How Spatial Planning can enable pathways to the implementation of Sustainable Urban Drainage Systems in the City Bowl, Cape Town

Dissertation submitted in partial fulfilment of the requirements for the Degree of Master in City and Regional Planning in the School of Architecture, Planning and Geomatics

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Catherine Harvey

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All Creatures of our God and King

All creatures of our God and King,
Lift up your voice and with us sing,
Alleluia! Alleluia!
Thou burning sun with golden beam,
Thou silver moon with softer gleam!

Refrain:

O praise Him! O praise Him!
Alleluia! Alleluia! Alleluia!

Thou rushing wind that art so strong,
Ye clouds that sail in heav'n along,
O praise Him! Alleluia!
Thou rising moon, in praise rejoice,
Ye lights of evening, find a voice!

Thou flowing water, pure and clear,
Make music for thy Lord to hear,
O praise Him! Alleluia!
Thou fire so masterful and bright,
That givest man both warmth and light.

And all ye men of tender heart,
Forgiving others, take your part,
O praise Him! Alleluia!
Ye who long pain and sorrow bear,
Praise God and on Him cast your care!

Let all things their Creator bless,
And worship Him in humbleness,
O praise Him! Alleluia!
Praise, praise the Father, praise the Son,

And praise the Spirit, Three in One!

William H. Draper, published in 1919

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My fellow classmates - what a blessing! Your unwavering support, humour, and help is quite simply unrivalled. I will forever cherish the friendships and memories.

'To God Be the Glory Alone' (Ephesians 1:3-14).

Abstract

The dramatic global trend of population growth has led to a rapid urbanisation, resulting in unprecedented land cover change. The incarnation of accompanying developed has typified impermeable surfaces. These surfaces have disconnected the stormwater component of the natural hydrological cycle, disregarding it as a nuisance and designing it to be rapidly removed from urban areas. Utilising Sustainable Urban Drainage Systems (SUDS) offers opportunities in urban areas to recycle the water and challenge the perception that stormwater is a nuisance and of no value. The current context of drought experienced by Cape Town has highlighted the need for less reliance on surface water resources; implementing SUDS could be a way of reconnecting the hydrological urban water cycle. It could also help to repair the human disconnect from nature that is prevalent in urban areas. The research question explored the role of spatial planning in enabling the implementation of SUDS in the City Bowl, Cape Town.

While conceptual and technical frameworks have been developed for SUDS in South Africa, at present there is no spatial guide as to how these interventions could be realised in a specific context and area. This research utilises the tools of spatial planning to re-imagine the City Bowl in relation to water. The case study method

is used, enabling a detailed understanding of the site. This was complemented by interviews with various planning professionals in order to understand the current role spatial planning plays in terms of implementing SUDS. The research suggests that whilst SUDS has many constraints, the opportunities that they provide for improving water quality and quantity, and surrounding amenities, suggests that this is one which has to be embraced if the City Bowl is going to respond innovatively and sustainably to the drought. It also highlights the need to improve coordination across different spheres and departments of governance, and emphasises the need to value local community knowledge. A prevalent silo approach to complex problems is no longer acceptable. The implications of the research are that implementing SUDS in the City Bowl requires planners to embrace a water literacy approach to spatial plans, and in doing so, return the focus to water.

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Acronyms

BMP Best Management Practice
CoCT - City of Cape Town
DWA- Department of Water Affairs
GI - Green Infrastructure
GIS – Geographic Information Systems
IUWM Integrated Urban Water Management
IDP - Integrated Development Plan
NDP National Development Plan
NWA National Water Act
NWRS National Water Resource Strategy NWSA National Water Services Act
SDF - Spatial Development Framework
SUDS - Sustainable Urban Drainage Systems
UHI - Urban Heat Island
UNDP - United Nations Development Plan
WC/WDM - Water Conservation / Water Demand Management
WCPG - Western Cape Government, Department of Environmental Affairs and Development Planning
WSUD - Water Sensitive Urban Design

Glossary

The following glossary is taken from the Water Sensitive Urban Design for South Africa: Framework and Guidelines (Armitage et al., 2014)

Bio-retention area here refers to a depressed landscaped area that collects stormwater runoff and infiltrates it into the soil below through the root zone thus prompting pollutant removal.

Catchment here refers to the area contributing runoff to any specific point on a watercourse or wetland.

Climate change is a continuous phenomenon and refers to the change in global climatic conditions, e.g. as a result of temperature increases due to anthropogenic emissions.

Detention pond here refers to a pond that is normally dry except following large storm events when it temporarily stores stormwater to attenuate flows. It may also allow infiltration of stormwater into the ground.

Drainage may refer to: (1) the removal of excess ground-water or surface water by gravity or pumping; (2) the area from which water bodies are removed; or (3) the general flow of all liquids under the force of gravity.

Drainage system refers to the network of channels, drains, hydraulic control structures, levees, and pumping mechanisms that drain land or protect it from potential flooding

Green roof is a roof on which plants and vegetation can grow. The vegetated surface provides a degree of retention, attenuation, temperature insulation and treatment of rainwater.

Hydrology refers to the physical, chemical and physiological sciences of the water bodies of the earth including: occurrence, distribution, circulation, precipitation, surface runoff, stream-flow, infiltration, storage and evaporation.

Impervious surface here refers to surfaces which prevent the infiltration of water. Roads, parking lots, sidewalks and rooftops are typical examples of impervious surfaces in urban areas.

Infiltration here refers to the process of penetration of rainwater into the ground.
Infiltration device is a SUDS element designed to aid the infiltration of surface water into the ground.

Permeability refers to the ability of a material to allow water to flow through when fully saturated and subjected to an unbalanced pressure.

Peak discharge is the maximum rate of flow of water passing a given point during or immediately after a rainfall event.

Precipitation is the water received from atmospheric moisture as rainfall, hail, snow or sleet, normally measured in millimetres depth.

Resilience refers to the preservation or enhancement of adaptive capacity, i.e. the capacity of a system to preserve core functioning in the presence of shocks and long-term changes.

Runoff generally refers to the excess water that flows after precipitation.

Soakaway is a subsurface structure that is designed to promote infiltration into the ground.

Source controls are non-structural or structural best management practices to minimise the generation of excessive stormwater runoff and/or pollution of stormwater at or near the source.

Stormwater is water resulting from natural precipitation and/or accumulation and includes rainwater, groundwater and spring water.

Stormwater runoff refers to the portion of rainfall which flows to the surface drainage system.

Stormwater system is constituted by both constructed and natural facilities including: stormwater pipes, canals, culverts, overland escape routes, ‘vleis’, wetlands, dams, lakes, and other watercourses, whether over or under public or privately owned land, used or required for the management, collection, conveyance, temporary storage, control, monitoring, treatment, use and disposal of stormwater.

SUDS is the abbreviation for sustainable drainage systems or sustainable urban drainage systems, which are a sequence of management practices and/or control structures or technologies designed to drain surface water in a more sustainable manner than conventional techniques.

Surface runoff is that part of the runoff that travels over the ground surface and in channels to reach the receiving streams or bodies of water.

Swale is a shallow vegetated channel designed to convey stormwater, but may also permit infiltration. The vegetation assists in filtering particulate matter.

Treatment train is a combination of different methods implemented in sequence or concurrently to achieve best management of stormwater. These methods include both structural and non-structural measures.

Water table is the upper most level of the zone of saturation below the Earth’s surface, except where this surface is formed by an impermeable body.

Wetland refers to any land translational between terrestrial and aquatic systems where the water table is usually at or near the surface, or is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil. This includes water bodies such as lakes, salt marshes, coastal lakes, estuaries, marshes, swamps, ‘vleis’, pools, ponds, pans and artificial impoundments.

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Every Drop Counts

Throughout history, water has been both of great challenge and of providence to humans. We have tamed it, marvelled at it, and in some cases, destroyed its natural state. Man can survive days without food, but only hours without water. It is essential not only for our lives however, but for all living systems.

Water is life.

1.1 Background

I have two particularly distinct childhood memories of water.

The first is flood: an abundance of water running through the riverbed, sweeping everything along its path, from trees to bridges. The second is drought: the parched arid landscape, using grey water in the garden, no water in the taps for long periods of the day. These landscapes shaped my memories and my relationship with the environment and natural systems.

I became humbly aware too, that my personal story of water is light compared to how many in the world live. More than a billion people lack access to a clean and safe supply of freshwater worldwide (WWAP, 2017). Drinking dirty water is a leading cause of cholera and a huge burden on health care systems. It also affects children's education levels, with an estimated 443 million school days lost each year to water-related diseases (Human Development Report, 2006). I felt compelled to study this further, as this expression of man's dominance over nature was so far from the stewardship of natural resources that I believe we are called to. Despite increasing examples around the world over as to the effects, consequences and realities of human action on the environment, to a large extent the behaviour patterns which drive these actions remain unchanged. Humanity increasingly funnels resources from all over the natural world into urban areas: cities currently take up just two per cent of the world's land surface, yet they use over 75 per cent of its resources and discharge similar proportions of waste (Girardet, 2000).

The compounding effects of a growing human population has amplified the depletion of natural resources .If we are to strive for values of social justice and equity, then addressing water quality and quantity seems to be inherently part of the first step.

In high school my Dad bought a book by Fred Pearce: 'When the Rivers Run Dry' (2006). What resonated in particular was a paragraph on the Rio Grande River. 95 percent or more of the river is diverted to irrigate surrounding farms and pastures (americanrivers.org). Pearce writes that

> 'The once mighty Rio Grande is now reduced to a sluggish brown trickle. In its middle stretches, the river often dries up entirely in the summer. All the water has been taken out by cities and farmers upstream. "The river's been disappearing since the fifties," says Bishop, who has farmed here since then. There hasn't been a flood worthy of the name since 1978. For

200 miles upstream of Presidio, there is no proper channel anymore, he says. They call it the forgotten river'.

Studying Environmental and Geographical Science at University, we learnt about the geographical distribution of global freshwater resources and population distributions; a pattern of dependence and heightened stress emerged. The distribution of water does not match with the distribution of people (Pearce, 2006). We learnt about the relationship between the increase in population and increasing movement of people to cities. And we learnt that this resulted in a rapid urbanisation that was altering the natural hydrological cycle, polluting runoff water from rain, and severing the cyclical nature of the cycle.

I wondered how best to apply the information I had been passionately taught. The Masters in City and Regional Planning offered the application of a skill set, with the appeal of being able to inspire a collective vision for a hopeful future.

Figure 1: Water shaping landscape of childhood, Namib Desert

Planning can play a large role in in terms of water resource management, and 'strategic spatial interface and relationship with water resource planning and management is fundamental to development and realisation of spatial potential' (Pretorius, 2012).

The following chapters will link these ideas as it explores the role spatial planning plays in connecting people and nature as we face as uncertain future.

1.2 Problem Statement

The global consumption of water is doubling every 20 years, which is more than twice the rate of human population growth (Barlow, 2010). This indicates that if these trends persist, by 2025 the demand for freshwater will increase by 50 % more than the amount of water which is currently available. The sources of freshwater are being diverted, depleted and polluted at a rate beyond which can be replenished (WWAP, 2017) and it is expected that that the discrepancies between water supply and demand will only continue to grow. Water resources are renewed through the continuous cycle

of precipitation, infiltration, evaporation and runoff (figure 2). This process is known as the hydrological cycle, and it encompasses the movement of water on Earth (Steiner and Butler, 2007). Global climatic forces determine the cycle, which introduces a degree of variability in precipitation occurrence and amount, as well as evaporation rates. This affects the water availability over space and time (WWAP, 2017).

Demand for water is twofold: there is competition between domestic household consumption and water as a productive resource. This competition is becoming more evident, and the effects worse, with the collapse of water based ecological systems, declining river flows and large-scale groundwater depletion (Watkins, 2006). It seems that human growth is at a point of collision with the resources on which it depends. If consumption continues from either or both sectors as is, then we will reach a point where water scarcity will impact food production, ecosystem functioning, health, safety and security (Jury and Vaux, 2007).

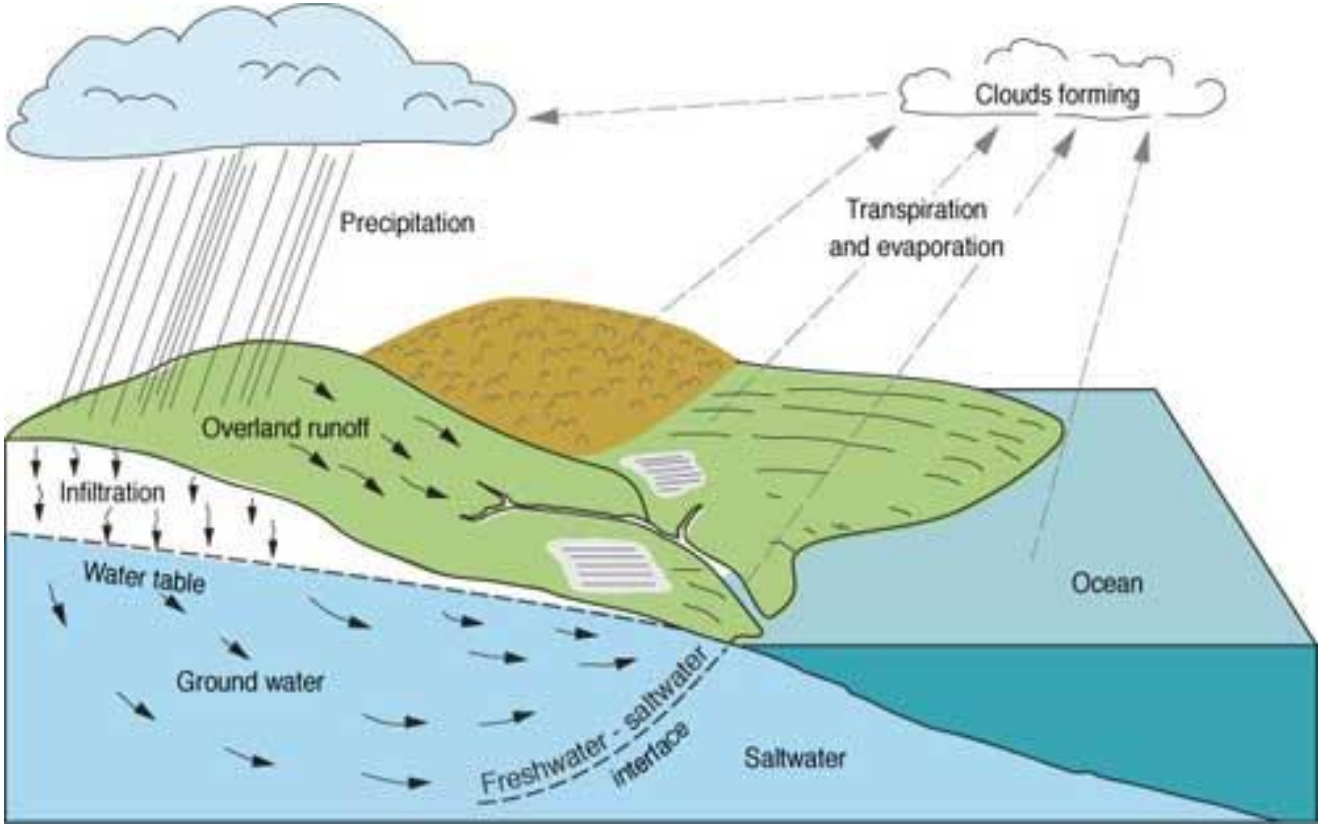


Figure 2: The natural hydrological cycle (kgs.ku.edu)

1.2.1 Urbanisation

Increasing urbanisation has disrupted the natural hydrological cycle, and, combined with an increasingly changing climate, resulted in a pattern of adverse environmental effects. The beginning of the 21st Century marked the period when ‘the proportion of the world’s population living in urban environments surpasses

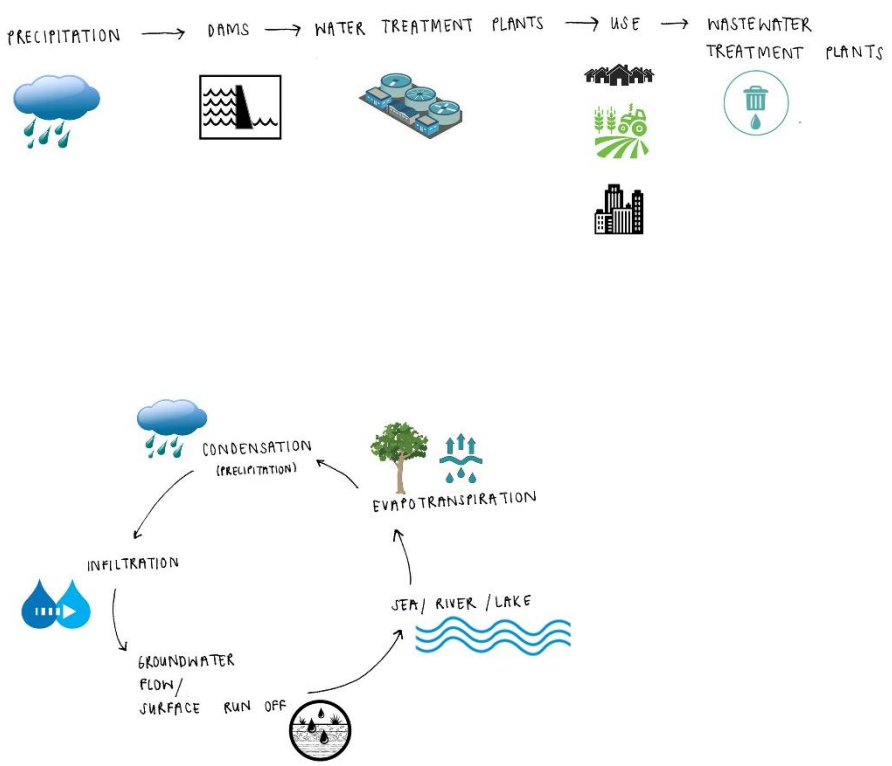


Figure 3: Linear and cyclical hydrological cycles (Author 2017)

that living in the rural environment' (Brown and Wong, 2009: 65). This means that not only do cities now need to provide more water to more people, but that the built environment will continue to perpetuate a negative impact on natural systems processes and functionality. In terms of the hydrological cycle, the flow of water has been altered due to the increased impermeable surfaces. Roads, rooftops, buildings and parking areas all restrict the amount of infiltration of precipitation into the ground. This lack of infiltration restricts the groundwater recharge, causing a lowering of the water table and a depletion in groundwater supplies (Steiner and Butler, 2007). Water infrastructure has not only forced the urban water cycle to follow a linear direction, but also cultivated the perception that the runoff from storms (stormwater) is a hazard and nuisance, and not a part of the hydrological cycle

(Figure 2 & 3). Its threat in flood events has promulgated the desire to remove it from the city as fast as possible. This is done through the system of grey pipes that are hidden beneath the cities. Flood events in urban areas have an decreased lag time (Figure 11) which means that there is less time between the rainwater failing and its discharge, which leads to instances of flash floods, as the water has less surface area to permeate the ground.

1.2.2 Resilience

There is a level of uncertainty concerning future water supplies and climate change. Actions need to incorporate a line of thinking that seeks to create resilient cities. Resilience can be about surviving through crisis, developing a strength from

within and a strong physical make up. Resilience is destroyed by fear, but it is built by hope, which reignites confidence and ability to face crisis. Hope is not blind to the possibility of everything getting worse, but it can be seen as a choice we make when facing challenges and adversity, and turning them around. Cities of hope build consensus around co-operation and partnerships. An approach towards spatial planning that is embedded in the desire to build a resilient city means that not considering plans for the long term, is not an option.

1.3 Context

South Africa is a water scarce country. It also faces the challenge of a driving need to transform the economy and provide a new legacy for its people, one that addresses the present day engrained inequalities. 2016 saw South Africa experience the worst drought in decades. Many towns and cities were left in precarious situations with water supply compromised and food production limited, affecting an already stressed economy (Fisher-Jeffes et al., 2016).

1.3.1 Cape Town

A lack of water in the city is currently being communicated as being the 'new normal' (DeLille, 2017a). As I write this chapter (July 2017), the dams that supply the City of Cape Town are at 21.2% storage (Water Dashboard Report, 2017) (Figure 4). This is unprecedented for the City.

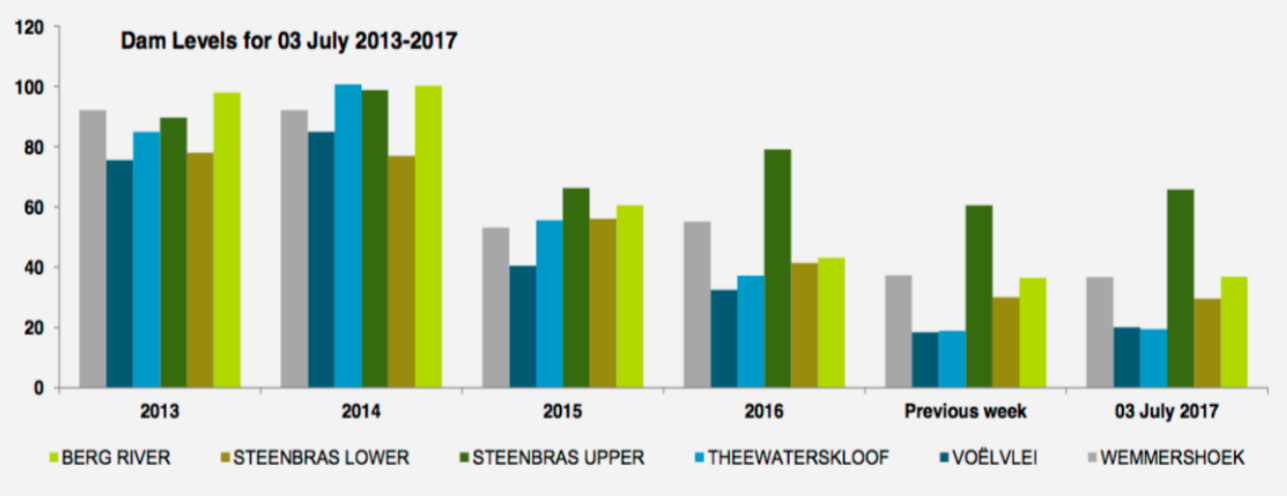


Figure 4: Comparison of dam levels between 2013 and 2017 that supply Cape Town Metropolitan (CoCT Water Dashboard, 2017)

Water security is no longer something that will bring future challenges: the challenge has already arrived. Within that challenge, however, emerges opportunity. It is possible to thrive in an increasingly semi-arid country by becoming water literate, and creating cities that are water sensitive. One such way of dealing with the water crisis would be to transform the existing water infrastructure systems into one that does not dismiss the element of stormwater as waste or risk laden, such as Sustainable Urban Drainage Systems.

1.3.2 SUDS and Green Infrastructure

SUDS are a series of Green Infrastructure components that when implemented, aim to improve the quality and quantity of water in cities, whilst positively contributing to the amenity of the surrounding landscape. In the South African context, stormwater harvesting is understood as the 'collection and storage of runoff from an urban region and its subsequent use irrespective of location, usually implemented by the relevant authority' (Fisher – Jeffes et al., 2016).

The emergence of the concept of Green Infrastructure intends to ensure growth processes are more efficient, cleaner and more resilient (Hallegate et al., 2011). Green infrastructure as a concept has emerged as a way of 'understanding how green assets and ecological systems function as part of the infrastructural fabric that supports and sustains society and builds resilience (Harrison et al., 2014: 67). It refers to the urban green network, including all natural, semi-natural and artificial ecological systems within, around and between urban areas and at all spatial scales (Sandström, 2002, Tzoulas et al., 2007). It considers conservation values and actions in conjunction with land development and built infrastructure planning. It should be considered an integral part of the city's infrastructure (Cilliers & Cilliers, 2016).

SUDS help return the circular nature to the hydrological urban cycle. In floods, they increase the rate of infiltration through porous spaces, and in droughts, they can store available water in cities in order to replenish natural water table levels. They help manage events so that when flood events do occur the

Figure 5: The Berg River Dam in June (Alexa Von Geusau 2017)

consequences are less intense, and when drought takes hold, what little water that is available is absorbed and stored rather than squandered.

1.3.3 Spatial Planning

Spatial planning plans and provide for sustainable living spaces, implying balancing the social needs of the citizens, the development pressure for economic growth and the surrounding environment (Cilliers et al., 2015). This is directly linked to issues surrounding the planning for water and people in urban areas.

Spatial plans are based on evidence through analysis; they address spatial priorities (including challenges and opportunities), enabling them to be realistic and strategic (focused on specific outcomes), and implementable. Spatial plans may help to formulate connected, eloquent medium and long-term objectives that illustrate a collective vision with the rational organization of the resources to achieve it.

In the absence of co-ordinated planning and co-operation between different spheres of government, it is likely that a growing number of water related issues will mark the remainder of the century. Many ecosystems intrinsic for human and natural systems to survive will be impacted. Spatial Planning can be used to address the need for a new attitude towards water in cities. By focusing on positive opportunities rather than problems, spatial planning can help implement green infrastructure measures. A sound understanding of the hydrological cycle is needed by planners to ensure that water resources and use are planned for accordingly.

Currently governance for the built and natural environments tend to act in a 'philosophically compartmentalised manner, binding them to institutional responsibilities and shaping perceptions of system boundaries' (Brown and Wong, 2009: 674). A move away from this is required. Natural water bodies are not confined to man-made systems nor boundaries, and a respect for the cycle and catchment basins has to be embraced and integrated into the way it is planned for. This is particularly pertinent in urban areas where demand is higher. The realisation that actions in one area can negatively – or positively – impact areas downstream needs to be considered too. Cities' reliance on water schemes that impound rivers needs to be disrupted with the recognition that water is part of a whole cycle.

The SUDS approach to urban water systems seeks to challenge the notion that water just comes from a tap, and replace it with the reality that it has travelled from rivers, streams, wetlands and mountains.

Combining SUDS with spatial planning offers the opportunity to spatialize how a different drainage system can bring many opportunities and positive impacts, for many people and the environment.

SUDS allows for the adoption of an approach that embraces advancements in technology, whilst embarking on a journey that responds to the call to steward and care for natural systems.

