boundaries of the City of Cape Town. • See the regulatory context of the Environmental strategy(Source 20 p.21)
6. Agents of change	6.1 Entrepreneurial agents	+	• The growing understanding of the complexity and uncertainty of flood risk has resulted in awareness that there is a need for innovative approaches which entail a certain level of risk. • The CoCT MUSIP has enabled entrepreneurial agents (consultants) to seize opportunities to innovate alternative SuDS technologies to incorporate into developments. The MUSIP does not prescribe what technologies are to be installed; it only requires the relevant and effective technologies to be incorporated onto the development (Source 17). • This results in entrepreneurial agents being afforded the opportunity to experiment with alternative technologies to address the issue of flood risk. Experimentation creates a learning environment for both consultants and city officials. Respondent 7 emphasises that experimentation is crucial in legitimising

			alternative technologies which may otherwise be doubted. Successful experimentation could therefore influence decision making in a positive way. • Projects such as the Franschhoek Water Hub can also enable entrepreneurial agents of change to seize and seek opportunities. The Water Hub is a partnership between the Stellenbosch Municipality, the Western Cape government and the University of Cape Town. The aim of the project is to create a centre where different types of alternative water techniques and technologies (including SuDS) are demonstrated for the African context. https://www.thewaterhub.org.za/ http://www.futurewater.uct.ac.za/FW-the-water-hub
	6.2 Collaborative agents	++	• GreenCape is a non-profit organisation which was established by the Western Cape government in 2010 as a special purpose vehicle to support the development of the green economy in the region. GreenCape tries to work with the government in helping the government create an enabling environment for businesses to operate within the green economy (Respondent 3). • GreenCape releases an annual water economy Market Intelligence Report which highlights business opportunities for water in the green economy in the Western Cape. In addition to identifying gaps in the market GreenCape runs projects which aim at understanding particular issues and thereafter attempt to produce practical products to address barriers. • See Source 21 and 22 (MIR 2017 + 2016) • GreenCape's sustainability as an agent of change is maintained by partial funding from the Western Cape government as well as considerable private funding.
	6.3 Visionary agents	+	• The Environmental Strategy for the City of Cape Town clearly states and sets out that there is a long-term, integrated and sustainability oriented vision for addressing environmental challenges such as flood risk in Cape Town (Source 20) • The city officials act as visionary agents by trying to create an enabling environment for actors to have the freedom and opportunity to develop a variety of alternatives and approaches to address flood risk. This is done through the policies which address flood risk i.e. MUSIP and FPRCMP • Visionary agents in the private sector i.e. consultants who are responsible for installing SuDS technologies in developments also act as visionary agents of change. These consultants promote the sustainable long-term vision of the City. An example of this is the Development of the Mitchells Plain Hospital where the various consultants working on this projected installed SuDS technologies on site in order to control the quantity and rate of runoff as well as to encourage natural ground water recharge (see Source 23). • Despite the fact that policy sets out an enabling environment for visionary agents to carry-out the city's long-term vision of sustainability, policy implementation still acts as a barrier. Suitable implementation strategies are still being sought after in order to address discrepancies between visions and implementation.
7. Multi-level Network	7.1 Room to manoeuvre	+	• There is recognition amongst city officials and other stakeholders that a high degree of freedom is necessary to deal with complex situations regarding flood risk.

Potential			• The City is therefore trying to create an enabling environment for actors to have the freedom and opportunity to develop a variety of alternatives and approaches to address flood risk. This is done through the policies which address flood risk i.e. MUSIP and FPRCMP. • The MUSIP and FPRCMP require that Sustainable Drainage Solutions (SuDS) are included in developments, but do not stipulate and specify the technologies to be used. It is the role of engineers and planners to design context specific technologies, thus affording them room to manoeuvre while complying with policy. • Actors have the freedom to develop alternatives, but the freedom to form ad-hoc, fit-for-purpose partnership is limited. *"The freedom is constrained by issues regarding money. Partnering with government and including money is a slippery to slope to corruption, which is rather avoided"* (Respondent 1). In addition, there are strict laws regulating public-private partnerships which may deter the formation of such partnerships, thus reducing room to manoeuvre.
	7.2 Clear division of responsibilities	**0**	• There is a clear mandate and legislation which sets out what local government can and cannot do. The different directorates and departments also have specific mandates which they have to follow. Many of the city officials are well versed in knowing what legislation stipulates and what they are mandated to do. officials often abide strictly to the set of conventional mandates in which their responsibilities are divided (Respondent 8) • The ambiguous areas with regards to a clear division of responsibilities occurs when the work of city officials requires them to work within new integrated concepts and principles such as climate adaptation, WSUD, IWRM, sustainability etc. This calls for officials to think outside of the box and to work in an integrated fashion instead of working in silos (Respondent 8). • City officials increasingly understand the theory behind these sustainability principles, but some officials are still hamstrung by playing by the rules (Respondent 7).
	7.3 Authority	**+**	• There is recognition of the need for long-term and integrated strategies to address flood risk in Cape Town. • In 2017 a Chief Resilience Officer was appointed in the mayor's office as a legitimate form of authority who would ensure that long-term, integrated and sustainable solutions for climate change and disaster resilience are implemented. • The mayoral office also plays an integral role in what is perceived as important in the city (Respondent 1). The current executive mayor of the city, Patricia de Lille is therefore also a legitimate form of power. As the head of the city her interests can easily set the tone for the city's vision and strategies. • They mayor has a vested interest in climate change adaptation and resilience. The mayor has entered into agreements such as the C40 Cities Climate Leadership Group and the 100 Resilient Cities programme which are two high profile global climate change initiatives. The mayor's involvement has changed what she sees as being important. There is therefore more anticipation for long-term integrated strategies for climate change adaptation to be seen through while the mayor is in office. https://www.iol.co.za/capeargus/news/de-lille-appoints-cape-towns-first-chief-resilience-officer-9256106 https://voices.nationalgeographic.org/2016/03/15/patricia-de-lille/

8. Financial viability	8.1 Affordability	-	• Poorer communities in Cape Town find it difficult to afford climate change adaptation measures. • Although this may be the case, poorer com munities may have already devised low cost/ make-shift adaptation measures over the years as they have repeatedly been exposed to flooding.
	8.2 Consumer willingness to pay	++	• Flood risk is fully comprehended by decision makers. There is political support to allocate substantial resources to address flood risk. The political will can be attributed to the fact that the City of Cape Town is led by the opposition party and is therefore under much scrutiny and tries not to fail (Respondent 1) • Expenditure for non-economic benefits is perceived as important, because expenditure for addressing flood risk does contribute towards service delivery, which is a highly important aspect of politics.
	8.3 Financial continuation	-	• Each year funds are allocated towards maintenance of stormwater infrastructure, which is meant to help alleviate flooding. The funds which are allocated are not additional funds; the funds are included into the baseline funding which the stormwater department received every financial year. • However, there is limited continuous financial support for addressing flood risk as the Stormwater branch is chronically underfunded. (Source 27 + 28).
9. Implementing capacity	9.1 Policy instruments	**0**	• The MUSIP as well as the FPRCMP are effectively developed in order to stimulate desired behaviour and discourage undesired activities. • Actors who are meant to be implementing policy (engineers, landscape architects etc.) are developing an open attitude towards the policies. • Despite the fact that policy instruments were developed effectively, implementation of policy is difficult. What happens on the ground may not necessarily reflect the intention of the policy (Respondent 5).
	9.2 Statutory compliance	-	• The legislation and policy which is used to address the challenge of flood risk in Cape Town is well-coordinated and clear. Compliance, however, is an issue. • There are some actors who do not comply by the MUSIP and the FPRCMP; however these actors manage to get away with non-compliance because there are no penalties inflicted on transgressors. • In addition limited financial and human resources hinders officials from conducting site/development inspections where the MUSIP and FPRCMP are being implemented. Therefore discrepancies between as-built designs and designs submitted along with building plans are often not picked up.
	9.3 Preparedness	++	• The City of Cape Town has been experiencing flooding in various areas for over 2 decades. This has allowed the city to incrementally be better prepared to deal with flood events. Uncertainty of flood risk has also been taken into account as they city prepares flood prone areas for flood events before the rainy season regardless of whether intense rains are expected or not. In other words, the precautionary principle is applied. • The Disaster Risk Management Centre also deals with reducing the impacts of flooding to communities on the ground. In rainy months there is always a level of preparedness from the DRM team to address flooding in affected communities. • The DRMC is also responsible to compile a Municipal Disaster Risk Management Plan for the City of Cape Town MDRMP.

			• The purpose of the MDRMP "is to outline policy and procedures for both the pro-active hazard and risk assessment, followed by disaster prevention (if possible), risk reduction, preparedness and the re-active disaster response, relief and rehabilitation phases of Disaster Risk Management. The Municipal DRM Plan is intended to facilitate multi-agency and multi-jurisdictional co-ordination in both pro-active and re-active related programmes" (Municipal DRM Plan, 2015 p.6). • Flood risk is listed as a high priority hazard in 2009/10 with the respondents' coping capacity for these years being rated as ranging from good to adequate meaning there is a good level of preparedness. (Source 24)

Source number	Source description
1	City launches winter readiness plan (Statement by the City's executive mayor, Patricia de Lille)
2	City's winter readiness plan underway (Statement by the City's executive mayor, Patricia de Lille – Published by the City of Cape Town, Media Office)
3	Pamphlet - Flood-wise: understanding the risk (Source: City of Cape Town, Disaster Risk Management)
4	Pamphlet - Flood-wise: preventing flooding (Source: City of Cape Town, Disaster Risk Management)
5	Pamphlet - Flood-wise: early warnings (Source: City of Cape Town, Disaster Risk Management)
6	Pamphlet – Flood-wise: if a flood occurs (Source: City of Cape Town, Disaster Risk Management)
7	Pamphlet – Be flood-wise! (Source: City of Cape Town, Disaster Risk Management)
8	Flood protection pamphlet (Source: City of Cape Town)
9	Flood-wise facilitator's guide (Source: City of Cape Town, Disaster Risk Management)
10	From Flooding to Formalization: A case study of the informal settlement of Green Park, Cape Town (Saaghus, 2016)
11	Article: Cape ups its game to beat rainy winter (Published by IOL)
12	City sends team to inspect Philippi Horticultural Area (Statement by the City's executive mayor, Patricia de Lille – Published by the City of Cape Town, Media Office)
13	City of Cape Town: Five-year Integrated Development Pan (IDP), 2017-2022
14	City of Cape Town; Climate Change Policy (2017)
15	City officials discover lawnmower in stormwater manhole (Source: City of Cape Town, Transport and urban Development Authority, 2015)
16	2012/14 IDP and budget time-schedule of events for the approval of the 2013/14 IDP and budget (Source: 2016)
17	City of Cape Town: Management of Urban Stormwater Impacts Policy (2009)
18	2012/14 IDP and budget time-schedule of events for the approval of the 2013/14 IDP and budget (Source: 2016)
19	City of Cape Town: Floodplain and river corridor management policy (2009)
20	Environmental Strategy For the City of Cape Town (2017)
21	GreenCape Market Intelligence Report (2017)
22	GreenCape Market Intelligence Report (2016)
23	Lentegeur psychiatric hospital Mitchells Plain: Landscaping Masterplan & Management Framework (2012)
24	City of Cape Town: Municipal Disaster Risk Management Plan (2015)
25	Statistics South Africa General Household Survey (2016)
26	Article: City's winter flood risk assessment completed (Published by IOL, 2018)
27	City of Cape: 2017/18 – 2019/20 Budget
28	Charging for stormwater in South Africa (Fisher-Jeffes & Armitage, 2012)

A3: Governance Capacity Framework scores, justifications and sources for wastewater treatment

Conditions	Indicators	Wastewater treatment Scores	Notes
1. Awareness	1.1 Community knowledge	**0**	• Most communities have a basic understanding of wastewater treatment; however there is little understanding of the risks, impacts and uncertainties of wastewater treatment. • Source 1 and Source 2 are both informative documents (downloadable from the City's website) that outline what wastewater treatment involves. This includes where wastewater goes, the City's wastewater treatment plants, the use of products such as sewage sludge and treated effluent. There is therefore an attempt by the City to raise some awareness to communities about wastewater treatment processes in the city by making these documents available to the public through the City's website.
	1.2 Local sense of urgency	**++**	• There is a general sense on importance regarding wastewater treatment in Cape Town. Wastewater treatment can have a direct impact on the daily lives of people living in the city. The lack of connection to the wastewater treatment system compromises the public's right to adequate sanitation. • Respondent 6 states that the wastewater department receives a substantial amount of public correspondence demanding that actions should be taken about certain issues. He admits that the public's complaints are a strong push factor in ensuring that issues relating to wastewater treatment are addressed. • Issues relating to the public's access to adequate sanitation are high on the political agenda and receive much media attention. This is another reason why there is a local sense of urgency in addressing wastewater treatment challenges. • Protecting the quality of urban water ways is also an important aspect of the City's water management and results in a sense of urgency to treat wastewater to required standards before it is discharged back into the environment.
	1.3 Behavioural internalisation	**-**	• There is very little behavioural change regarding wastewater treatment in Cape Town. • The wastewater treatment system is taken for granted. Respondents express that communities are mainly prompted to change their behaviour when there is risk or crises related to a water challenge. For instance the current drought has resulted in more businesses being prompted to change their behaviour by using more treated effluent instead of potable water where possible (Respondent 6).
2. Useful knowledge	2.1 Information availability	**++**	• Comprehensive documentation on wastewater treatment can be found on the local website. This includes policy, strategies as well as the annual Water Services Development Plan (WSDP) which outlines progress related to effective implementation. The information produced and provided is reliable information which can be used to enhance well-informed decision making. (Source 3 and 4: annual WSDP).

			• Information regarding the state of social, economic and ecological processes is also available and easily accessible. This information is also used by city officials in the wastewater treatment department to enhance decision making processes (Respondent 6). See Source 5: 2012 Cape Town State of the environment report.
	2.2 Information transparency	+	• Information on wastewater treatment is easily accessible on open source information platforms. Information is mostly accessible through the City's website in various forms. • Information is cohesive and easily understandable for experts and non-experts. Source 2 is a great example of information which is cohesive and easily understandable for non-experts.
	2.3 Knowledge cohesion	+	• Sectors cooperate in a multidisciplinary way, which results in complete information on wastewater treatment. The Environmental Strategy of The City of Cape Town clearly sets out the functions of each sector as well as the relevant supporting sectors. E.g. cooperation between solid waste department and wastewater department is crucial when dealing with sewage sludge. • The annual WSDP reports are also a collaboration of the different branches which fall under the water and sanitation department (which deals with all aspects of water supply, sewerage and wastewater treatment). Therefore reports are coherent and provide complete information on water and sanitation as a whole in Cape Town. (Source 3 and 4)
3. Continuous Learning	3.1 Smart monitoring	+	• Annual reports show that there is continuous monitoring of progress and process. Annual water and sanitation reports provide information on the progress and processes of projects related to wastewater treatment. Monitoring the progress of projects also provides cohesive information on the areas within the City of Cape Town which have benefited from projects and how they have benefited. (Source 3 and 4). • Respondent 6 further mentioned that monitoring processes have revealed that wastewater treatment process in Cape Town consume the most electricity in the city. This revelation has become a driver for promoting sustainable energy use in wastewater treatment processes. This will inform future plans to recover energy from wastewater treatment processes and re-use the energy on site. • Effluent quality and compliance scores at wastewater treatment plants is also made available in the WSDP as well as the GreenDrop Reports[23]
	3.2 Evaluation	**0**	• Respondent 1 expresses that reporting in government is a very onerous process which is quite meaningless. Reporting focuses more on compliance rather than on evaluation. Respondent 1 stated that "it is really out of evaluation that you get learning." • Evaluation of policy in the city is not systematic (Respondent 1; Respondent 8). Evaluation is limited regarding both frequency and quality and in most cases it takes place on an ad-hoc basis.

[23] The Green Drop system is an incentive-based method which grants Green Drop Status to Water Service Authorities (in this case the City of Cape Town) based on their level of compliance with wastewater legislation and other best practices as required by DWS.

			• However, there is national legislation that requires the evaluation of processes and progress with regards to wastewater treatment projects and programmes. The National Water Services Act requires Water Service Authorities (in this case the CoCT) to develop a WSDP which is to be maintained every five years and updated annually. • The WSDP by the Water and Sanitation Department includes the evaluation of progresses of wastewater treatment related strategies and objectives for each year.
	3.3 Cross-stakeholder learning	**+**	• According to Respondent 6, stakeholder interaction is considered valuable and useful for improving policy and implementation. Respondent 6 mentions that the wastewater department constantly interacts and learns from varied stakeholders including: The provincial Department of Environmental Affairs and Development Planning, community organisation, political organisation within the political framework of Cape Town, tertiary institutions and consultants (who often do work for the city, but always bring new knowledge and ideas) • The learning experiences certainly do take place in various forms; however the experiences and/or programmes may not be registered and shared.
4. Stakeholder Engagement Process	4.1 Stakeholder inclusiveness	**0**	• Stakeholders are consulted by the city when necessary both on a formal and informal basis. • The mandates which the city officials have to abide by state clearly who the decision makers are, therefore some stakeholders do not have the mandate to make arrangements and decisions. • Opportunities for stakeholder inclusiveness processes such as public participation processes are made clear by the city. The public is made aware through various platforms of opportunities for public participation. • Stakeholders who are involved do not have the mandate to make any formal arrangements or to make decisions. Decision makers are thus faced with the task of ensuring that the values of the consulted stakeholders are taken into consideration when making decisions. Not all the views of the participating stakeholders may be taken into account when making decisions. This is due to the fact that representation may not always mirror the demographic of the city. This means that minority groups may not be represented, but in the end decisions which are taken have to be beneficial for all citizens of the city (Respondent 1; Respondent 7).
	4.2 Protection of core values	**0**	• Stakeholders are often consulted because it is believed that they will add value to a decision making process. Therefore participation opportunities are made clear to stakeholders and exit possibilities are also made clear. This however does not lead to stakeholders being more committed to the process. (Respondent 7; Respondent 1; Respondent 8). • Although stakeholders are consulted, their influence on end results is limited and decisions comply with the interests of the initiating party primarily.
	4.3 Progress and variety of options	**+**	• There is sufficient room for stakeholders to elaborate alternatives. The consultants who are hired to do work for the wastewater department are often suggesting alternatives to city officials (Respondent 6). • In addition to this, city officials try by all means to stay aware of the various sustainable alternatives and

			new technologies that can be retrofitted and implemented at wastewater treatment plants (Respondent 6).
5. Management ambition	5.1 Ambitious and realistic management	++	• The visions and goals for wastewater treatment are often found online as the department's strategy and they align with the city's overall strategy. • The goals which are set are ambitious and realistic goals. This includes goals such as setting up a new beneficiation facility and the zero discharge plant. • The city's wastewater department has received environmental authorisation for the development of a biosolids beneficiation facility. The goal is for biosolids to be beneficiated and used for energy and resource recovery. (Source 6) https://www.esi-africa.com/features/interview-with-peter-flower-city-of-cape-town/ • The Fisantekraal wastewater treatment works is also an indication of the ambitious, yet realistic management of wastewater treatment in Cape Town. The treatment work, opened in 2012, is a zero discharge plant as all the treated water is being piped to customers for irrigation purposes (Source 2).
	5.2 Discourse embedding	+	• Local context is used smartly to address wastewater treatment. The City of Cape Town comprises of both formalised and informal areas. Even though this is the case, it is ensured that both communities living in formal and informal areas are connected to the wastewater system through container toilets and other ablution facilities. Communities who live in informal areas may not be directly connected to the network through a piped network, but alternative methods are used to ensure that they receive this service.
	5.3 Management cohesion	+	• Policy to address wastewater treatment is coherent. • The Principles of the Environmental Strategy for the City of Cape Town are underpinned by those of the National Environmental Management Act (NEMA). The Principles of NEMA apply throughout South Africa across all organs of state which many significantly affect the environment. • The City's Environmental Strategy for the City of Cape Town is an overarching policy which aims to address the City's environmental challenges. The policy provides a strategy which is appropriate for the governance, long-term planning and the optimisation of the city's resources. The strategy sets out principles within which the City wishes to perform and operate. The strategy also sets out a framework for the regulations and mechanisms which are required to achieve the city's desired outcomes related to long-term environmental management. The environmental strategy applies to all directorates and departments within the CoCT. Therefore the principles of the policies, strategies and plans which are developed within directorates have to be underpinned by those of the Environmental Strategy. Environmental governance is therefore approached thematically rather than in a sectoral manner (Source 7). • The tools set out by the Environmental strategy to address issues of water management in Cape Town, including wastewater treatment, are underpinned by the same principles which all only apply to the geographic and administrative boundaries of the City of Cape Town.

6. Agents of change	6.1 Entrepreneurial agents	**+**	• Entrepreneurial agents have been enabled to seize low risk opportunities and have access to resources. Entrepreneurs are enabled to purchase treated effluent as well as sewage sludge for industrial use. • There is an understanding that there is a need for innovative approaches which seek to promote sustainability. Hence the implementation of the biosolids beneficiation facility.
	6.2 Collaborative agents	**++**	• GreenCape is a non-profit organisation which was established by the Western Cape government in 2010 as a special purpose vehicle to support the development of the green economy in the region. GreenCape tries to work with the government in helping the government create an enabling environment for businesses to operate within the green economy (Respondent 3). • GreenCape releases an annual water economy Market Intelligence Report which highlights business opportunities for water in the green economy in the Western Cape. In addition to identifying gaps in the market GreenCape runs projects which aim at understanding particular issues and thereafter attempts to produce practical products to address barriers. • See Source 6 and 9 (MIR 2017 + 2016)
	6.3 Visionary agents	**+**	• The Environmental Strategy for the City of Cape Town clearly states and sets out that there is a long-term, integrated and sustainability oriented vision for addressing environmental challenges such as wastewater treatment in Cape Town (Source 9) • City officials act as visionary agents as they are responsible for carrying out their work in a manner which promotes the city's vision. This is done by effectively pushing forward long-term and integrated strategies to address wastewater treatment. • Visionary agents such as GreenCape are also promoting the city's vision of addressing challenges such as wastewater treatment in an integrated and sustainable way.
7. Multi-level Network Potential	7.1 Room to manoeuvre	**0**	• The interviewed respondents acknowledge that a high degree of freedom is necessary to deal with complex water challenges such as wastewater treatment in the form of experiments and seeking unconventional approaches. Despite this acknowledgement, there are factors which limit flexibility and high degrees of freedom to deal with such complex challenges. The two main factors said to limit flexibility are municipal regulations relating to finance as well as the specified mandates which government officials are to follow. • Flexibility is perceived to be possible when initiated by the mayor. This is due to the fact that the mayor has more financial flexibility as well as flexibility in terms of mandates to form ad hoc committees to adequately address challenges (Respondent 1). • i.e. A Water Resilience Task Team (WRTT) has been put together by the mayor's office (in 2017) to act as a special ad-hoc team which would adequately address the drought in the city. This is through exploring various alternatives and approaches.
	7.2 Clear division of responsibilities	**0**	• There is a clear mandate and legislation which sets out what local government can and cannot do. The different directorates and departments also have specific mandates which they have to follow. Many of the city officials are well versed in knowing what legislation stipulates and what they are mandated to

			do. Officials often abide strictly to the set of conventional mandates in which their responsibilities are divided (Respondent 8) • The grey areas with regards to a clear division of responsibilities occurs when the work of city officials requires them to work within new integrated concepts and principles such as climate adaptation, WSUD, IWRM, sustainability etc. This calls for officials to think outside of the box and to work in an integrated fashion instead of working in silos (Respondent 8). • City officials increasingly understand the theory behind these sustainability principles, but some officials are still hamstrung by playing by the rules. There is chance for collaboration, and such chances are seized as and when possible. This mainly due to the fact that there is recognition among actors that knowledge is scattered within the local network and does not lie in individual silos.
	7.3 Authority	+	• There is recognition of the need for long-term and integrated approaches by the public, city officials and political arena. • Legitimate authorities are assigned to coordinate long-term integrated policy and implementation. • Sustainability approaches regarding wastewater treatment are being implemented as declarations of intent. E.g. Beneficiation facility • In 2017 a Chief Resilience Officer was appointed in the mayor's office as a legitimate form of authority that would ensure that long-term, integrated and sustainable solutions for climate change and disaster resilience are implemented. • The mayoral office also plays an integral role in what is perceived as important in the city (Respondent 1). The current executive mayor of the city, Patricia de Lille is therefore also a legitimate form of power. As the head of the city her interests can easily set the tone for the city's vision and strategies. • They mayor has a vested interest in climate change adaptation and resilience. The mayor has entered into agreements such as the C40 Cities Climate Leadership Group and the 100 Resilient Cities programme which are two high profile global climate change initiatives. The mayor's involvement has changed what she sees as being important. There is therefore more anticipation for long-term integrated strategies for climate change adaptation to be seen through while the mayor is in office. https://www.iol.co.za/capeargus/news/de-lille-appoints-cape-towns-first-chief-resilience-officer-9256106 • https://voices.nationalgeographic.org/2016/03/15/patricia-de-lille/
8. Financial viability	8.1 Affordability	-	• A share of Cape Town's population living in poor neighbourhoods or informal settlements has serious difficulty to pay for basic water services. • These poor communities cannot afford climate adaptation measures to protect themselves against impacts of climate change. • Even middle income communities in Cape Town may have difficulty affording certain climate change adaptation measures.

			• Indigent[24] households in the City receive free basic water and sanitation services (see contextual analysis)
	8.2 Consumer willingness to pay	++	• Wastewater treatment is fully comprehended by decision-makers and is an important component of delivering adequate sanitation to people (Respondent 6). Adequate sanitation and living in a healthy environment is a basic human right; therefore there is public and political support to allocate substantial financial resources to wastewater treatment. • For this reason, expenditure for non-economic benefits is perceived as important.
	8.3 Financial continuation	+	• There is continuous financial support for addressing wastewater treatment challenges. • Each financial year funds are allocated to the department of water and sanitation and its respective branches. The funds which are allocated are not additional funds; the funds are included into the baseline funding which the department of water and sanitation receive every financial year. • The WSDP outlines the status of various projects related to sewer upgrades and replacements. Therefore the finances allocated to the wastewater branch may be sufficient (to a certain degree) to ensure adequate treatment of the City's wastewater now and in the future. • The main challenge regarding financial continuity for wastewater treatment processes is the fact that, while upgrading and maintaining existing infrastructure, new infrastructure needs to be installed in informal areas which are expanding at a rapid rate.
9. Implementing capacity	9.1 Policy instruments	+	• The Wastewater and industrial effluent By-law as well as the Treated effluent By-law have been used effectively to stimulate desired behaviour and discourage undesired activities and choices. • Undesired behaviour includes: discharging foreign substances such as petrol, greases, wax, insecticide of paints into the stormwater system; tempering with municipal sewers; unauthorised use of treated effluent; not maintaining private sewer installations • The wastewater and industrial effluent By-law: " The Wastewater & Industrial Effluent By-law enables the City of Cape Town to enforce control over activities linked to the disposal of wastewater and industrial effluent" (Environmental strategy of the City of Cape Town, 2017 p.23) • The treated effluent By-law: "The Treated Effluent By-law allows for the safe re-use of treated effluent in order to contribute to a resource efficient City by reducing waste and pollution." (Environmental strategy of the City of Cape Town, 2017 p.23)
	9.2 Statutory compliance	+	• Legislation regarding wastewater treatment is well-coordinated, clear and transparent. • Most actors are willing to comply with legislation. Non-compliance with the treated effluent By-law shall result in an offense and a fine and/or imprisonment. Non-compliance with the wastewater and industrial effluent By-law shall result in an offence and a fine and/or a term of imprisonment not exceeding 12 months.

[24] Indigent Criteria: (a) Property values of less than or equal to R400 000; (b) The monthly household income is less than R4000; or (c) Pensioners (CoCT, 2017)

			• A total of 30 fines were issued for the non-compliance with the treated effluent and industrial effluent By-law in the 2013/14. Revenue relating to the By-law enforcement for treated effluent and industrial effluent By-law combined amounted to: R1 648 342
	9.3 Preparedness	+	• A departmental risk management register is compiled for the water and sanitation department, where a wide range of risks have been considered. The register outlines the possible risks, potential causes and action plans for each risk. The precautionary principle is followed as risk and management system procedures are reviewed for department are reviewed on an annual basis. (Source 8) • The Municipal Disaster Risk Management Plan (Source 10) also outlines emergency plans and protocols to be followed in the event that quality, compliance and/or legislative requirements are not met. • Consequences for emergencies such as sewer overflows/spills into rivers and load shedding (electricity cuts) affecting water and sewer reticulation pumping are also considered.

Source number	Source description
1	City of Cape Town website page – where does my wastewater go?
2	Water Services and the Cape Town Urban Water Cycle (City of Cape Town, 2017)
3	Water and Sanitation Department Annual Water Services Development Plan (2013/14)
4	Water and Sanitation Department Annual Water Services Development Plan (2016)
5	City of Cape Town: State of the Environment Report (2012)
6	GreenCape Market Intelligence Report (2016)
7	Environmental Strategy for the City of Cape Town (2017)
8	City of Cape Town: Water Services Departmental Sector Plan for 2012/13 – 2016/17 IDP term (2015/16 review)
9	GreenCape Market Intelligence Report (2017)
10	City of Cape Town: Municipal Disaster Risk Management Plan (2015)

Appendix B: Consent form

INFORMED VOLUNTARY CONSENT TO PARTICIPATE IN RESEARCH STUDY

Project Title: Using a diagnostic indicator assessment to understand sustainability transitions towards Water Sensitive Urban Design (WSUD) in the City of Cape Town

Invitation to participate: You are invited to participate in a research study conducted by Miss Boipelo Madonsela, a Masters student at the University of Cape Town, Civil Engineering Department. The aim of this study is to understand the institutional contexts which will allow for sustainability transitions towards WSUD in the City of Cape Town. This study will make use of the City Blueprint Approach (CBA) which is a "baseline assessment of the sustainability of water management in a municipality." (E-Brochure City Blueprint Approach, p.2). The CBA will use two frameworks, the City Blueprint Performance Framework (CBF) and the Governance Capacity framework (GCF), to assess how cities are managing their water cycle and to assess where cities can improve their water governance respectively. Both assessments have been developed by the KWR Watercycle Research Institute in cooperation with Utrecht University in the Netherlands. You are being asked to participate in this study because you are familiar with an area of interest to the research. Your experience will be a valuable source of information, and it is hoped that by participating you may also gain useful knowledge.

Procedures: During this study, you will be asked to answer a number of questions related to Cape Town's governance capacity to deal with one of three water-related challenges (water scarcity, flood risk or wastewater treatment).

Risks: There are no potentially harmful risks related to your participation in this study.

Compensation: There will be no compensation given for participating in this study

Disclaimer/Withdrawal: Your participation is completely voluntary; you may refuse to participate, and you may withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you choose to withdraw, the researcher commits not to use any of the information you have provided without your signed consent. Note that the researcher may also withdraw you from the study at any time.

Confidentiality: All information collected in this study will be kept private. However, the names of your affiliated organisations and job titles may be included in this study. For this reason you may be identified by name or by affiliation to an institution depending on your consent.

Interviews: It is your right to decide whether or not you will allow the researcher to make an audio recording of the interview.

What signing this form means: By signing this consent form, you agree to participate in this research study. The aim, procedures to be used, as well as the potential risks and benefits of your participation have been explained verbally to you in detail, using this form. Refusal to participate in or withdrawal from this study at any time will have no effect on you in any way. You are free to contact me, to ask questions or request further information, at any time during this research.

I agree to participate in this research (tick one box)	**I agree to give researcher permission to record interview**
☐ Yes ☐ No _____ (Initials)	☐ Yes ☐ No _____ (Initials)

I agree to give researcher consent to publish my name or the name of the organisation I am affiliated with

☐ Yes ☐ No _____ (Initials)

Name of Participant:

Signature: **Date:**

Appendix C: City Blueprint Framework indicators and scoring method

INDICATORS OF THE CITY BLUEPRINT FRAMEWORK (24-01-2016)

The CBF framework consists of 25 indicators divided over 7 main categories (water quality, solid waste treatment, basic water services, wastewater treatment, infrastructure, climate robustness and governance). An overview of the CBF indicators is presented below.

Application of the Framework

The 25 City Blueprint indicators are standardized to a scale of 0-10 in which 10 points implies an excellent score and 0 points is a poor score. This is done by comparing the values from an international range, using natural boundaries of 0 and 100% or by using ordinal classes. Often the min-max method is applied:

$$\frac{\text{value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}} \; X \; 10 = \text{Indicator score}$$

The seven steps in the process to be followed are:

1. Municipalities and regions are contacted to participate or they contact KWR Watercycle Research Institute (KWR) without any obligation at: city.blueprint@kwrwater.nl or +31 306069649 to perform a City Blueprint analysis of their municipality or region.

2. If a decision has been taken, the city appoints a coordinator for the information collection. This coordinator contacts the stakeholders in the municipality/region to provide the necessary information for the municipality or region.

3. The coordinator completes the City Blueprint Framework (CBF) questionnaire for 25 indicators. This will take a few days. The questionnaire (or an identical word file) is then used to collect the information, step by step (indicator by indicator).

4. For each indicator scoring information is gathered. The information, the sources (websites, documents or publications, and if necessary the page number(s) are provided and included in the CBF questionnaire word file (copy paste).

5. For each indicator, the scores are calculated as explained in Section 4 of this document.

6. After the completion of this questionnaire a radar chart of all 25 indicators (the City Blueprint) and the Blue City Index (BCI) can be provided. These indicators and the BCI vary from 0 (concern) to 10 (no concern). The City Blueprint spider diagram and the calculation of the BCI can be obtained by introducing the scores for the 25 indicators in the excel file for **the calculation of the BCI**. This file can be downloaded from http://www.eip-water.eu/City_Blueprints (click on documents). This file now contains the scores for the city of Amsterdam. For your municipality or region, these scores should be replaced by the indicator scores of your municipality or region.

7. Please contact KWR. KWR will review the information and check the calculation and contact you again to discuss this. After mutual agreement the information can be used to make reports and/or can be added to the City Blueprint Database at KWR Watercycle Research Institute. KWR will then also provide the results of the TPF indicators.

Assessment method

Category 1: Water quality

Indicator 1: Secondary WWT

Principal: Measure of the urban population connected to secondary waste water treatment plants. The focus on secondary treatment is chosen because primary treatment is considered rather insufficient for BOD and nutrient removal.

How to calculate: X = Percentage of population connected to secondary sewage treatment. We assume that there is only tertiary treatment after secondary treatment has been done.

Definition: Secondary treatment: process generally involving biological treatment with a secondary settlement or other process, with a BOD removal of at least 70% and a COD removal of at least 75% (OECD, 2013).

Indicator 1 = X/10

Indicator 2: Tertiary WWT

Principal: Measure for the urban population connected to tertiary waste water treatment plants. This treatment step is important for water quality because much nutrients and chemical compounds are removed from the water before it inters the surface water.

How to calculate: X = Percentage of population connected to tertiary sewage treatment.

Indicator 2 = X/10

Definition: Tertiary treatment: treatment of nitrogen or phosphorous or any other pollutants affecting the quality or a specific use of water (microbiological pollution, color, etc.) (OECD, 2013).

Indicator 3: Groundwater quality

Principal: Measure of relative groundwater quality. A lower Indicator score is given for poorer quality.

How to calculate: Base the calculation on national or regional data where city-level data are not available. A limitation is that in any country, city water quality is typically worse than the national average

X = Number of samples of 'good chemical status'
Y = Number of samples of 'poor chemical status'

Indicator 3 = X / (X+Y) * 10

Note: for non-EU countries, an alternative method should be applied, depending what data are available.

Category 2: Solid waste treatment

Indicator 4: Solid waste collected

Principal: Represents waste collected from/ produced by households, small commercial activities, office buildings, institutions such as schools and government buildings, and small businesses that threat or dispose of waste at the same used for municipally collected waste (OECD, 2013).

How to calculate: X = kg/cap/year of collected solid waste. The min-max method is applied. Here the lowest and highest 10% produced solid waste of all countries that are available is taken. These are respectively 136.4 kg/cap/year and 689.2 kg/cap/year.

Indicator 4 = [1 - $\frac{X-136.4}{689.2-136.4}$**] * 10**

All values of x ≤ 136.4 lead to an indicator score of 10

Indicator 5: Solid waste recycled

Principal: Percentage of solid waste that is recycled or composted.

How to calculate: This indicator represents the percentage of the total collected municipal waste that is recycled or composted. However, when solid waste is used for incineration with energy recovery, it is not possible to also use it for recycling while both practices are sustainable. Therefore the % solid waste that is incinerated is subtracted from the total (100%) of collected municipal waste to obtain the potential percentage of solid waste that can be recycled (in numerator). Thus this indicator is calculated as shown below.

Indicator 5 = $\frac{\%\text{ recycled or composted}}{100-\%\text{ used for }\textbf{incineration}\text{ with energy recovery}}$ *** 10**

Indicator 6: Solid waste energy recovery

Principal: Percentage of solid waste that is incinerated with energy recovery.

How to calculate: This indicator represents the percentage of the total collected municipal waste that incinerated with energy recovery (techniques). However, when solid waste is recycled or composted, it is not possible to also use it for incineration with energy recovery, while both practices are sustainable. Therefore the % solid waste that is recycled or composted is subtracted from the total (100%) of collected municipal waste to obtain the potential percentage of solid waste that can be incinerated with energy recovery (in numerator). Thus this indicator is calculated as shown below.

Indicator 6 = $\frac{\%\text{ incinerated with energy recovery}}{100-\%\text{ recycled or composted}}$ *** 10**

Category 3: Basic water services

Indicator 7: Access to drinking water

Principal: The proportion of the population with access to affordable safe drinking water. A lower Indicator score is given where the percentage is lower.

How to calculate: X = Percentage (%) of total urban population with access to potable drinking water.

Indicator 7 = $\mathbf{X/10}$

Indicator 8: Access to sanitation

Principal: A measure of the percentage of the population covered by wastewater collection and treatment. A lower Indicator score is given where the percentage is lower.

How to calculate: X = Percentage (%) of total urban population with access to proper sanitation facilities.

Indicator 8 = X/10

Indicator 9: Drinking water quality

Principal: A measure of the level of compliance with local drinking water regulations. A lower Indicator score is given where compliance is lower.

How to calculate: The result is expressed as a percentage of the samples meeting the applicable standards.
X = Total number of samples meeting standards.
Y = Total number of samples

Indicator 9 = X/Y * 10

Category 4: Wastewater treatment

Indicator 10: Nutrient recovery

Principal: Measure of the level of nutrient recovery from the wastewater system.

How to calculate:
A. Wastewater treated with nutrient recovering techniques at the wastewater treatment plants (Mm3 year-1)
B. Total volume of wastewater passing the wastewater treatment plants (Mm3 year-1)

Indicator 10 = $\frac{A}{B} * \frac{\%\ \text{secondary WWT coverage}}{100} * 10$

Indicator 11: Energy recovery

Principal: Measure of energy recovery from the wastewater system.

How to calculate:
A) Total volume of wastewater treated with techniques to recover energy (Mm3/year).
B) Total volume of water produced by the city (Mm3/year).

[A / B] * 10 = score

Often only the total volume of wastewater that enters the treatment facilities is known together with wastewater treatment coverage's (% of water going to the treatment facilities). In this case:
C) Total volume of wastewater treated with techniques to recover energy (Mm3/year).
D) Total volume of wastewater treated in wastewater treatment plants (Mm3/year).

Indicator 11 = $\frac{C}{D} * \frac{\%\ \text{secondary WWT coverage}}{100} * 10$

Indicator 12: Sewage sludge recycling

Principal: A measure of the proportion of sewage sludge recycled or re-used. For example, it may be thermally processed and/or applied in agriculture.