1.4 Spatial Focus of Study

1.4.1 Cape Town Metropolitan

The study will consider the Cape Town Metropolitan Area, whilst focusing on the City Bowl area of the Central City of Cape Town (Figure 6). The City Bowl is an area used and visited by a wide range of diverse people, reflecting the many faces of the City.

Cape Town is a city of immense beauty; however, the apartheid legacy remains

Figure 6: Spatial focus of study (Google Earth 2017)

entrenched. The spatial segregation and physical separation of people from resource access and economic opportunities is still astoundingly evident. Access to green spaces is not something that every resident of the city is able to enjoy; nor, in fact, is running water. Thus working within these realms one has to be incredibly sensitive and thoughtful to the disparities amongst residents.

1.4.2 City Bowl

The City Bowl has a historic relationship with water resources and early settlement patterns. This makes it a compelling place to study, as the re-connection and re-imagining of people to natural systems can be envisioned here. Implementing Green Infrastructure in the form of Sustainable Urban Drainage could provide inspiration for future projects, and encourage the implementation elsewhere in the metropolitan area. Projects – whether successful or not – could provide invigorating lessons and embolden planners and other members of civil society, as well as the public, to the notion that transitions from old infrastructure and ideas, can and should be done.

People's lives, experiences and perceptions are shaped by their interaction with the City Bowl built environment and the interspersed pockets of natural systems intertwined through the urban grid. Briefly living in this area has allowed me to share some of these experiences, and is why I was drawn to study the area. I have seen the delight taken in green spaces, the joy of children enjoying the parks, and have begun many a day running around the Molteno Reservoir (Figure 7).

Figure 7: Molteno Reservoir, Cape Town

1.5 Philosophical Underpinning of Study

Planning cannot be separated from values and ethics, as ultimately the perspective of the planners is intertwined in their work.

1.5.1 Stewardship

My research is steered by the Christian faith, founded on the belief that God created the world, and that 'the earth is the Lord's' Psalm 24;1 (NIV) .

I believe that God rules over all and that the earth reveals its Creator's wisdom and goodness (Psalm 19:1 – 6). I believe that men and women were created in the image of God, and commanded to exercise stewardship over the earth (Gen. 1:26—28; Ps. 8:5). I think that we have a responsibility to care and ensure that our actions do not neglect, harm, abuse, degrade or corrupt the earth.

We all share and depend upon the same world, with its finite and often non-renewable resources. Stewardship implies caring management and not selfish exploitation; it implies a concern for both present and future as well as self (Church of England, 1990).

1.5.2 Environmental Humanities

The silo approach to planning and governance is one that I believe needs to be challenged. The environmental humanities offer planners an opportunity to embrace a 'broad multidisciplinary approach' (Sorlin, 2012) by focusing on a 'common effort in which the relevance of human action is on par with the environmental aspect'.

This interdisciplinary approach and endeavour forms the basis of the exploration of the relationship between humans and the environment. The Environmental Humanities seeks to harness the interpretive power of the humanities, combined with other bodies of knowledge. The approach recognises that the 'environment' is not something that merely surrounds human societies.

Combining this with the responsibility of stewardship sets the tone for the chapters that follow. We are dependent on our environment, yet capable of manipulating and managing it. We are simultaneously apart from, yet a part of our physical, social and anthropogenic environment.

Water is a gift, and life of any form is impossible without it. I think that using spatial planning to ensure that it continues to be a gift for future generations is of utmost importance.

1.6 Structure of Study

The structure is guided by the primary and secondary research questions that were informed by initial research and the subsequent literature review.

1.6.1 Research Question

The overarching research question that I aim to answer through the project is how Spatial Planning can optimise pathways to the implementation of Sustainable Urban Drainage Systems in the City Bowl.

1.6.2 Further questions:

What is the impetus for Spatial Planning in the role of water management?

1. What is Green Infrastructure and how is it linked to spatial planning?
2. What is the intent of SUDS?
3. What are the challenges faced in the implementation of SUDS?
4. How can spatial planning help overcome these?

The dissertation begins with this chapter, which includes an overview of the methods used for this project and then moves to establishing the foundation of the study in Chapter 2. The literature review will review the literature critically, and explore the role of planning in facilitating the transitions to Sustainable Urban Drainage Systems (SUDS). It will incorporate both global and local scale writings on the subject, as well as elaborating on why this is a pertinent approach in terms of addressing water resources. The review will provide the necessary depth and breadth of knowledge gained from theory and critical ideas to undertake the contextual analysis of the City Bowl of Cape Town. It will also provide an understanding of the current contestations and debates to the implementation of SUDS.

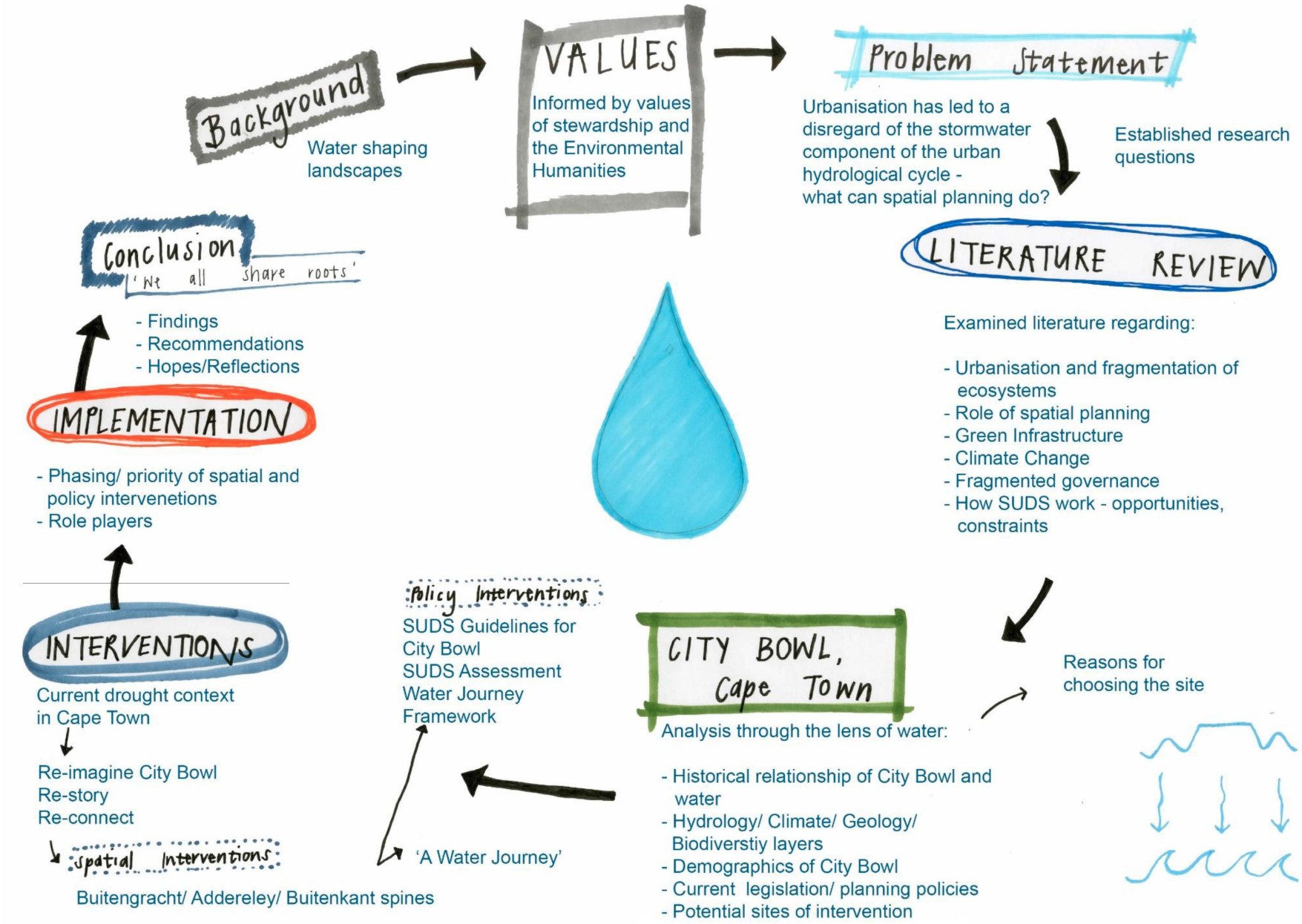
Chapter 3 is a contextual analysis of the spatial and policy environment of the City of Cape Town. The focus begins with the physical and demographic layers of the City Bowl before moving to the relevant water and planning legislation documents. It concludes with opportunities and constraints facing planners and SUDS, forming the foundation of the Chapter 4 interventions.

Chapter 4 contains the proposed policy and spatial interventions for SUDS in the City Bowl. It draws from the literature examined in Chapter 2 and the contextual analysis of the City Bowl area to do so.

Chapter 5 outlines the Implementation processes that will facilitate the interventions. The chapter will consider some of the necessary role players needed to bring the proposed interventions to life. It will include a suggested timeframe and phasing to guide the proposed interventions.

Chapter 6 will offer concluding thoughts on the research, as well as reflections on the hopes and visions illuminated by the findings. It will point to areas for potential further research and investigation.

Method Diagram:



1.7 Research Methods

Research methods refer to the process used for gathering information and data. Research for the literature review provided the theoretical basis for the project. The theory and research on Green Infrastructure proved to be the crucial link between spatial planning and implementing SUDS, supplemented with the increased notion of needing to plan for resilience and sustainable cities.

1.7.1 Case Study Method

This research will use the case study method to study the City Bowl of Cape Town, in relation to the primary question of the role that spatial planning in helping implement SUDS within the area.

The case study approach allows for an in-depth understanding as to the current water situation in the City Bowl, as well as how planning currently falls short of enabling SUDS to be implemented. The specific location focus is useful as it provides a deeper understanding of how global forces manifest locally (Flyvbjerg, 2011) (for example how an increase in hard surfaces has led to an increase in stormwater runoff rates).

Subsequently it will guide in terms of creating policy interventions and spatial recommendations. The researcher will benefit from being situated within the location. This creates a platform for greater understanding of the value and power systems at work. It allows the research to be a process of discovery, and to focus on a specific space. The study should comprise ‘more detail, richness, completeness and variance’ (Flyvbjerg, 2011: 301). This helps to recognize and understand complexity at task.

Yin (1998) writes that case study research data can come from a variety of sources, which is helpful as it means that my time constraint is not a restriction with regards to methodology. Secondary data in the form of desk top studies, historical sources, and my own observations form the basis for the research. I conducted several interviews with professionals involved in planning and SUDS. These provided great insights into obstacles encountered with SUDS and their implementation, and equipped me with a greater understanding of what form propose spatial interventions could take.

The case study method provides the contextual depth within which the context can be analysed and researched. This is crucial in working towards answering a complex layered question.

Case studies on SUDS tend to be focused on the Global North, where the idea of SUDS originated. The context for

the implementation of SUDS in the Global North is very different to that of the Global South, where Cape Town is, and it is vital that a knowledge base of examples of successful SUDS projects is compiled to inspire and encourage. As Cape Town grapples with its drought, research about SUDS may be used in the future to establish how global trends are increasingly found in local urban environments.

The disadvantages are that the method will rely on my biases and interpretations of the material being analysed. Bearing this in mind, I will try to be as consciously aware of any personal biases subjections that may influence my research.

1.8 Research Techniques

1.8.1 Dialogue

Dialogues with City of Cape Town City officials, planners, engineers and environmental specialists will be undertaken. This will provide an understanding of the current Spatial Planning approach to water resource management, as well as how planning could seek to enable the transition of infrastructure to a more sustainable one. These will have the advantage of gathering deeper insights and rich descriptions of phenomenon, as well as providing a greater flexibility and truth compared to questionnaires. Interviews are a means of qualitative data, as they generate non-numerical information and thus are ideal for this type of research. They can produce a greater understanding of the participant's experiences and thoughts which are not obtainable from a questionnaire.

The questions will be semi structured in order to provide a certain degree of flexibility, and the opportunity to listen intently – and ultimately hear clearly – what the interviewee is trying to tell me. This format involves close contact between the participant and the interviewer, and allows for the questioning of data that is detailed and extensive. The interview would encompass a number of broad questions (a topic guide), which would encourage the participants to shape their own narrative whilst being probed in depth. Questions with answers such as 'yes' or 'no' should be avoided, as they tend to allow affirmation rather than description. Questions will be structured around the theme of 'understanding the role that planning plays in the implementation of SUDS'. They will be

focused around answering how to overcome planning hurdles, and requirements of SUDS sites.

However, I will be limited by time, and will ensure that questions are crafted carefully to avoid being leading. I will also take note of body language, as well as words and attitudes to ensure that they are always comfortable and happy to be involved in the research.

1.8.2 Data analysis

Analysing data involves seeing if there is a connection between the reality studied, and the findings of the research. The findings will be analysed based on the themes or categories that have been established from in-depth review of the relevant literature. To this end I will aim to code by categorising the data into various groupings which focus on concepts, constructs and relationships.

1.9 Limitations

The biggest limitation faced by this project is the time constraint. The nature of research is thus limited to secondary data collection. Desktop studies were relied upon extensively and I am thus restricted from determining the actual process of navigating the path of transitioning to SUDS in the City Bowl. Planning is a process, and it therefore would have been crucial to include public participation activities. Involving residents, City officials, other users of the City Bowl, as well as stakeholders would provide a much deeper understanding of the challenges, and solutions for best to overcome them. It would have provided the space to learn about current attitudes and values towards water, and to develop clarification on ways in which to create a collective vision for the need to implement SUDS. This would have contributed to knowledge about how to encourage a paradigm shift, and encourage people to think about how they move through the City Bowl, and where possible sites of intervention should be.

The time constraint also influences the amount of information gathered; there was a limit as to how much time could be spent researching before needing to begin writing the findings and determining the proposed interventions. In addition, the progressively worsening nature of the drought meant that city officials involved in stormwater were likely burdened with other tasks and were thus difficult to communicate with.

Some of the limitations will be engaged with in the recommendations for future research in the conclusion.

1.10 Conclusion

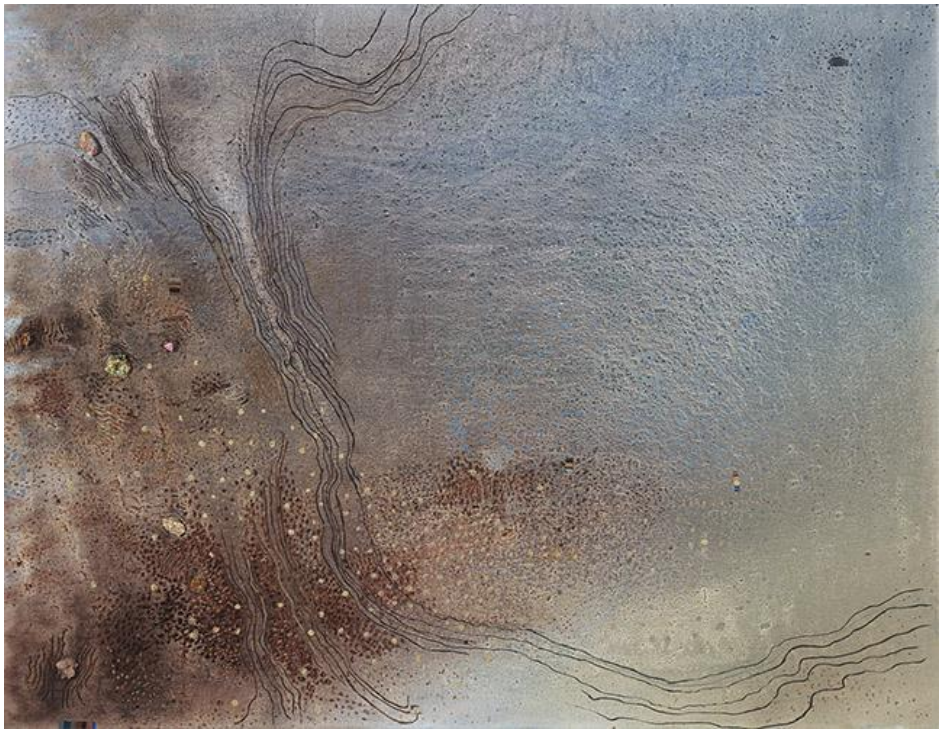
In the 5th Century, Heraclitus was quoted as saying that ‘change is the only constant in life’ (WWAP, 2017). Today this certainly holds ground as we face tumultuous times, not least marked by an unprecedented change in climate. We are living in a period of increasing and intensifying disorder, with the reality of a planetary multi-crisis. With growing populations and urban settlements, the continued transformation of the planet by one species has had disastrous impacts: rivers no longer kiss the sea, soil is no longer as fertile, temperatures are soaring and storms intensifying.

As the realisation that water is not an inexhaustible resource becomes clearer day by day, it is evident that the approach to use of it has warranted a rapid diminishing of its quality and quantity. It is clear that the embracing of a new approach to it is necessary. Even as we face uncertainty in terms of climate change, mounting population pressures, and difficult political circumstances, water remains the constant: without it, we cannot survive.

SUDS offer an opportunity to reconsider the current perception of stormwater and incorporate it into the management of water flows through the city. In doing so this could help address the issues of drought that Cape Town is living through. The city can no longer afford to squander water of any nature; if we mean to truly work on our actions being resilient, then this is an essential transition to make.

The literature review will explore these concepts in further theoretical detail.

2
Searching for Water



Lost River (Ann Neely 2014)

“As ‘first nature’ becomes ‘covered over’ by infrastructure, it is gradually severed from social experience.

When people need water or heat, that is, they increasingly interact not with rivers or sun, but with faucets and radiators.

Thus, infrastructure turns into ‘second nature’.”

(Jensen, 2016)

2.1 Introduction

This Chapter contains the Literature Review. Its purpose is to ground the research within the academic debates and discourse concerning the topic of SUDS and Spatial Planning.

Impermeable surfaces - a result of the increase in urban areas referred in Chapter 1 - have changed the physical environment in ways both seen and unseen, recognised and unrecognised. As climate shifts become more dramatic and apparent, these impermeable surfaces are set to increase the severity of urban droughts, floods, and cause increases in the Urban Heat Island effects, as well as cause further air quality problems and biodiversity loss (Li, et al. 2016: 1). This is an opportunity to heed calls for action and embrace the many opportunities to approach the current challenges. Whilst cities are home to many of the problems, they also offer a wide scope of exciting opportunities, not least of which one is an alternative approach to drainage systems. Sustainable Drainage Systems could provide improved environmental, sociological and economic benefits, and better equip urban areas in terms of creating innovative structures.

This literature review will explore patterns of water consumption through a through a global lens to begin with. This will help set the scene, providing context of attitudes towards water consumption. It will move to consider the importance of ecosystem services, exploring what the term encompasses and why they are important.

The next section will examine the concept of Spatial Planning, seeking to understand the role that planners play. This section is linked to the rise of Green Infrastructure; the term is unpacked and considered in relation to building resilience, and climate change concerns.

Historical attitudes to stormwater are examined in order to establish the current context of stormwater drainage systems today. This section forms the basis for the following section on Sustainable Urban Drainage Systems (SUDS). Their intent, aim and challenges of implementation are considered. The difference in language and terminology with regard to SUDS is briefly explored.

Case Studies from Manchester and North Carolina will be used to illustrate the link between planning and the implementation of SUDS. They will inspiration for future implementation.

The Literature Review will summarise the examinations and formulate the theoretical foundation and context from which the following chapters will be based on.

2.1.1 Increasingly urbanised

The literature examined consistently points to conflicts between the pattern of human development, and their construction of the built environment, and the resulting adverse impacts on the natural biological one. With a seemingly insatiable appetite for wealth creation, cities have become the place where this is increasingly realised. However, despite the apparent economic

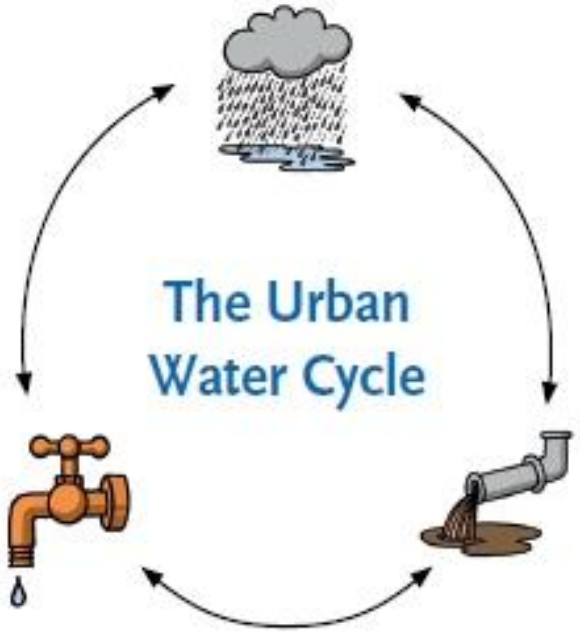


Figure 8: Urban Water Cycle (www.sswm)

and social progress that this urbanisation is meant to represent, the sheer speed at which it has occurred has meant that the ramifications from an environmental degradation and ecosystem services perspective have been unprecedented, unexpected and uncontained.

Water is an ecosystem service (Figure 12). This highlights the increasing importance of treating it well within each phase of the hydrological cycle; it is a diminishing resource a result of urbanisation and the subsequent pollution thereof in urban areas (e.g. from surface runoff). Water runs through the economic, social and environmental grains of life; its resources and the service it provides are thus key to achieving poverty reduction and improved public health, food security and a harmonious relationship with the natural environment.

Human society is intrinsically linked to the supply of water. Hydraulic capacities have long been the hallmark of organised social systems and can make or break modern political economies (Jeffrey & Gearey, 2006). There is no denying that water is life, and that a guaranteed supply is instrumental in achieving public health

and food security, industrial, agricultural, social and cultural development. However, the path to capturing this precious resource has led to the destruction of it. (Li, et al. 2016). The effects of urbanisation that have allowed for human growth and development, have extended to habitat fragmentation, biodiversity loss, urban flooding and increases in water pollution (Li, et al. 2016).

Primarily, the present day urban built environment has created impermeable surfaces, thus altering the natural hydrological cycle of these areas, as seen in Figure 10. This has contributed towards an increased volume of surface run-off (Li, et al. 2016), and an overall loss of permeability (O'Sullivan et al., 2012). In addition to an increased run off rate, urbanisation contributes to a deterioration in water quality, as stormwater picks up pollutants such as oil and fertilisers on its journey. This not only affects freshwater systems (Roy et al. 2008) but also means that a larger volume of water has to be treated once the water reaches the treatment plant. This suggests that there is a need for a more cyclical system approach to the treatment of water. Acknowledging that water needs to be viewed from the perspective of an integrated process has emerged as of utmost importance if we are to consider a future generation's needs.

This has also been linked to increased flood risks. Urbanisation affects the entire natural catchment area, as infiltration is interrupted when the size of available permeable ground is reduced. This altering of the hydrological cycle restricts how much water can infiltrate the ground (Burns et al., 2012). An overall loss of permeability from urban surfaces, and the compacted soils has a negative effect on flood hydrographs (Figure 11) and the green spaces available in cities as the volume of runoff increases.

Stormwater is often contaminated, due to its contact with pollution loads on urban surfaces. This means that the stormwater is exposed to hazardous substances and microbial pathogens (Armitage et al., 2014) and by the time the water is returned to the nearest river or wetland, it has the potential to cause harm to both humans and natural ecological systems. From this arises another question and challenge for SUDS – once the components have been implemented, there is ambiguity as to how long they are able to store the water; how long until the water is of usable quality, and what should the stored water be used for. SUDS effectiveness in terms of cleaning water remains largely untested.