The decision whether or not to apply sewage sludge in agriculture depends on the levels of organic and inorganic micro-contaminants. Often, sewage sludge is contaminated and in many countries it is not allowed to apply sewage sludge in agriculture. Instead, the sludge is burned in waste destruction installations or as biomass in power plants for the generation of electricity.

How to calculate:
A. Dry weight of sludge produced in wastewater treatment plants serving the city
B. Dry weight of sludge going to landfill
C. Dry weight of sludge thermally processed
D. Dry weight of sludge disposed in agriculture
E. Dry weight of sludge disposed by other means
(As a check, A should = B + C + D +E)

Indicator 12 = $\frac{C+D}{A}$ ***** $\frac{C\%\ \text{secondary WWT coverage}}{100}$ *** 10**

To measure the full potential of nutrient and energy recovery, it is specifically chosen to multiply the first term in the equation above with the percentage of secondary WWT coverage as secondary WWT produces much more sewage sludge than primary WWT.

Indicator 13: Energy efficiency WWT

Principal: A measure of the energy efficiency of the wastewater treatment. A lower Indicator score is given where efficiency measures are more limited.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment based on the plans, measures and their implementation to improve the efficiency of wastewater treatment. Self-assessment based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

Indicator 13 =

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Indicator 14: Stormwater separation

Principal: A measure of the proportion of the wastewater system for which sanitary sewage and storm water flows are separated. In principal, a separate system is better than a combined system as extreme weather events may lead to sewer overflows into surface water. These sewer overflows are a major source of pollution. Also flooding vulnerability is larger if stormwater separation ratio is low. A lower Indicator score is given where the proportion of combined sewers is greater.

How to calculate:
A. Total length of combined sewers managed by the utility (km)
B. Total length of stormwater sewers managed by the utility (km)
C. Total length of sanitary sewers managed by the utility (km)

Indicator 14 = $\frac{B+C}{A+B+C}$ *** 10**

Category 5: Infrastructure

Indicator 15: Average age sewer

Principal: The age of the infrastructure for wastewater collection and distribution system is an important measure for the financial state of the UWCS.

How to calculate: The average age of the infrastructure is an indication of the commitment to regular system maintenance and replacement. The method compares the average age of the system to an arbitrarily maximum age of 60 years. Moreover, it is assumed that an age of <10 years receives a maximum score since younger systems generally well maintained.

X = Average age sewer

Indicator 15 = $\frac{60-X}{60-10}$ *** 10**

NB. All values of x > 60 will lead to an indicator score of 0.

Indicator 16: Water system leakages

Principal: A measure of the percentage of water lost in the distribution system due to leaks (typically arising from poor maintenance and/or system age).

How to calculate: Leakage rates of 50% or more are taken as maximum value and thus scored zero. A best score of 10 is given when the water system leakage is zero.

X = Water system leakages (%)

Indicator 16 = $\frac{50-X}{50-0}$ *** 10** All values of x > 50 will lead to an indicator score of 0

Indicator 17: Operating costs recovery (ratio)

Principal: Measure of revenue and cost balance of operating costs of water services. A higher ratio means that there is more money available to invest in water services, e.g. infrastructure maintenance or infrastructure separation.

How to calculate: Only the operational cost and revenues for Domestic water supply and sanitation services are included.

$$\text{Operating cost recovery (ratio)} = \frac{\text{Total annual operational revenues}}{\text{Total annual operating costs}}$$

Definitions: Total annual operational revenues: Total annual income from tariffs and charges for drinking water and sanitation services (US$ or any other currency/year). Total annual operating costs: Total annual operational expenditures for drinking water and sanitation services (US$ or any other currency/year).

If the ratio is >1 than there is no 100% coverage of operating costs. However, ratios <1 are often applied at utilities. This means that there is more than a 100% coverage in many cases (Figure 1).

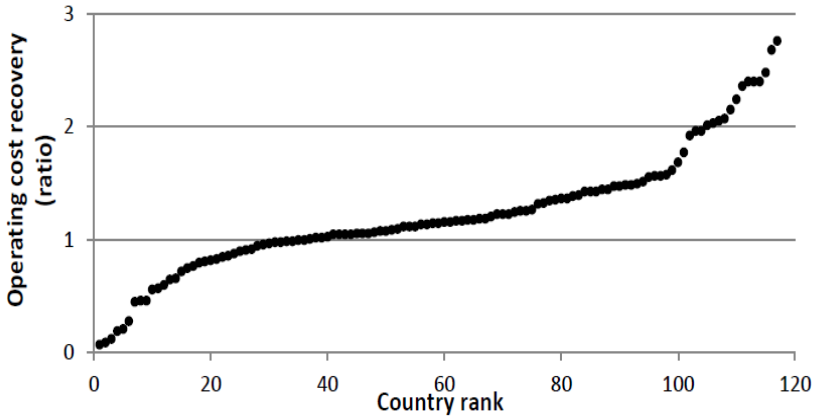


Figure 1: Operating cost recovery ratio for all 117 countries available (ib-net.org). Note that the majority of the countries have more than 100% operating cost recovery (which is a ratio of 1).

Of the operating cost recovery ratio's for all countries available (shown in Figure 1) the highest and lowest 10% are averages and used as minimum and maximum value to rescale the operating cost recovery ratio's to a score between 0 and 10 points. The minimum and maximum are respectively 0.33 and 2.34. The operating cost recovery is X.

X = Operating cost recovery (ratio)

$$\textbf{Indicator 17} = \frac{X - 0.33}{2.34 - 0.33} * 10$$

All values of x < 0.33 will lead to an indicator score of 0.

Category 6: Climate robustness

Indicator 18: Green space

Principal: Represents the share of green and blue area which is essential to combat the heat island effect in urban areas (area defined as built-up area lying less than 200 meters apart).

How to calculate:
City specific: Numbers are provided in %
Country average: Share of green and blue areas is available for all European cities. The EEA city database presents data for of 367 European cities. From these data the average of the lowest 10% is taken as minimum (16%) and the average of the highest 10% is taken as maximum (48%). The percentages for the EU cities are standardized according to the min-max method. For non-European cities percentages for green and blue area are mostly not available. A best

estimate is given by comparing this city to a similar European city. It is important for these cities to provide better information on the share of green area.

X = Share of blue and green area (%)

Indicator 18 = $\frac{X-16}{48-16}$ *** 10**

All values of x < 16 will lead to an indicator score of 0 and all values > 48 will lead to an indicator score of 10.

Definition of green area (EEA, 2012A): These are green urban areas, sports and leisure facilities, agricultural areas, semi-natural areas and wetlands, forests, discontinuous low density urban fabric as a proxy for private gardens and water bodies.

Indicator 19: Climate adaptation

Principal: A measure of the level of action taken to adapt to climate change threats. A lower Indicator score is given where actions or commitments are more limited.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment of the measures and their implementation to protect citizens against flooding and water scarcity related to climate change (e.g. green roofs, rainwater harvesting, safety plans etc.). Self-assessment based on information from public sources (national / regional / local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Indicator 20: Drinking water consumption

Principal: Measure of the average annual consumption of water per capita. A lower Indicator score is given where the volume per person is greater.

Definition: In this questionnaire we use authorized consumption as defined by the International Water Association (IWA). This is the total volume of metered and/or non-metered water that, during the assessment period (here: 1 year), is taken by registered customers, by the water supplier itself, or by others who are implicitly or explicitly authorized to do so by the water supplier, for residential, commercial, industrial or public purposes. It includes water exported. It is IWA code A14. This is then divided by the city population.

How to calculate: X = m3/person/year drinking water consumption.

The volume is then normalized against maximum and minimum volumes for European cities. The minimum is for Rotterdam at 45.2 m3/person/yr. The maximum is for Kiev at 266 m3/person/year (European Green City Index).

Indicator 20 = [1 - $\frac{X-45.2}{266-45.2}$] * 10

All values of x < 45.2 will lead to an indicator score of 10 and all values of x > 266 will lead to an indicator score of 0

Indicator 21: Climate robust buildings

Principal: A measure of whether there is a clear policy for buildings to be robust regarding their contribution to climate change concerns (principally energy use). A lower Indicator score is given where policies are weaker.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment of the policies in place to promote energy efficiency for heating and cooling of houses and buildings, including the use of geothermal energy. Assessment is based on information from public sources (national / regional / local policy documents, reports and websites of actors, e.g. water companies, cities, provincial or national authorities).

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Category 7: Governance

Indicator 22: Management and action plans

Principal: A measure of the application of the concept of Integrated Water Resources Management (IWRM) in the city. A lower Indicator score is given where plans and actions are limited.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment of local and regional commitments to adaptive, multifunctional, infrastructure and design for IWRM as demonstrated by the ambition of the action plans and the actual commitments by local authorities or utilities. The assessment should be based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities).

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Indicator 23: Public participation

Principal: A measure of share of people involved or doing unpaid work.

The obtained estimates for the indicator involvement in voluntary work (*public participation)* are standardized using the min-max method. To avoid unrealistic values due to extrapolations (e.g. negative number of people being involved or doing voluntary work), the minimum for *public participation* is set on 5%. Extrapolations from the indicator *rule and law* that give percentages for *public participation* that are below 5% are set to 5% and consequently scored zero in the CBF.

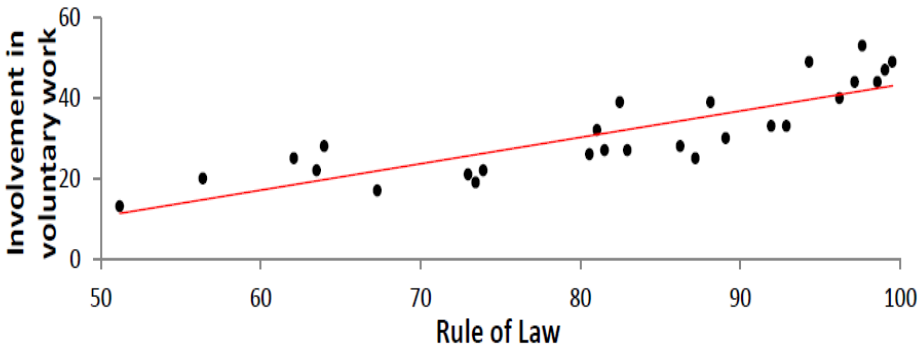


Figure 2: Relation between involvement in voluntary work and the World Bank indicator Rule of law. Equation: 0.6573*Rule of law – 22.278 Correlation coefficient is r=0,8437.

How to calculate:

X = Involvement in voluntary work **X = 0.6573*Y – 22.278**

Y = Rule of law score

Indicator 23 = $\frac{X-5}{53-5}$ *** 10** All data of x < 5 will lead to an indicator score of 0

Indicator 24: Water efficiency measures

Principal: Measure of the application of water efficiency measures by the range of water users across the city. A lower Indicator score is given where efficiency measures are more limited.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment based on information from public sources (national/regional/local policy document, reports and websites of actors (e.g. water companies, cities, provincial or national authorities). It should consider plans, measures and their implementation to improve the efficiency of water usage by e.g. water saving measures in taps, toilets, showers and baths, water efficient design, or behavioural changes.

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans

9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Indicator 25: Attractiveness

Principal: A measure of how surface water features are contributing to the attractiveness of the city and wellbeing of its inhabitants. A lower Indicator score is given where 'attractiveness' is less.

Definition: Examples of cities that attract lot of tourists are Venice, Hamburg and Amsterdam. Water is a dominant feature of those cities. Often the property prices in the vicinity of canals and harbors are much higher than in other parts of the city where the presence of water is not so dominant. Private companies, the owners of the houses, and also the local authorities are often working together to increase the attractiveness of those cities.

How to calculate: This measure is unlikely to already have a value applied. Instead, apply a self-assessment of how surface water is supporting the quality of the urban landscape as measured by the community sentiment/well-being within the city. The assessment should be based on information (policy documents, reports or research articles, or documents related to water-related tourism that deal with the sentiment of the citizens. Provide score between 0 (no role) to 10 (water plays a dominating role in the well-being of citizens).

Indicator score	Assessment
0	no information is available on this subject
1	limited information is available in a national document
2	limited information is available in national and local documents
3	the topic is addressed in a chapter in a national document
4	the topic is addressed in a chapter at the national and local level
5	a local policy plan is provided in a publicly available document
6	as 5 and the topic is also addressed at the local website
7	plans are implemented and clearly communicated to the public
8	as 7 plus subsidies are made available to implement the plans
9	as 8 plus annual reports are provided on the progress of the implementation and/or any other activity indicating that this is a very high priority implemented at the level of the local community.
10	as 9 and the activity is in place for = 3 years

Appendix D: City Blueprint Framework calculations, scores and sources for Cape Town

Category	Indicator	Indicator score calculation	Sources
I Water quality	**1.Secondary WWT**	$Indicator\ 1 = \frac{x}{10}$ X: Percentage of population connected to secondary sewage treatment X = 100% $\boldsymbol{Indicator\ 1 = 10}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 11)
	2.Tertiary WWT	$Indicator\ 2 = \frac{x}{10}$ X: Percentage of population connected to tertiary sewage treatment X = 100% $\boldsymbol{Indicator\ 2 = 10}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 11)
	3.Groundwater quality	•There is limited information on ground water quality in the City of Cape Town •A report published by the National Department of Water and Sanitation (Source 2) provides information on the water quality of three groundwater monitoring routes which are within the municipal boarders of the City of Cape Town. •The three monitoring routes: Cape Flats, Diep river and Bergriver Baseline •Cape Flats: deterioration of water quality in the cape flats aquifer. This is due to increasing residential development. The residential developments and the agricultural activity in	• Source 2: Department of Water and Sanitation SA, Groundwater status report – Western Cape Region Feb2015

		the Phillipi area have also resulted in the addition of potential pollutants into the aquifer. •Diep river: The water quality has seasonal patterns. Water quality is seen to be better after the rainy season as fertilisers added to the field get washed out of the soil. •Berg river baseline: Groundwater quality around the upper parts of the Berg River catchment and around Franschhoek has low ECs and low pH values. The water quality deteriorates northwards towards Riebeck West with higher EC values and more natural pH Values. The water quality is also affected by the lime added to the soil for citrus trees. ***Indicator 5 = 5 (This indicator has been estimated)***	
II Solid Waste treatment	**4.Solid waste collected**	$Indicator\ 4 = \left[1 - \frac{x - 136.4}{689.2 - 136.4}\right] * 10$ X: Kg/cap/year of collected solid waste X = 630.81 kg/cap/year $\boldsymbol{Indicator\ 4 = 1.056}$	• Source 3 (1): GreenCape Waste Market Intelligence Report 2018 (page 77)
	5.solid waste recycled	$Indicator\ 5 = \frac{\%recycled\ or\ composted}{100 - \%used\ for\ incineration\ with\ energy\ recovery} * 10$ % recycled waste = 10% % used for incineration with energy recovery = 0% $\boldsymbol{Indicator\ 5 = 1}$	• Source 3: Department of Environmental Affairs – National Waste Information Baseline Report FY2012 (Page 14)
	6.solid waste energy recovered	$Indicator\ 6 = \frac{\%incinerated\ with\ energy\ recovery}{100 - \%recycled/composted} * 10$	• Source 3: Department of Environmental Affairs – National Waste Information Baseline Report FY2012 (Page 14)

		%incinerated with energy recovery = 0% %recycled/composted = 10% $\boldsymbol{Indicator\ 6 = 0}$	
III Basic water services	**7.Access to drinking water**	$Indicator\ 7 = \frac{x}{10}$ X: Percentage of total urban population with access to potable drinking water X = 100 $\boldsymbol{Indicator\ 7 = 10}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 10)
	8.Access to sanitation	$Indicator\ 8 = \frac{x}{10}$ X: Percentage of total urban population with access to proper sanitation facilities. X = 100 $\boldsymbol{Indicator\ 8 = 10}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 11)
	9.Drinking water quality	$Indicator\ 9 = \frac{x}{y} * 10$ X: Total number of samples meeting standards Y: Total number of samples X/Y = 0.9675 $\boldsymbol{Indicator\ 9 = 9.675}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 67)
IV Wastewater treatment	**10.Nutrient recovery**	$Indicator\ 10 = \frac{A}{B} * \frac{secondary\ wastewater\ treatment\ coverage}{100} * 10$	• • Source 18: Data obtained from City Official (WWT Branch)

		A:Wastewater treated with nutrient recovering techniques (mm^3/year) B: Total volume of wastewater passing the wastewater treatment plants (mm^3/year) A/B = 0.13706 ***Indicator 10 = 1.4***	
	11.Energy recovery	$$Indicator\ 11 = \frac{C}{D} * \frac{\%\ secondary\ WWT\ coverage}{100} * 10$$ C: Total volume of wastewater treated with techniques to recover energy (Mm^3/year) D: Total volume of wastewater treated in wastewater treatment plants (Mm^3/year) C/D = $3.55\ 10^{-4}$ ***Indicator 11 = 3***	• Source 18: Data obtained from City Official (WWT Branch)
	12.Sewage sludge recycling	$$Indicator\ 12 = \frac{C + D}{A} * \frac{\%\ secondary\ WWT\ coverage}{100} * 10$$ A: Dry weight of sludge produced in wastewater treatment plants serving the city B: Dry weight sludge going to landfill C:Dry weight of sludge thermally processed D: Dry weight of sludge disposed in agriculture E: Dry weight of sludge disposed by other means (A = B + C + D + E) C + D/A = 0.79 ***Indicator 12 = 7.9***	• Source 18: Data obtained from City Official (WWT Branch)

	13.WWT energy efficiency	Score for Indicator 13 = criteria based scoring (Assessment table available in appendix B) ***Indicator 13 = 9 (Annual reports are provided on the progress of the implementation and/or any other activity indicating that energy efficiency in WWT is a very high priority at the local level)***	•
V Infrastructure	**14.Stormwater separation**	$$Indicator\ 14 = \frac{B + C}{A + B + C} * 10$$ A: Total length of combined sewers (km) B: Total length of stormwater sewers (km) C: Total length of sanitary sewers (km) A = 0 B = 7500km C = 8970.84km $$\boldsymbol{Indicator\ 14 = 10}$$	• Source: for total length of stormwater sewers managed by the City of Cape Town: http://www.tct.gov.za/en/network/stormwater/ • Source 4: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2014 (Page 47)
	15.Average age sewer	$$Indicator\ 15 = \frac{60 - x}{60 - 10} * 10$$ X: Average age sewer X = 40 $$\boldsymbol{Indicator\ 15 = 4}$$	• City of Cape Town official
	16.Water system leakages	$$Indicator\ 16 = \frac{50 - x}{50 - 0} * 10$$ X: Water system leakages (%) X = 9.5%	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 36)

		$\boldsymbol{Indicator\ 16 = 8.1}$	
	17.Operation cost recovery	$Indicator\ 17 = \frac{x - 0.33}{2.34 - 0.33} * 10$ X: Operation cost recovery (ratio) X = 1.14 $\boldsymbol{Indicator\ 17 = 4}$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 59)
VI Climate robustness	**18.Green space**	$Indicator\ 18 = \frac{x - 16}{48 - 16} * 10$ X: Share of blue and green area (%) X = 48.22% $\boldsymbol{Indicator\ 18 = 10}$	• Source 5: African Green City Index (Page 49)
	19.Climate adaptation	• The topic is addressed in a chapter at the local level and at the local website • A local policy plan is provided in a publicly available document • Plans are implemented and communicated to the public • Reports are provided on the progress of implementation • The policy and actions have been in place for more than 3 years. $\boldsymbol{Indicator\ 19 = 7}$	• Source 6: City of Cape Town: Five-year Integrated Development Plan (IDP) 1 July 2012 – 2017 Executive Summary Review (Page 14, 20, 26) • Source 7: City of Cape Town Five-year plan for Cape Town 2012 – 2017 Integrated Development Plan (IDP) 2012/13 Review (Page 17, 28, 66)
	20.Drinking water consumption	$Indicator\ 20 = \left[1 - \frac{x - 45.2}{266 - 45.2}\right] * 10$	• Source 1: City of Cape Town Annual WSDP Performance and Water Services Audit Report FY2016 (Page 35)