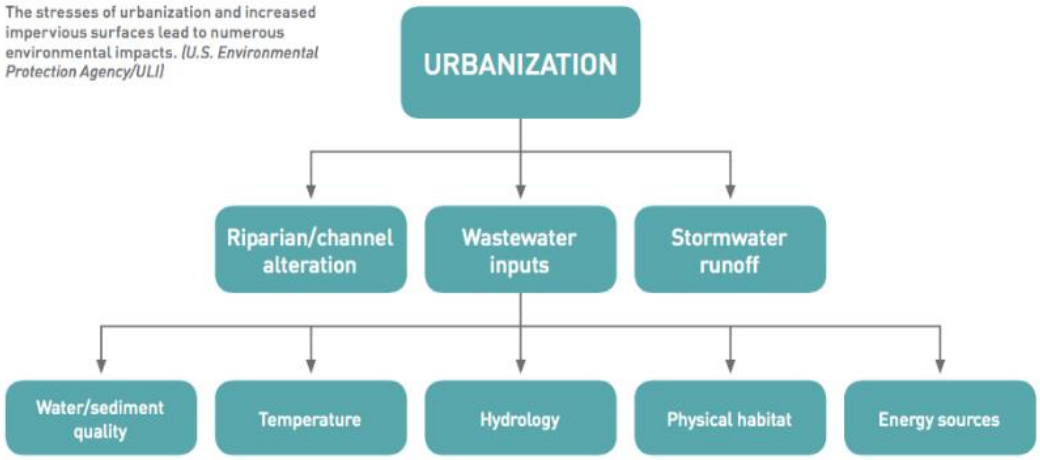


Figure 10: Burgess et al., 2017)

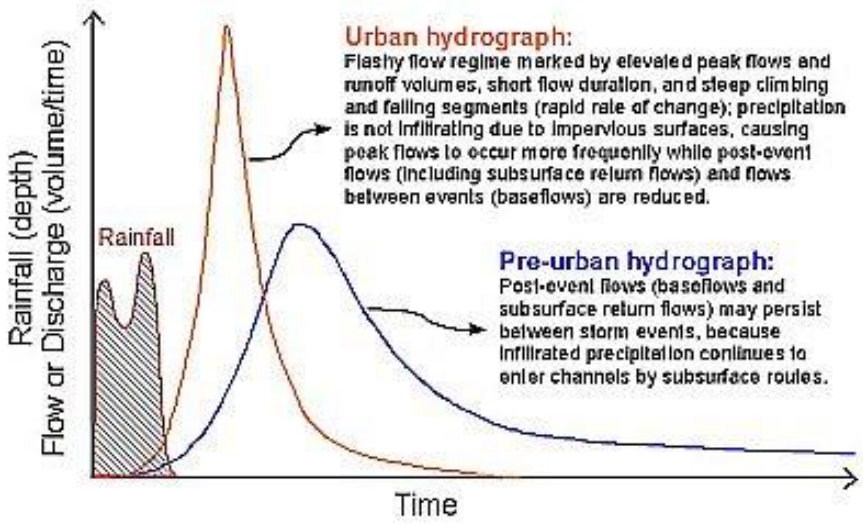


Figure 11: Urban lag time compared to Urban SUDS lag time

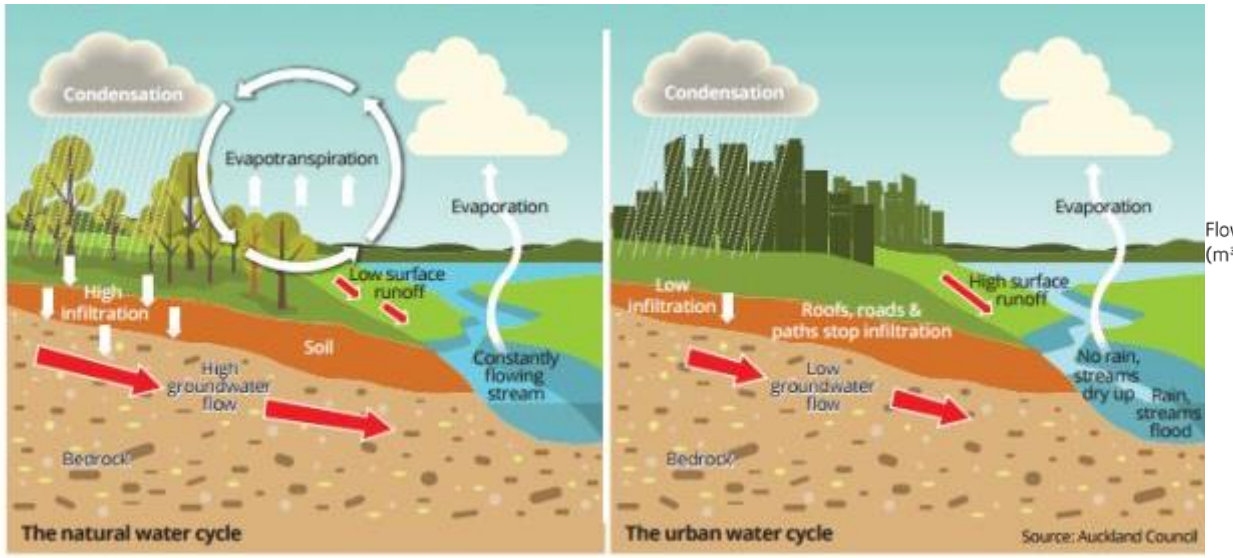
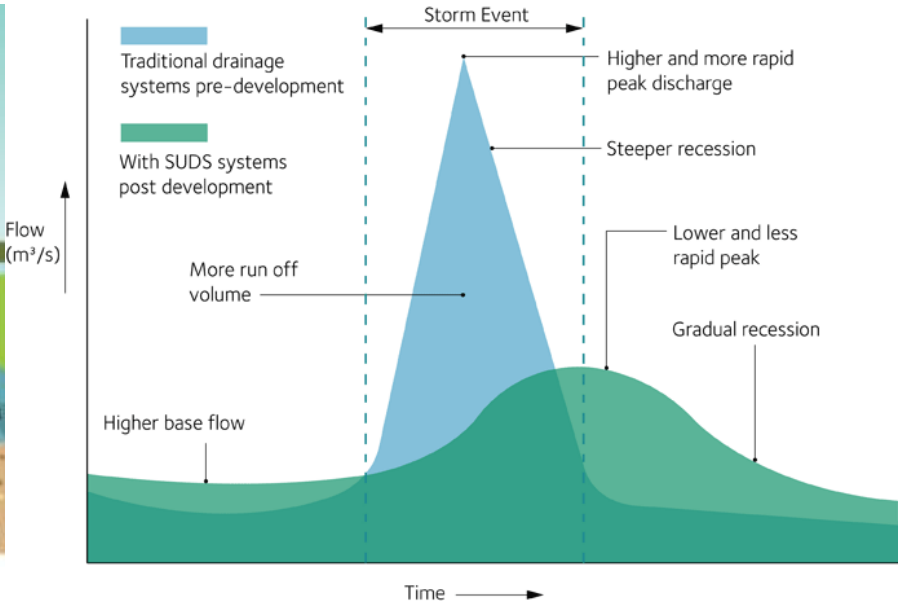


Figure 9: Comparison of the natural water cycle and the urban water cycle (Auckland Council, New Zealand)



2.2 Ecosystem Services

Ecological functions are understood as the processes that provide benefits and services from ecosystems. This can be in the form of stabilising climatic extremes, enabling the cycling of nutrients, controlling pests, maintaining biodiversity and purifying air and water (EEA, 2011). The concept of ecosystem services can be used to help communicate the value of ecological functions to society, as it can be translated into physical health, economic or social benefits.

Ecosystem services remain undervalued and under-recognised within most current economic and resource management approaches. Ecosystem services consist of provisioning (production of food and water); regulating, (climate and disease control); supporting, (nutrient cycles and crop pollination); and cultural, (spiritual and recreational benefits) (Armitage et al., 2014).

The implementation of SUDS can provide a link between the enhancement and protection of ecosystems, and the potential to benefit human livelihoods. SUDS could aid ecological functions of an area, and in this regard could be monitored as part of 'performance criteria to indicate whether a SUDS treatment train is functioning properly' (Armitage et al. 2014). Ultimately the SUDS approach aims to protect, restore, and improve the immediate environment through efficient and effective stormwater management' (MBWCP, 2006).

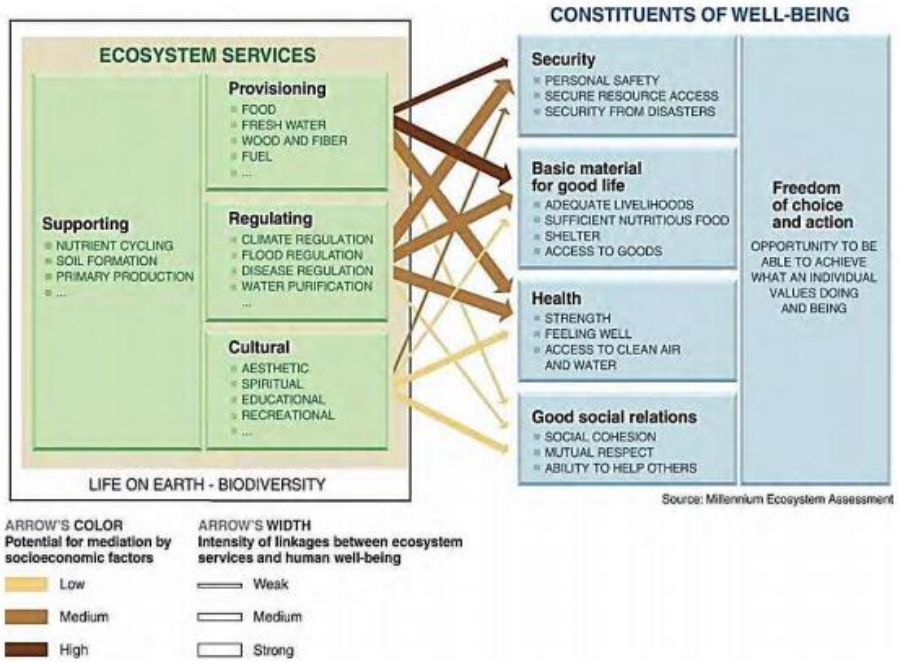


Figure 12: Ecosystems Services (Armitage et al., 2014)

The financial aspect of transferring away from a conventional stormwater system is often hinged on the monetary costs to various stakeholders, whilst ignoring the value that a SUDS system would bring to the ecosystem services of the area. Ecosystem services are explained in the diagram in Figure 12.

2.3 Spatial Planning

Spatial planning can be considered as a 'place shaping and space- mediating mechanism which aims to intervene in order to shape the development outcomes affecting a specific area, whether it is a region or a neighbourhood' (CUPS, 2004). Spatial planning is a tool that can be moulded to a number of situations and contexts. By developing a shared understanding and joint vision, strategic spatial planning can be instrumental in transforming attitudes and places.

There is a need for planning that helps to protect resources on which humans and the natural environment depend on for long –term survival (Carter, 2007: 332). Water is one of the most vital resources, and it is worth noting that ecological services aside, economic and social welfare are reliant on it too. Carter writes that 'planning authorities have a responsibility to ensure that the implications for water of new developments and proposed changes in land use are considered during spatial plan preparation' (Bahri, 2012: 323).

Spatial planning has recently taken environmental considerations into decision-making processes, and the 'green-environment is gaining more and more importance in political, social, and economic terms' (Cilliers, 2015). There are limitations and restrictions of however, in the form of municipal budgets, lack of developer or public buy in, and the perceived value of green space. Often urban development is favoured over the cultivation of green spaces. Using spatial planning to focus on the natural environment in and around cities can draw on the strengths of regarding them as part of a network of 'multifunctional green spaces' which enhance social and ecological processes' (Cilliers, 2015). Therefore helping increase resilience (Schäffler & Swilling, 2013: 247).

A change in attitudes towards cities and water is highlighted in Australia, 1994. Researchers illustrated the connection between urban planning and stormwater management (mainly because of the emerging need to protect the groundwater in aquifers). A severe drought had shifted focus from simple stormwater management policies to considering the quality and quantity of it – a topic which is now considered of national importance (Carmon and Shamir, 2009).

Spatial planning has the power to guide concepts, and inspire and communicate

the essence of a vision to a point where something tangible and functional can be derived. They often take the form of metaphors which are relatable to by the public, but which also support the actual planning process (Zonneveld, 1991). Using spatial planning to enable the implementation of SUDS could be a formidable combination in to encouraging a change in mind-set concerning water resource management. Spatial plans and concepts 'represent an important interface of empirical and intuitive knowledge through which rational knowledge is complemented with creative insights'; they are 'essential tools for proactive, or innovative planning, and can structure and inspire the planning process, particularly with respect to achieving genuine and effective public participation (Ahern, 2012:185. It provides a bridge between the tendency to be bound by the scientific confounds of knowledge which society is increasingly reliant on today, by proposing a creative design and encouraging a 'leap of faith' as such. The frameworks tend to be orientated around long –term thinking, and can be flexible – an essential element when considering climate change uncertainty. Planning brings together the key mechanisms for implementing values and priorities (Crawford & French, 2008).

However, planners and practitioners need to have a 'conceptual understanding of environmental systems', knowledge of multi-functionality as it applies to green areas and an understanding of how environmental, economic and social issues intermingled in relation to sustainable communities and sustainable development agendas (Mell, 2010: 79).

Planning with Green Infrastructure can be done by focusing on the connectivity aspect of it. The connection of the landscape can be done at a variety of scales (Mell, 2010), which planning can help enable. Landscapes are linked by their 'functions, structures and interactions' (Forman, 1995; Farina, 1998, 2003; Mell, 2010), and thus should be planned for accordingly, and not in isolation.

Drawing on this connectivity aspect, GI theory contributes to the support of the case for the implementation of SUDS.

2.4 Green Infrastructure

Green Infrastructure (GI) can be considered the overarching umbrella from which SUDS fall under. Though the concept is understood by a number of authors in different ways, it has become popular as a way of guiding planning objectives in the last few years (Hansen &

Pauleit, 2014). It brings the 'concept of green' to planning in terms of infrastructure provision, and can connect the fragmented hard and soft elements of the network (Armitage et al. 2014). Lafortezza et al (2012) write that it is 'an inter-connected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations'; as well as the 'ecological framework needed for environmental, social and economic sustainability'.

The European Commission in 2013 defined it as 'strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services', (Hansen & Pauleit, 2014: 516).

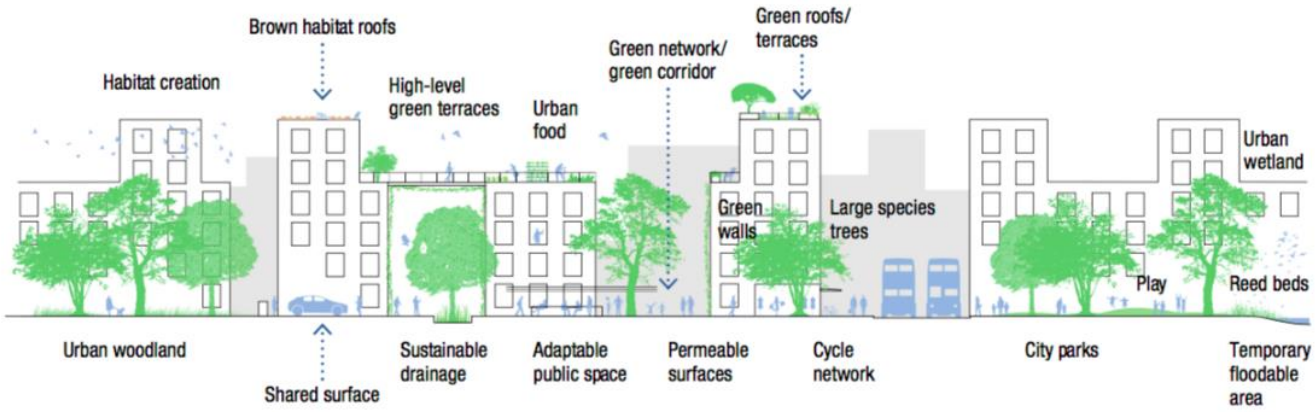


Figure 13: Green Infrastructure can take on a range of forms, shapes, sizes - depending on the stormwater management goals, building types, and surrounding development context (Burgess et al., 2017)

It is thought to influence planning processes by encouraging the inclusion of maximised green spaces and corridors, and in the process flag the role that these spaces play in ecosystem services (Fletcher et al., 2015:532). Often it is adopted on the basis that it covers a broader line of thinking than traditional infrastructure management (such as in the case with stormwater management, see Figure 12). It is perceived to create environmental benefits in communities that result in an enhanced urban environment.

The principles of connectivity, networks and multi-functionality form the crux of the concept.

In planning terms, GI renders a synthesis of innovative approaches to nature conservation and green space planning, and can be used with spatial planning to link green corridors or spaces in order to encourage biodiversity. GI enhances

urban resilience by 'using flexible interventions to improve preparedness for both flooding and drought' (Burgess et al., 2017: 3). These interventions focus on utilizing the natural ecological systems to help slow water down, and then use it as a resource, conveying it through landscaped features that seek to reunite people with water. GI thus can be used to cultivate a landscape that is both attractive and functional.

The connectivity aspect of GI is perhaps the most crucial principle in terms of spatial planning. It 'represents the spatial distribution and relations of GI elements, and consequently the distribution and relations of benefits they provide (Hansen & Pauleit, 2014: 520). Connectivity is not limited to a physical meaning, but rather extends to a function one too; this is demonstrated in its ability to impact functions such as the Urban Heat Island effect and access to green space for recreational use (Pauliet et al., 2011).

GI requires a 'level of co-operation and co-ordination between departments' in order to 'deliver the benefits that green infrastructure planning can confer' (Kambites & Owen, 2006); it is recommended that it should become embedded within the planning system as a 'normal part of the preparation and review of development plans' (Kambites & Owen, 2006). It is thought that the implementation would help reduce sewer system overflows and help manage stormwater runoff, as well enhance recreational opportunities (see Figure 14)

GI is considered a more effective and holistic approach to planning with ecological aspects in mind, and suited to urban areas as there are 'characterized by strong dynamic interplay of ecological and social systems' (Hansen & Pauleit, 2014).

Thus it presents a positive starting block from which to reconsider the way in which the urban water system is treated. In terms of spatial planning, it is applicable at both a city and regional scale (forming the overarching multifunctional open-space network) (Burgess et al., 2017), while at a local scale, it essentially deals with stormwater management in an approach that 'mimics natural hydrological processes' (Burgess et al., 2017: 3) I.e. SUDS.

The challenge however is that the focus has been for so long on improving the connectivity of built systems in urban environments, that natural systems in these same environments have been neglected. This has caused land fragmentation, subsequently impacting the unique ecological processes which are relying on connectivity.

With climate change playing an increasingly prominent part of current reality, the value of the concept of GI is being promoted as a way of 'controlling climate change through the sustainable design of housing and larger scale infrastructure development' (Mell, 2010). SUDS could offer a way to link planning to the action phase of considering climate change.

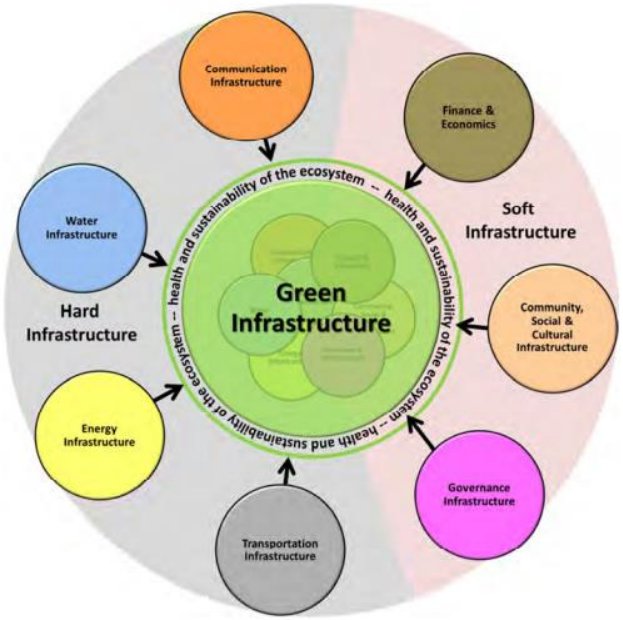


Figure 14:Green Infrastructure (Armitage et al., 2014)

Although early ideas of GI focused on 'achieving stability, practicing effective management and the control of growth and change' (Ahern, 2011), recent thinking has challenged this notion, recognizing the value of embracing change, and uncertainty as a way to respond to the emerging need to create resilient communities. Resilient communities are those that have systems that are able to 'reorganize and recover from change and disturbance without changing to other states'. This goes beyond the traditional approach to building things that are 'fail-safe', and rather develops a system that is 'safe to fail'. However, Ahern notes that the concept is alluring, but in practice, it has not played out in planning.

The next section will explore resilience further, particularly in the context of cities and the role planning plays in responding to the theories of it.

2.4.1 Resilience

Ahern (2011) proposed number of positive strategies that can help build urban resilience with concepts such as multi-functionality (in term of ES services), biodiversity, and planning and design. Planning for the inclusion of spaces that allow for the integration of activities which have a strong emphasis on community participation, for example, may bring 'social, natural, economic, and physical capital into the urban sphere and make cities more resilient and adaptive to change and disturbance' (Childers et al., 2013).

It is also necessary to deal with the critique of the concept of resilience. Ernstson et al., (2010) distinguished between resilience "in" cities (individuals or social groups on a city scale) and resilience "of" cities (broader categories of stakeholders on a bigger scale, such as a

system of different cities). It is important to note that there is argument that these concepts are related, but not the same (Harrison et al., 2014:5).

Therefore, applying resilience thinking to urban policies and plans needs to be done in careful consideration as to how these theories of resilience translate from natural systems, to the human world, and include aspects of justice and fairness.

This is challenging because 'resilience for some, may lead to the loss of resilience for others' (Davoudi et al., 2012:36), and there appears to be some danger in overemphasizing resilience thinking.

2.5 Climate Change

Urban areas are high-risk areas in terms of climate change, as they are home to a large concentration of people as well as bodies of infrastructure, and thus are key players in the larger economic and political – and indeed social – processes. They are also places of opportunity for exactly those reasons.

Climate Change impacts are anticipated to be a combination of hazards and natural phenomena rather than single drought or flood events. Despite droughts and floods being experienced throughout history, their frequency and intensity is predicted to increase in the face of climate change (Birkman et al., 2010). Sea level rise and new dimensions of Urban Heat Island (UHI) impacts should be expected too (Birkman et al., 2010). Areas prone to drought may be at risk of flooding due to compacted soils creating an impenetrable surface and causing flash floods (Burgess et al., 2017: 9). Though humans have adapted to changing environments, the speed at which these changes may happen and the magnitude at which they occur may happen at a scale never before experienced by modern societies (Birkman et al., 2010). Thus, thinking should now not be limited to adaptations and responsive strategies; rather it should embrace and incorporate the unpredictable nature of the anticipated trends. Climate Change is anticipated to test existing capacities of cities and countries. Wong and Brown (2008) argue that the slow response of the majority of cities to climate change is due to the overhaul required of the hydro-social contract that tends to underpin conventional approaches. There has been an entrenchment of the accepted way to deal with problems, and the steadfast belief that certain protocols must be adhered to, rather than thinking outside of the box, or beyond the red tape.

2.6 Silo and Fragmented Thinking

Many analysts and professionals argue that water management has been too reductionist and sectoral for too long. There is a need to better co-ordinate not only the management of different elements of the resources (groundwater to surface water) but also between chains in the supply, such as the path between providing drinking water to wastewater treatment and between administrative boundaries (Butterworth et al., 2001).

Urban infrastructure is tradtionally percieved as being largely a stationary product of a linear trajectory, produced by engineers in conjunction with public authorities (Brown et al., 2011). With the increasing realistaion that climate change will induce a large degree of uncertainty, the need to be flexible and adaptive is ermeging as a necessary condition in the way in which we view the construction of the built environment. Infrastructure systems are 'seen as important means of responding to climate change; as such they configure, and will increasingly be configured by, urban responses to climate change (Bulkeley et al., 2014; Mguni, 2015). Mguni uses this to link to Sustainable Urban Water Management (SUWM), which 'considers 'green developments and concepts at the micro-scale and links them with larger watershed-level management infrastructures for water supply, sewerage and stormwater' (2015; Novotny, 2010). Instead of following the traditional approach of compartmentalising the management of the supply, sewage and stormwater of urban water, SUWM rather seeks to focus on managing the whole water cycle, based on the concepts of environmental protection and sustainability.

A new understanding has developed over the past few decades with regard to the relationship between urbanisation and the consequences on urban drainage and the urban water cycle. This has brought an attempt to shift thinking from a reductionist and reactionary approach that focused on stormwater as a negative hazard, towards a more layer, holistic approach, driven by a cultural change that recognises the opportunities that stormwater represents (Fletcher et al., 2015).

Mguni (2015) writes that 'there is an inherent need for a transdisciplinary multi-tiered approach that is different from the linear, engineer driven conventional centralised water system' (12). The untried nature of SUDS mean that often the water quality and quantity improvement performances at city level are uncertain. Cities around the world face the task of both sustainability - how

to transition water management from a 'path – dependent and technocratic sector can change direction towards more sustainable and resilient trajectories' – as well as a 'transition challenge of how such a change in trajectory could be realised' (Mguni, 2015:130).

Understanding the power dynamics within the regime that governs the water in a city is essential to understanding the barriers and the opportunities towards implementing SUDS (Mguni, 2015). Thus the transition process is likely to largely be a political process where the 'play of power relations between actors is what ultimately decides what is discussed and implemented, and what is not' (Mguni, 2015).

This is examined further in the following section, which focuses on understanding Stormwater Urban Drainage Systems in detail.

2.7 Sustainable Urban Drainage Systems (SUDS

Historical approaches to stormwater drainage will be examined in order to understand the current context of the infrastructure. This will be followed by a brief explanation of the way SUDS work, and the different terminology used. Case Studies and constraints and opportunities of the SUDS approach follow.

Figure 15: Cities without SUDS: discharging polluted water into rivers and oceans (Thames21.org)

2.7.1 Historical approach to stormwater drainage

The implementation of Green Infrastructure in the form of SUDS at a local, neighborhood scale can take place in use of features that can capture, retain and slow the release of stormwater during both routine and peak events. This can be done through the storage, infiltration, evaporation and carrying capacity of

Figure 16: Cities with SUDS, returning health to natural systems, and providing green spaces for people (Thames21.org)

distributed elements, opposed to hided pipes and centralized detention basins. The distributed elements include green roofs, bioswales, rain gardens and permeable paving (Burgess et al., 2017). These mechanisms support the natural infiltration of the site and can connect and enhance local ecosystems. They also help from an economic perspective, as they reduce the need for buried storm water systems, which lowers infrastructure costs.

2.7.2 Terminology

It is necessary to briefly examine the differences in the associated professional terminology as it has been driven by 'local and regional perspectives, understandings and context' (Fletcher et al., 2015: 526), with different terms being used to define similar contexts. The terminology used to describe the principles and practices of stormwater and urban drainage has over the years become as complex as the attitudes towards the management of it' (Fletcher et al., 2015: 525).

This can lead to confusion and contradictions, which is why it is necessary to observe some of the differences. The hope is that this will provide clarity for this research project and the local context, by considering the associated complexities of communicating in different languages, even when the aim and intention is the same.

The route which countries travel to reach an agreed upon definition differs, but one particular striking example is of New Zealand, whose terminology around urban drainage has been 'developed with the recognition of Maroi values and their links to water and the environment' (Fletcher et al. 2015: 526). This is a wonderful way of incorporating traditional belief and value systems into modern day terminology, recognising the importance of including local communities and tribes.

2.7.3 Low Impact Development (LID):

Most commonly used in North America and New Zealand, it is an approach that 'attempts to minimise the cost of stormwater management, by taking a design with nature approach' (which in itself is influenced by the work done by prominent Landscape Architect, Ian McHarg, 1971). The term was used by those pioneering the creation of planning policy for Environmentally Sensitive Areas (ESA), particularly in reference to the protection of areas such as 'aquifer recharge and headwaters' (Fletcher et al., 2015: 526) i.e. only allowing low impact development there.