		X: m^3/person/year drinking water consumption X = 70m^3/person/year $\boldsymbol{Indicator\ 20 = 8.8}$	
	21.Climate-robust buildings	• The topic is addressed in a chapter at the local level and at the local website • A local policy plan is provided in a publicly available document • Plans are implemented and communicated to the public • Reports are provided on the progress of implementation • The policy and actions have been in place for more than 3 years. $\boldsymbol{Indicator\ 21 = 7}$	• Source 8: City of Cape Town Integrated Metropolitan Environmental Policy (IMEP) 2008 • Source 9: City of Cape Town Energy 2040 brochure 2015 (Page 3) • Source 10: Cape Town's Action Plan for Energy and Climate Change 2011 (Page 20, 21, 33, 45-49)
VII Governance	**22.Management and action plans**	• A local policy plan is provided in a publicly available document • The topic is addressed at the local website • Plans are clearly communicated to the public $\boldsymbol{Indicator\ 22 = 7}$	• Source 8: City of Cape Town Integrated Metropolitan Environmental Policy (IMEP) 2008 • Source 11: Management of Urban Stormwater Impacts Policy 2009 • Source 12: Floodplain and River Corridor Management Policy 2009 • Source 13: Water Services Departmental Sector Plan for City of Cape Town 2012/13 – 2016/17 IDP Term Overview Plan (Page 9, 10, 11) • Source 14: Western Cape Integrated Water Resources Management Action Plan 2011 • Source 17: Western Cape Sustainable Water Management Plan – 2012 Part 1: "The Water Plan" • Source: http://info.worldbank.org/governance/wgi/index.aspx#home
	23.Public participation	World bank indicator *rule of law* 2916 = 59.13	• Source 7: City of Cape Town Five-year plan for Cape Town 2012 – 2017 Integrated Development Plan (IDP) 2012/13 Review • Source 15: Republic of South Africa Department on Public

		0.6573***59.13 – 22.278 = x = 16.588149** **[16.588149** -5 / 55-5] * 10 = 2.4 • National chapters and documents addressing public participation • local reports of public participation during certain City of Cape Town decision making processes • However information on public participation in City decision making processes is limited $\boldsymbol{Indicator\ 23 = 2.4}$	Service and Administration Guide on public participation in the public service
	24.Water efficiency measures	• The topic is addressed in a chapter at the local level and at the local website • There is no local policy, however the City of Cape Town does offer water efficiency information to citizens on the local website and on social media platforms • Businesses in the City of Cape Town are implementing water efficiency measures • The Western Cape government has also set up a special purpose vehicle (GreenCape) to support the development of the green economy in the region • GreenCape publishes annual water economy Market Intelligence Reports to highlight business opportunities for water in the green economy in the Western Cape Province. $\boldsymbol{Indicator\ 24 = 6}$	• http://www.jgi.co.za/sustainable-solutions/ (Bayside Mall Rainwater harvesting) • http://www.capetown.gov.za/search?k=tips%20for%20saving%20water (City of Cape Town website water efficiency information for public) • Source 16: GreenCape Water Market Intelligence Report 2016 • http://sq1.co.za/portfolio/the-towers-merriman-square/
	25.Attractiveness	• There is limited information on how surface water features are contributing to attractiveness of the city and wellbeing of inhabitants. $\boldsymbol{Indicator\ 25 = 4}$	• Cape Town was voted the best place in the world to visit by the New York Times in 2014, and there are plenty of reasons why. Visiting Cape Town will give you the opportunity to enjoy the high sophistication of its premier wines and authentic South African cuisine. Visit the breath-taking Table Mountain National Park, which is home to 2,200 species of plants. A key part of the

			attractiveness of Cape Town is the charm and rich experiences of its multicultural people. • There are many beautiful beaches, but other beaches and rivers are polluted too: http://www.traveller24.com/MyTravels/Cape-Towns-rivers-of-shame-20150218 • There are waterfront shopping malls too: https://www.google.nl/search?q=waterfront+shopping+mall+cape+town&rlz=1T4VRHB_enNL744NL745&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiw-aq17vnVAhWDZ1AKHU0WD4AQ_AUICigB&biw=1366&bih=544 • On the other hand there are long-term plans for the city, but the focus is not on water attractiveness, but mainly on dealing with sanitation and water scarcity: • http://resource.capetown.gov.za/documentcentre/Documents/City%20strategies%2c%20plans%20and%20frameworks/IDP%202017-2022.pdf

Appendix E: Trends and Pressures Framework indicators and scoring method

The Trends and Pressures Framework indicators consist of a total of 18 indicators (including the sub-indicators) and are divided over the following broad categories: socials pressures, environmental pressures and financial pressures.

Application of the Framework

The 18 Trends and Pressures indicators are standardized to a scale of 0-4 and divided in ordinal classes expressed as a 'degree of concern' and shown below.

TPF indicator score	Degree of concern
0 – 0.5	no concern
0.5 – 1.5	little concern
1.5 – 2.5	medium concern
2.5 – 3.5	concern
3.5 – 4	great concern

KWR Watercycle Research Institute will provide the scores for all Trends and Pressures indicators.

Assessment method

Category 1: Social Pressures

Indicator 1: Urbanization rate

Principal: Percentage of population growth either by birth or migration. The percentages are annually averages per country. Urbanization increases the pressure on IWRM.

Calculation method:

X = Urbanization rate (%)
Score = $-0.114X^2 + 1.3275X + 0.1611$

Indicator 2: Burden of disease

Principal: The gap between current health status and an ideal situation where everyone lives into old age, free of disease and disability (WHO, 2004). The average DALY per 100.000 people is a strong tool to indicate the burden of disease.

Calculation method: The indicator measures the age-standardized disability-adjusted life years (DALY) per 100.000 people. DALY is the quantification of premature death, burdens of disease and disability in life years. It is a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health, e.g. disease, injuries and risk factors (WHO, 2004). The WHO subdivided these DALY's per 100.000 people into 5 classes. These classes are used to standardize this indicator to a score of 0 to 4 in the TPF analysis as shown in the Table below.

DALY = Years of premature death + Years lost due to disability

Years of premature death: Sum of, the number of deaths at each age * [global standard life expectancy for each age - the actual age].

Years lost due to disability: Number of incident cases in that period * average duration of the disease * weight factor.

DALY per 100.000 people	Score
0 – 20.000	0
20.000 – 40.000	1
40.000 – 60.000	2
60.000 – 80.000	3
80.000<	4

Indicator 3: Education rate

Principal: Education rate expressed as percentage of children completing their primary education.

Calculation method:

X = Education rate (%)
Score = $-10^{-5}X^3 + 0.0012X^2 - 0.00426X + 4.3057$

Indicator 4: Political instability (and absence of violence)

Principal: The estimated likelihood that the government will be destabilized or overthrown by violent means such as terrorism and politically-motivated violence.

Calculation method: Political stability (and absence of violence) is part of the set of governance indicators developed by the World Bank. The estimates of the indicator are aggregates of sub-indicators normalized by a standard normal distribution ranging from -2.5 to 2.5. The sub-indicators used by the World Bank to develop this indicator are: Orderly transfer; Armed conflict; Violent demonstrations; Social Unrest; International tensions/terrorist threat; Cost of Terrorism; Frequency of political killings; Frequency of disappearances; Frequency of tortures; Political terror scale; Security Risk Rating; Intensity of internal conflicts: ethnic, religious or regional; Intensity of violent activities of underground political organizations; Intensity of social conflicts (excluding conflicts relating to land); Government stability; Internal conflict; External conflict; Ethnic tensions; Civil unrest: How widespread political unrest is, and how great a threat it poses to investors. Demonstrations in themselves may not be cause for concern, but they will cause major disruption if they escalate into severe violence. At the extreme, this factor would amount to civil war; Terrorism: Whether the country suffers from a sustained terrorist threat, and form who many sources. The degree of localization of the threat is assessed, and whether the active groups are likely to target or affect businesses (World Bank, 2014).

The indicator political stability and absence of violence in this City Blueprint pressure analysis is normalized using the reversed min-max method:

$$4 - \left[\frac{Estimated\ political\ stability\ score - -2.5}{2.5 - -2.5} \times 4\right] = \boldsymbol{Score}$$

Category 2: Environmental pressures

Indicator 5: Water scarcity
Indicator 5 consists of three sub-indicators:
5.1 Fresh water scarcity
5.2 Groundwater scarcity
5.3 Salinization & seawater intrusion

Indicator 5.1: Fresh water scarcity

Principal: The abstracted fresh water as percentage of total renewable resource. This includes surface water and groundwater sources.

Calculation method: The scoring method is in accordance with the European Environmental Agencies classification (OECD, 2004; WRI, 2013).

% of renewable resources abstracted	Score
0 – 2	0
2 – 10	1
10 – 20	2
20 – 40	3
>40	4

Indicator 5.2: Groundwater scarcity

Principal: The abstracted groundwater as a percentage of the annual groundwater recharge. This is a measure of the pressure on groundwater resources. Groundwater development stress (GDS) is defined as the current annual rate of groundwater abstraction (A) divided by the mean annual natural groundwater recharge (R), multiplied by 100%: GDS = A/R*100%

Calculation method: The indicator scoring is in accordance with the classification used by UNESCO.

% abstracted of annual recharge	Score
0 – 2	0
2 – 20	1
20 – 50	2
50 – 100	3
>100	4

Indicator 5.3: Salinization and/or seawater intrusion

Principal: Measure of the vulnerability of seawater intrusion and salinization of the soil.

Calculation method: This indicator score is based on a quick literature check in which seawater and groundwater intrusion are scored as suggested below

Seawater intrusion:

Description	Score
No sweater intrusion reported and city not prone to (future) intrusion	0
No sweater intrusion reported and city can experience intrusion in coming century	1
No sweater intrusion reported but city is prone to intrusion in the near future	2
Seawater intrusion reported	3
Seawater intrusion reported and city is particularly prone to intrusion	4

Groundwater salinization:

Based on literature studies, here the following scheme is applied to determine a score:

Description	Score
No concern	0
Low concern	1
Medium concern	2
Concern	3
Great concern	4

The highest score of the two indicators is used as the final score for salinization and/or seawater intrusion.

Indicator 6: Flood risk
The indicator flood risk consists of 4 sub-indicators:
6.1 Urban drainage flood
6.2 Sea level rise
6.3 River peak discharges
6.4 Land subsidence

Indicator 6.1: Urban drainage flood

Principal: Risk of flooding due to intensive rainfall expressed as the share of urban soil that is sealed.

Calculation method: Sealed soil cover in the city standardized according to the min-max method. The minimum and maximum values are determined by taking the bottom and the top 10% of the 572 European cities assessed (EEA 2015).

Indicator 6.2: Sea level rise

Principal: Measure of the vulnerability of flooding due to sea level rise. Percentage of the city that would flood with 1 meter sea level rise. Only environmental circumstances are considered. Protection measures such as dikes, dams *etcetera* are not considered (that would be a performance).

Calculation method In accordance with the European Environmental Agency (2012) the following classification is used to standardize the area being affected by a 1 meter sea level increase without flood protection on a scale from 1 to 5.

Urban area affected (%)	Score
0 – 5	0
6 -10	1
11 - 20	2
21 - 40	3
41 - 100	4

For non-European cities, the assessment is based on literature available. Classes are in principle the same as for European cities.

Indicator 6.3: River peak discharges

Principal: Measure for the vulnerability of flooding due to river level rise. Also flash floods from outside the city are included in this indicator. Percentage of the city that would flood with 1 meter river level rise. Only environmental circumstances are considered. Protection measures such as dikes, dams etcetera are not considered (that would be a performance).

Calculation method In accordance with the European Environmental Agency (2012) the following classification is used to standardize the area being affected by a 1 meter river level increase without flood protection on a scale from 1 to 5.

Urban area affected (%)	Score
0 – 5	0
6 -10	1
11 - 20	2
21 - 40	3
41 - 100	4

For non-European cities, the assessment is based on literature available. Classes are in principle the same as for European cities.

Indicator 6.4: Flood risk due to subsidence

Principal: Land subsidence increases the risks of river and coastal floods and salt water intrusion. The cause of land subsidence is irrelevant for its impact on flooding.

Calculation method: This score is based on a qualitative assessment according to the following classification:

Description	Score
No infrastructure damage, no flood risk	0
Low/medium infrastructure damage expected, no major increase in flood risk expected	1
Experienced infrastructure damage and medium infrastructure damage expected or <0.5m subsidence by 2100 in a substantial area of the city	2
Serious experienced infrastructural damage or <1m subsidence by 2100 in a substantial area of the city	3
Serious experienced infrastructure damage, imminent flooding/ <2m subsidence by 2100 in a substantial area of the city	4

Indicator 7: Water quality

Water quality consists of two sub-indicators:

7.1 Surface water quality

7.2 Biodiversity

Indicator 7.1: Surface water quality

Principal: Measure of relative surface water quality. A lower Indicator score is given for better quality.

Calculation method: A national surface water quality index (WQI) is available as a measure out of 100. Then, the indicator is calculated as follows:

Score = $\frac{100-WQI}{25}$

Indicator 7.2: Biodiversity

Principal: Measure of the biodiversity of aquatic ecosystems in the city. A low indicator score is given where biodiversity is good.

Calculation method: The calculation is based on national or regional data when city-level data are not available. There are many ways of assessing biodiversity, so there is no globally uniform approach.

For EU countries, it is recommended to use data from the European Environment Agency (EEA) on 'percent of classified waters in less than good ecological status' as shown in this map – for which a high resolution version is available via the link. Then apply the following criteria to determine an Indicator score

% of waters with less than good ecological status or potential	Score (for EU countries)
<10%	0
10 to 30%	1
30 to 50%	2
50 to 70%	3
≥70%	4

For non-EU countries, it is recommended to use data from a program called the Environmental Performance Index (EPI), led by Yale University (epi.yale.edu). The latest 2012 update does not include the relevant parameter called *'Water – impact on ecosystem'*. This is available from the 2010 version (see also Indicator 4). The value is obtained from the Country Profiles:

score = $\frac{\mathbf{100 - water\ (impact\ on\ ecosystems)}}{\mathbf{25}}$

Indicator 8: Heat risk

Principal: Prediction of heat island effects severity on human health.

Calculation method:

1. Number of combined tropical nights (>20 oC) and hot days(>35 oC) in the period 2071-2100, where the maximum is set on 50 days. The number is standardized using the following formula: [Number of combined tropical nights and hot days / 50] x 4 = score

2. Percentage of green and blue urban area. Share of green and blue areas is available for all European cities. The EEA city database presents data for of 367 European cities. From these data the average of the lowest 10% is taken as minimum (16%) and the average of the highest 10% is taken as maximum (48%). The percentages for the EU cities are standardized according to the min-max method. For non-European cities percentages for green and blue area are mostly not available. A best estimate is given by comparing this city to a similar European city. It is important for these cities to provide better information on the share of green area. Formula: score = 4 - [(% green and blue area – 16) / (48 -16) x 4]

3. The overall score is the arithmetic average of both standardized scores.

Category 3: Economic pressures

Indicator 9: Economic pressure

Principal: Gross Domestic Product (GDP) per head of the population is a measure of the economic power of a country. A low GDP per capita implies a large economic pressure.

Calculation method:

X = GDP per capita per year (US$)
Score = 4 – [(**X** – 514.7) / (59231.2 – 514.7)*4]

Indicator 10: Unemployment rate

Principal: Percentage of population of the total labour force without a job.

Calculation method:

X = Unemployment rate (%)

Score: = $0.0002X^3 – 0.0173X^2 + 0.5077X – 0.8356$

Indicator 11: Poverty rate

Principal: Percentage of people that is below the poverty line of 2 *US$* a day.

Calculation method: Percentages of the population living from less than 2 US$ a day.

X = Poverty rate (% less than 2US$ a day)
Score = -0.0001**X**2 + 0.0404**X** + 1.1686

Indicator 12: Inflation

Principal: Percentage inflation per year. High inflation rates may hamper investments.

Calculation method:

X = Inflation rate (%)

Score = $0.0025X^3 – 0.0744X^2 + 0.8662X + 0.0389$

Appendix F: Trends and Pressures Framework calculations and scores for Cape Town

Category 1: Social pressures

Indicator 1: Urbanization rate

Principal: Percentage of population growth either by birth or migration. The percentages are annually averages per country. Urbanization increases the pressure on IWRM.

Calculation:

X = Urbanization rate (%)
Score urbanization rate = $-0.114\mathbf{X}^2 + 1.3275\mathbf{X} + 0.1611$

For urbanization rates lower than 0% the score is also zero and the above formula is not applied.

Cape Town: 1.33% annual rate of change (2015-20 est.) Applying formula results in: $-0.114*[1.33]^2 + 1.3275*[1.33] + 0.1611 = -0{,}20165 + 1.7656 + 0.1611 = 1.725$

Indicator 2: Burden of disease

Calculation method: The indicator measures the age-standardized disability-adjusted life years (DALY) per 100.000 people. DALY is the quantification of premature death, burdens of disease and disability in life years. It is a time-based measure that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health, e.g. disease, injuries and risk factors (WHO, 2004). The WHO subdivided these DALY's per 100.000 people into 5 classes. These classes are used to standardize this indicator to a score of 0 to 4 in the TPF analysis as shown in the Table below.

DALY = Years of premature death + Years lost due to disability

Years of premature death: Sum of, the number of deaths at each age * [global standard life expectancy for each age - the actual age].

Years lost due to disability: Number of incident cases in that period * average duration of the disease * weight factor.

DALY per 100.000 people	Score
0 - 20.000	0
20.000 - 40.000	1
40.000 - 60.000	2
60.000 - 80.000	3
80.000 <	4

Cape Town: 67541: Score = 3

Indicator 3: Education rate

X = Education rate (%)
Score education rate = $-10^{-5}\mathbf{X}^3 + 0.0012\mathbf{X}^2 - 0.0426\mathbf{X} + 4.3057$

Cape Town:

In SAl 95.8% of the children have completed their primary education in 2013. Applying the formula results in: -10^{-5}***[95.8]**^{3} + 0.0012***[95.8]**^{2} – 0.0426***[95.8]** + 4.3057 =

-8,79 + 11.03- 4.08+ 4.3057 = 2.45

Indicator 4: Political instability (and absence of violence)

Calculation method: The indicator political stability and absence of violence in this City Blueprint pressure analysis is normalized using the reversed min-max method:

$$\mathbf{4} - \left[\frac{\text{Estimated political stability score} - -2.5}{\mathbf{2.5} - \mathbf{-2.5}}\ \boldsymbol{x}\ \mathbf{4}\right] = \boldsymbol{Score}$$

Cape Town -0.13

$$4 - \left[\frac{-0.13 - -2.5}{2.5 - -2.5}\ x\ 4\right] = 2.104$$

https://www.timeslive.co.za/news/south-africa/2018-05-02-watch-service-delivery-protest-turns-violent-in-cape-town/

Category 2: Environmental pressures

Indicator 5: Water scarcity

Indicator: 5.1 Fresh water scarcity

Calculation method: The scoring method is in accordance with the European Environmental Agencies classification (OECD, 2004; WRI, 2013).

% of renewable resource abstracted	Score
0 - 2	0
2 - 10	1
10 – 20	2
20 – 40	3
>40	4

Cape Town 30.2 = Score 3

Indicator: 5.2 Groundwater scarcity

Calculation method: The indicator scoring is in accordance with the classification used by UNESCO.

% abstracted of annual recharge	Score
0 - 2	0
2 - 20	1
20 - 50	2
50 - 100	3
>100	4

Cape Town 2-20 Score 1

5.3 Salinization and/or seawater intrusion

Calculation method: This indicator score is based on a quick literature check in which seawater and groundwater intrusion are scored as suggested below.

Seawater intrusion:

Description	Score
No seawater intrusion reported and city not prone to (future) intrusion	0
No seawater intrusion reported and city can experience intrusion in coming century	1
No seawater intrusion reported but city is prone to intrusion in the near future	2
Seawater intrusion reported	3
Seawater intrusion reported and city is particularly prone to intrusion	4

Groundwater salinization:

Based on literature studies, here the following scheme is applied to determine a score:

Description	Score
No concern	0
Low concern	1
Medium concern	2
Concern	3
Great concern	4

The highest score of the two indicators is used as the final score for salinization and/or seawater intrusion.

Cape Town:

https://www.dailymaverick.co.za/article/2017-11-27-op-ed-cape-water-crisis-setting-the-record-straight-on-aquifers-and-saline-intrusion/#.WoKo3meWzIU

https://www.timeslive.co.za/news/south-africa/2016-04-13-cape-water-crisis/

Seawater intrusion score = 3

Groundwater salinization = 3

Indicator 6: Flood risk

6.1 Urban drainage flood

Cape Town:

https://www.siemens.com/entry/cc/features/greencityindex_international/all/en/pdf/capetown.pdf

Home to multiple nature reserves containing some of the world's rarest plant species, Cape Town has the most green space in the Index. The city boasts an estimated 289 square metres of green space per person, about four times the Index average of 74 square metres. A local environmental resource management department oversees Cape Town's green spaces and environmentally sensitive areas. So Cape Town has no shortage of green parks and green space

Furthermore the map of Cape Town here: http://www.gbcsa.org.za/wp-content/uploads/2013/06/ICLEI-Cape-Town_-An-Urban-Biodiversity-Network.pdf

Overall the city has a lot of green space but the central urban part is quite urban!

https://www.news24.com/SouthAfrica/News/cape-town-roads-flooded-homes-affected-after-heavy-rainfall-20170127

Based on the occurrence of significant flooding observed the score is set at 1 (estimate)

Estimate: 50% sealed/50% green space

6.2 Sea level rise

Urban area affected (%)	Score
0-5	0
6-10	1
11-20	2
21-40	3
41-100	4

Cape Town:

https://www.westerncape.gov.za/eadp/files/basic-page/downloads/City%20of%20Cape%20Town%20Phase%203%20Sea-Level%20Rise%20Risk%20Assessment.pdf

Scenario 1: The present day worst case scenario. It is assumed that this involves a 2.5 metre increase in sheltered environments, a 4.5 metre increase in exposed environments and a 6.5 metre increase in very exposed environments. This scenario would see 25.1 km2 covered by the sea (1 per cent of the Cape Metro's total area of 2,499 km2), albeit for a short time.

So score = 0

6.3 River peak discharges

Calculation method:

Urban area affected (%)	Score
0-5	0
6-10	1
11-20	2
21-40	3
40-100	4

Cape Town:

https://www.imesa.org.za/wp-content/uploads/2015/11/Paper-5-Lessons-learned-from-the-2013-floods-on-the-Lourens-River-Somerset-West-Prof-Kobus-du-Plessis-Franz-Von-Molkte.pdf

http://www.capetown.gov.za/Media-and-news/City,%20Public%20Protector%20and%20SA%20Human%20Rights%20Commission%20inspect%20work%20in%20Masiphumelele

http://www.monitor.co.ug/Magazines/HomesandProperty/The-risks-of-building-in-wetlands/689858-1970004-87x4kwz/index.html

Cape Town: score = 3

6.4 Flood risk due to subsidence

Calculation method: This score is based on a qualitative assessment according to the following classification:

Score	Description
0	No infrastructure damage, no flood risk
1	Low/medium infrastructure damage expected, no major increase in flood risk expected
2	Experienced infrastructure damage and medium infrastructure damage expected or <0.50m subsidence by 2100 in a substantial area of the city.
3	Serious experienced infrastructural damage or < 1m subsidence by 2100 in a substantial area of the city
4	Serious experienced infrastructure damage, Imminent flooding/ < 2m subsidence by 2100 in a substantial area of the city

Cape Town:

http://www.geoscience.org.za/mwg-internal/de5fs23hu73ds/progress?id=0DajR8eMkvTTkz-UX1x92NZpgeqa2WQphy5Dm1LZtPU

Sink holes but for the rest not likely: 0

Indicator 7: Water quality

7.1 Surface water quality

Calculation method: A national surface water quality index (WQI) is available as a measure out of 100. Then, the indicator is calculated as follows:

$$\frac{100 - WQI}{25} = score$$

Cape Town **84.2 = 0.632**

7.2 Biodiversity

Calculation method: The calculation is based on national or regional data when city-level data are not available. There are many ways of assessing biodiversity, so there is no globally uniform approach.

% of waters with less than good ecological status or potential	Indicator 21 value (for EU countries)
<10%	0
10 to 30%	1
30 to 50%	2
50 to 70%	3
≥ 70%	4

$\frac{100 - Water\ (impact\ on\ ecosystems)}{25} = score$ factor out of 100.

Cape Town **68.1 = score = 1.28**

Indicator 8: Heat risk

Calculation method:

1. Number of combined tropical nights (>20 ^{o}C) and hot days (>35 ^{o}C) in the period 2071-2100, where the maximum is set on 50 days. The number is standardized using the following formula: [Number of combined tropical nights and hot days / 50] x 4 = score

Cape Town = 10 maximal 10/50 x 4 = score = 0.8

2. Percentage of green and blue urban area. Share of green and blue areas is available for all European cities. The EEA city database presents data for of 367 European cities. From these data the average of the lowest 10% is taken as minimum (16%) and the average of the highest 10% is taken as maximum (48%). The percentages for the EU cities are standardized according to the min-max method. For non-European cities percentages for green and blue area are mostly not available. A best estimate is given by comparing this city to a similar European city. It is important for these cities to provide better information on the share of green area. Formula: score = 4 - [(% green and blue area – 16) / (48 -16) x 4] =

3. The overall score is the arithmetic average of both standardized scores.

Cape Town 50% (is max = 48%): This leads to score 0. So final score = 0.8 / 2 = final score = 0.4

Category 3: Economic pressures

Indicator 9: Economic pressure

Calculation method
X = GDP per capita per year (US$)
4 – [(**X** – 514.7) / (59231.2 – 514.7)*4]

Cape Town GDP =

South Africa	GDP per capita, current prices	USD					7,256

Cape Town: 4- [(7256-514.7)/ (58716.5)*4] = 3.54

Indicator 10: Unemployment rate

Calculation method:

X = Unemployment rate (%)
Score unemployment rate = $0.0002\mathbf{X}^3 – 0.0173\mathbf{X}^2 + 0.5077\mathbf{X} – 0.8356$

Cape Town $0.0002\mathbf{X}^3 – 0.0173\mathbf{X}^2 + 0.5077\mathbf{X} – 0.8356$ ((24.4 + 20.6)/2= 22.5)

2.278 – 8.758 + 11.42 – 0.8356 = 4.1

Indicator 11: Poverty rate

Calculation method: Percentages of the population living from less than 2 US$ a day.

X = Poverty rate (% less than 2US$ a day)
Score poverty rate = $-0.0001\mathbf{X}^2 + 0.0404\mathbf{X} + 1.1686$

Data SA (year 2011) 16.6, so score = $-0.0001*\mathbf{[16.6]}^2 + 0.0404*\mathbf{[16.6]} + 1.1686$ =
-0.027+0.671+1.1686 = 1.81

Indicator 12: Inflation

Calculation method:

X = Inflation rate (%)
Score inflation rate = $0.0025\mathbf{X}^3 - 0.0744\mathbf{X}^2 + 0.8662\mathbf{X} + 0.0389$

SA 6.3%; $0.0025*\mathbf{[6.3]}^3 - 0.0744*\mathbf{[6.3]}^2 + 0.8662*\mathbf{[6.3]} + 0.0389 =$

$0.625 - 2.95 + 5.457 + 0.0389 = 3.17$

Appendix G: Governance Capacity Framework indicators and scoring method

INDICATORS OF THE WATER GOVERNANCE CAPACITY FRAMEWORK

This document provides the method for the application of the Governance Capacity Framework (GCF) to five water-related challenges in cities. The GCF is a governance capacity assessment method consisting of three dimensions, nine key conditions and 27 indicators.

Application of the framework

The GCF was applied to three water-related governance challenges:

1. Water scarcity
2. Flood risk
3. Wastewater treatment

These challenges are the most reoccurring water related challenges that will steadily increase in importance and frequency due to climate change and urbanization. These '*governance challenges*' typically have fragmented scopes, viewpoints and responsibilities. As there are many causes leading to complexity, uncertainty and disagreement, there is no single best approach to solve governance challenges. In fact, it is an iterative process that requires governance capacity to find dynamic long-term solutions that are supported with flexible intermittent targets to anticipate on emerging barriers and changing situations.

A triangular method is applied:

1. An analyses of policy documents and reports provide preliminary scores of the twenty-seven indicators for each of the five governance challenges
2. At least fifteen interviewees, three for each of the five governance challenges, need to be selected. The most relevant stakeholders are identified, their interdependencies are plotted and key persons from different levels of decision-making are selected. There are twenty-seven predefined questions that the research needs to answer, one for each indicator and specifically asked with regards to the five governance challenges. The questions are open, non-technical, with follow-up questions to either target specific elements or for further clarification.
3. After the interviews the participants receive the predefined questions with the preliminary indicator scores and are asked to provide constructive feedback and additional information that can be included in the final scoring.

The 27 indicators all have a specific pre-defined question that the researcher needs to answer to for each of the five governance challenges using documents, reports and in-depth interviews. The answers provide the basis for the indicator score based on a Likert-type method which is specific for each of indicator. Here we provide these pre-defined questions and Likert-type scoring method for each of the twenty-seven indicators.

Assessment method

Condition 1: Awareness

Awareness refers to the understanding of causes, impact, scale and urgency of the water challenge.

Indicator 1.1: **Community knowledge**

Predefined question: To what extent is knowledge regarding the current and future risks, impacts, and uncertainties of the water challenge dispersed throughout the community and local stakeholders which may results in their involvement in decision-making and implementation?

++	**Balanced awareness**	Nearly all members of the community are aware of and understand the actual risks, impacts and uncertainties. The water challenge is addressed the local level. Local communities and stakeholders are familiar with or are involved in the implementation of adaptation measures
+	**Overestimation**	The community is knowledgeable and recognize the many existing uncertainties. Consequently, they often overestimate the impact and probability of incidents or calamities. The water challenge has been raised at the local political level and policy plan may be co-developed together with local communities
0	**Underestimation**	Most communities have a basic understanding of the water challenge. However the current risks, impacts and frequencies are often not fully known and underestimated. Future risks, impacts and frequencies are often unknown. Some awareness has been raised amongst or is created by local stakeholders and communities
-	**Fragmented knowledge**	Only a small part of the community recognizes the risks related to the water challenge. The most relevant stakeholders have limited understanding of the water challenge. As a result, the issue is hardly or not addressed at the local governmental level
--	**Ignorance**	The community, local stakeholders and decision-makers are unaware or ignore the water challenge. This is demonstrated by the absence of articles on the issue in newspapers, on websites or action groups addressing the issue

Indicator 1.2: Local sense of urgency

Predefined question: To what extent do actors have a sense of urgency, resulting in widely supported awareness, actions, and policies that address the water challenge?

++	**Strong demand for action**	There is a general sense of importance regarding the water challenge. There is continuous, active, public support and demand to undertake action and invest in innovative, ground-breaking solutions. This is evident, since the issue receives much media attention and action plans are implemented
+	**General sense of urgency of long-term sustainability goals**	There is increasing understanding of the causes, impacts, scale and urgency of the water challenge. It leads to general sense of urgency of the need for long-term sustainable approaches. However, measures requiring considerable efforts, budget, or substantial change with sometimes uncertain results are often receiving only temporal support. The water challenge is a main theme in local elections
0	**Moderate willingness for small changes**	There is growing public awareness and increasing worries regarding the water challenge. However, the causes, impact, scale and urgency are not widely known or acknowledged leading to the support for only incremental changes. It is a side topic in local elections
-	**Raising of awareness by small groups**	A marginalized group (e.g. the most vulnerable, environmentalists, NGOs) express their concerns, but these are not widely recognized by the general public. Adaptation measures are not an item on the political agenda during elections
--	**Resistance**	There is generally no sense of urgency and sometimes resistance to spend resources to address the water challenge. It is not an item on the political agenda during elections, as is evident from the lack of (media-) attention

Indicator 1.3: Behavioural internalization

Predefined question: To what extent do local communities and stakeholders try to understand, react, anticipate and change their behaviour in order to contribute to solutions regarding the water challenge?

++	**Full internalisation**	Because actors are fully aware of the water challenge, their causes, impacts, scale and urgency, the it is integrated into long-term and joint strategy, practices and policies. All actors are encouraged to participate. At this point, the water challenge is integrated into everyday practices and policies

+	**Moderate internalisation**	Awareness has evolved to mobilization and action. There are various incentives for actors to change current practices and approaches regarding the water challenge. The water challenge, however, is not yet fully integrated into clear strategy, practices and policies
0	**Exploration**	There is a growing awareness, often as a result of local, exploratory research regarding the causes and solutions of the water challenge. There are only incremental changes in actions, policy and stakeholder's behaviour
-	**Recognized as an external pressure**	The water challenge is partly recognized, mainly due to external pressure instead of intrinsic motivations. There is no support to investigate its origin or to proceed to action or changing practices
--	**Unawareness**	There is unawareness of the water challenge with hardly any understanding of causes and effects or how current practices impact the water challenge, the city or future generations

Condition: 2 Useful knowledge

This condition describes the qualities of information with which actors have to engage in decision-making.

Indicator 2.1: Information availability

Predefined question: To what extent is information on the water challenge available, reliable, and based on multiple sources and methods, in order to meet current and future demands so as to reveal information gaps and enhance well-informed decision-making?

++	**Comprehensive information enabling long-term integrated policy**	A comprehensive and integrated documentation of the issue can be found on local websites and policy papers. It is characterized with adequate information, an integrated description of social, ecological and economic processes regarding the water challenge, as well as goals and policies. Furthermore, progress reports on effective implementation can be found
+	**Information enhancing integrated long-term thinking**	Strong effort is put in providing integrated information from various fragmented sources. Information gaps are identified and attempted to be bridged. This may be clear from extensive documentation on the long-term process. Also citizen knowledge may be taken into account
0	**Information fits demand, limited exploratory research**	Information on the water challenge is available. Knowledge on understanding or tackling the water challenge is progressing and is produced in a structural way. Knowledge gaps are hardly identified due to lock-in into existing disciplines and policy. This is apparent from the quantity of factual information, but the causes, risks and impacts of long-term processes are lacking behind
-	**Information scarcity and limited quality**	Limited information is available which does not grasp the full extent of the water challenge. In some cases not all information is of sufficient quality to generate a comprehensive overview
--	**Lack of information**	No information on the water challenge can be found. Or the scarce available information is of poor quality

Indicator 2.2: Information transparency

Predefined question: To what extent is information on the water challenge accessible and understandable for experts and non-experts, including decision-makers?

++	**Easy access to cohesive knowledge**	Information is easily accessible on open source information platforms. There are multiple ways of accessing and sharing information. Information is often provided by multiple sources and is understandable for non-experts
+	**Sharing of partly cohesive knowledge**	All interested stakeholders can access information. Action has been taken to make knowledge increasingly understandable. Still, it is a time-consuming search through a maze of organizations, protocols and databases to abstract cohesive knowledge and insights
0	**Sharing of very technical knowledge**	There are protocols for accessing information; however, it is not readily available. Although information is openly available, it is difficult to access and comprehend

		because it is very technical. The water challenge is reported on local websites and reports
-	**Low sharing of fragmentized knowledge**	Information is sometimes shared with other stakeholders. However, information is inaccessible for most stakeholders. Furthermore, knowledge is often technical and difficult to understand for non-experts. The water challenge may be addressed on local websites
--	**Not transparent and inaccessible knowledge**	Information is limitedly available and shared. sharing may be discouraged. The information that is available is difficult to understand. The water challenge is not addressed on local websites

Indicator 2.3: Knowledge cohesion

Predefined question: To what extent is information cohesive in terms of using, producing and sharing different kinds of information, usage of different methods and integration of short-term targets and long-term goals amongst different policy fields and stakeholders in order to deal with the water challenge?

++	**Implementation of cohesive knowledge**	Stakeholders are engaged in long-term and integrated strategies. Information can be found that is co-created knowledge and will contain multiple sources of information, multiple and mixed methods taking into account the socio-, ecological and economic aspects of the water challenge
+	**Substantial cohesive knowledge**	Sectors cooperate in a multidisciplinary way, resulting in complete information regarding the water challenge. Besides multiple actors, multiple methods are involved to support information. Too many stakeholders are involved, sometimes in an unbalanced way. Knowledge about effective implementation is often limited
0	**Insufficient cohesion between sectors**	Data collection within sectors is consistent and is sustained in multiple projects for about two to three election periods. Knowledge on the water challenge, however, is still fragmented. This becomes clear from different foci of the stakeholders as stated in their organisation's strategies and goal setting
-	**Low-cohesive knowledge within sectors**	Information that is found is sector specific and information is inconsistent within and between sectors
--	**Non-cohesive and contradicting knowledge**	A lack of data strongly limits the cohesion between sectors. Information that is found can even be contradictory

Condition 3: Continuous learning

Continuous learning and social learning is essential to make water governance more effective. The level of learning differs from refining current management, critical investigation of fundamental beliefs or questioning underlying norms and values.

Indicator 3.1: Smart monitoring

Predefined question: To what extent is the monitoring of process, progress, and policies able to improve the level of learning (i.e., to enable rapid recognition of alarming situations, identification or clarification of underlying trends)? Or can it even have predictive value?

++	**Useful to predict future developments**	Monitoring system is adequate in recognizing alarming situations, identifying underlying processes and provides useful information for identifying future developments. Reports of monitoring will display discrepancies between fundamental beliefs and practices. The monitoring is changed in order to act upon these findings by altering the fundamental beliefs. Often regulatory frameworks are changed, new actors are introduced, new risk management approach are used
+	**Useful to recognize underlying processes**	The abundant monitoring provides sufficient base for recognizing underlying trends, processes and relationships. Reports of monitoring will display discrepancies between assumptions and real process dynamics. Acting upon these findings by altering the

		underlying assumptions characterizes this level of smart monitoring. Often also system boundaries are re-defined, new analysis approach introduced, priorities are adjusted and new aspects are being examined
0	**Quick recognition of alarming situations**	Monitoring system covers most relevant aspects. Alarming situations are identified and reported. This leads to improvement of current practices regarding the technical measures. There is only minor notification of societal and ecological effects
-	**Reliable data but limited coverage**	Monitoring occurs, however the monitoring system does not cover all facets of the water challenge, with sometimes incomplete description of the progress and processes of technical and policy measures. Monitoring is limited to singular effectiveness or efficiency criteria and cannot identify alarming situations
--	**Irregular, poor quality or absent**	There is no system to monitor the water challenge or monitoring is irregular

Indicator 3.2: Evaluation

Predefined question: To what extent are current policy and implementation continuously assessed and improved, based on the quality of evaluation methods, the frequency of their application, and the level of learning?

++	**Exploring the fitness of the paradigm**	Frequent and high quality evaluation procedures fully recognize long-term processes. Assumptions are continuously tested by research and monitoring. Evidence for this is found in sources (primarily online documents) that report on the learning process and progress. Uncertainties are explicitly communicated. Also, the current dominant perspective on governance and its guiding principles are questioned
+	**Changing assumptions**	There is continuous evaluation, hence continuous improvements of technical and policy measures and implementation. Innovative evaluation criteria are used. This is evidenced by reports containing recommendations to review assumptions or explicitly indicating the innovative character of the approach
0	**Improving routines**	The identified problems and solutions are evaluated based on conventional (technical) criteria. Current practices are improved. This becomes clear from information of the used and existing criteria, the small changes recommended in reports and short-term character
-	**Non-directional evaluation**	Evaluation is limited regarding both frequency and quality. Evaluation occurs sometimes, using inconsistent and even ad-hoc criteria. Also the evaluation is not systematic. There is no policy on the performance of evaluations, only the evaluation(s) itself are reported
--	**Insufficient evaluation**	There is no evaluation of technical or policy measures regarding the water challenge. Otherwise it is not documented

Indicator 3.3: Cross-stakeholder learning

Predefined question: To what extent are stakeholders open to and have the opportunity to interact with other stakeholders and deliberately choose to learn from each other?