The original intent was to achieve 'natural hydrology by use of site layout and

integrated control measures'. The natural hydrology was deemed to consist of 'pre-development runoff, infiltration, evapotranspiration volumes' (Fletcher et al., 2015: 527) and be achieved through the creation of a 'functionally equivalent hydrological landscape' (Fletcher et al. 2015: 527). By the 1990s the interpretation had digressed to 'encompass any set of practices that treated stormwater'; researchers between 2005 and 2010 attempted to push back to the original intent. More recent manuals now 're-establish hydrological targets for both retrofit and new urban developments and provide design options to meet and sustain these objectives' Fletcher et al. 2015: 527). The use of LID has been codified in legislation and has become a somewhat mainstream means of stormwater management approach in the USA.

2.7.4 Water Sensitive Urban Design (WSUD):

This began to be used in the 1990s in Australia, with the following initial objectives:

1. "manage the water balance (considering groundwater and streamflow, along with flood damage and waterway erosion),

2. maintain and where possible enhance water quality (including sediment, protection of riparian vegetation, and minimise the export of pollutants to surface and groundwater),

3. encourage water conservation (minimizing the import of potable water supply, through the harvesting of stormwater and the recycling of wastewater, and reductions in irrigation requirements), and

4. maintain water-related environmental and recreational opportunities"

(Fletcher et al. 2015: 528).

As it represented a shift in thinking, WSUD was described as having a philosophical element, and was regarded as 'urban planning and design that aims to minimise the hydrological impacts of urban development on the surrounding environment' (Fletcher et al. 2015: 528). There was also a distinction made between the principles and objectives of WSUD and the techniques used to achieve these. The application initially focused on stormwater management; and has now shifted to incorporate the recognition of the need for considering stormwater management within a more integrated framework, that considers the urban water cycle as a whole. WSUD indicates the processes towards achieving Water Sensitive Cities.

2.7.5 Integrated Urban Water Management (IUWM):

This term combines the management of water supply, groundwater wastewater and stormwater. The underlying principles are recognising the integrated nature of the water cycle, from both a natural and constructed perspective, and striving for sustainability, 'aiming to balance environmental. Social and economic needs in the short, medium and long term' (Fletcher et al. 2015: 529).

2.7.6SUDS (Sustainable Urban Drainage Systems):

The acceptance of stormwater management advanced in Scotland in the 1990s and was largely based on the concept of the sustainable drainage triangle (quantity, quality, habitat/amenity). The term SUDS was first used to describe stormwater technology. The 'urban' is sometimes omitted from the term, but the meaning remains largely the same. SUDS in the United Kingdom consist of 'a range of technologies and techniques used to drain stormwater / surface water in a manner that is more sustainable than conventional solutions' (Fletcher et al., 2015: 530). As with LID, they are built on the desire to replicate the natural drainage of a site, and are considered as a sequence of stormwater practices and technologies that work together to form a management train.

2.7.7 Function

SUDS work in a treatment train (Figure 13). 'SUDS are a sequence of management practices and or control structures or technologies designed to drain surface water in a more sustainable manner than conventional techniques' (Armitage et al., 2013: 23). They are considered a branch of Water Sensitive Urban Design (mentioned above).

SUDS offer an alternative to the current entrenched desire of mostly engineers to remove water as rapidly as possible from urban areas. They are 'stormwater management systems that are designed to mimic the natural hydrological cycle process by using the natural processes of infiltration, storage, detention, retention, evapotranspiration conveyance and treatment of stormwater in the green infrastructure of the urban landscape' (Mguni et al. 2016: 244). As previously mentioned, the underlying philosophy is that as closely as possible the 'natural, pre-development drainage from a site' should be replicated (Fletcher et al., 2014).

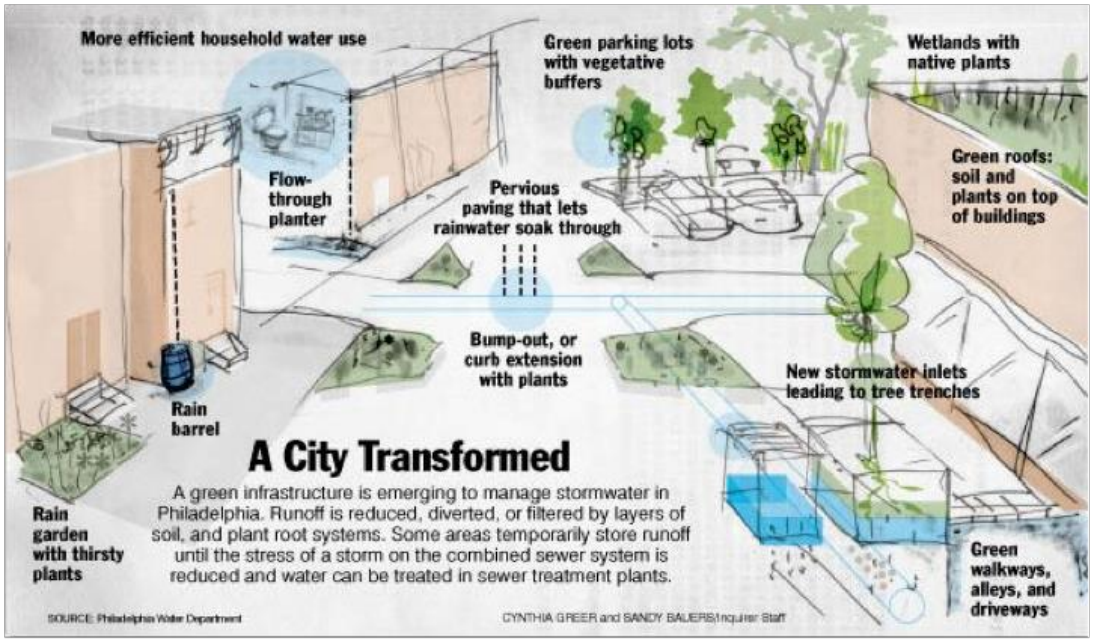


Figure 17: Transforming cities with SUDS (Philadelphia Water Department)

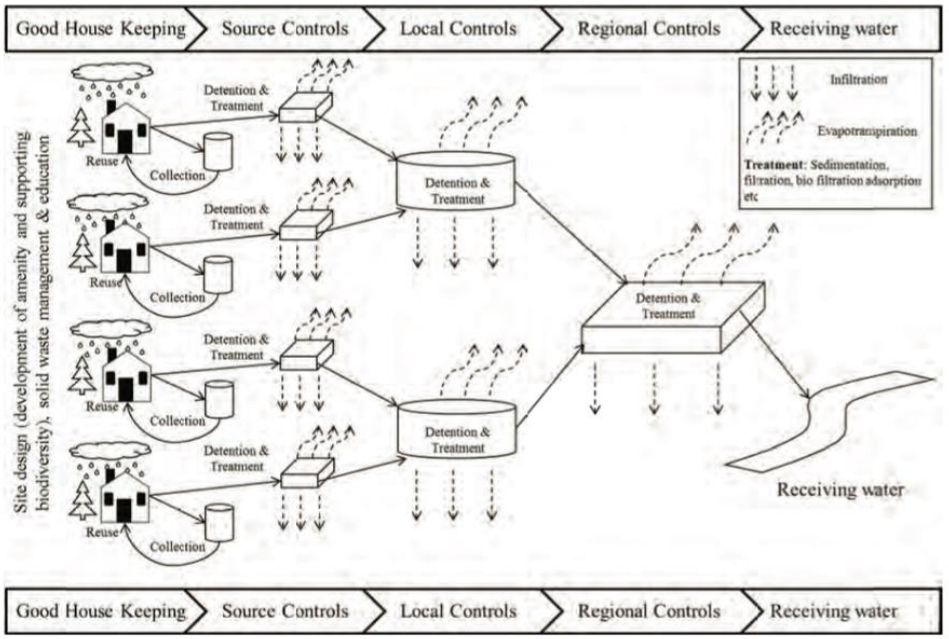


Figure 18: SUDS Train (Armitage et al., 2011)

The term incorporates a number of different systems that 'slow and sometimes retain runoff to attenuate surface drainage' (Jones & MacDonald, 2007: 537).

According to Mguni et al., (2016: 244), the concept focuses on three aims:

1. 'reducing the **quantity** of run-off through source control and slowing the velocity of run-off;
2. improving the **quality** of stormwater by providing passive treatment of collected surface water before discharge onto land or a watercourse;
3. Enhancing **amenity** and maintaining biodiversity'.

To achieve these aims, four hydrological processes are undertaken: temporary storage, infiltration into the soil, evaporation into the air and conveyance of the water, as well as treatment of the water (Mguni et al., 2016). A crucial part of the process is the pre-treatment of the stormwater, in order to reduce the level of

pollutants that will be released into the environment (non-structural elements). Their structural elements are designed to work in conjunction with the existing hard infrastructure, in sewer systems. Both structural and non-structural elements are arranged in treatment trains (Armitage et al., 2012). See Figure 18.

These goals are deemed able to provide a framework for cities to work towards a future that encompasses a sustainable attitude and indeed, a reverence to natural systems, whilst acknowledging that the journey is not one with an end state but rather one that requires a constant evolution of ideas, work and attention. By approaching water from a perspective that includes stewardship for natural systems, humanity may be able to change the path of destruction that is currently been undertaken.

2.8 Case studies

The Manchester case study considers the role of spatial planning and in the implementation of SUDS, drawing on the gap between policy, legislation, and local actors in England.

The North Carolina case study briefly examines the strategies used to communicate SUDS in the state.

2.8.1 Manchester

The risk of an increased volume of surface water, as a result of urbanisation, has been recognised in England, and SUDS was identified as a key aspect of managing the associated flood hazard. The role of spatial planning has been 'highlighted as the main mechanism for implementation' (White and Alarcon, 2009).

Heavy flooding in 1998 demonstrated the inefficiency of the prevailing approach to the management of surface water. In 2001 a Planning Policy Guidance Note was released confirming that the inability to manage the flood was deemed a direct result of increased urbanisation (White and Alarcon, 2009: 516). This note maintained the need for a strong link between land use and water management, and introduced SUDS to the UK planning vocabulary. SUDS were considered as being a part of a transition towards a more sustainable, natural, water management agenda. Policy and regulations have further reinforced this thinking, with a revision of the Building Regulations in 2002 emphasising their implementation over other drainage techniques.

White and Alarcon (2009) compared the spatial distribution of SUDS sites in ten local authorities (LA) within the

Manchester area. This was to determine the effectiveness of the role that planning should play in their implementation. The SUDS in the areas were identified, plotted, and compared, to 'the extent of their spatial distribution with the intricacies of the relevant planning policy framework in operation' (White and Alarcon, 2009) (Figure 19).

The Local Authorities (LA) were grouped according to the strength of their SUDS policies (with the authors assigning 'strong', 'average' or weak'). White and Alarcon note that:

> The nature of planning means that the wording of policies has an effect on the surface water management decisions of developers and architects. This seems to indicate that a mere matter of wording has a direct impact on whether or not SUDS are considered for implementation. For example, one LA may state that all new buildings 'will be required to use SUDS', and another LA may only state 'SUDS may be considered (2009:519).

Interestingly, there was a negative correlation between strong SUDS policy and the implementation, suggesting that there is in fact no relationship between a strong policy and the number of SUDS implemented.

1 The three best performing LAs in terms of policy had the least number of SUDS sites; this is in contrast to LAs who had weak policies, but many SUD sites. This spatial differentiation suggests an inconsistency at a local level and a 'considerable disconnect between strong SUDS policy provision and SUDS implementation' (2009: 522). This is suggested by the authors as indicative that the SUDS policies are ineffective as a result of other factors, such as supporting legislation and public perception.

Challenges

The challenges faced in Manchester are outlined below:

Figure 19: Map of SUDS in Greater Manchester (White and Alarcon, 2009)

- Adaptation and Maintenance were considered to be the two biggest barriers to the implementation of SUDS. The current legislation was established before the emergence of SUDS, which meant that there

was a lack of supporting legislation and confusion as to who is responsible for their implementation and maintenance.

- The perceived cost of SUDS, with stakeholders considering them to cost more, as they were a diversion from the norm. This indicates a lack of clarity and understanding of SUDS and can perhaps be attributed to a 'lack of evidence pertaining to their maintenance costs over their life cycle' (523).
- The translation of national policy to local policy lacks a relation to SUDS. There is little specific local circumstance provided, which creates scope for a variation in local SUD policy.
- Some SUD techniques appear to be preferable to others, which suggests that an affiliation to certain SUDS techniques means that the most appropriate technique is not always used. The absence of a clear definition of what a SUD is and when to use them was also cited; this 'renders the position of SUDS within the planning system as unclear and highlights the inadequacy of a one size fits all approach' (524).
- A lack of communication between stakeholders has led to a 'deficiency of integrated and holistic thinking concerning SUDS, with some stakeholders becoming insular due to a lack of confidence in others' abilities. There is a need for a strategic vision to be clearly understood and then articulated by those with the technical expertise.

- There is a need for a local champion to secure the successful implementation at a local level. However, the authors deem this to indicate that the planning system is flawed; as such, individuals should not have to be relied upon in order to ensure success.
- Improvement to legislation with regard to sustainability considerations for drainage

The majority of barriers - and thus opportunities - appear to stem from issues with legislation.

Successes

- The financial benefits of SUDS should be promoted, with the suggestion that the government or LA should give a financial incentive to encourage their use. Building an evidence base is vital to informing policy. Maps and good practice examples should be utilised. The

maps would be able to provide local context and have the potential to create a visible link between ‘local upstream priority areas, best practice local case studies and the wider, strategic implementation of SUDS’ (527).

- Integrated and holistic thinking to share information and skills would be beneficial; ‘engineers could assist in preparing planning policy in relation to SUDS, while planners could advise on strategic dimensions’ (527).
- Good communication is necessary in the early consultation phase of the development process; this has been identified as a ‘crucial factor in securing SUDS use’ (527).

Conclusion

The SUDS policy framework for Manchester is found to be lacking, with only 36 SUDS sites having been realised in the area. The existing planning policy framework appears to have no correlation with SUD sites, suggesting that the barriers are largely rooted in the legislation or a lack thereof. It highlights the need for a collective vision, constructed with the involvement of both the public and technical experts. The case study suggests that a local champion for SUDS would be instrumental in a stronger rate of success.

2.8.2 North Carolina, USA

The following case study examines the guidelines that North Carolina has provided for Stormwater (referring to them as Best Practice Management’. These guidelines are given in the form of a manual, available to residents and business owners alike.

Best Practice Management

North Carolina, United States, has recognised the link between urbanisation, decreased land available for permeability in rain events, and implemented ‘stormwater BMPs’. The creation of a Stormwater BMP Manuel for the state has outlined the difference between structural and non-structural BMPs, and identified technologies and specifications of BMPs. These help users reach the minimum regulatory requirements for stormwater BMPs and ensure that they perform in a manner that will protect the state’s water

quality standards (NCDENR, 2007). The State has recognised that without stormwater controls, the increased runoff from urban areas can impart further damage; eroding stream channels, increase pollutant loads in water, downstream flooding and preventing groundwater recharge. The water quality of a number of different types can be degraded. It is imperative to protect these so as it look after wildlife habitats, human health and recreation, as well as drinking water (NCDENR, 2007). The state has pursued water pollution management to fulfil the requirements of the Clean Water Act.

Water pollution was examined in 17 river basins, and specific plans developed according to each one were designed. This speaks to the notion that water resource management should be approached from a catchment level.

Manual

North Carolina prefers non-structural methods. This focus on public education and participation, controlling material use exposure (such as pesticide and fertiliser use) and roadway cleaning, vegetation controls and drainage channel maintenance.

12 Bioretention

Description
Bioretention is the use of plants and soils for removal of pollutants from stormwater runoff via adsorption, filtration, sedimentation, volatilization, ion exchange, and biological decomposition. In addition, bioretention provides landscaping and habitat enhancement benefits.

Regulatory Credits		Feasibility Considerations	
Pollutant Removal – No IWS			
85%	Total Suspended Solids	High	Land Requirement
35%	Total Nitrogen	Med-High	Cost of Construction
45%	Total Phosphorus	Med-High	Maintenance Burden
Pollutant Removal – with IWS Coastal Plain & Sand Hills		Small	Treatable Basin Size
85%	Total Suspended Solids	Med	Possible Site Constraints
60%	Total Nitrogen	Med-High	Community Acceptance
60%	Total Phosphorus		
Pollutant Removal – with IWS Piedmont & Mountains Counties			
85%	Total Suspended Solids		
40%	Total Nitrogen		
45%	Total Phosphorus		
Water Quantity			
yes	Peak Runoff Attenuation		
possible	Runoff Volume Reduction		

Advantages
- Efficient removal method for suspended solids, heavy metals, adsorbed pollutants, nitrogen, phosphorus, pathogens, and temperature.
- If providing infiltration in appropriate soil conditions it can effectively reduce peak runoff rates for relatively frequent storms, reduce runoff volumes, and recharge groundwater.
- Flexible adaptation to urban retrofits.
- Individual units are well suited for use in small areas, and multiple, distributed units can provide treatment in large drainage areas.
- Natural integration into landscaping for urban landscape enhancement.
- Addition of upturned elbow in design can increase N and P removal and be added as an inexpensive retrofit.

Disadvantages
- Surface soil layer may clog over time (though it can be restored).
- Frequent trash removal may be required, especially in high traffic areas.
- Vigilance in protecting the bioretention area during construction is essential.
- Single unit can only serve a small drainage area.
- Requires frequent maintenance of plant material and mulch layer.
- IWS requires well-drained soils.

Figure 20: Bioretention Guidelines, North Carolina (NCDENR, 2007)

The structural aspect of BMPs (physical structures designed to remove pollutants from stormwater runoff at various stages of the flow, i.e. before it enters the collection system with filter strips, or at the end of the pipe with retention basins).

All designs have to meet requirements in the North Carolina Administrative Code, or else will not be approved for construction. The manual notes that knowledge about stormwater management is advancing continuously, and that thus the manual or parts of it will be regularly updated (NCDENR, 2007).

The manual provides information on the design of BMPs; it focuses on the soils and vegetation which influence the structure. It also guides on the construction, operation and maintenance, and aids any calculations that may be necessary.

The minimum design criteria for each type of BMPs are explained further, meaning that potential users have adequate amounts of information to allow for successful intervention. The manual states that selecting the right BMP is 'an art as well as a science' (NCDENR, 2007), and 'provides the link between stormwater regulatory requirements and physical site constraints, as well as issues of cost and community acceptance' (2007). An example of the guidance on the construction of a Bioretention basin is given in Figure 20.

There are additional resources available to help create more awareness on BMPs and resources for schools too. This helps children learn the importance of the structures, and how they are necessary in urban areas.

The maps in Figure 21 and 22 are taken from the NCDENR website. They interactive and mean that programs in their various stages can be updated online. This is helpful to local authorities in terms of monitoring water quality and quantity; in areas of poor quality there may be a BMP intervention which is suited to improving this.

The website contains information about the map results and tutorials on map features

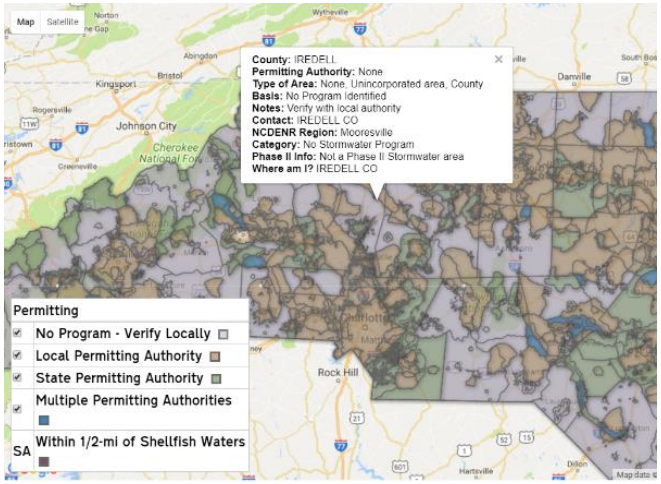


Figure 21: Mapping BMPs (deq.nc.gov/)

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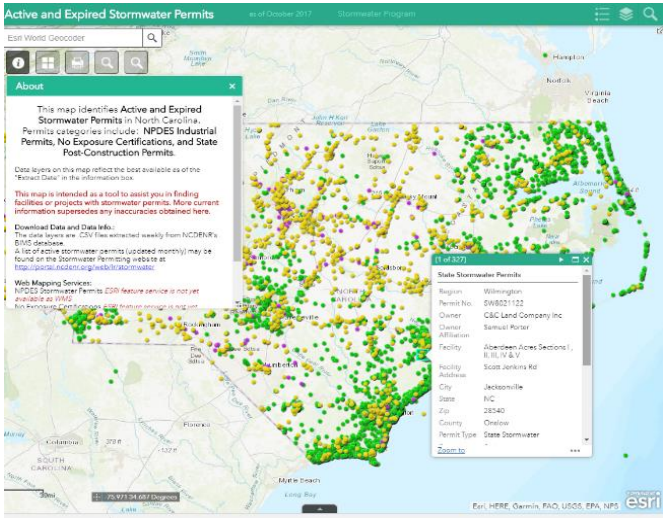


Figure 22: Mapping existing BMPs in North Carolina (deq.nc.gov/)

Conclusion

It appears that the approach by the State has been well researched and implemented. The state has combined knowledge on the effect of stormwater runoff in urban areas, and sought to combat the pollutants carried in this water with non-structural and structural interventions. These ave been meticulously communicated, through public participation workshops, and the resulting guidelines are clear and concise to understand.

2.9 Critique of SUDS

Cost plays an imperative role in the implementation of alternative systems, with the argument often that it is too expensive to change or upgrade the whole system. However, New York City recently evaluated two stormwater management strategies, and discovered that they would save US$ 1.5 billion if the City implemented a green infrastructure plan that included green roofs, stream restoration and bioswales (Burgess et al., 2017), instead of a traditional grey infrastructure plan.

In the context of cities or areas where SUDS are used as part of community upgrading schemes, with the aim of improving the image of informal settlements, the raise land value may cause concern. This may be considered an opportunity, but it also bears risk. If the upgrading is done in isolation of socio economic improvement, then SUDS may 'inadvertently cause "aestheticization of poverty", merely painting over deep rooted problems' (Mgui et al., 2016: 252).

In addition to these complexities, the successful implementation of SUDS is reliant on a sound understanding of the technical side of the drainage mechanisms, as well as of the often complex socio-political, institutional and biophysical context of the area (Fryd et al., 2012: 866; Chocat et al., 2007). This is why it is essential that a cohesive approach is applied, that seeks to turn away from silo thinking and actions, towards incorporating professionals from a number of disciplines, and government officials from a variety of departments. The clients/ locals are important actors

too, as they are ultimately the end users of the product.

Some of the elements of SUDS require high levels of maintenance; swales and dry ponds are likely to fail unless regularly looked after. This is expensive and skill intensive, which may be lacking in developing countries (Mguni et al. 2016). Municipalities are often reluctant to implement SUDS as a result.

There is a considerable amount of stakeholder decision making required at various levels in SUDS, and often a requirement that different spheres of government work together, as well as with the private sector. Space can also be a restriction, as cities that are densely developed may not have ample room for the implementation of some of the SUD elements. Planners too can be reluctant, wanting assurance of success before implementing schemes

Politics too plays a large role. It is influential, particularly when it comes to the distribution of resources, and the need to navigate the balance between environmental, economic and social values (of water). The World Bank in 2003 conceded that 'water resource management is intensely political'; politics is often viewed as the problem – but there certainly is room for it to become an opportunity, particularly as a catalyst for public involvement and change (Butterwort et al., 2010: 74).

2.10 Opportunities

However, the literature examined presents many positive outcomes too.

With climate change becoming more of a current reality, rather than a planning or adapting for the future scenario, water is not exempt from being affected. According to the IPCC (2007), freshwater ecology will be among the systems most affected by climate change. Water supplies will be affected as precipitation patterns, river flows and groundwater tables change (UN Habitat, 2011).

According to Wong and Brown (2008), nineteen scholars across several disciplines agreed that a city which adapts a Water Sensitive approach to water and stormwater management would 'ensure environmental repair and protection, supply security, public health and economic sustainability, through water sensitive urban design; enlightened social and institutional capital, and diverse and sustainable technology choices' (2008: 2).

SUDS helps realise the opportunity to facilitate the implementation of integrated urban water resource thinking, with the potential to begin to actually view water as part of its cycle, and treat it that way.

Where cities have to consider climate change, SUDS may be one such way in which they build resilience to an uncertain future. They are able to deliver benefits at different spatial scales and offer the opportunity to construct something which endures 'indefinitely' as it 'neither depletes resources not degrades environmental quality' (Wong & Brown, 2008:1).

SUDS not only provide biodiversity benefits, but aesthetic ones too, which can help create strong ecological landscapes in urban areas. These areas can serve as a point for people to re-connect with nature, learning about the essential relationships between water and the environment, and humanity. This could help challenge the aforementioned conventional philosophical approach of urban communities who draw on natural systems benefits without realizing the extent or destructive consequences of their actions.

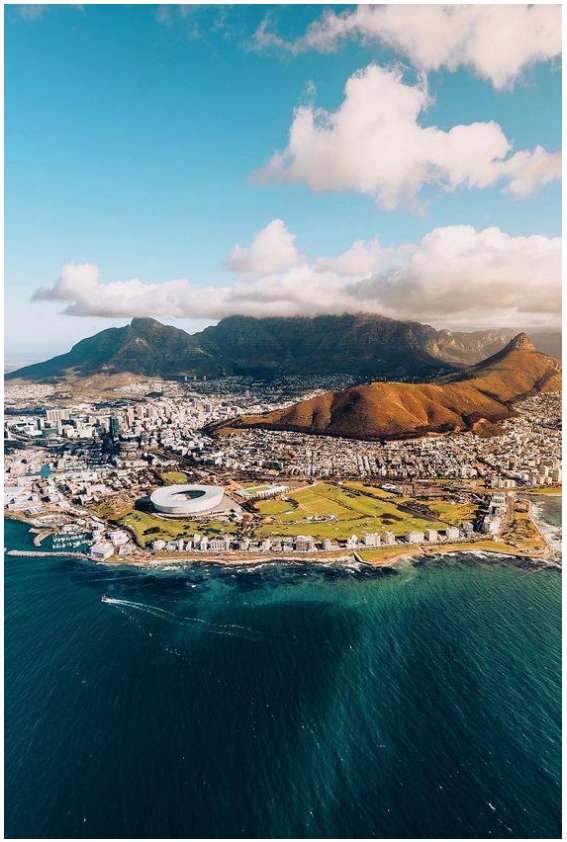
SUDS require a wide range of stakeholders for decision-making and implementation. Though this is a challenge, it also offers opportunity in the sense that previous infrastructure implementation schemes were likely to have been top down, institutional approaches. For cities where the informal sector often does not have a say, this could be incredibly valuable, offering a voice to the previously marginalised. SUDS have the ability to help reduce flood risks too, contributing to the flood hazard mitigation as it delays the storm hydrograph (through the process of reintroducing infiltration areas).