++	**Putting cross-stakeholder learning into practice**	There is recognition that the water challenge is complex and that cross-stakeholder learning is a precondition for adequate solutions and smooth implementation. This is evidenced by broad support for policy measures and implementation. Moreover, continuous cross-stakeholder learning programs are in place or may be institutionalized
+	**Open for cross-stakeholder learning**	Stakeholder interaction is considered valuable and useful for improving policy and implementation. Various initiatives for cross-stakeholder learning have been deployed, yet the translation into practice appears difficult. The programs may not be structural and the learning experience may not be registered and shared
0	**Open for stakeholder interaction**	Stakeholders are open to interaction, though not much learning is going on due to the informative character of the interaction. Often, a number of stakeholders, that do not necessarily share interests or opinions, are involved in the decision-making process
-	**Small coalitions of stakeholders with shared interest**	Interaction occurs in small coalitions based on common interests. Opinions of those outside the coalition are generally withheld. Only information for the shared point of view is sought. This is evidenced by the finding of only one perspective regarding the

		water challenge or few perspectives that are supported by means of circle-referencing
--	**Closed attitude towards cross-stakeholder learning**	There is no contact with other parties, contact may even be discouraged. This is apparent from limited sharing of experience, knowledge and skills. No information is shared outside organisation and sector, nor is external information used

Condition 4: Stakeholder engagement process

Stakeholder engagement is required for common problem framing, gaining access to a wide variety of resources and creating general support that is essential for effective policy implementation.

Indicator 4.1: Stakeholder inclusiveness

Predefined question: To what extent are stakeholders interact in the decision-making process interaction (i.e., are merely informed, are consulted or are actively involved)? Are their engagement processes clear and transparent? Are stakeholders able to speak on behalf of a group and decide on that group's behalf?

++	**Transparent involvement of committed partners**	All relevant stakeholders are actively involved. The decision-making process and the opportunities for stakeholder engagement are clear. It is characterised by local initiatives specifically focussing on water such as local water associations, contractual arrangements, regular meetings, workshops, focus groups, citizen committees, surveys
+	**Timely, over-inclusive and active involvement**	Stakeholders are actively involved. It is still unclear how decisions are made and who should be involved at each stage of the process. Often too many stakeholders are involved. Some attendants do not have the mandate to make arrangements. Stakeholder engagement is abundantly done for often overlapping issues
0	**Untimely consultation and low influence**	Stakeholders are mostly consulted or informed. Decisions are largely made before engaging stakeholders. Frequency and time-period of stakeholder engagement is limited. Engagements are mainly ad hoc consultations where stakeholders have low influence on the end-result
-	**Non-inclusive involvement**	Not all relevant stakeholders are informed and only sometimes consulted. Procedures for stakeholder participation are unclear. If involved, stakeholders have but little influence
--	**Limited supply of information**	No stakeholders are included, or their engagement is discouraged. Information cannot be found on the extant decision-making process.

Indicator 4.2: Protection of core values

Predefined question: To what extent 1) is commitment focused on the process instead of on early end-results? 2) do stakeholders have the opportunity to be actively involved? 3) are the exit procedures clear and transparent? (All three ensure that stakeholders feel confident that their core values will not be harmed.)

++	**Maximal protection of core values**	Stakeholders are actively involved and have large influence on the end-result. There are clear exit possibilities and leading to more stakeholders more committed to the process. The participation opportunities and procedure of implementation are clear.
+	**Requisite for early commitment to output**	Stakeholders are actively involved and expected to commit themselves to early outcomes in the process. Hence relevant stakeholders may be missing in contractual arrangements as they do not want to commit themselves to decisions to which they have not yet contributed. At this point involved stakeholders have influence on the end-result and therefore the output serves multiple interests
0	**Suboptimal protection of core values**	As stakeholders are consulted or actively engaged for only short periods, alternatives are insufficiently considered. Influence on end-result is limited. Decisions comply with the interests of the initiating party primarily. There are no clear exits in the engagement process
-	**Non-inclusive and low influence on results**	The majority of stakeholders is engaged, but the level of engagement is low (informative or sometimes consultative). There is a low influence on the result which invokes resistance, for example on internet platforms and newspapers
--	**Insufficient protection of core**	Because stakeholders are hardly engaged or informed, core values are being harmed. Implementation and actions may be contested in the form of boycotts, legal implementation

	values	obstructions and the invoking of anti-decision support. There may be distrust and an absence of participation

Indicator 4.3: Progress and variety of options

Predefined question: To what extent are procedures clear and realistic, are a variety of alternatives co-created and thereafter selected from, and are decisions made at the end of the process in order to secure continued prospect of gain and thereby cooperative behaviour and progress in the engagement process?

++	**Active engagement with choice selection at the end of the cooperation**	There is active engagement of all relevant stakeholders and clarity of participation procedure and realistic deadlines. The range of alternatives is fully explored and selection of the best alternatives occurs at the end of the process. Reviews of stakeholder meetings provide the alternatives addressed. Stakeholders are engaged throughout the whole process as specified in contractual agreements
+	**Active involvement with abundant choice variety**	Stakeholders are actively involved and there is sufficient room for elaborating alternatives. Procedures, deadlines and agreements are unclear. There is no or few specification on deadlines in terms of dates. Due to inexperience with active stakeholder engagement, decisions are taken too early in the process leading to the exclusion of argument and solutions. Hence, decisions may not be fully supported
0	**Consultation or short active involvement**	There is a clear procedure for consultation or short active involvement of stakeholders, but the opportunities to consider all relevant alternatives is insufficient. Decisions are therefore still largely unilateral and solutions suboptimal. The suboptimal character of a solution can be observed from evaluations or difference in opinions
-	**Rigid procedures limit the scope**	Informative and consultative approaches are applied, according rigid procedures with low flexibility. The period of decision-making is short with a low level of stakeholder engagement. These unilateral decision-making processes may lead to slow and ineffective implementation. The latter can be observed from critique via public channels
--	**Lack of procedures limit engagement and progress**	The lack of clear procedures hinder stakeholder engagement. This unilateral decision-making limits progress and effectiveness of both decision-making and implementation. It might result in conflicting situations. Often, much resistance can be found online and implementation may be obstruct

Condition 5: Management Ambitions

Policy ambitions assesses if current policy is ambitious, feasible, well-embedded in local context and if it forms a cohesive set of long-term and short-term goals within and across sectors.

Indicator 5.1: Ambitious and realistic management

Predefined question: To what extent are goals ambitious (i.e., identification of challenges, period of action considered, and comprehensiveness of strategy) and yet realistic (i.e., cohesion of long-term goals and supporting flexible intermittent targets, and the inclusion of uncertainty in policy)?

++	**Realistic and ambitious strategy**	Policy is based on modern and innovative assessment tools and policy objectives are ambitious. Support is provided by a comprehensive set of intermittent targets, which provide clear and flexible pathways. Assessment tools and scenarios analyses identify tipping points that may be found in policy documents
+	**Long-term ambitious goals**	There is a long-term vision that incorporates uncertainty. However, it is not supported by a comprehensive set of short-term targets. Hence, achievements and realistic targets are difficult to measure or estimate. Visions are often found online as an organisation's strategy. They often entail a description of the water challenge and need for action
0	**Confined realistic goals**	There is a confined vision of the water challenge. Ambition are mostly focused on improving the current situation where unchanging conditions are assumed and risk and scenarios analyses are lacking
-	**Short-term**	Actions and goals mention sustainability objectives. Actions and goals are "quick fixes" mainly,

	goals	not adhering to a long-term vision or sustainable solutions. Uncertainties and risks are largely unknown
--	**Short-term, conflicting goals**	Goals consider only contemporary water challenges, are short-sighted and lack sustainability objectives. Goals are arbitrary and sometimes conflicting and the character of policy is predominantly reactive

Indicator 5.2: Discourse embedding

Predefined question: To what extent is sustainable policy interwoven in historical, cultural, normative and political context?

++	**Embedding of sustainable implementations**	Local context is used smartly to accelerate policy implementation. Innovations are subdivided into suitable phases which are more acceptable and effectively enables sustainable practices. Effective policy implementation is enabled by a general consensus that long-term integrated policy is needed to address the water challenge
+	**Consensus for sustainable actions**	There is a consensus that adaptation is required, but substantial effort is necessary as there is little experience in addressing the water challenge in a long-term integrated approach. Furthermore, the decision-making periods are long as trust relations with new unconventional partners need to be built
0	**Low sense of urgency embedded in policy**	Current policy fits the local context. The water challenge is increasingly identified, framed and interwoven into local discourse, but the disregard of uncertainty prevents a sense of urgency that is necessary to adopt adequate adaptation measures. Decision making often results in very compromised small short-term policy changes
-	**Persistent reluctance and poor embedding**	Actors feel reluctant to execute current policy as it conflicts with their norms and values. Policy hardly takes the local context and existing discourses into account. And the policy does not correspond with societal demands. This may lead to distrust between actors, inefficient use of resources and ineffective overall implementation
--	**policy mismatch**	Cultural, historical and political context is largely ignored, leading to arduous policy implementation. Actors may not understand the scope, moral or to whom it applies or how to implement it (total confusion)

Indicator 5.3: Management cohesion

Predefined question: To what extent is policy relevant for the water challenge, and coherent regarding 1) geographic and administrative boundaries, and 2) alignment across sectors, government levels, and technical and financial possibilities?

++	**Cohesive synergetic policies**	Policies are coherent and comprehensive within and between sectors. There is an overarching vision resulting in smooth cooperation. Goals are jointly formulated, evaluated and revised to adapt to new challenges. This is evidenced by thematic instead of sectoral approaches. Many inter-sectoral meetings, interdisciplinary reports and cohesiveness in goals and strategies are formulated
+	**Overlapping comprehensive policies**	There is cross-boundary coordination between policy fields to address the water challenge. Policies are cohesive, but have not yet resulted in broad multi-sectoral actions. Efforts to harmonize different sectors are evident by employee functions or assignments and protocols
0	**Fragmented policies**	Policy is fragmented and based on sector's specific scope and opportunities for co-benefits are hardly explored. However, effort may be made to balance the resource allocation between sectors
-	**Opposing sectoral policies**	Overall water and climate adaptation policy is characterised by fragmentation and imbalance between sectors. The majority of resources is spent on the dominant policy field and overlap between sectors lead to inefficient use of resources
--	**Incompatible policies**	Policies between and within sectors are strongly fragmented and conflicting. This is evidenced by contradicting objectives and the squandering use of resources

Condition 6: Agents of change

In order to drive change, agents of change are required to show direction, motivate others to follow and mobilize the resources required.

Indicator 6.1: Entrepreneurial

Predefined question: To what extent are the entrepreneurial agents of change enabled to gain access to resources, seek and seize opportunities, and have influence on decision-making?

++	**Long-term support for entrepreneurship**	There is recognition of the need for continuous innovation, hence applied research is enabled that explores future risk management and supports strategy formulation. The experiments yield increased benefits and new insights. This is recognized by other actors, thereby providing access to new resources. Continuous experimentation is secured by long-term and reliable resource allocation
+	**Tentative experimental entrepreneurship**	There is a growing understanding of the water challenge's uncertainty, complexity and need for innovative approaches that entail a certain level of risk. Tentative experimental projects set in but are paid by conventional resources. Projects are small-scale pilots
0	**Conventional and risk-averse entrepreneurship**	Entrepreneurial agents of change are better able to seize low-risk opportunities. Therefore opportunities for innovative approaches and synergies are hardly pursued. Small changes can be observed
-	**Room for short-sighted entrepreneurship**	Agents of change struggle to gain access to resources to address imminent water challenges. Windows of opportunity to identify and to act upon perceived risks are limited. Opportunities to address stakeholders with potential access to resources are rarely seized
--	**Insufficient entrepreneurship**	Ignorance for risk and threats leads to ineffective rigid governance and lack of opportunity for entrepreneurial agents to enable improvements. Moreover, distrust by other actors and potential investors, further decrease access to resources

Indicator 6.2: Collaborative

Predefined question: To what extent are actors enabled to engage, build trust-collaboration, and connect business, government, and sectors, in order to address the water challenge in an unconventional and comprehensive way?

++	**Agents of change enhances wide-spread synergetic collaboration**	There is on-going build-up of productive and synergetic collaborations. Facilitators may even be administered to coordinate this through mediation and authority. There is a conception of the ideal collaboration composition
+	**Agents of change can push for collaboration between new stakeholders**	There is an understanding that water challenges requires long-term and integrated solutions. Hence, wide-spread collaborations between a variety of stakeholders and sectors are being established. New collaborations with unconventional actors, result, more and more, in valuable new insights and effective networks
0	**Agent are enabled to enhance conventional collaboration**	Traditional coalitions are preserved to maintain status quo. There is trust within these coalitions. There is limited space to create new collaborations. If new collaboration occurs solutions are still mostly sectoral and short- to mid-term
-	**Insufficient opportunities for collaborative agents**	There is insufficient opportunity for agents of change to go beyond conventional collaboration. The current collaborations are deemed sufficient to deal with the water challenge whereas the vision is limited to ad hoc command and control approaches
--	**Lack of collaborative agents**	Collaboration is discouraged, because of a strong hierarchical structure. There is distrust between stakeholders and the willingness and thereby opportunities for collaborative agents are largely lacking

Indicator 6.3: Visionary

Predefined question: To what extent are actors in the network able to manage and effectively push forward long-term and integrated strategies which are adequately supported by interim targets?

++	**Long-term vision supported by short-term targets**	Visionary agents of change in different positions and with different backgrounds actively and successfully promote a sustainable and tong-term vision regarding the water challenge, that is communicated clearly. Short-term targets fit the long-term visions. There is interest and employment in trend analysis.
+	**Long-term vision with flawed communication**	There is a clear long-term, integrated and sustainable-oriented vision. There is still some discrepancy between short-term targets and implementation strategies and the long-term vision from visionary agents of change. This means that agents are not always clear in their formulation regarding the effect and impact of envisioned strategies
0	**Defense of status quo**	The visions of the existing agents of change are limited to promoting the business as usual. They do not oppose nor promote long-term, integrative thinking. Interest or employment in trend analysis is limited
-	**Unilateral and short-term vision**	There is a unilateral vision regarding the water challenge, which considers a limited groups of actors. The vision often has a short-term focus, with a maximum of 3 to 4 years
--	**Deficient sustainability vision and short-term focus**	There is a lack of visionary agents that promote change towards a long-term, sustainable vision regarding the water challenge. Diverging expectations and objectives of stakeholders are the result. This may be evidenced by indecisiveness or even conflicts. Long-term and integrative initiatives may also be blocked

Condition 7: Multi-level network potential

Urban water governance involves a plethora of actors and interests from all levels of government, organizations and (private) stakeholders. For sustainable solutions, working in networks is an essential determinant for effective solutions.

Indicator 7.1: Room to manoeuver

Predefined question: To what extent do actors have the freedom and opportunity to develop a variety of alternatives and approaches (this includes the possibility of forming ad hoc, fit-for-purpose partnerships that can adequately address existing or emerging issues regarding the water challenge)?

++	**Freedom to develop innovative solutions**	There is a common and accepted long-term vision for dealing sustainably with the water challenge. Within the boundaries of this vision, actors are given the freedom to develop novel and diverse approaches and partnerships, resulting in continuous improvements and exploration. These partnerships are most likely institutionalized
+	**Redundancy to address uncertainty**	There is recognition that a high degree of freedom is necessary to deal with complex situations in the form of experiments and looking for new unconventional collaborations. There is a dynamic mix of cooperative partnerships and a redundant set of diverging alternative solutions. A clear overall vision to steer research is however lacking
0	**Limited room for innovation and collaboration**	Actors are given the means to perform predefined tasks for dealing with problems that are framed with a narrow, short-term and technical-oriented scope. There is limited room to deviate. Solutions are sought in own sectoral field and expertise
-	**Limited autonomy**	Only a few actors receive some degree of freedom, there are limited opportunities to develop alternatives, and there is hardly any opportunity to form partnerships with unconventional actors
--	**Strictly imposed obligations**	The actions of stakeholders are strictly controlled and there are rigid short-term targets. Freedom to form new partnerships is strongly limited as actor network composition is fixed and small. There are no resources made available for exploring alternatives that might be more effective or efficient whereas many actors that are affected by the water challenge do not have a voice

Indicator 7.2: Clear division of responsibilities

Predefined question: To what extent are responsibilities clearly formulated and allocated, in order to effectively address the water challenge?

++	**Dynamic, fit-for-purpose corporation**	There are many synergetic corporations within the urban water network that can provide solutions for the water challenge. The roles and responsibilities are clearly divided amongst actors. These corporations are dynamic and result in fit-for-purpose problem solving necessary to solve complex, multi-level and unknown challenges
+	**Innovative cooperative strategies**	Actors recognize that knowledge and experience are scattered within the local network. Therefore, extra effort is made to bundle the scattered expertise and to reach fit-for-purpose division of clear roles and responsibilities. New cooperation compositions are explored
0	**Inflexible division of responsibilities**	Responsibilities are divided over a limited set of conventional actors. Opportunities for new cooperation and more effective division of responsibilities are not seized or even recognized. Sometimes conventional actors get more tasks to deal with new water challenges
-	**Barriers for effective cooperation**	Authorities are fragmentized or they lack interest. Moreover, miscommunication and lack of trust are causes that block effective water governance
--	**Unclear division of responsibilities**	There is an unclear division of responsibilities and often the relationships are over-hierarchical. Everybody expects someone else to make required effort and trust is hardly found

Indicator 7.3: Authority

Predefined question: To what extent are legitimate forms of power and authority present that enable long-term, integrated and sustainable solutions for the water challenge?

++	**Strong well-embedded authority**	Long-term, integrated approaches regarding the water challenge are well embedded in policy and regulatory authorities. Authoritative figures receive much support both politically and by society. Their opinions and statements also receive much media attention
+	**Stirring authority**	There is recognition of the need for long-term and integrated approaches by both the public and the political arena. Sustainability approaches regarding the water challenge are now implemented as declarations of intent and sustainability principles in policy and regulation. Legitimate authorities are assigned to coordinate long-term integrated policy and implementation
0	**Restricted authority**	The water challenge is addressed as long as the status quo is not questioned. Long-term policy visions are limited and new policy mainly needs to fit into existing fragmentized structure. This means small (technical) changes are occurring
-	**Unfruitful attempts**	The water challenge is put forward by individuals or a groups of actors, but there is only little interest which is also fragile due to poor embedding of sustainability principles in current policy mechanisms, interests, and budget allocation. The challenge may have been mentioned in reviews or reports but left unaddressed
--	**Powerlessness**	The addressing of the water challenge is regularly overruled with contradicting and competing interests and so it is hardly included in policy, regulation or administrative principles

Condition 8: Financial viability

Sufficient financial resources are crucial for good water governance. Willingness to pay for water challenge adaptation services is important to gain access to reliable funding for long-term programs. At the same time, water and climate adaptation services need to be affordable for everyone including poor people or people being disproportionally affected.

Indicator 8.1: Affordability

Predefined question: To what extent are water services and climate adaptation measures available and affordable for all citizens, including the poorest?