Finally, ultimately, SUDS offer the chance to address urban water management from a more holistic perspective, recognizing that everything is connected. Importantly, it offers the chance to close the urban water cycle loop.

It is necessary to provide 'connections between the urban water system, green infrastructure and land use planning among other urban functions' (Mguni, 2015, Ashley et al., 2011). The concept is based on the vision for a Water Sensitive City, where cities can act as the water catchment, whilst providing ecosystem services and that are home to citizens who behave in increasingly environmentally thoughtful ways (Mguni, 2015; Wong & Brown, 2009).

3

The City Bowl through the Lens of Water: Pump Pipe Pave



Water has created a tense relationship between human and nature, with civilisations thirst for tapping and taming it now pushing society to the brink of a stark future: life without it.

3.1 Introduction

The Literature Review laid out the theoretical context for Green Infrastructure, and highlighted arguments for it, as well as the challenges it faces. SUDS is understood to be a powerful tool, and they represent a shift away from the traditional mantra of pumping water out of the ground, piping it into human settlements, and then paving over it. Combining SUDS with spatial planning can provide a pathway to the implementation of a different infrastructure and attitude approach to planning with water resources.

This chapter will provide context of the City Bowl, Cape Town, and will set the scene (Figure 24) for the basis on which the Interventions (Chapter 4) draw from.

The Chapter will begin with a reflection on the history of water supply and demand within the City Bowl, exploring how this relationship has, in many ways, shaped the area. This will be followed by an explanation of the choice of study area, detailing the motivation for the site and describing the boundaries.

The site is within the area known locally as the City Bowl. This is nestled between the majestic backdrop of Table Mountain and the Atlantic Ocean of Table Bay, as seen in Figure 7. The term the 'City Bowl' is used from here on after in reference to the boundaries described in the following section (and indicated in figure).

The chapter concentrates on the natural and physical attributes of the City Bowl (place) and the demography of users of the site (people), using a spatial analysis to guide the reader through the landscape.

It then turns the focus to understanding the institutional and legal frameworks that influence and determine the ways in which water is managed and governed. The analysis provides the background to the existing and established attitudes and practices towards natural systems within the national, provincial and local setting. It focuses on the role that planning currently plays within the City of Cape Town, and highlights gaps in the vision, aims and objectives of the Table Bay District SDF, the Cape Town SDF and the Integrated Development Plan.

Finally, the findings are presented in conjunction with information collected from interviews (conducted with planners, engineers, and landscape architects). The chapter concludes with opportunities - outlining possible sites of exploration and intervention of SUDS within the City Bowl - and constraints, acknowledging that there are challenges to overcome.

3.2 History of water supply and demand in the City Bowl

"They came for the water. Otherwise they would have gone to Saldanha" (Chief Merchant of the British East India Company's ship, Ascension) (Brown et al., 2009:55)

Reflecting on the history of Cape Town provides an interesting account of the struggle between consumption, demand and supply; the City has been in search of a steady water supply essentially since written records began. Little is recorded about the area before the Europeans arrived. However, we do know that the Khoi called it Camissa, which means 'place of sweet waters' (Reclaim Camissa, 2004). This water supply was the reason that the Dutch East India Company established a provisioning station here for their ships on their journeys east. When Van Rieebeck arrived in 1652 he named the river that flowed from Table Mountain the Varsche

River (Varsche meaning 'fresh' in Dutch), and built a garden to provide vegetables for the station. To provide a constant supply of water for the gardens and the settlement that grew around it, he directed the Varsche River into a series of furrows. These were in the style of canals that the Dutch had built back home, and were soon expanded into canals (Figure 25 and Figure 27). Canal means gracht in Dutch, and the names given to present day streets in the City Bowl reveal the traditional paths that water flowed through the settlement. Heerengracht, Buitengracht and Keizersgracht streets are marked in Figure 29.

Figure 23: Original grid of the City Bowl, looking towards the Atlantic Ocean (UCT Digital Archives)

Van Rieebeck records waiting for rain to relieve the parched crops in 1654, and his predecessor (Wagenaar) wrote nine years later 'In consequence of the continuous drought, so very unusual at this time of year, the ground can hardly be entered by the plough; at the same time, the grass is dying and dying away' (Burman, 1969:97).

The early settlement continued to grow, and took the form of the grid still evident today in the City Bowl. Wagenaar built a reservoir on the present Grand Parade (which provided water for the next 140 years (and whose remains were uncovered in the building of Golden Acre Shopping Centre, Figure 83).

Figure 25: The Wash Houses (Gasson from the Cape Argus)

A water house (Figure 28) on Hof Street was built to store 250, 000 gallons to provide for the growth of the settlement. In the meantime, the canals were becoming increasingly polluted with effluent and rubbish, caused by people washing on the banks of the river. This pollution raised concerns around public health. Municipal washhouses were built in response in 1888 (Brown et al., 2009). From these wash houses a cobbled walk used to connect to upper Buitenkant Street (Burman, 1969) (Base Map, Figure

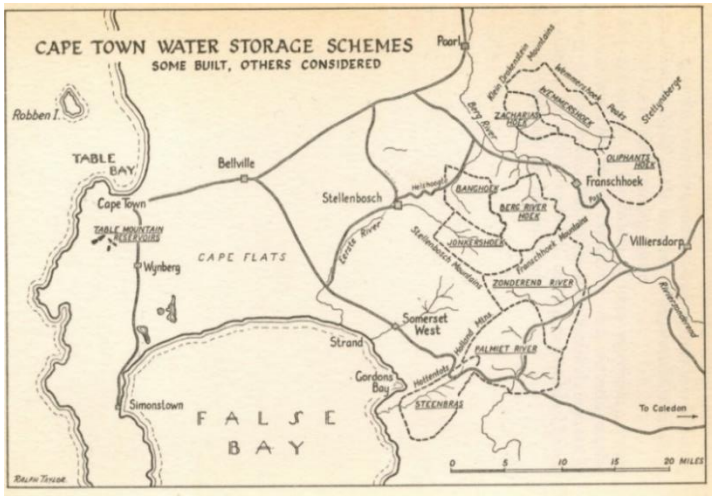


Figure 24: The Table Mountain Reservoirs, Steenbras and Wemmershoek Storage schemes (Burman, 1969)

37). Much of this is hidden underneath the road today, with hardly a 'trace left of the old road along which generations of slaves trudged in the past' (Burman, 1969).

From here, the Varsche River runs into a stormwater drain in Capel Street, where it crosses Upper Mill Street and cuts across to Clare Street before passes down Upper Canterbury Street and to the Castel of Good Hope (Burman, 1978) 9Figure 37).

In 1852 and 1856, two more reservoirs were built between Orange and Hof Street (Figure 29), providing the additional capacity of 2,500, 000 gallons. This was still not ample enough for resident's needs. The Molteno Reservoir was built to hold 41 000 000 gallons and yet this too was insufficient, with records of water rationing occurring in the City Bowl of that year (Burman, 1969). The focus of water provision then turned to the Dias Gorge, with the building of Woodhead Tunnel (the Pipe Track today) intended to bring water over Kloof Nek, and into the Molteno Reservoir (Figure 8). Despite the tunnel, officials realised that more 'expensive and far-sighted schemes

would have to be undertaken', and that the tunnel was only a step in the path towards achieving water security (Burman, 1969:103).

Work thus began on the construction of a reservoir on Table Mountain (Woodhead Reservoir, completed in 1897). Again this only lasted a year before Council found that consumption had overtaken supply (the reservoir could hold 210, 000,000 gallons).

By 1905, the Cape Town Council discovered that daily water consumption had risen dramatically to between 2,300,000 and 3,000,000 gallons a day (Burman, 1969:108). The Steenbras scheme was implemented in 1916, piping 600,000,000 gallons through the mountain ridge for 40 miles to Cape Town. Once more consumption increased, and, combined with drought in 1923, a need arose for the augmentation of Steenbras. In addition to quantity supply struggles, the quality of water from Steenbras was so poor that it required a filtration plant. An additional dam was built – Wemmershoek - in 1951, which had the capacity of 12, 900,000,000 gallons (Figure 24). This has been supplemented by the Vogelvlei dam scheme.

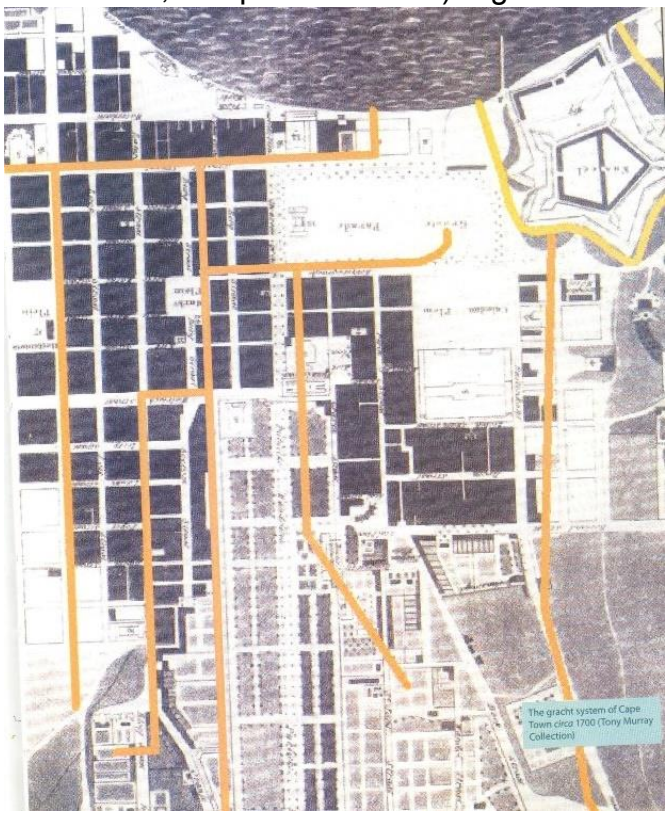


Figure 27: The gracht system of Cape Town (Brown et al., 2009)

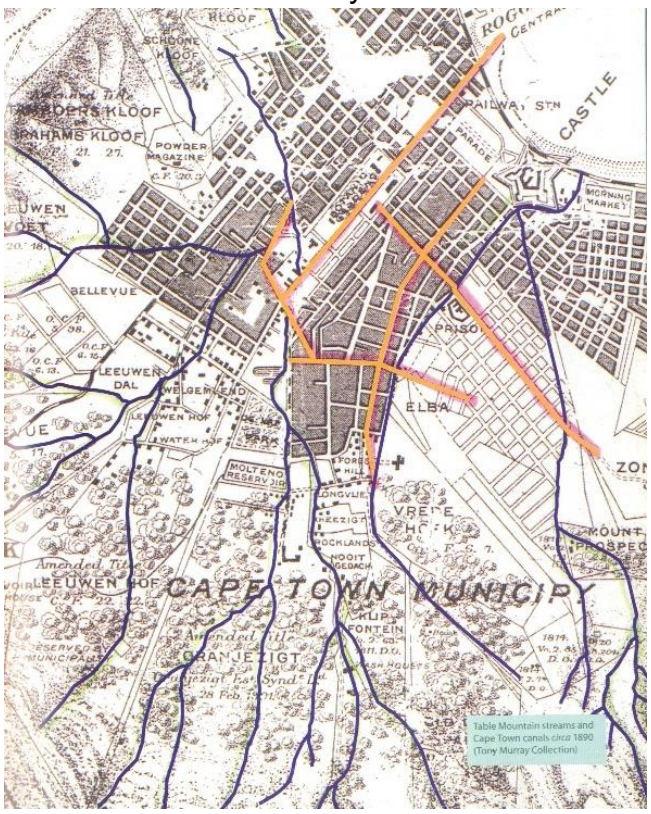


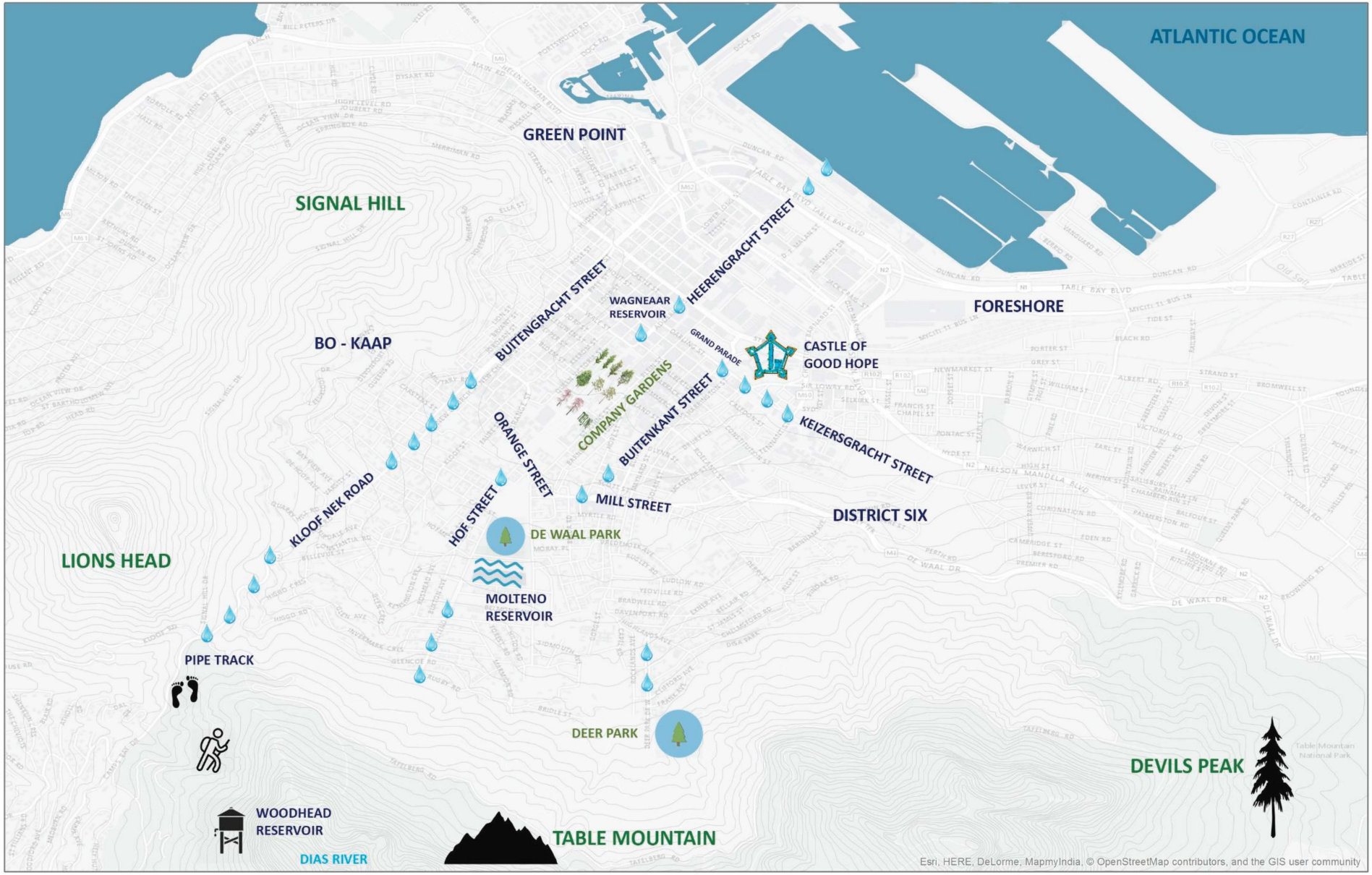
Figure 26: The streams of Table Mountain and the City Bowl canals (Brown et al., 2009)

The pattern of demand increase and supply shortage, combined with intermittent drought conditions, has created a destructive pattern of use and carved an assumption that simply building more dams can solve the problem. The drought that the City of Cape Town is facing now has proven otherwise.

An expansion of the City has resulted in an increase in urbanisation (Figures 30 and 31) has created a vast impermeable surface, reducing the ability of stormwater to infiltrate and replenish groundwater tables. This has caused a disconnection to the hydrological cycle, reducing a precious water source to waste in a time of dire need. Paving over the water arteries of the City Bowl has disconnected people from interacting with the hydrological and ecological systems too, reducing the experience of water to what comes out of taps. The streams from Table Mountain 'form a unique system of ecological and historical significance' that supports a 'cultural landscape' (Reclaim Camissa, 2004), and hold potential for a return to the reverence of water in the City Bowl.

Figure 28: Heerengracht Street around 1832 (Reclaim Camissa)

Today the tributary of this stream flows 'into a culvert at the foothill zone of the mountain and becomes a sub-surface storm water channel that spills out, polluted, into the Atlantic Ocean' (Kotzé, 2010: 27).



CITY BOWL: Historical context

Figure 29: Historical context of the City Bowl. (Data source: UCT GIS Technical Library)

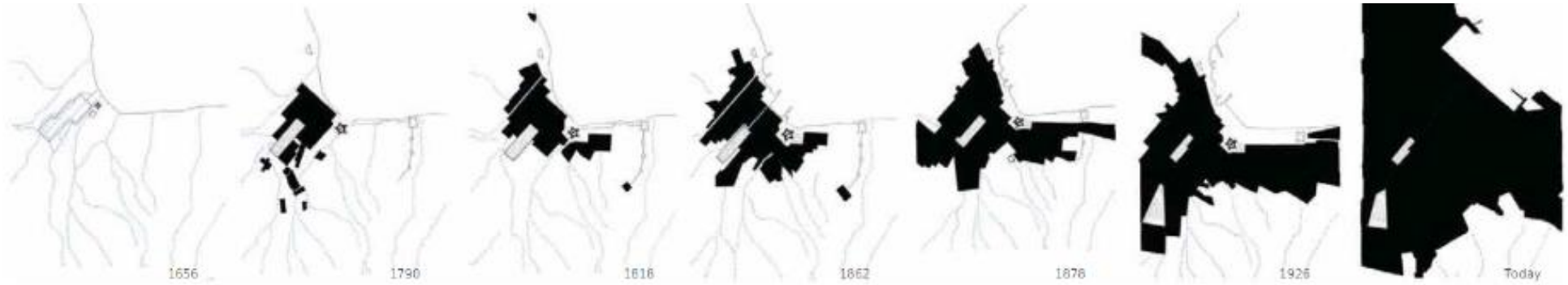


Figure 30: Urbanisation of the City Bowl (The Fringe, 2012)

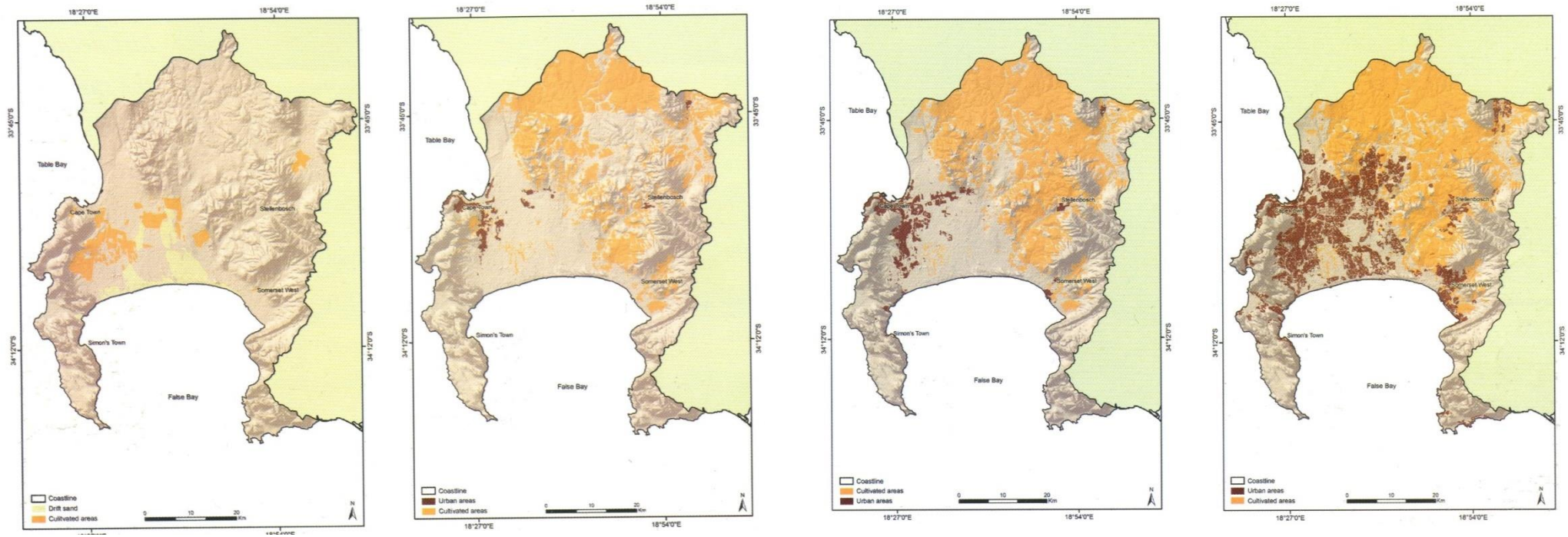


Figure 31: Increasingly urbanised: Cape Town metropole growth (Brown et al., 2009)

3.3 Spatial Informants

The following section will outline the boundary for the study area within the City Bowl.

The study area for this project is based on a number of considerations.

In 2007 the organisation Cape Town Partnership - an organisation that brings 'people together around common goals for Cape Town's transformation' (Cape Town Partnership, 2017) – connected with the City of Cape Town (here after referred to as CoCT) to begin a process to create a shared vision for the future of the Central City (Cape Town Partnership, 2017). The focus on the Central City was to enhance its reputation as a dynamic business and people centre. The project was called the Central City Development Strategy (CCDS), and the intention was to 'enhance the urban fabric by being

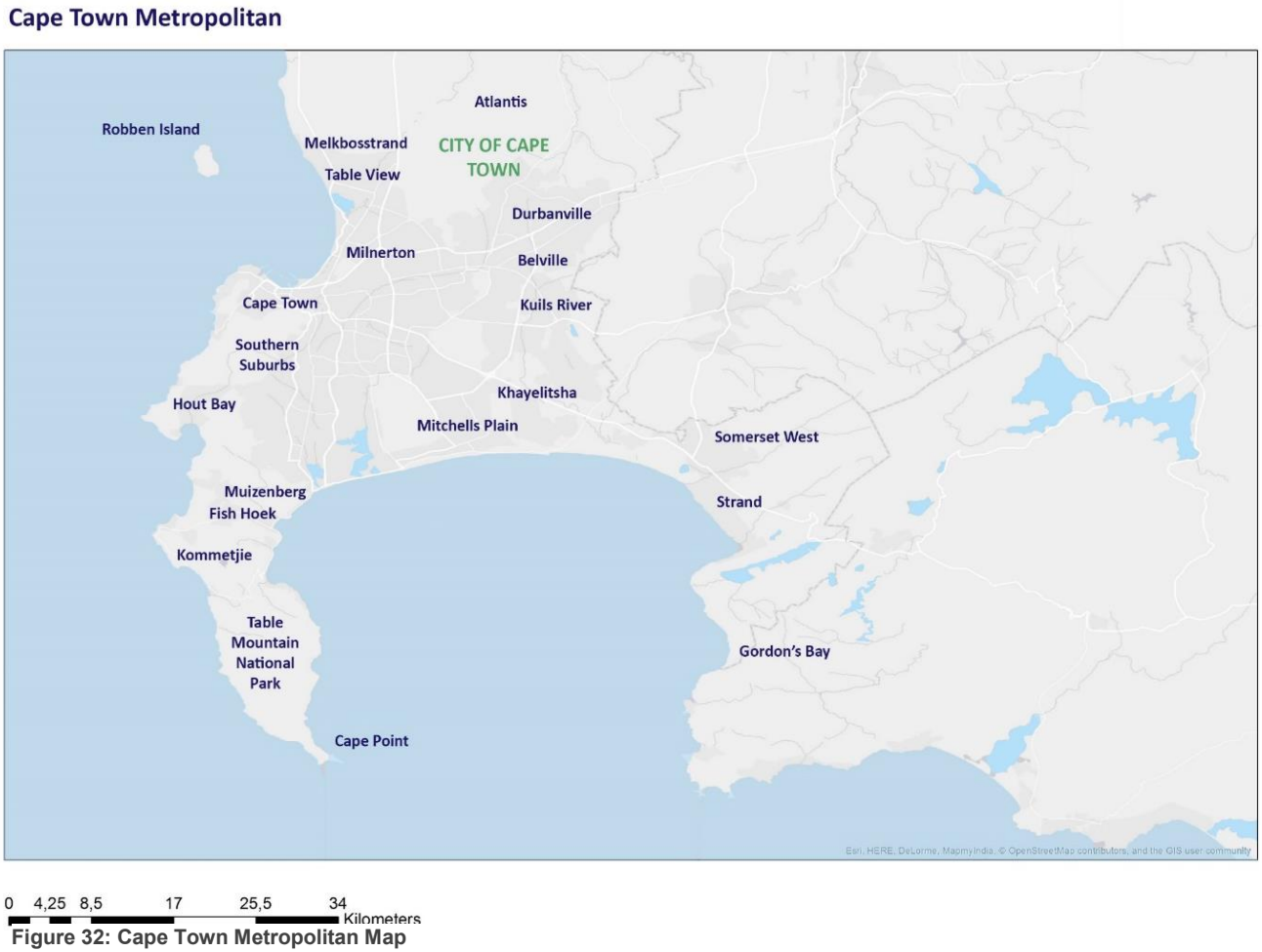


Figure 32: Cape Town Metropolitan Map

sensitive to the users of the Central City through a consideration of what their needs are in different parts of it' (The Fringe, 2012). With the process of public participation, the CCDS identified a common vision that resulted in the twenty character neighbourhoods identified in Figure 33 and Figure 34. The aim was to establish a 'clear spatial coherence and to strengthen the Central City as the

economic, administrative and historical core of the Cape Metropolitan Area' (Briggs, 2012). The neighbourhoods are defined based on their character, role and history in the city (Figure 33).