++	**Climate adaptation affordable for all**	Programs and policies ensure climate adaptation for everyone. This includes public infrastructure and private property protection. The solidarity principle is clearly percolated in policy and regulation
+	**Limited affordability of climate adaptation services**	Serious efforts are made to support climate adaptation for everyone, including vulnerable groups. There is often recognition that poor and marginalized groups are disproportionately affected by the water challenge. This is increasingly addressed in policy and regulation
0	**Unaffordable climate adaptation**	Basic water services are affordable for the vast majority of the populations, however poor people and marginalized communities have much difficulty to afford climate adaptation measures to protect themselves against impacts such as extreme heat, flooding or water scarcity.
-	**Limited affordability of basic water services**	A share of the population has serious difficulty to pay for basic water services such as neighbourhoods with low-income or marginalized groups. There is hardly any social safety net regarding water services, let alone for climate adaptation measures
--	**Unaffordable basic water services**	Basic water services are not affordable or even available for a substantial part of the population. This may be due to inefficient or obsolete infrastructure, mismanagement or extreme poverty

Indicator 8.2: Consumer willingness to pay

Predefined question: How is expenditure regarding the water challenge perceived by all relevant stakeholders (i.e., is there trust that the money is well-spent)?

++	**Willingness to pay for present and future risk reductions**	The water challenge is fully comprehended by decision-makers. There is political and public support to allocate substantial financial resources. Also expenditure for non-economic benefits is perceived as important. There is clear agreement on the use of financial principles, such as polluter-pays- and user-pays- or solidarity principle
+	**Willingness to pay for provisional adaptation**	Due to growing worries about the water challenge, there are windows of opportunity to increase funding. However, the perception of risk does not necessarily coincide with actual risk. Financial principles, such as polluter-pays principle, may be introduced. Due to inexperience, implementation is often flawed. Focus groups decide on priority aspects regarding the water challenge, but there is confusion regarding the extent and magnitude of the water challenge
0	**Willingness to pay for business as usual**	There is support for the allocation of resources for conventional tasks. There is limited awareness or worries regarding the water challenge. Most actors are unwilling to financially support novel policies beyond the status quo. Generally, there is sufficient trust in local authorities
-	**Fragmented willingness to pay**	Willingness to pay for measures addressing the water challenges are fragmented and insufficient. The importance and risks are perceived differently by each stakeholder. Generally, their estimates of the cost are substantially lower than the actual costs
--	**Mistrust and resistance to financial decisions**	There is a high level of mistrust in decision making of resource allocation. At this level financial decisions are based on prestige projects, projects that benefit small groups or specific interests. As expenditures often do not address the actual water challenges, there is a high degree of resistance regarding resource allocation

Indicator 8.3: Financial continuation

Predefined question: To what extent do financial arrangements secure long-term, robust policy implementation, continuation, and risk reduction?

++	**Long-term financial continuation**	There is secured continuous financial support for long-term policy, measures and research regarding the water challenge. These costs are included into baseline funding. Generally, both economic and non-economic benefits are considered and explicitly mentioned
+	**Abundant financial support with limited**	Abundant financial resources are made available for project based endeavours that are often exploring new solutions but lack long-term resource allocation or institutionalized

	continuation	financial continuation. Hence, long-term implementation is uncertain
0	**Financial continuation for basic services**	Financial resources are available for singular projects regarding basic services of the water challenge. The allocation of financial resources is based on past trends, current costs of maintenance and incremental path-dependent developments. Costs to deal with future water challenges are often not incorporated. Limited resources are assigned for unforeseen situations or calculated risks
-	**Inequitable financial resource allocation**	There are potential resources available to perform basic management tasks regarding the water challenge, but they are difficult to access, are distributed rather randomly and lack continuity. No clear criteria can be found on the resource allocation. Resources allocation is ad hoc and considers only short-time horizons
--	**Lack of financial resources**	There are insufficient financial resources available to perform basic tasks regarding the water challenge. Financing is irregular and unpredictable leading to poor policy continuation

Condition 9: Implementing capacity

Implementing capacity is about the effectiveness of policy instruments with respect to the water challenge. Part of the effectiveness is also due to the level of compliance to policy and regulation and the familiarity with (calamity) action plans.

Indicator 9.1: Policy instruments

Predefined question: To what extent are policy instruments effectively used (and evaluated), in order to stimulate desired behaviour and discourage undesired activities and choices?

++	**Effective instruments enhance sustainable transformations**	There is much experience with the use of policy instruments. Monitoring results show that the current use of instruments proves to be effective in achieving sustainable behaviour. Continuous evaluation ensures flexibility, adaptive capacity and fit-for-purpose use of policy instruments
+	**Profound exploration of sustainability instruments**	Instruments to implement principles such as full cost-recovery and polluter-pays principle, serve as an incentive to internalize sustainable behaviour. The use of various instruments is explorative and therefore not yet optimized and efficient. The use of instruments is dynamic. There are a lot of simultaneous or successive changes and insights
0	**Fragmented instrumental use**	Policy fields or sectors often have similar goals, but instruments are not coherent and may even contradict. Overall instrumental effectiveness is low and temporary. There is sufficient monitoring and evaluation leading to knowledge and insights in how instruments work and actors are getting a more open attitude towards improvements
-	**Unknown impacts of policy instruments**	Instruments are being used without knowing or properly investigating their impacts on forehand. The set of instruments actually leads to imbalanced development and inefficiencies that are hardly addressed
--	**Instruments enhance unsustainable behaviour**	Policy instruments may enhance unwanted or even damaging behaviour that opposes sustainability principles, e.g., discount for higher water use stimulates spilling and inefficiency. There is hardly any monitoring that can be used to evaluate the counterproductive effects of these policy instruments

Indicator 9.2: Statutory compliance

Pre-defined question: To what extent is legislation and compliance, well-coordinated, clear and transparent and do stakeholders respect agreements, objectives, and legislation?

++	**Good compliance to effective sustainable legislation**	Legislation is ambitious and its compliance is effective as there is much experience with developing and implementing sustainable policy. Short-term targets and long-term goals are well integrated. There is a good relationship among local authorities and stakeholders based on dialogues.

+	**Flexible compliance to ambitious explorations**	New ambitious policies, agreements and legislations are being explored in a "learning-by-doing" fashion. Most actors are willing to comply. Some targets may be unrealistic and requires flexibility
0	**Strict compliance to fragmentized legislation**	Legal regulations regarding the water challenge are fragmented. However, there is strictly compliance to well-defined fragmentized policies, regulations and agreements. Flexibility, innovations and realization of ambitious goals are limited. Activity may be penalized multiple times by different regulations due to poor overall coordination
-	**Moderate compliance to incomplete legislation**	The division of responsibilities of executive and controlling tasks is unclear. Legislation is incomplete meaning that certain gaps can be misused. There is little trust in local authorities due to inconsistent enforcement typically signalled by unions or NGO's
--	**Poor compliance due to unclear legislation**	Legislation and responsibilities are unclear, incomplete or inaccessible leading to poor legal compliance by most actors. If legislation is present it enjoys poor legitimacy. Actors operate independently in small groups. Fraudulent activities may take place

Indicator 9.3: Preparedness

Predefined question: To what extent is the city prepared (i.e. there is clear allocation of responsibilities, and clear policies and action plans) for both gradual and sudden uncertain changes and events?

++	**Comprehensive preparedness**	Long-term plans and policies are flexible and bundle different risks, impacts and worst case scenarios. They are clearly communicated, co-created and regularly rehearsed by all relevant stakeholders. The required materials and staff are available on short-term notice in order to be able to respond adequately. Evaluations on the rehearsals or reviews on dealing with calamities are available
+	**Fragmented preparedness**	A wide range of threats is considered in action plans and policies. Sometimes over-abundantly as plans are proactive and follow the precautionary principle. Awareness of risks is high, but measures are scattered and non-cohesive. They may be independent or made independently by various actors. Allocation of resources, staff and training may therefore be ambiguous
0	**Low awareness of preparation strategies**	Based on past experiences, there are action plans and policies addressing the water challenge. Actions and policies are clear but actual risks are often underestimated and the division of tasks is unclear. They are not sufficient to deal with all imminent calamities or gradually increasing pressures. Damage is almost always greater than is expected or prepared for
-	**Limited preparedness**	Action plans are responsive to recent calamities and ad hoc. Actual probabilities and impacts of risks are not well understood and incorporated into actions or policies. Reports can be found on how the water sector deals with recent calamities
--	**Poor preparedness**	There are hardly any action plans or policies for dealing with (future) calamities, uncertainties and existing risks. The city is highly vulnerable

Appendix H: Interview responses

Respondent 1: Research Associate (African Climate and Development Initiative, University of Cape Town)

Response summary:

Awareness

There has always been a high level of awareness around flood risk. There have been challenges regarding flood risk in the City for a long period of time and so these have been resolved over time. Areas prone to flood risk are mainly informal settlements and a lot of work has been done to address flood risk in these areas. Awareness over a long period of time has been able to incrementally improve flooding.

However, with regards to water scarcity, awareness was low before the 2015 -2018 drought. South Africans have been used to living in a water-stressed country and have taken for granted that water has always been available to them. For this reason, water scarcity has not been high on the agenda amongst City officials neither has it been high on the agenda of environmental lobby groups. Since the drought, the City of Cape Town (CoCT) has done a lot of work to increase awareness.

Division of responsibilities

Water management can be tricky due to mandates that cause tension between local, provincial and national government (each sphere of government has set responsibilities). Respondent states that the drought could encourage more collaborative work between the three spheres, this could also increase awareness of issues such as water scarcity.

Sense of urgency

Flood risk has long been a challenge for Cape Town. There has thus been a high sense of urgency to address flood risk in the City. The City has been proactive by being on guard, warning people and going to flood prone areas before the rainy season and anticipated flood events.

The drought has resulted in an increased sense of urgency, both amongst residents and municipality, to address issues of water scarcity.

Respondent notes that owing to the fact that the Cape Town is opposition-led; the City is risk averse and tries by all means to avoid political criticism. For this reason there is always a sense of urgency in the City to ensure that critical issues that have an effect on people's lives, such as flood risk and water scarcity are addressed promptly.

Behaviour change

There has been a degree of behaviour change with regards to flooding in the City. For instance, homes in informal areas are increasingly being built with more raised floors.

Respondent has noticed a lot of behaviour change, especially amongst middle to upper income residents. Various rate payers associations and neighbourhood initiatives are starting to focus more on water.

Stakeholder learning

The respondent states that while working in local government, it was important to liaise closely with other departments and branches. For instance, while involved in the development of climate change adaptation plans for the City, the respond was liaising closely with colleagues from disaster risk management department.

In 2009/10 'The Climate Change Think Tank' (a knowledge transfer programme) was used to bring decision-makers and academics together to facilitate cross-stakeholder learning.

Information availability
The South African Weather Services (SAWS) sends out flooding warnings to the City. Only SAWS is allowed to give these warnings, this is to ensure that fake warnings are avoided.

Respondent notes that there is a degree of frustration amongst academics who have produced climate change research that highlighted drying trends for Cape Town. The information has been communicated to the local municipality over the years. Academics feel that the research was not taken up by the municipality until the 2015 drought.

Evaluation
Reporting in government is an onerous process and can be quite meaningless. Government focuses more on compliance rather than evaluation on policy, plans and programmes. Respondent emphasises that it is really out of evaluation that true learning can occur.

The Disaster management function of the City has been a useful example of ongoing engagement with other local government departments as well as with the public.

Authority
Respondent states that in the City, the mayor is quite powerful in setting the tone of the City. The Mayoral office plays a huge role in the type of information that will be communicated to the local municipal structures and this is also influenced by what the Mayor perceives as being important. The current Mayor of Cape Town has bought into the climate change narrative and has been actively involved in the C40 and 100 Resilient Cities global climate change networks for cities. This has the potential for climate change issues such as flood risk to be placed high on the City's agenda.

Realistic and ambitious management
The respondent notes that the City looks 'good on paper'. However, the City has fallen short on implementation. The City has been a leader with regards to climate change; however that is not always translated on the ground.

Respondent however, also notes that stormwater systems are often cleaned prior to heavy rains/storms in the City. This is to ensure that the risk of flooding is reduced.

Respondent also states that the general attitude in the City is to continue with business as usual until there is an issue; hence flooding is always on the agenda as it occurs on a yearly basis.

Entrepreneurial agents
Respondent states that in the City of Cape Town, business is an anchor tenant in policy. Politicians aim to keep the business sector happy, as opposed to taking on a socialist approach. Some private sector actors have access to opportunities and to officials within the city, whilst residents do not have access. Respondent states, for example, that the resident association the respondent belongs to relies heavily on the respondent to get access to local government structures. This is owing to the fact that respondent is a former local government employee.

Policy
Respondent states that owing to the fact that there is no National legislation addressing the issue of climate change it is difficult to work effectively in the climate change space in the City. Certain city officials are willing to work in the space and others are not. For this reason, only people who are willing work together. This does not create an enabling environment for climate change related issues such as flood risk to be addressed.

Ad hoc partnerships
Respondent notes that it is not easy for local government structures to partner up with other organisations such as universities, NGOs and businesses. These ad hoc partnerships are constrained by complex procurement legislation. There is limited flexibility.

Respondent 2: City official (Department of Water and Sanitation, Water Demand Management and Strategy Branch)

Response summary:

Information availability
The respondent states that there is information available to guide decision-making in the City. The City is continuously collecting and building on information to ensure that decision-making is based on reliable and coherent information.

Ambitious and realistic management
In terms of water scarcity the City sets different management goals and interventions depending on forecasted rainfall probability and demand patterns. For instance, in the current drought period the City has different initiatives and interventions, such as looking into alternative water supply sources such as desalination and groundwater sources. The drought has resulted in the municipality adopting a new management approach called the 'new normal' in which the City will have make use of different water sources to the water supply system. The Cape Town water supply system has been depending too much on the dams. This is to ensure that even after the current drought the City will try to exist as a 'water sensitive city'.

Policy
The respondent confirms that there are policies and regulations addressing water scarcity in the City, and are approved by the City Council. All water related policy is informed by national laws: the National Water Act and the National Water Services Act. The City tries to develop various water policies and try to ensure that these are beneficial for the various communities in the City.

Stakeholder inclusiveness
Including a wide range of stakeholders in workshops and decision-making processes has only become more defined and formal now as a result of the water crisis. Prior to this, stakeholders have only been making inputs in 'informal' ways. The respondent states that even before the drought they have always been working together with various academics to get their inputs on various issues regarding water scarcity.

The Western Cape Water Reconciliation Strategy also involves different industry stakeholders who meet periodically to discuss water supply/demand issues and water plans in the Western Cape.

Discourse embedding
The respondent emphasises the importance of considering the different contexts in the City when addressing water scarcity and implementing measures in various communities. The respondent states that for instance when considering wastewater reuse, some religious groups have issues with this. It is important for the City to understand how and whether certain groups would adapt. It is important for the City to engage with various community groups regarding their acceptance of alternative water sources.

Evaluation
In addition the City has a Water Demand Management Strategy, which summarises all the water demand management goals for the City. It was developed in 2007 after the City experienced a severe drought. The strategy is currently being reviewed to ensure that new information regarding water scarcity (and events such as the drought) in the City is integrated into planning tools such as the Water Demand Management Strategy.

The City also has performance management systems at each employment level in the local municipality. These systems measure and evaluate the performance levels of city officials to ensure that city employees are meeting performance targets so that water challenges are addressed in an effective and efficient measure.

Affordability
Affordability is a relative word. During times of crisis (such as the drought), people seem to be able/willing to afford more. People are paying a lot of money installing water saving technologies such as rainwater harvesting systems and pool covers at their homes.

Low-income households can also find something that works for them. E.g. in informal settlements, people can do their own rainwater harvesting with a bucket.

Preparedness
According to the respondent the City was prepared for a water crisis in 2015. However, the City was not prepared for a severe water crisis as experienced in 205 – 2017.

The City's water conservation and demand management systems and plans are developed based on a confidence level. Normally the City plans are based on a 98% confidence of success for the water supply system. At this point the City has been experiencing extremes over a number of years (2015 0 2017).

In order to improve preparedness the City has started exploring different ways to address the water crisis. This has been done through creating ad-hoc task teams and sending out educational messages to the public to encourage water saving. In addition the City is also planning for a worst-case scenario (when dams run dry), which has been termed 'day zero'. The ad-hoc task teams have explored various measures to put in place to avoid 'day zero' and measures to deal with 'day zero' in the event that it occurred.

Respondent 3: Practitioner, water analyst (GreenCape)

Response summary:

Collaborative and visionary agents
GreenCape Water team does different types of sector development work. GreenCape works with water technology businesses who are trying to operate within the green economy, and tries to map out what the opportunities and barriers for business to operate in the green economy. GreenCape also works with the government to help create an enabling environment for businesses to operate in the green economy by advising government on policy, By-laws and incentives that hinder or promote these businesses. GreenCape also goes beyond trying to identify the issues and barriers in the water sector. The sector development agency also runs projects in order to produce practical products to address the barrier.

Sense of urgency
Respondent agrees that there is an increasing sense of urgency from the City to address water scarcity, and there has been a significant shift due to the water crisis. From the respondent's experience, in 2017 there has been a rapid acceleration in terms of the City realising that water scarcity is a really big issue that they have to think about, not only right now, but also longer term. This is especially owing to the fact that it is highly possible that a drought of this magnitude may be a recurring event in the City.

The appointment of a Chief Resilience Officer is an example of the way the City is really trying to engage addressing water scarcity for the long-term, and not only looking at large scale supply augmentation, but trying to start to change its water management approach.

City officials are also starting to talk about the concept of a Water Sensitive City, which the respondent acknowledges was not part of the narrative of water management in the City.

Stakeholder inclusiveness
GreenCape has also been invited to sit on the multi-stakeholder Water Resilience Task Team that will be working on developing measures for addressing the Cape Town water crisis.

Authority
GreenCape has funding from the City of Cape Town municipality to help businesses adapt to water scarcity. This project has been funded by the mayor's office, firstly because the local department of water and sanitation is bound by strict budgets and complicated procurement processes (money from the mayor's office can be used more flexibly). Secondly, the mayor is able to fund such processes because the project will drive economic outcomes.

Behaviour change
Respondent notes that there has been a significant appreciation of the value of water and how important water is. It is obviously going to be very interesting to see how people's behaviours will change when the drought ends. The drought has resulted in an increased awareness to conserve water, for example people are trying to save water during their day-to-day processes for reuse in their own households.

Affordability
The water crisis (2015 – 2017) has resulted in a significant shift in understanding how important water is for livelihoods as well as for the sustainability of the City. For wealthier residents, we are seeing some investments starting to take place such as pool covers, rainwater and greywater system installations etc. some wealthier residents in the City also still wanting to have gardens but are looking at ways to try to reduce their reliance on the potable water system and they are starting to consider other options such as boreholes, greywater and rainwater use to water their gardens. For the some of the wealthier residents, behaviour change may not be driven by cost saving and contributing to the greater good; it is more related to maintaining the same standard of living in a water scarce environment.

Preparedness
From a preparedness perspective the City had some level of preparedness to address issues of water scarcity, based on water supply augmentation plans outlined in the Western Cape Water Supply System Reconciliation Strategy. However, the respondent does not think the City was ready for the scale of this drought and that it is going to take the City a very long time to recover from it.

A lot of the plans that the City was trying to implement for addressing water scarcity were not being implemented but being pushed out further and further. This is mainly because augmentation measures usually come at a high capital cost (expensive) and therefore there was no political will to prioritise it from a budget perspective. The drought has changed all of that because now the mayor and the other councillors recognise water scarcity as one the biggest priorities they have to deal with right now.

Respondent 4: Practitioner, Climate change, energy and resilience (International Council for Local Environmental Initiatives [CLEI])

Response summary:

Awareness
Respondent states that the Cape Town drought has drastically increased awareness around water scarcity and how important it is. In South Africa we live in a semi-arid environment but we don't really take into account where the water really comes from when we open our taps. Over the last 20 years climate change has helped increase awareness amongst most people.

In the time that we're living in, increasing population numbers putting stress on resources has resulted in increased awareness. Some of the social media campaigns that the Cape Town municipality have employed have been quite

successful. The respondent is on Facebook and that has been one of her main information platforms for receiving information regarding awareness around water scarcity.

The City's communications department has had to be quite sophisticated in tailoring the message for different economic groups in the City and doing it in such a way that it is not just doom and gloom to encourage citizens to take action and make a change.