The 20 neighbourhoods are:

1. Green Point Common
2. V&A Waterfront
3. Green Point
4. Bo-Kaap
5. De Waterkant
6. Convention District
7. Mid City
8. Company's Gardens
9. East Foreshore
10. Cape Town Station
11. East City
12. District Six

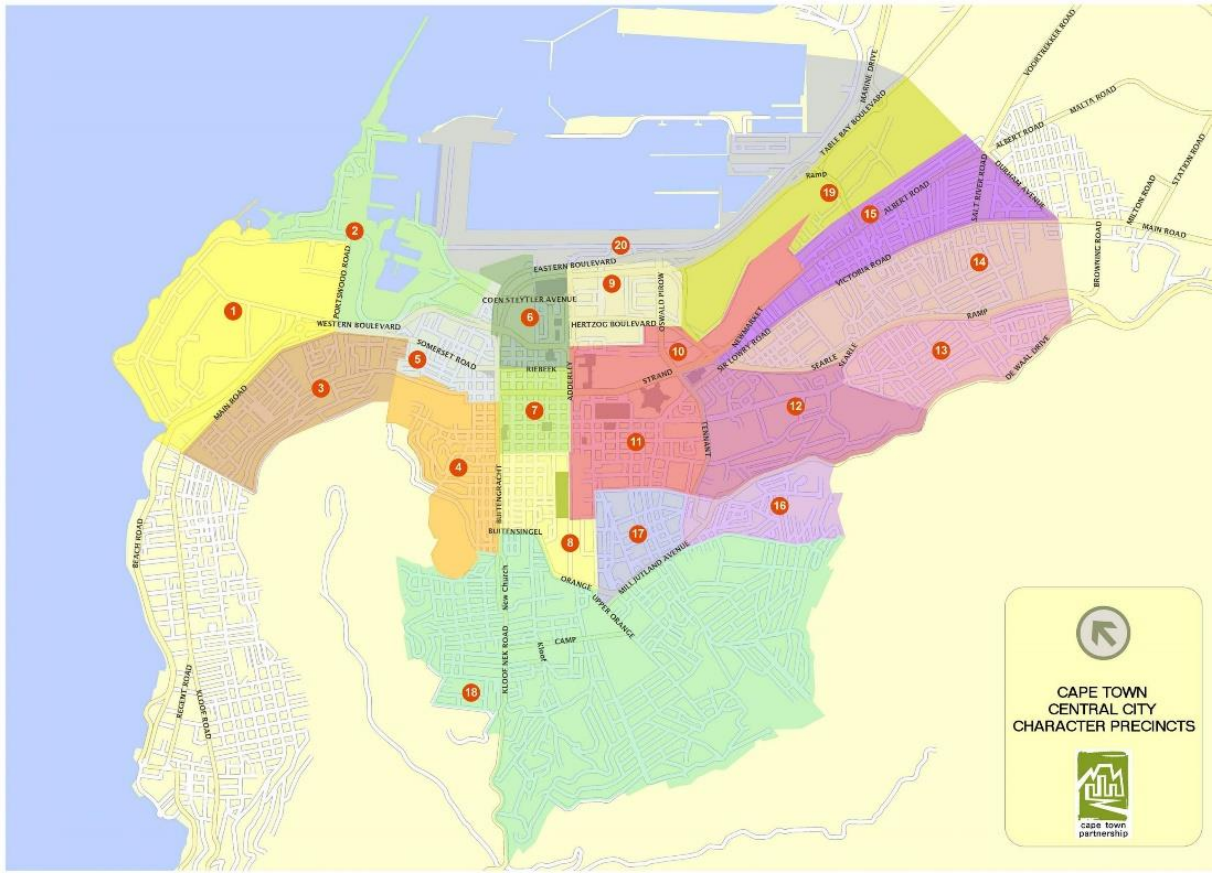


Figure 33: CCDS Boundaries Character areas (capetownpartnership.co.za)

13. Walmer Estate
14. Upper Woodstock
15. Lower Woodstock / Salt River
16. Vredehoek
17. Lower Gardens
18. Upper Table Valley
19. Culemborg
20. Port

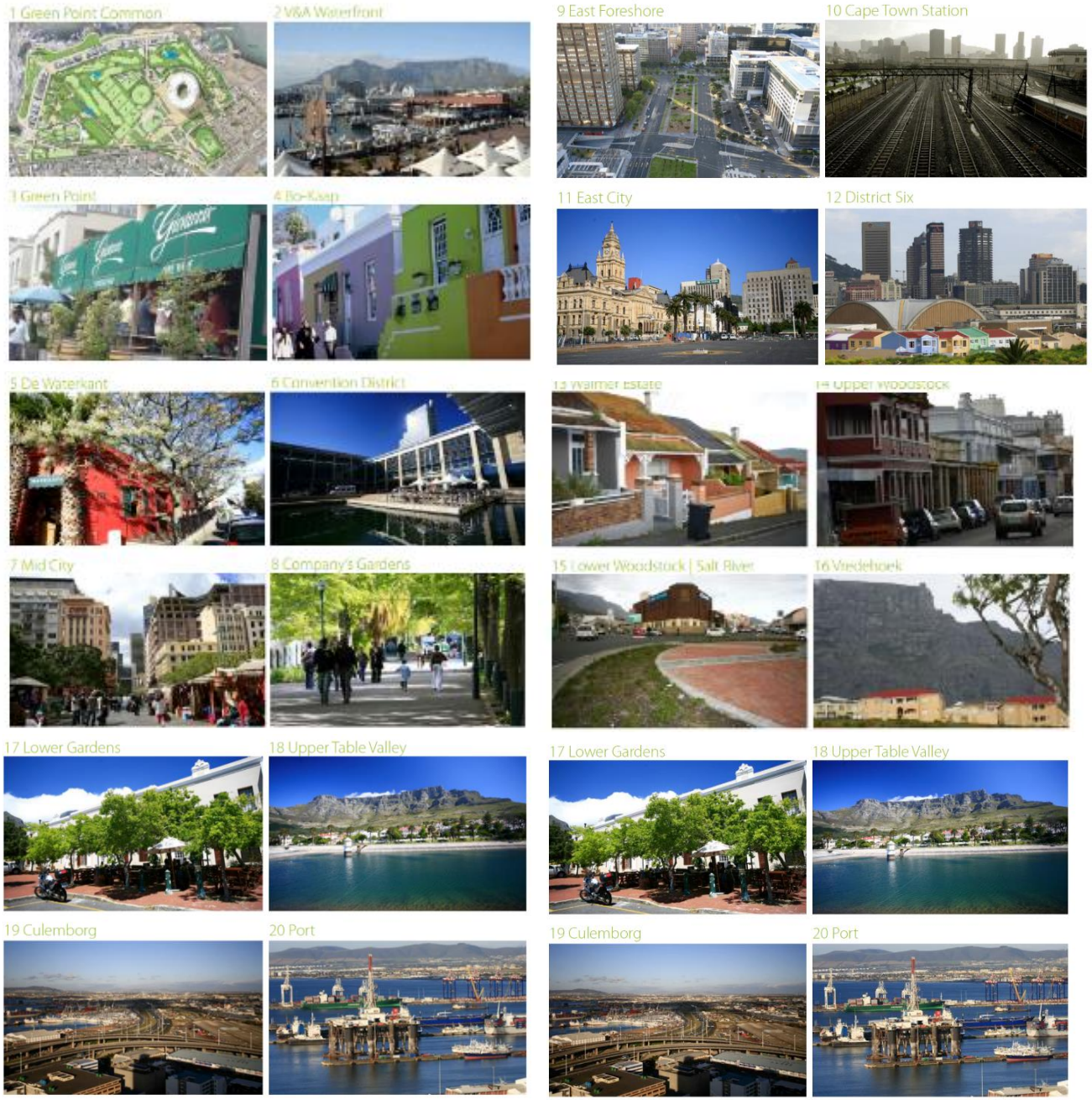


Figure 34: CCDS Character Areas (CCDS Workbook)

Secondly the Cape Town Central City Improvement District (CCID) boundaries were examined (Figure 35). Property owners in the geographical area founded the CCID in 2000, with the intention of establishing a 'welcoming vibrant, successful Central City' that is 'people-centred' (Cape Town Partnership, 2017). The CCID is a public-private partnership housed under the Cape Town Partnership.

The Central City as defined by them stretches from Lower Kloof to the Upper CBD, the East City, and extends to the Foreshore.

Thirdly, the Draft Urban Design Framework for The Fringe (The Fringe, 2012) (Figure 36) was analysed. This

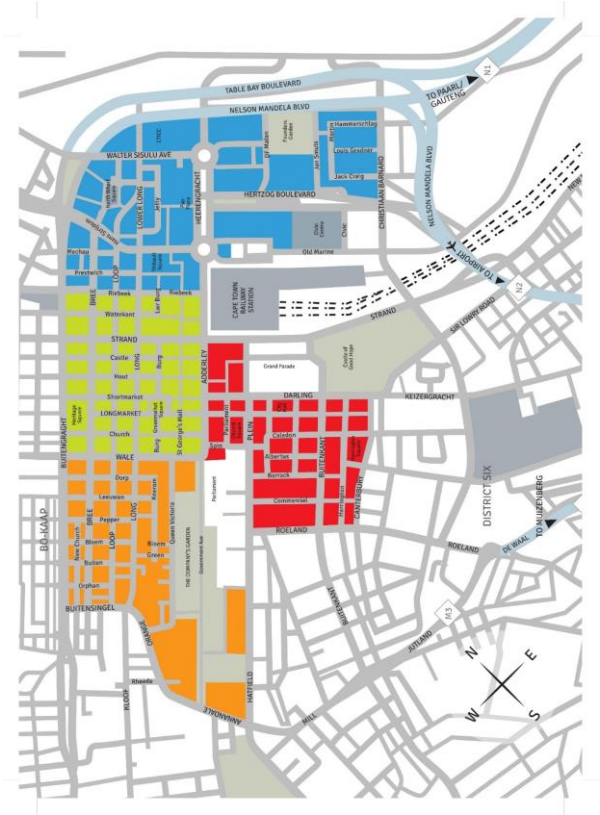


Figure 35: CCID boundary for the City Bowl (Annual Report, 2015)

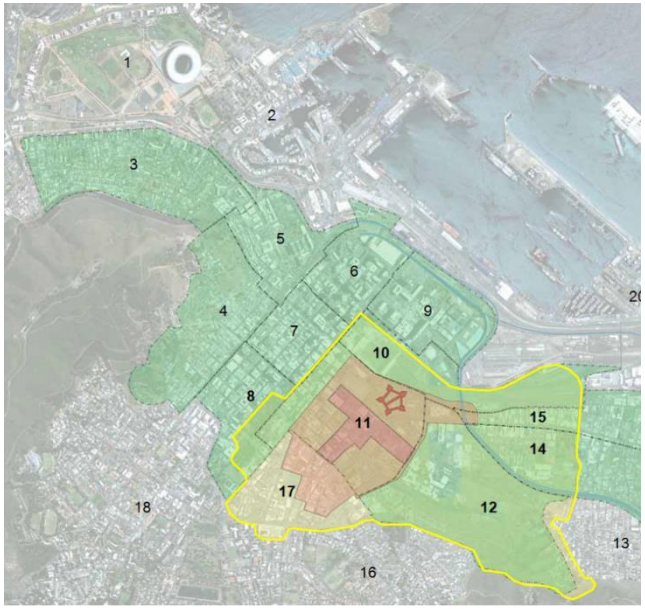


Figure 36: The East City area outlined in relation to the CCDS 20 neighbourhoods (The Fringe, 2012)

body of work focuses on the eastern edge of the city, with the driving idea behind the Framework that establishing the Fringe space would 'build on, and help to entrench, a natural process of creative clustering already happening; and that is happening here for very particular reasons that relate to opportunity, integrity and character' (The Fringe, 2012).

3.4 Boundaries for study area

The boundaries for the research study area drew extensively on the existing work and initiatives established described above. For the purpose of working towards a spatial concept intervention with SUDS, reducing the scale was decided upon in order to effectively focus on a few specific sites where intervention may take place.

Thus the boundaries are drawn along Buitengracht street to the Foreshore, connecting back along Adderley Street and extending to include a part of the Eastern District in Harrington and Constitution Street (Figure 37).

CITY BOWL: Base Map

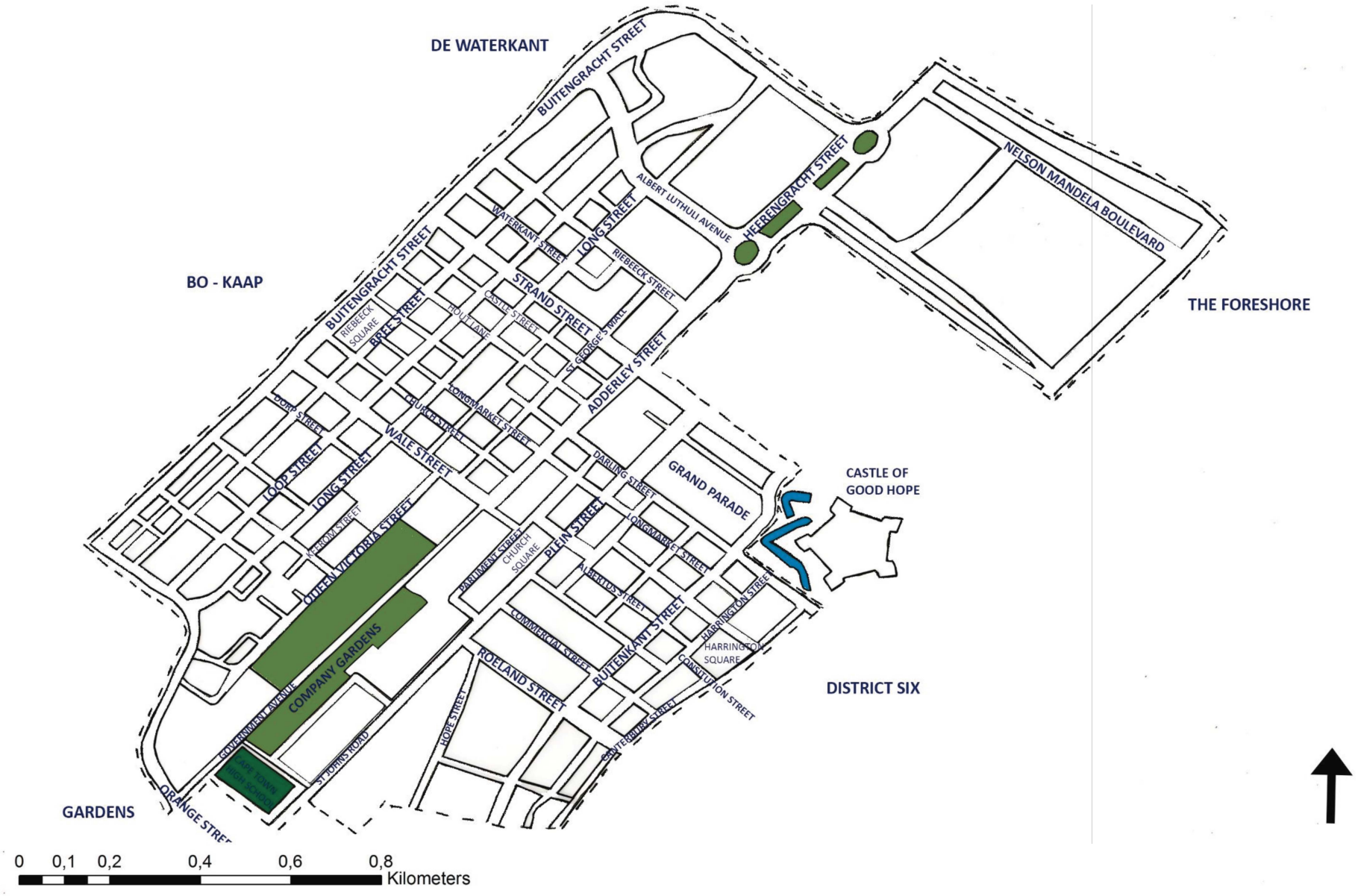


Figure 37: City Bowl Base Map (Authors, 2017)

“The art of land doctoring is being practiced with vigour, but the science of land health is yet to be born” Aldo Leopold, 1949.

In a time of great water stress, it is significant to examine both the physical and demographic layers of the City Bowl through the lens of water. Drought occurs when ‘the rainfall is below the long-term mean, which leads to the reduction of storage of water in dams and therefore impacts on the available yield that can be abstracted’ (City of Cape Town, 2007: 22), and is what Cape Town is currently facing.

Water plays an integral role in development on both a local and regional scale (Pretorius, 2012), and should be at the centre of all development plans as it affects everything, from food production, to industry and of course environmental systems. A lack of water is be a limiting factor for economic growth, and a restriction on the upliftment and social development of society.

The purpose of this section is to provide an in-depth understanding of the physical attributes that constitute the study area of the City Bowl (Figure 37). The area will be examined from a demographic perspective too, in order to learn more about the users of the space.

Cape Town is renowned for its beauty (CoCT, 2015. The magnificent coastline and the strong ridge of striking mountain ranges both shape and frame the city, as do the rivers, streams and wetlands which run through the tapestry of the urban landscape. These systems are commonly referred to as ‘blue-green networks’, in reference to sites of ecological diversity on land, and important water bodies within Cape Town.

The following analysis of the geology, hydrology, and demographics will explore how utterly inter-related interconnected and inter-dependent these systems are to water.

3.4.1 Hydrology

Table Mountain is the source of a number of streams and springs with the four main ones identified as the Platteklip Stream, Molenwater, Third Stream and Zwaartrivier, (Brown et al., 2009). These rivers no longer meet the sea, and have been directed into stormwater drains (laying of pipes in the City Bowl took place in the late 1700s) (Figure 40 and 46). The combined waters of the Molenwater, Third

Stream and Zwaartrivier were diverted to the canals of Buitengracht Street (Brown et al., 2009) (Figure 37). The existing open water bodies found on the Mountain are shown in the map in Figure 40, in location to the study site. The Map illustrates how the water supply has been disconnected from the City Bowl and the Atlantic Ocean.

Fourteen dams are responsible for the collection and storage of larger Cape Town's drinking water and sanitation provision. The combined capacity of these dams is approximately 900 million cubic meters. The City Bowl is supplied by five regional dams: Steenbras Upper and Lower, Theewaterskloof, Wemmershoek, Berg River and Voëlvlei (Figure 38).

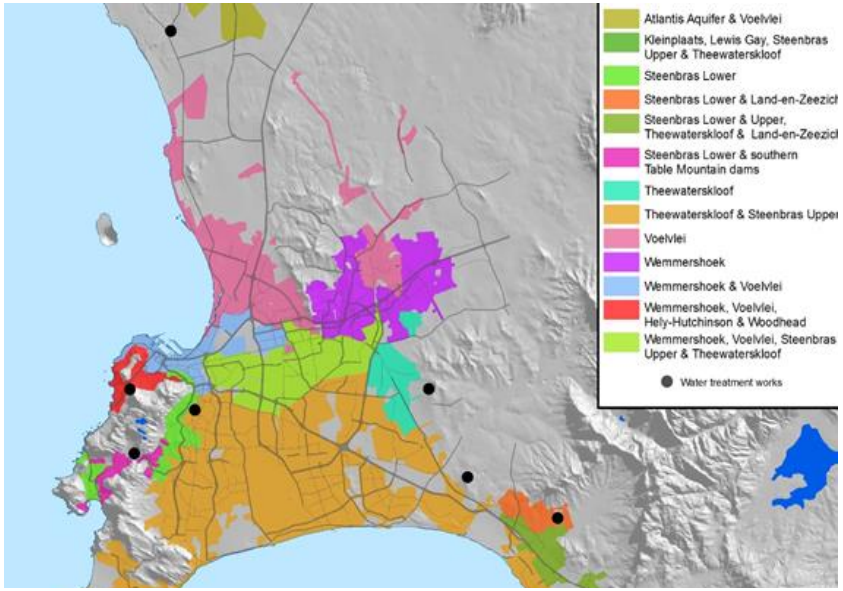


Figure 38: Water Distribution, City of Cape Town (capetown.gov)

The hydrology map (Figure 39) shows the Molteno Reservoir (marked as wetland) and the stormwater drainage network in relation to the groundwater yield. The City Bowl is at 0.1- 0.5, which indicates that SUDS interventions should be affected by the existing groundwater levels.

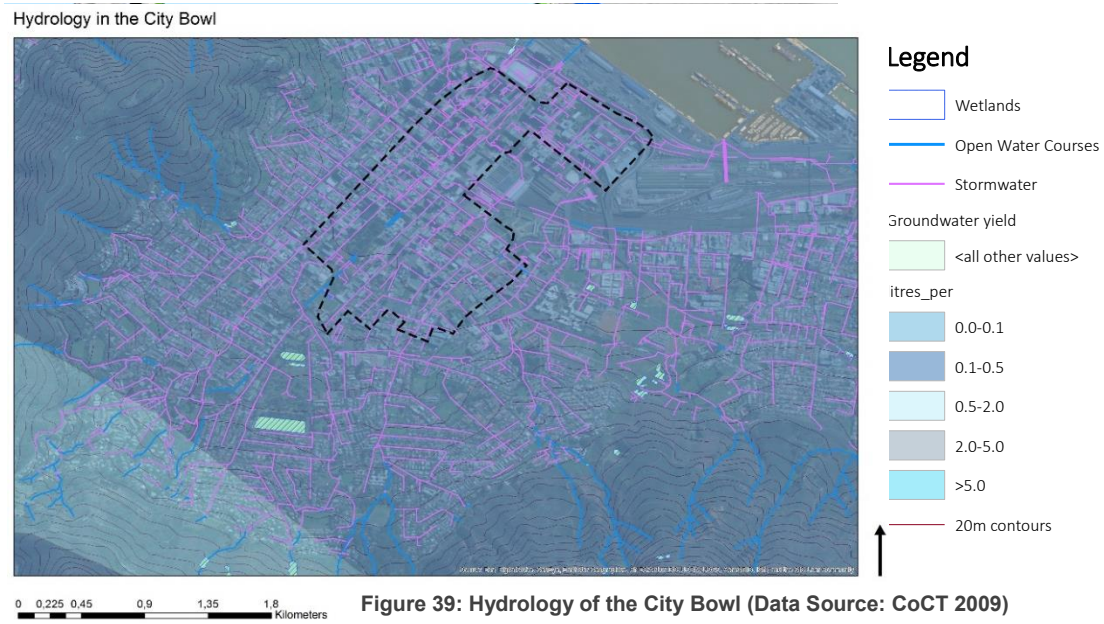


Figure 39: Hydrology of the City Bowl (Data Source: CoCT 2009)

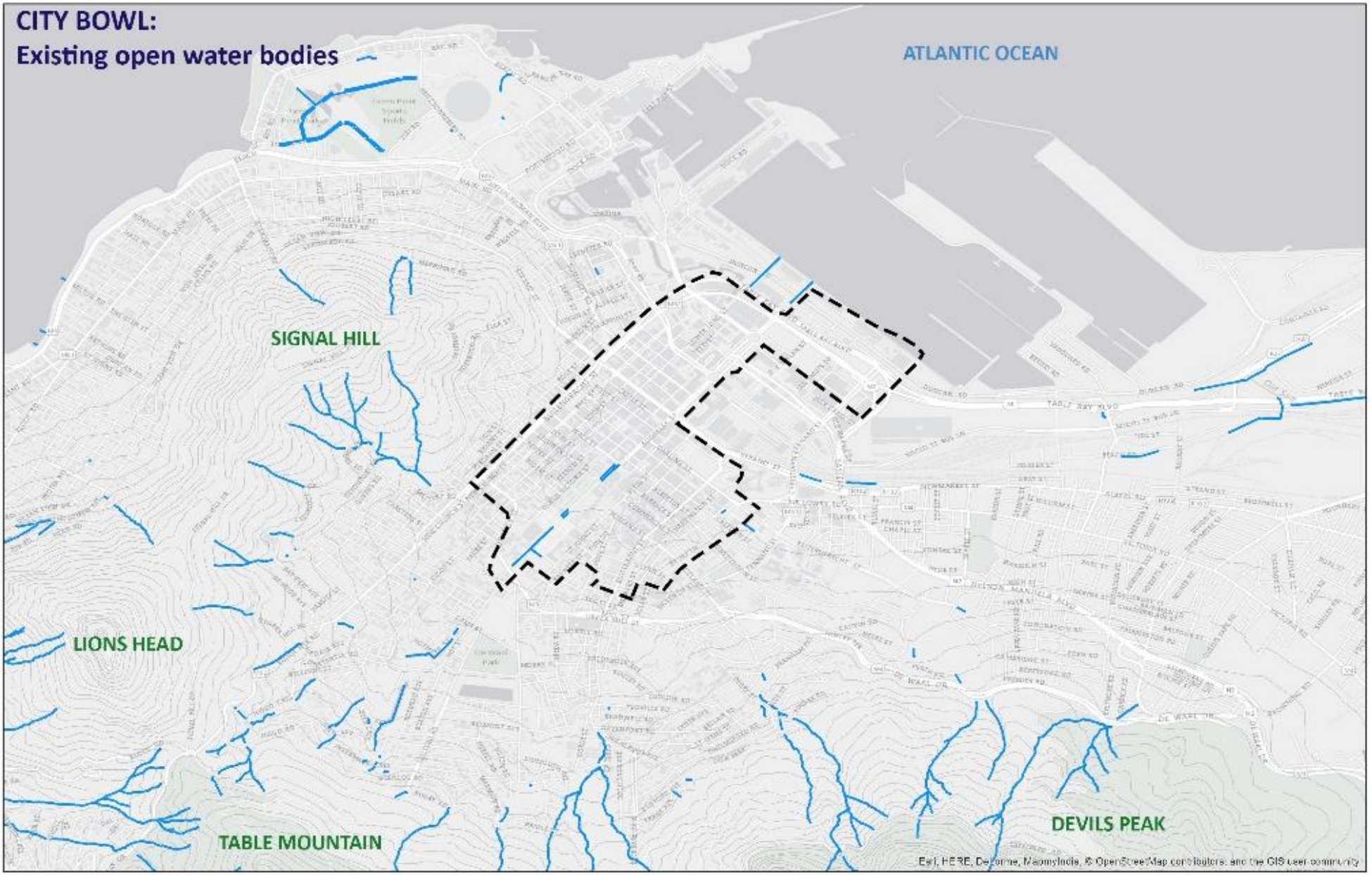


Figure 40: Open water bodies in relation to the City Bowl study site (Source: ArcGIS Base Map, 2017)

Figure 41 and 42 provides an indication of the current dam levels which provide the City of Cape Town with water. They are designed to show the levels in relation to when the rainy season begins (Wolski, 2017b) in the winter months. This data is then combined with water use from the City of Cape Town (Figure 42). The pattern of declining rainfall is clear. The city is facing a disaster in terms of supply.

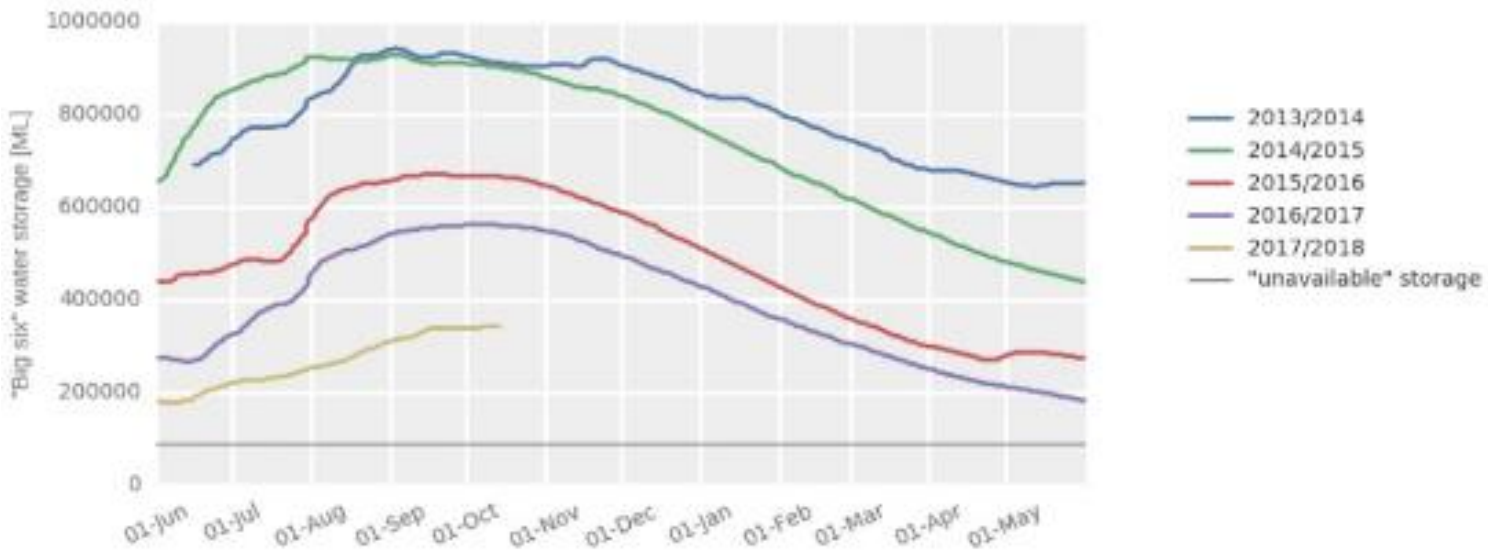


Figure 41: Dam storage since 2013 (Wolski, 2017b)

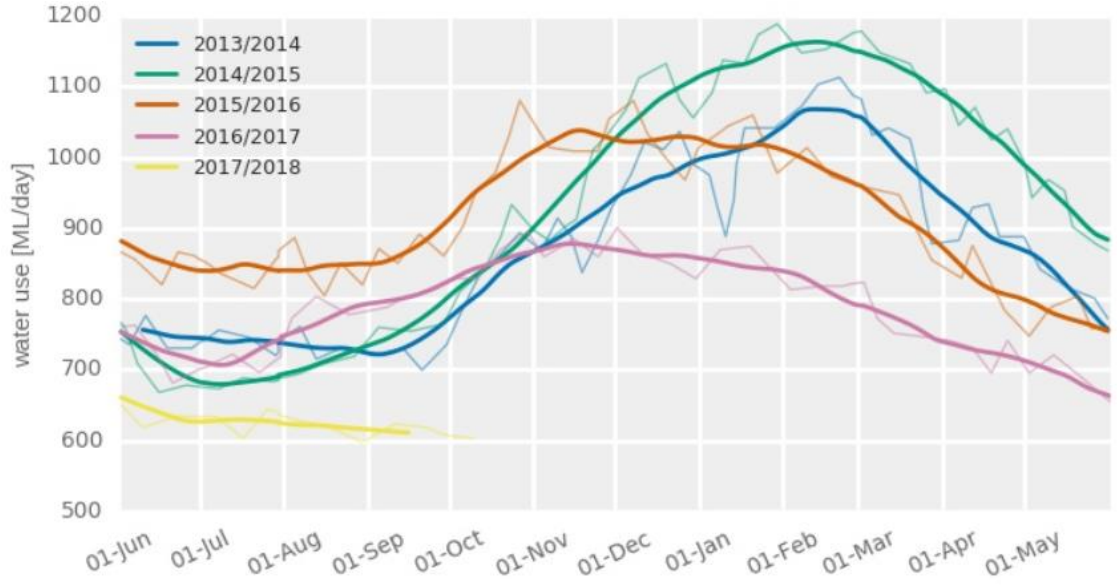


Figure 42: Dam storage combined with CoCT water consumption data (Wolski, 2017b)

The spatial legacy of apartheid in Cape Town has meant that the majority of the city's residents are still subject to inadequate provision of services, and water is one of them. It is estimated that there is only 'one tap for every 25 households' in informal settlements (City Views, 2013b). Private gardens in the city guzzle up to 50% of all water used in urban areas (using drinkable water in swimming pools and on lawns, for instance) (City Views, 2013b). This indicates some of the disparity in equitable access to water. Whilst the research site boundaries encapsulate few resident dwellings, it is nevertheless important to bear the discrepancies in access in mind when considering interventions.

3.4.2 Climate

Climate and cities are intertwined; 'climate influences the ways in which city space is being used and the climatic performance and needs of buildings. In its turn, the city influences the climate' (Kleerekoper et al., 2011).

The climate thus determine the use of public spaces in the City Bowl. A comfortable climate is linked to more people spending time outside, engaging with one another and the streetscape. Whilst Cape Town traditionally has a Mediterranean climate, experiencing mostly dry warm summers and historically mild but wet winters , the past three years have seen considerably less rainfall recorded (Figure 43), leading to a state of hydrological drought (see map in Figure 44).

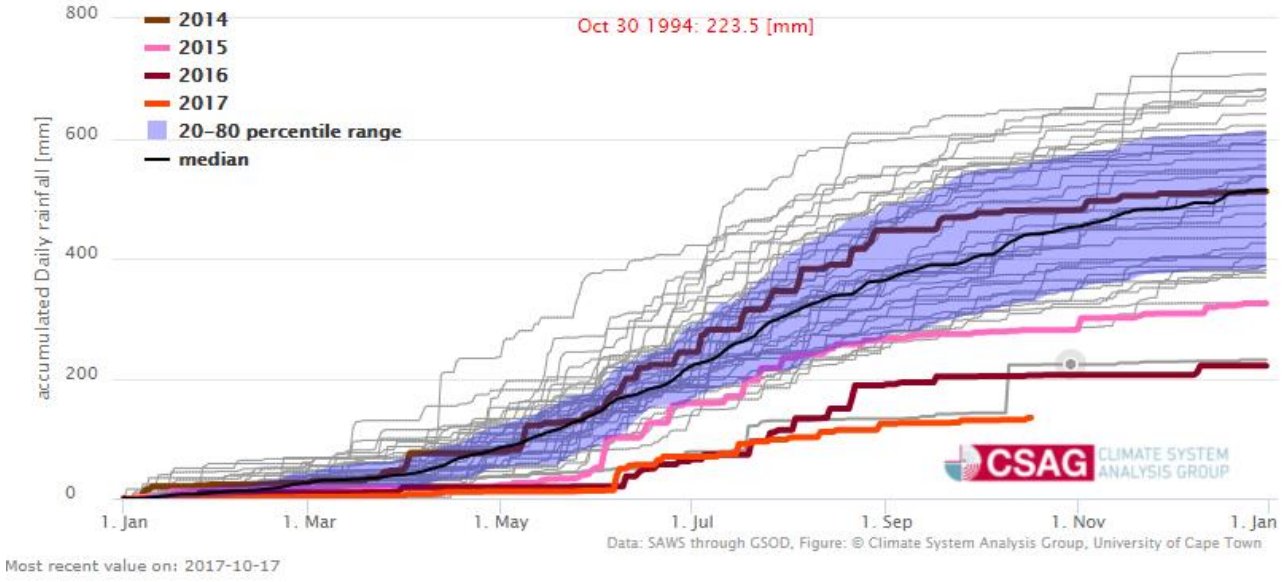


Figure 43: Rainfall recorded at Cape Town Airport (Wolski, 2017a)

The years 2015-2017 were the driest three-year period recorded, since records began in the early 20th century (Wolski, 2017). The decreasing amount of rainfall received in the city is marked in Figure 45.

In addition to a lack of rain, the City Bowl climate tends to be warmer than other, less dense, areas of the city. This is due to the Urban Heat Island (UHI) effect, which causes an increase in temperature due to the presence of the many tarred, paved and reflective surfaces. On days without wind, the temperature increase is particularly noticeable.

More green open spaces in the City Bowl would help mitigate these effects, as well as vegetation on buildings (in the form of green roofs and rain gardens), which helps cool the environment and the building itself. The former does not have

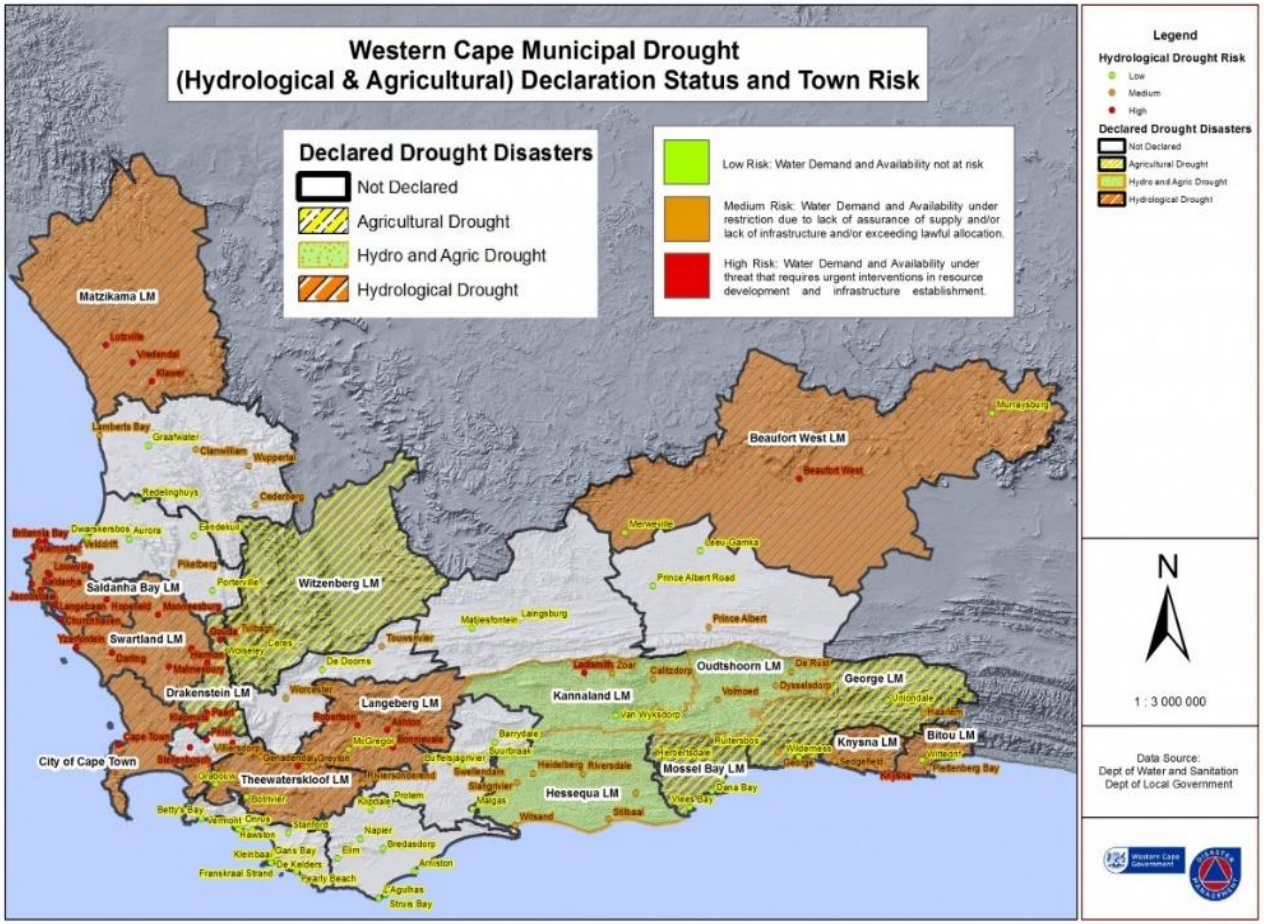


Figure 44: Map of Western Cape drought areas (westerncape.gov.za)

to be large in order to make a difference to reducing the temperature (Kleerkoper et al., 2012).

The lack of available water (current water restriction means that commercial properties must ensure that their monthly consumption of municipal water is reduced by 20 percent compared to last year (CoCT, 2017a).

This is connected to water use, as in normal office buildings, 48% of all water is used by the air-conditioning systems (City Views, 2013). However water can be used in a positive way: if the fountains in the City Bowl (for example those found in Adderley Street and the Company Gardens (figure…) were filled with recycled stormwater, then the moving water can contribute to the cooling of the surrounding areas.

Climate Change will likely lead to sea level rise felt and seen in the City Bowl. By 2100, the rise could be as much as 76cm (City Views, 2013b). When rain does occur, it is predicated to be received in stronger, more intense storms. This could cause flooding in the City Bowl due to the increased impermeable areas.

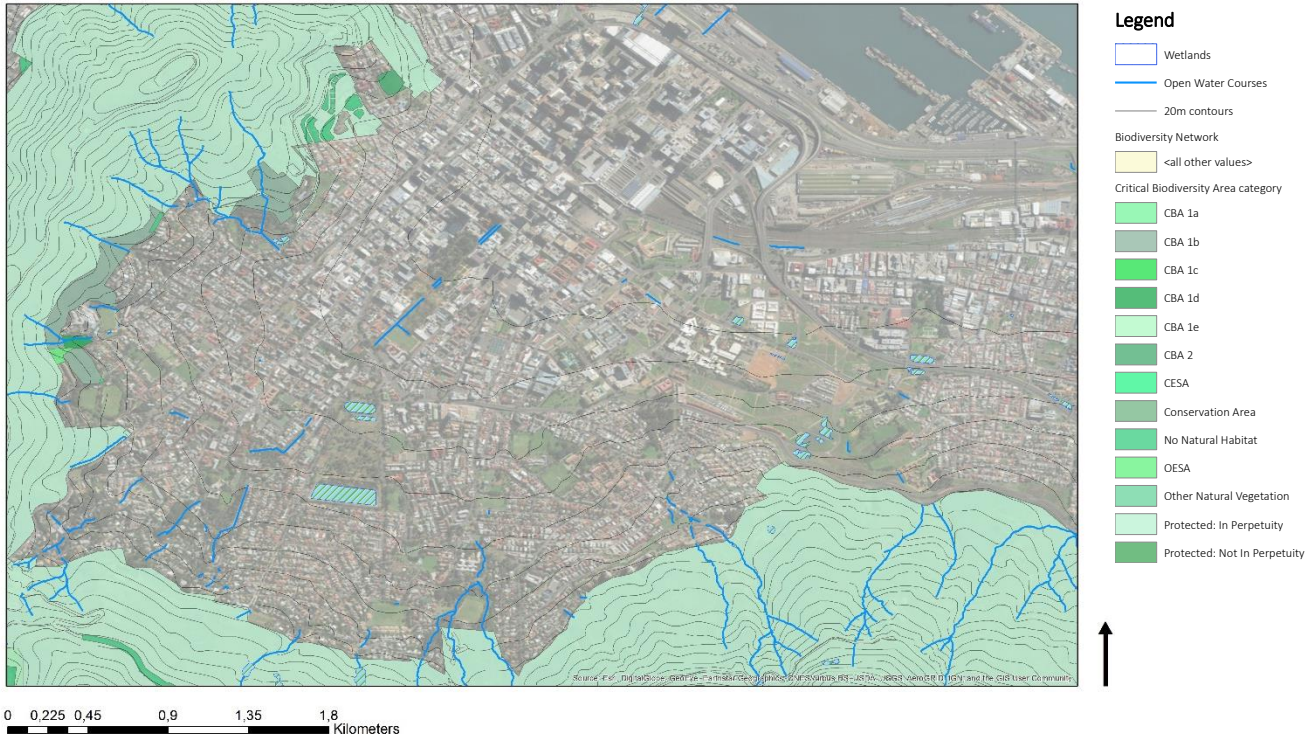


Figure 45: Biodiversity networks surrounding the City Bowl (Data source CoCT, 2009)

3.4.3 Biodiversity

The map in Figure 46 highlights the green network that surrounds the City Bowl. It includes the Critical Biodiversity Areas (CBA), with 1a to 2 forming part of the classification Core 1, which is part of the critical Metropolitan Open Space System (MOSS) and should be protected. CESA is part of Core 2, which is part of significant MOSS (CoCT, 2015). The City Parks data indicates community parks and other public open space. This should be viewed as potential linking sites to strengthen the biodiversity network. This is crucial in the City Bowl as natural ecosystems provide essential services to people in urban areas (see Chapter 2).

The map highlights the biodiversity and the hydrological system (blue-green networks); note how both systems are severed by the urbanisation of the City Bowl.

It is perhaps even more crucial because Cape Town is home to the Cape Floristic Region (CFR). It is a global biodiversity hotspot. This means that the city is a species rich area that has high levels of endemism - 70% in the case of the CFR (endemism refers to when animals or plants only exist in one geographical location). The urban nature of the City Bowl means that much of the natural ecosystems found within the CFR are threatened, as their natural habitats have been destroyed or altered. There are 18 different major national terrestrial vegetation types found in Cape Town, of which 14 are threatened because of habitat transformation (City Views, 2013a). Cape Town also an estimated 3 000 indigenous plant species: 190 are endemic, 318 are considered threatened and 13 are extinct or extinct in the wild (City Views, 2013b). Mammals and bird species are also at risk: of the 83 mammal species that remain in Cape Town, 24 are on the IUCN Red List and eight have recently become extinct. (City Views, 2013a).

3.4.4 Disconnected: blue and green networks

The map in Figure 46 illustrates the disconnection of the natural open flowing mountain streams to the Atlantic Ocean. Rather, the hard, piped stormwater system is the connection, paved over hard surfaces covering the natural blue network of the City Bowl.

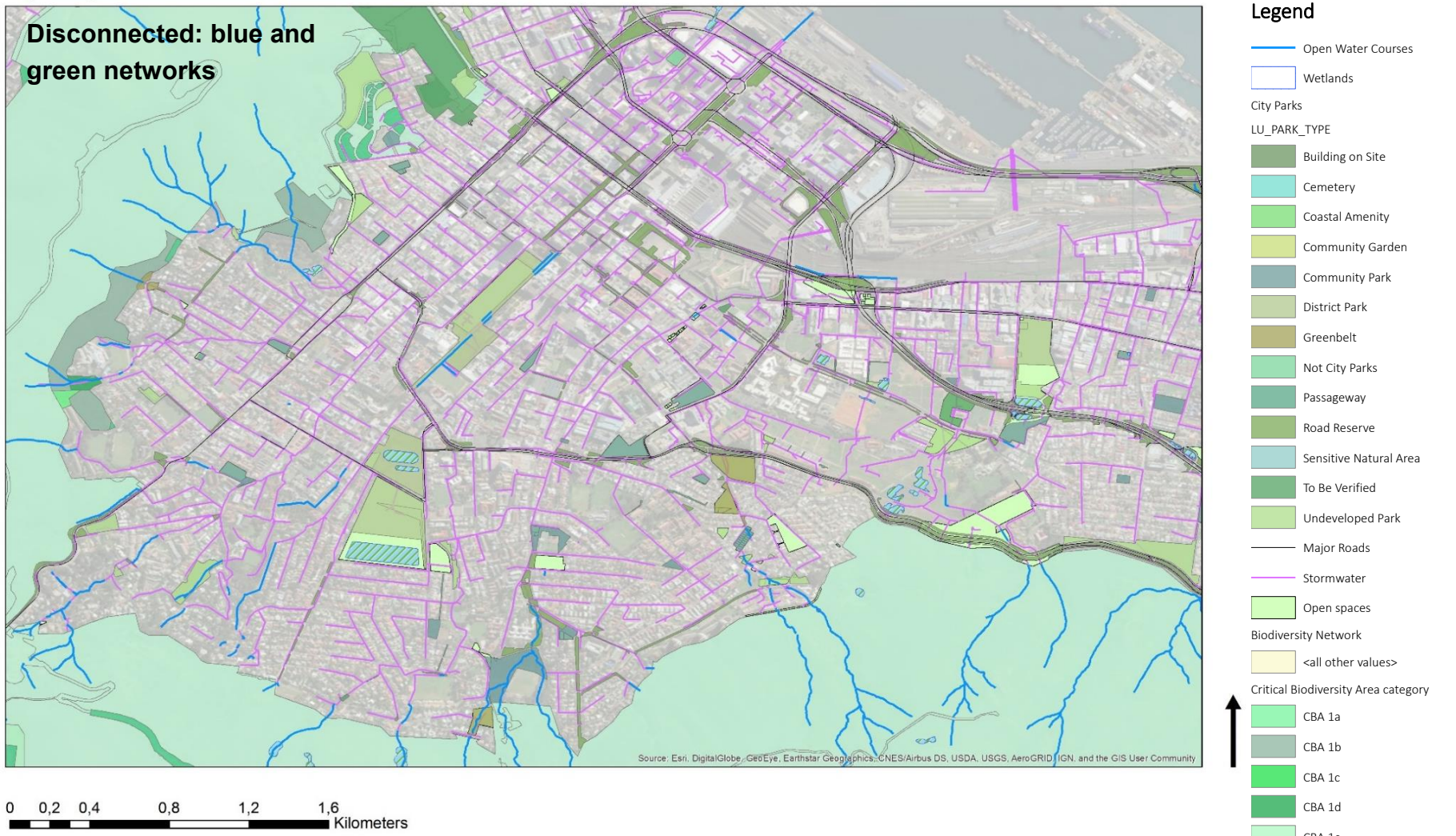


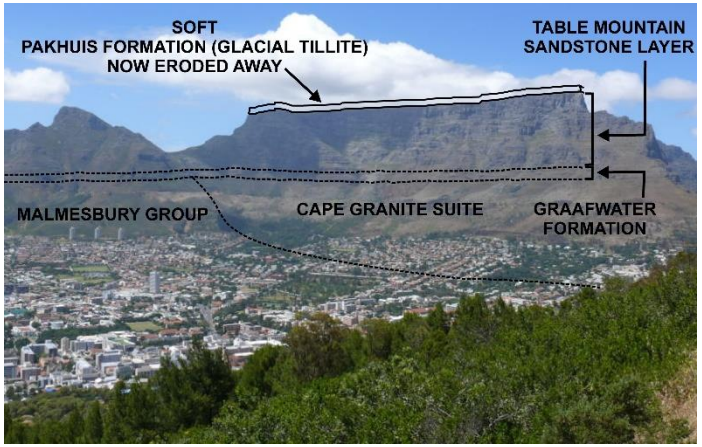
Figure 46: Stormwater system of City Bowl (Data source CoCT, 2009)

3.4.5 Geology

Geology is important to understand in urban areas, because, when combined with the resulting soil, it can influence the built environment. The underlying geology can determine the topography, hydrology and biodiversity of the area, and ultimately, human activity.

Cape Town is formed on three rock types: the Malmesbury Group, Cape Granite and the Table Mountain Group (sanparks.org). The Malmesbury Group is a shale rock, consisting largely of mudstones and shale, and provides the basis for many of the tall buildings found in the City (CoCTa, 2011). The Table Mountain Group sandstones lies above the Malmesbury and Granite groups.