Behaviour change

There currently is behaviour change regarding the challenge of water scarcity in the City, but maybe not to an extent we would have liked to see in such a short period of time. Causing behavioural change is a long-term process, and that's what we're asking ourselves and others to do. People struggle to change their behaviour when it becomes inconvenient, in addition some of the measures we need to take are expensive and people may not be willing to dip into their pockets to do that.

Respondent states that in her own area where she lives, she has seen people taking behaviour change very seriously E.g. neighbours monitoring each other's water saving and wasting practices and holding each other accountable.
Behaviour change is also influenced by what the hook is for people to actually adopt water-saving practices: for some it may be about the greater good and for others it may only be about avoiding fines (non-compliance to water restrictions) etc. So the City has had to take many different approaches to try getting everybody to bring the consumption down.

Awareness

The City of Cape Town has been running various campaigns to raise awareness about water scarcity and the current water crisis. It has been very important for the City's communications department to tailor public awareness campaigns so that they reach different economic groups and to do it in such a way that it does not create panic regarding the water crisis, but rather encourages people to want to adopt sustainable water-use practices.

Information

From a climate change perspective, there is a challenge of getting the science of climate change communicated to city officials in the way that they can utilise the information effectively.

It is important to get producers of climate science and practitioners closer together to ensure that the information feed is both ways. E.g. scientists often cannot downscale models to fine scales due to uncertainties of global climate models, but city officials are constantly calling for more sophisticated and fine-scaled science. There needs to be a middle ground where scientists feel happy that the information they're giving is fair, adequate and takes into account uncertainties but it still useable by city officials. There is still a lot of learning to go to get to that point, and that is frustrating from a science perspective because scientists want to see action and sometimes City practitioners can't act if they do not have more specific information.

Agents of change

Respondent states that innovators need to play an increasing role in being agents of change in addressing the challenge of water scarcity in Cape Town. For instance the City hosted a water innovation indaba (exhibit) where businesses and citizens were able to showcase water saving technologies that can be used to address water scarcity.

Organisations such as ICLEI also plays a role as an agent of change in addressing issues such as water scarcity and flood risk in cities. The organisation plays a role in trying to bring together different stakeholders and be a knowledge broker between them in order to facilitate learning.

Preparedness

Respondent acknowledges that planning in local government is a complex task and that despite the fact that science may have predicted drought conditions for the City, some events such as the current water crisis are worse than could have been predicted. It is therefore difficult to say the City was ill-prepared for serious challenges of water scarcity.

Respondent 5: City official (Department of Strategic Governance)

Response summary:

The water task team was put together to establish suitable short to long-term measures for addressing water scarcity (in particular the 2015 2017 drought) in Cape Town. This multi-stakeholder task team included several working groups, one of which the respondent is a part of. Working group is currently looking into water related policy and how policy can be used as an intervention to address water scarcity challenges in Cape Town. Respondent states that the issue with current water related policy is implementation of policy. The drought has therefore created an opportunity for policy learning and evaluation in the City.

For instance with regards to building plans, respondent states when approving building plans in the City, it is important that the resilience aspects of a building are considered. For instance sustainable water-use measures, such as Sustainable Drainage Systems (SuDS) which addresses issues of flood risk and water quality; and potable water-saving measures such greywater and stormwater storage systems. Despite the fact that the City has two stormwater policies which aim to address flood risk at development scale, there are loopholes in the policy which result in certain developments not including SuDS in plans.

Respondent emphasises that despite the fact that Cape Town has policies to address water challenges, the various policies do not work well together, and may create an incoherent policy landscape. Respondent states that there is a lack of common themes between policies. Respondent suggests that this gives people (city officials) a loophole to pick and choose which policies to implement and which to possibly ignore.

Considering a variety of options

The City does try to consider a variety of options, in certain instances, to ensure that water resources are used and managed in a sustainable way. For instance, a variety of options were considered for irrigating Green Point Urban Park. The options that were considered include rainwater harvesting and diverting a stream from the mountain (Table Mountain) into storage at the park and desalination. Costing analyses have been done for each option in order for local government to select the cost effective and more sustainable option.

Capacity

Respondent states that there is also a lack of expertise for ensuring that policy is implemented correctly in the City. Respondent suggests policy training as an imperative aspect of improving implementation capacity.

Respondent 6: City official (Department of Water and Sanitation, Wastewater Treatment Works Branch)

Response summary:

Respondent states that it is imperative that they consult various stakeholders in certain aspects of their work. The local department of environmental affairs is one of the various departments the wastewater treatment branch often consults and tries to work closely with. Community and political organisations (such as ward councillors) are also amongst key stakeholders engaged with. Academics from various universities as well as consultants are also engaged with, especially with the aim of facilitating cross-stakeholder learning.

Implementing Capacity
Respondent states that a lack of capacity in the form of expertise is definitely an issue for the City, especially in the water field. There is a lack of skilled individuals such as water engineers who are mostly working in the private sector as consultants. He recognises this as one of the barriers to successful implementation of policy and plans.

Financial continuation
The respondent states that it is common for municipalities to feel like their budgets are not sufficient to satisfy the amount of work that needs to be done. The wastewater treatment branch aims to satisfy people's basic needs in terms of wastewater treatment and developments. Cape Town is developing at a rapid rate both in terms of formal and informal sectors. This means that more money is constantly spent on wastewater infrastructure to ensure that new developments are serviced. Therefore according to the respondent, much of the wastewater treatment branch's budget is spent on refurbishment and maintenance of old infrastructure as well as installing new infrastructure.

Management ambitions
The management ambitions for wastewater treatment in the City are driven by the need for sufficient wastewater infrastructure and the need to ensure that wastewater treatment processes do not adversely affect the environment.

Alternatives
In wastewater treatment changes in technology are happening so rapidly, it is thus important to keep up to date with new technologies. Respondent states that consultants often play a role in informing and updating City officials about new wastewater treatment technologies on the market.

Reclamation of water for drinking purposes will be piloted in the City soon. For this reason, there is a drive for wastewater improving its quality and also changing its technologies to make sure that treated effluent transferred to bulk-water treatment plants is of satisfactory quality to be treated further to potable standards.

Entrepreneurial agents
Treated effluent from wastewater treatment processes is sold to business for industrial use, agricultural use as well to irrigate city parks and open spaces. Respond states that the municipality is encouraging more businesses to start using treated effluent as a result of the drought.

Respondent 7: City official (Environmental Management Department, Coastal Management Branch)

Response summary:

Respondent notes that there are collaborations and committees such as the water resilience task team being formed to address the water crisis. However, respondent fears that once the water crisis is over the cross-stakeholder approach to addressing water scarcity will fizzle out.

Respondent also expresses that there is a lost opportunity in having a strong relationship between academia and government. The respondent notes that research hardly translates to the work government does. On the other hand, many government officials are not reading academic papers. This has resulted in a knowledge gap for addressing water challenges such as flood risk and water scarcity. For this reason, a lot of money is paid to private consultants, by government, to do research that could be done in academic institutions. Respondent states that there would be better value for public money to fund research initiatives.

However, respondent notes that one of the barriers to funding research initiatives at academic institutions is strict government procurement processes that are in place to prevent corruption.

With regards to cross-stakeholder learning and collaborative work across local government departments, the respondent states that the intention is to work collaboratively but there are also empires and silos that hinder collaboration.

Knowledge

Climate change research involves predicting the likely hood of flood and drought events that will happen in the future. Respondent states that owing to the uncertainty of climate change research it is difficult for governments to incorporate it into the policy environment at local government level. This is particularly because politicians are working on a five year cycle. Politicians are getting 'squeezed' by a whole lot of other factors such as economic growth, housing, water and sanitation etc. In addition to this, politicians want hard evidence, and as soon as information is not absolute, no decisions are made.

Planning

Planning for addressing issues of water scarcity and flood risk require that climate change is taken into consideration and incorporated into policy. The respondent states that it takes very strong political leaders to make decisions now that will be in the best interest of the City in thirty years. Short-term goals seem more beneficial, and so the natural response is to deal with the challenges of flood risk and water scarcity. This affects policy and planning.

Respondent states that over the last twenty years lobbying and advocacy work has helped to get topics of water scarcity, flood risk and climate change on the political agenda. This has resulted in Cape Town's policy steps over the last twenty years addressing challenges of flood risk and water scarcity to an extent. Although this is the case, policy requires successful implementation and sometimes there is disconnect between policy and implementation in Cape Town. For instance the respondent notes that some of the City's policies are not binding

Agents of change/Authority

The mayor is recognised as a champion in encouraging the incorporation of climate change and resilience in addressing issues of water scarcity and flood risk in the City. The mayor is active in the 100 Resilient Cities and C40 foundations.

Stakeholder inclusiveness

Respondent states that stakeholder inclusiveness is only done for formality in the City (particularly with regards to citizens/public participation). Respondent states that there is some stakeholder inclusiveness, however it is difficult to pin point how and where it happened or is happening. Politicians get to decide everything in the local government (in theory they are representing the will of the people who elected them). Respondent states however that some political structures such as sub-council do hold community engagement meetings, but often the public does not attend meetings, resulting in no public consultation. In the event that meetings are successful, not all issues raised by the public are taken into account. This is mainly because of the fact that some issues are complex and decisions have to be based on the best interests of marginal groups.

Clear division of responsibilities

There are clear divisions of responsibilities for each local government department. Each department follows a strict mandate which sets out roles and responsibilities.

Preparedness

Respondent notes that the rate of demand on Cape Town from the urban population is massive. The City is, in a way, always running in crisis mode. For this reason there may be limited time to sit back and plan for the future when the City is dealing with one crisis after another. For example fires, floods, protests, traffic and drought.

Urgency

The respondent recons that the current drought (2015 – 2017) is a learning curve for the City, and water scarcity will be taken seriously in the future. Before the drought the City underestimated the value of water. A City collapses without water! There are negative impacts on health, economy, and social unrest.

The respondent also notes that a sense of urgency to address a specific challenge always increases in times of crisis. For instance an energy crisis experienced in the country resulted in an increased sense of urgency to address energy issues

in the City. The same has been the case for flood risk in the City, winter rains often result in floods especially in the City's informal settlements. This has resulted in a high sense of urgency to address the challenge of flood risk.

Affordability
Respondent notes that adaptation measures for water scarcity and flood risk are not available to the most vulnerable and marginalised groups. However, these groups have probably found ways to adapt to water scarcity and flood risk.

Expenditure
Most people do not really know how the City spends its money, despite the fact that the City's budget is accessible to the public. Respondent notes that the public really only engages when their pockets are affected.

Respondent 8: Academic (African Climate and Development Initiative, University of Cape Town)

Response summary:

Cross-stakeholder learning
Research collaborations between city officials and academia are essential for cross-stakeholder learning. Mistra Urban Futures is an example of a two-way learning initiative between city officials and academics. The initiatives involved academic researchers being embedded in local government structures to conduct research, whilst city officials spent time at the University of Cape Town writing-up on City projects, policy analysis and research for publication. The two-way knowledge transfer allowed for academic institutions and local government to engage in research initiatives that are of common interest to both stakeholder groups.

Another two-way learning initiative which followed a similar format to Mistra Urban Futures is the Climate Change Think Tank. The Think Tank involved the commissioning of research work to, one of which was research conducted by the respondent. This research focused on how stormwater management and planning in Cape Town needs to change in order to accommodate the projected changes of the City's climate.

The respondent also notes that the Climate Change Think Tank contributed towards the knowledge and some of the stakeholder relations that made it possible to create a receptive environment for the development of the City's first climate change policy which addresses challenges of water scarcity and flood risk.

Stakeholder inclusion
Respondent acknowledges that a lot of the stakeholders involved in pushing the water resilience agenda in the City are often the same people. These stakeholders are often involved in accumulating knowledge and creating networks of people who advocate for sustainable management of water resources in the City. These networks include academics, city officials, consultants and other practitioners.

With regards to public participation there are clear public participation rules that have to be followed; however these do not always translate in practice. Invitations for public participation are often published in newspapers, in libraries etc. The public does not always attend public participation engagements and some meetings are disproportionally represented. In water management public participation is mainly driven by complaints.

Sense of urgency
Respondent notes that some of the local government branches have been sceptical about climate change; however since the current drought (2015 – 2017) these departments have become receptive to the climate change message. Prior to the drought, population growth and water demand has been at the top of the water management agenda.

Now there is a useful sense of urgency. Respondent states that the City has to make the best of the water crisis to adopt more long-term resilient and sustainable measures.

Policy learning
Respondent thinks that the City in general is quite poor at policy learning in a systematic sense. Policy learning is not well institutionalised. Respondent states that although this is the case there are city officials who, in their own capacity, are interested to learn from policy and implementation and who use learning to influence making adjustments to policy where possible.

Clear division of responsibilities
There is a very clear mandate and legislation on what the roles and responsibilities of local government are. These stem from the National Constitution as well as the sectoral Acts. The areas of ambiguity emerge with incorporating concepts, such as Sustainable Drainage Systems (SuDS), Water Sensitive Urban Design (WSUD), Integrated Water Resource Management (IWRM), sustainability and climate change adaptation which call for city officials to think outside of the box and work collaboratively. The respondent notes that city officials, especially younger staff, are aware of terms such as SuDS, IWRM and WSUD but are hamstring by mandates, budget and failed attempts at collaboration.

Respondent 9: City Official (Department of Water and Sanitation, Bulk Water Branch)

Response summary:

Clear division of responsibilities
There are clear divisions of responsibilities for each local government department. Each department follows a strict mandate which sets out roles and responsibilities.

Sense of urgency
The City has always had intention to manage and govern water resources more sustainably. The drought has given the local government a push to act on intention and plans that were expressed in the Western Cape Water Supply System Reconciliation Strategy.

Learning
City officials learn from other cities and towns where sustainable water management approaches have been adopted. Respondent states that Cape Town aims to learn from the town of in the Western Cape Province South Africa. Atlantis has been recycling stormwater runoff and treated domestic wastewater for potable use for four decades.

Agents of change
The private sector plays an important role in supporting a transition towards sustainable water-use and management practices. A lot of green buildings, alternative solutions are being incorporated into private development. The private sector is starting to challenge the norm.

GreenCape is a sector development agency that aims to support the growth of the green economy plays an important role in the water sector. GreenCape supports businesses that want to enter the green economy, the organisation is therefore an important agent of change in the water sector.

Policy
It is the responsibility of local government to create an enabling environment for sustainable use of water resources in the City in order for water challenges to be addressed. This has been done through policy and legislation that governs different aspects of water management in the City. What is important at this point is to ensure that the principles of sustainability are incorporated into policy-making in order for the philosophy and approach for water management in the City to be underpinned by principles of sustainability.

Affordability

Respondent identifies affordability as a factor that should encourage the use of alternative, diverse water supply sources in the City. Transporting water from water sources (dams) that are far out of the City is costly. Decentralising is therefore an important cost saving method which also guarantees sustainable water-use and management practices.

Stakeholder inclusiveness

Respondent states that there is limited public participation as project level. Although this is the case, the City does conduct public participation on broader and integrated issues.

Respondent 10: Consulting Engineer

Response summary:

The respondent highlights an aspect of the key role that engineers (consultants) play in the transition towards a Water Sensitive Urban Design (WSUD) approach in Cape Town.

An important point raised by this respondent is the fact that non-consultants (such as academics and City officials) are often the proponents of alternative approaches such WSUD. This is however not enough, as it is important that consultants also buy into these approaches, in order for implementation to take place on the ground. If engineers have not bought into approaches such as WSUD they will not sign off on development plans that include the implementation of alternative approaches.

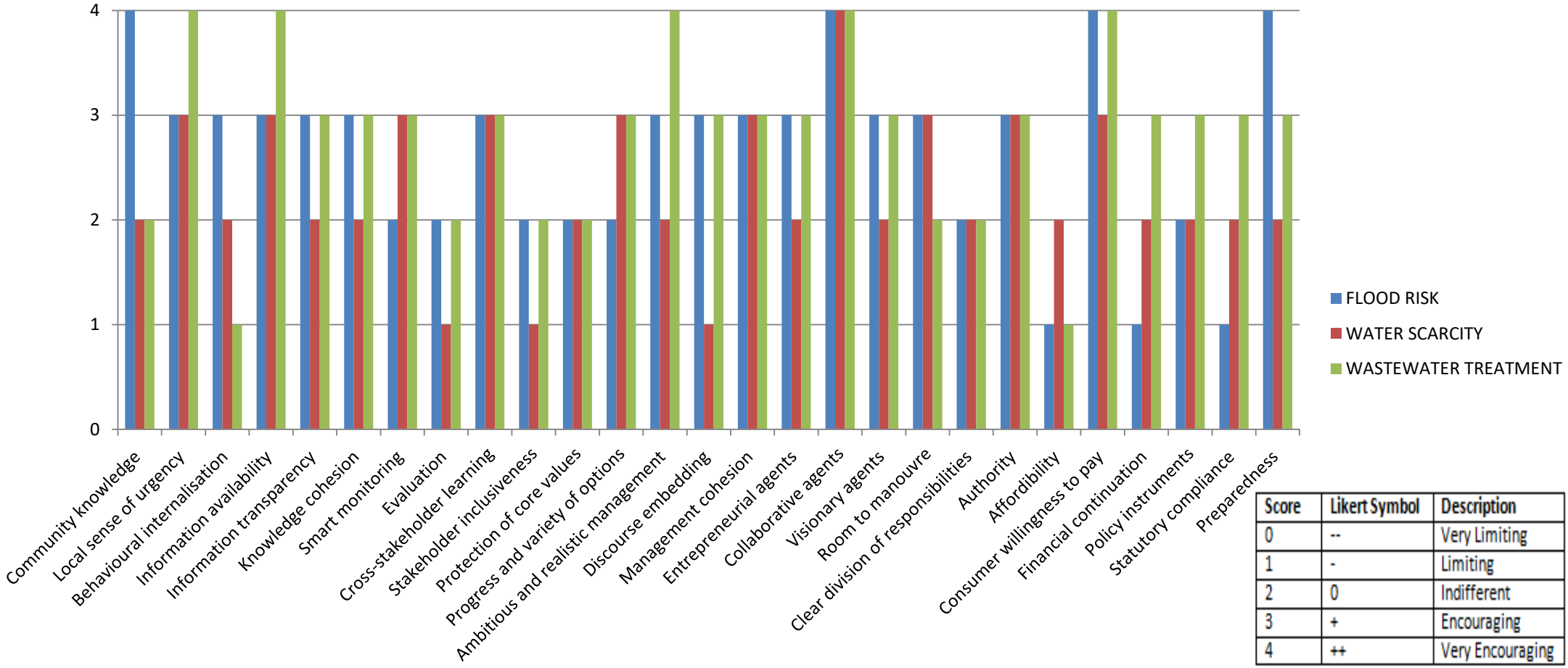
As such, the respondent highlights the fact that it is important for City officials who work for the City's Water and Sanitation department are registered engineers. This is mainly owing to the fact that, as proponents and developers, the City will not have to rely on consultants (registered engineers) to sign-off on municipal developments plans.

It is important to note that consultants need to thoroughly investigate the feasibility of plans and projects before they can sing-off, therefore consultants cannot be expected to sign-off on plans and approaches they do not believe will work.

In addition, respondent notes that when working on municipal developments and projects there is no monetary incentive for consultants to include alternative, 'sustainable' water technologies and approaches etc. This is mainly owing to the nature of municipal tender processes which require consultants to do the work quickly (within a set time period), efficiently and cheaper. This does not always lend itself to enabling consultants to incorporate the principles of WSUD in their work. Respondent highlights that this is not the case when working on private developments, because developers often have the time and money that allows consultants to incorporate WSUD principles in developments.

Appendix I: Governance Capacity Framework assessment for Cape Town graph

Governance Capacity Framework indicator scores for flood risk, water scarcity and wastewater treatment



Score	Likert Symbol	Description
0	--	Very Limiting
1	-	Limiting
2	0	Indifferent
3	+	Encouraging
4	++	Very Encouraging