Geology is one of the primary considerations for the intervention of SUDS as the different rock type influences how porous an area is. This can determine which component of the SUDS train is chosen (Klitzner, 2017). Soils that are more porous can be used to create a sponge (allowing water to infiltrate). Soils that are less porous can be used as sinks (Klitzner, 2017), storing water rather and keeping it for use elsewhere. The City Bowl is comprised of reclaimed land –fill, and white sand with



Cape Town rock types (Oggmus, adapted from Hilton Teper's photograph)

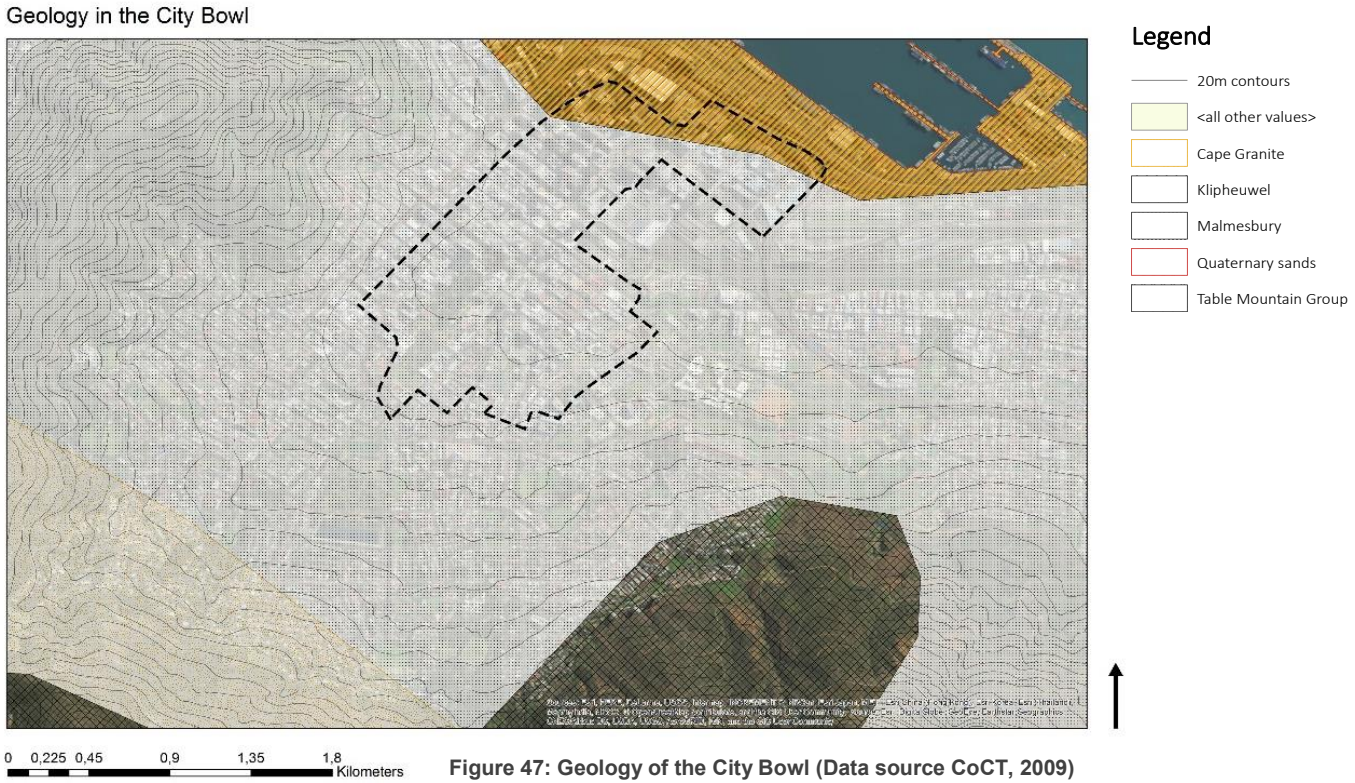


Figure 47: Geology of the City Bowl (Data source CoCT, 2009)

finely crushed shell. As seen in Figure 47, the geology of the City Bowl study area is Malmesbury shale.

SUDS in the City Bowl could be used to help recharge Cape Town's local aquifers. Re-charging of the water table should happen where possible, whilst bearing in mind that different soils re-charge at different rates. For example, clay soils re-charge at a slower rate; the water sinks and then expands into the ground, which can be a very slow process. Therefore, if developments take place on clay soils then it would be better to detain the water to allow for a slower infiltration rate.

Some areas in the City Bowl could be demarcated as being better suited for 'sponges' that allow the storage of water, and some that are better suited to 'sinks', which allow the water to be cleansed and infiltrate into the ground (Klitzner, 2017, Winter, 2017).

3.4.6 Demographics

Cape Town metropolis is home to 3.7 million people. As discussed previously in this chapter, the city is still a spatially segregated and physically separated city (State of the Central City Report, 2012. The map in Figure 48 clearly indicates this. The City Bowl however is used by a wide diversity of people, from tourists, to commerical and retail staff. 36% of people surveyed by the CCID are Cape Town locals, with 35% from elsewhere in South Africa, and 17% from inernational

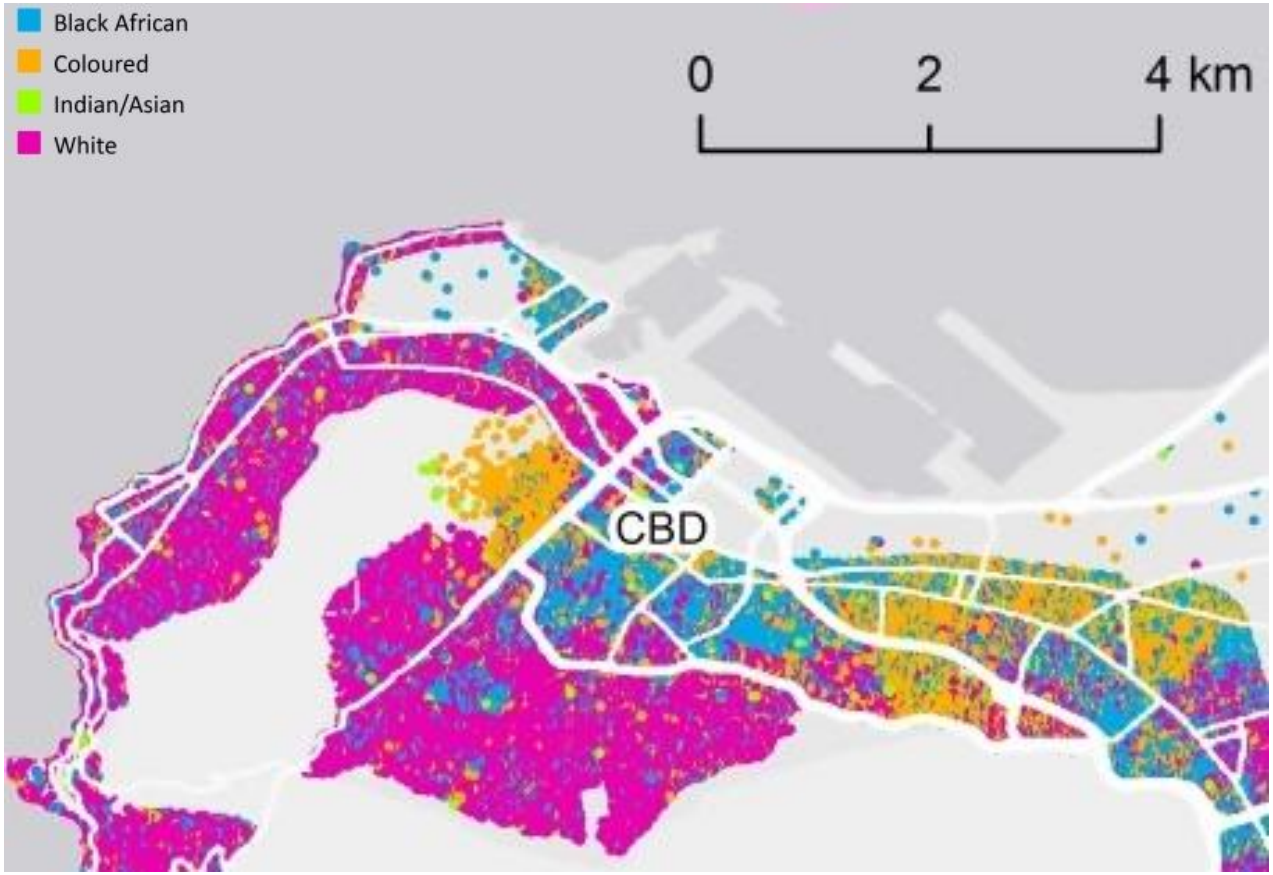


Figure 48: The social tapestry of Cape Town Census 2011 (1 dot = 1 individual) (Stats SA, 2011)

destinations (CCID, 2013). 23% of residents had lived in the City Bowl for 5-10 years, with 9% having lived there for 0-6 months. 58% of the people surveyed were between 26 and 49 years old (CCID, 2013).

65% of residents live within 3km of their work, indicating a large number of people who are able to walk to work, though only 45% of people do. 10% cycle and 9% ride the bus. According to the CCID Report in 2016, a decade ago, just 750 people lived in the City Bowl, that figure is now estimated to be around 6000 people. 200 000 people are thought to move through the City Bowl daily (State of the Central City Report, 2016).

80% of people use the Company Gardens and 62% use St George's Mall, while only 24 % use Church Square (CCID, 2013).

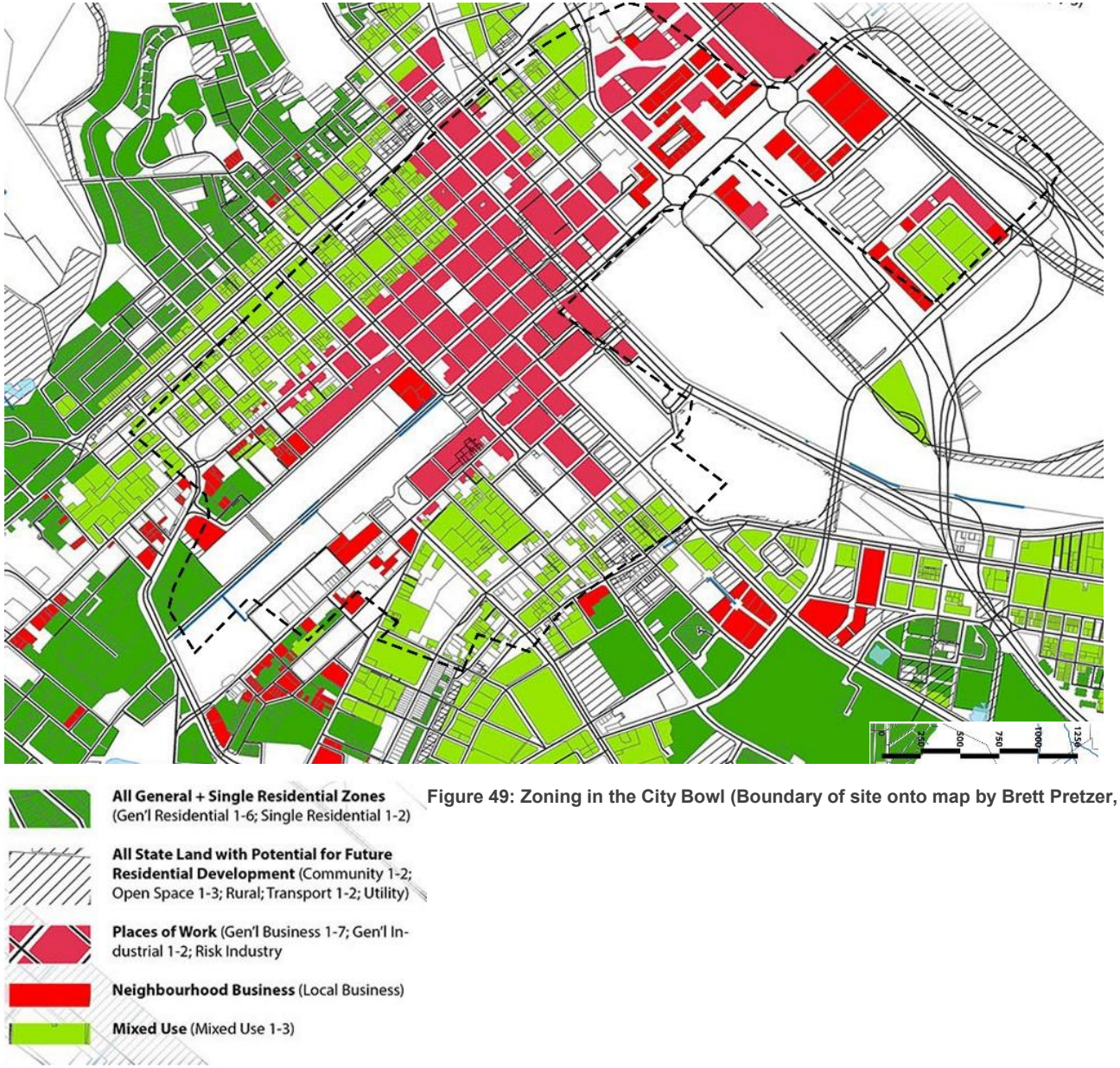


Figure 49: Zoning in the City Bowl (Boundary of site onto map by Brett Pretzer, 2014)

Figure 49 indicates how the City Bowl area is largely commercial and retail, with mixed use zones dominating the immediate boundary, and single residential zones found bordering that.

The City Bowl is considered the glue for the 'larger City's vast cultural, ethnic and lifestyle diversity' (State of Cape Town Central City Report, 2012).

The slave routes that run through the City Bowl also err as reminders to the dark history of Cape Town after Dutch, and later English, settlers arrived. Even the beautiful Company Gardens have a darker undertone, with a symbolic bell to represent bells on early farms that were used to call salves to work. Church Square (adjacent to Company Gardens) for example, has born witness to significant portions of the turbulent history of the country; it was one of the main public elements that was strategically located, and has contributed to the 'overall public spatial structure of the town' (Todeschini, 2014: 6).

3.5 Current Legal and Institutional Environment

The National Development Plan (NDP) provides an overarching framework to planning in South Africa. The primary planning framework for the City Bowl is outlined in the Integrated Development Plan (IDP), which is mandated by the Municipal Systems Act of 2000 (MSA). This communicates a vision for the municipality for five years, outlining the planning and budget schemes. The IDP has to contain a spatial element in the form of the Spatial Development Framework (SDF). This provides a long-term vision (twenty years) for the City of Cape Town. The Cape Town SDF guides the smaller scale plans known as the District Spatial Development Plans, which run on a ten-year period.

The City Bowl falls under the Table Bay District.

The City of Cape Town has a progressive policy the management of Urban Stormwater Impacts where it details aspects of Sustainable Urban Drainage Systems.

The analysis of the policies began by identifying the vision of the document, followed by establishing the aims of the policy, and then relevant text or reference to water or stormwater. It highlights what the policies suggested to achieve these are, and whether there was a specific link to spatial planning and the City Bowl.

3.6 National

3.6.1 Constitution:

The Constitution states that the right of access to sufficient water is accorded to everyone. It requires the State to take reasonable legislative and other measures, within its available resources, to achieve the progressive realisation of the right (RSA, 1996).

It does also however determine that the provision of stormwater services in urban areas is the responsibility of the local municipality. Thus, there is opportunity here for the CoCT to act further, and motivate for a transforming of attitudes towards stormwater, through SUDS.

3.6.2 The National Development Plan: 2012 (NDP)

In terms of policy and regulation, the NDP has outlined a broad strategy and ambitious goals in order to progress towards a desirable future for the country. Whilst the plan includes the provision of 'affordable, sufficient and safe water to meet the needs of the population while ensuring limited negative environmental impact' (Armitage et al., 2014), it does not articulate specific detail with regard to water management.

3.6.3The National Water Act (Act No 36 of 1998): Department of Water Affairs, Republic of South Africa (NWA)

The Act recognises that water is scarce, and part of an interdependent cycle. It notes that water has not always been equally accesses, due to apartheid laws and practices. It is important to note that the Act outlines that the National Government has responsibility over the nation's water resources and their use.

It is mindful of the connection between the protection of the quality of water resources and the need to manage water resources in an integrated manner.

There is no mention of spatial planning in the NWA though there is reference to the provision of plans, mainly in the form of catchment management strategies.

These are intended to be in harmony with the National Water Resources Strategy and should be performed in conjunction with various stakeholders and interested persons. The catchment strategy should include a water allocation plan[1].

The guiding principles of the Plan are encapsulated in the vision of sustainability and equity, as the Pact recognises both the need to use and conserve water resources, whilst acknowledging that there is also a need to promote social and economic development through the use of water.

3.6.4 National Water Resource Strategy (June 2013, Second Edition): Department of Water Affairs, Republic of South Africa (NWRS-2)

The vision is "Sustainable, equitable and secure water for a better life and environment for all", and the objectives of the strategy are to ensure that:

- water supports development and the elimination of poverty and inequality
- water contributes to the economy and job creation, and
- water is protected, used, developed, conserved, managed and controlled sustainably and equitably.

The report recognises that policies, legislation and strategies should be streamlined to remove obstacles on the path to achieving equity in water allocation. It clearly links the importance of water to sustainable development and growth, outlining the need for good governance and improved management of the resource to ensure that 'every drop counts' (NWRS2, 2012).

With regard to planning, the report deals with the emerging theme of the need to plan for water resource infrastructure to provide 'basic water services and equitable allocation, while meeting the needs of inclusive economic growth without threatening the integrity of aquatic ecosystems' (NWRS2, 2012).

The NWRS2 intended to improve planning and policymaking processes, with the express intention 'to place water

[1] The City of Cape Town falls under the Berg River Water Management Area, but is also reliant on the Breede River Water Management Area.

at the heart of all planning in the country, so that any decisions that rely on the steady supply of water, factor in water availability adequately' (NWRS2, 2012:6).

The NWRS2 follows through from the NWA and outlines the implementation of catchment management agencies, meant to address water resource management. However, it fails to set a vision for urban water management. It does not consider the whole water cycle, and does not recognise stormwater as a potential resource. It has a clear argument for desalination (despite noting that it is expensive). The potential to use WSUD or SUDS is not considered.

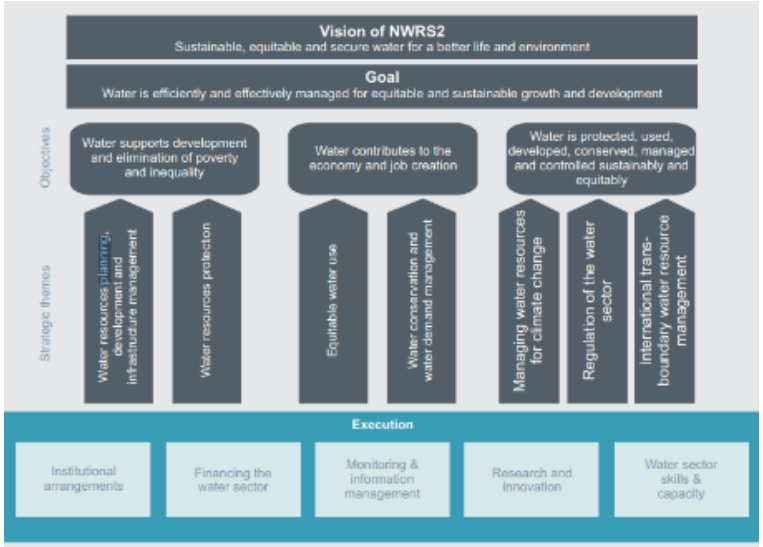


Figure 50: Overview of the NWRS2 Strategy from vision to execution (NWRS2, 2012)

3.6.5 Water Conservation and Water Demand Management Strategy for the Water Services Sector: Department of Water Affairs and Forestry, Republic of South Africa (2004) (WC/WD)

The strategy refers to the need to manage water resources in light of providing services to ensure environmental sustainability, social equity and economic development is at the heart of the report's aim. There is a call for a 'new approach in which Water Conservation and Water Demand Management (WC/WDM) are expected to play a crucial role' (DWA, 2004).

The objectives are outlined in Figure 51.

In terms of planning constraints, current practices seem to focus only on the supply side of water management, failing to consider transitions to sustainable infrastructure as an option to integrate water resource management into policy. Again, the lack of co-ordination between the various chains of governance in the water supply chain is evident, with a particular lack of clarity on the different roles and responsibilities in institutions.

Objective	Description of Objective
Objective 1	To facilitate and ensure the role of WC/WDM in achieving sustainable, efficient and affordable management of water resources and water services
Objective 2	To contribute to the protection of the environment, ecology and water resources
Objective 3	To create a culture of WC/WDM within all water management and water services institutions
Objective 4	To create a culture of WC/WDM for all consumers and users
Objective 5	To support water management and water services institutions to implement WC/WDM
Objective 6	To promote the allocation of adequate capacity and resources by water institutions for WC/WDM
Objective 7	To enable water management and water services institutions to adopt integrated planning
Objective 8	To promote international co-operation and participate with other Southern African countries, particularly basin-sharing countries, in developing joint WC/WDM strategies

Figure 51: Objectives of WC/WD strategy (DWA, 2004)

3.7 Provincial Level

3.7.1Western Cape Sustainable Water Management Plan (2012): Western Cape Government, Department of Environmental Affairs and Development Planning (WCPG)

The Plan is an attempt to link with current strategies and planning initiatives at national, provincial and local level. With regard to 'water re-use', the report notes that the City of Cape Town is looking into the feasibility of 'large-scale water re-use opportunities', without indicating what these may be. Perhaps a fundamental flaw is that despite the establishment of Catchment Areas, water resources are still allocated within political municipal boundaries. This fails to recognise that

INFRASTRUCTURE	• Asset management and operation and maintenance of all municipal owned water supply infrastructure and networks; • Water Pressure Management; • Appropriate monitoring of bulk and reticulated water; • Appropriate IWA water balances and its monthly reporting, particularly in terms of system input volumes, water losses and non-revenue water reduction programmes.
ALTERNATIVE OPTIONS	• Grey-water re-use; • Installation of rainwater tanks; • Retro-fitting with water efficient fittings in commerce, domestic and state owned buildings; • Water re-use in industry.
POLICY / LEGISLATIVE OPTIONS	• By-laws to compel the use of water efficient fittings in new developments; • Appropriate zoning to water supply; • Appropriate tariff structures for water supply to encourage consumer behaviour; • Inefficient water fittings and appliances phase-out in the market; • Eradicate illegal connections and illegal water use.
AWARENESS RAISING	• Public education and awareness raising campaigns on water and ecosystem conservation; • Outreach to improve public attitudes towards municipal water revenue streams (e.g. metering, billing and revenue collection from all municipal water users, including indigents where more than the free water allocation is used).

Figure 52: Table showing the WC/WDM options for consideration in Municipal strategies and plans (WCPG, 2012)

water sources and flows often follow geographical and not political lines.

The link between urbanisation and increased water demand is highlighted, with the report drawing the conclusion that conventional water supplies (dams for example) are becoming less suitable to draw from.

It is encouraging to see the suggestion of grey water re-use and the installation of rainwater tanks, as well as re-use of water in industry mentioned (Figure 52).

Desalination:

This is becoming an increasingly apparent reality, as the City of Cape Town seeks to do everything in its power to avoid reaching Day 0 (where there is no available surface water left in the dams) (Parsons, 2017). The feasibility of a desalination plant in Cape Town would need to pay careful attention to 'current surface water supply schemes, groundwater development from the Table Mountain Group Aquifer, water reclamation / re-use, and the storage capacity for product water into the Integrated Western Cape Water Supply System' (WCPG, 2012:8).

Water Scarcity:

Climate change is an acknowledged threat, and the report realises that 'conventional interventions' are limited, with alternatives to both water demand and supply required.

3.8 Metropolitan Level

3.8.1 Long-Term Water Conservation and Water Demand Management Strategy (April 2007): Department of Water and Sanitation, City of Cape Town

The vision is:

'To become leaders in the provision of equitable, sustainable, people-centered, affordable and credible Water Services to all' (CoCT, 2007).

The strategy considers water as both a social and economic good, noting that

water resource planning has too long been focused on supply augmentation. The report seeks to build onto the Integrated Water Resource Planning Study to ensure a more balanced approach can be ascribed to. This Integrated water Resource Planning is described as a method which helps to reconcile the available water (calculated from long-term mean rainfall and runoff) resources with the anticipated and projected demands.

The strategy stresses the importance of responding to the new normal of less water likely to be experienced by the city. In 2001 a Water Conservation/ Water Demand Management (WC/WDM) policy was created. This was to 'ensure the long-term balance between available Water Resources and water demand, to postpone the need for expensive capital infrastructure projects for as long as it is economically viable and to minimise water wastage' (CoCT, 2007:8).

The strategy of implementation was, however, considered unsustainable and when combined with a number of institutional challenges meant that the commitment to WC/WDM was reduced drastically (CoCT, 2007). The revised strategy now 'seeks to overcome these challenges' and adapt to the City's approach in light of current socio-political, environmental and urban management imperatives' (WDMS, 2015). The vision is not just limited to the current shortage of water; rather it looks to include water resource and environmental protection, as well as reconciling supply and future demand, whilst considering the financial viability of the Water Services business. The strategy speaks to the crucial need to creating a deeper sense of understanding with regard to how water is used.

3.8.2 Water Service Development Plan (2010/11 – 2013/14): Department of Water and Sanitation, City of Cape Town

The City of Cape Town's Water and Sanitation Vison:

'To be a beacon in Africa for the provision of water and sanitation services'. Water Demand Management is deemed essential to the sustainability of water supply to the City (CoCT, 2009: 84). Thus, it has implemented a number of projects that range from repairing leaking infrastructure, to educational campaigns.

Stormwater is mentioned as being at risk from contamination both in storage within the system, and during transportation. It is also noted as a problem in terms of overflows into sewers, which negatively affects the conveyance system and

wastewater treatment works. There is no mention of reintegrating it to the urban hydrological cycle.

3.8.3 Cape Town Spatial Development Framework 2012: City of Cape Town (SDF)

The vision of the SDF for Cape Town is:

'To, by 2040, turn Cape Town into one of the world's greatest cities in which to live and learn, work, invest and discover – a place of possibility and innovation, with a diverse urban community and all the opportunities and amenities of city life, within a natural environment that supports economic vibrancy and inspires a sense of belonging in all' (CoCTa, 2012: 8).

The goal is to achieve a sustainable and just city, both in terms of environmental considerations, and economic achievements.

In terms of water, the SDF acknowledges that ample water supply would be a challenge, and anticipated that the Berg River Dam would only provide a sufficient volume of water until between 2016 and 2019 (CoCTa, 2012). The SDF suggested that water from groundwater sources, as well as desalination and water recycling, are potential ways of accommodating for future demand. This is reflected in the City's approach thus far to the drought.

The SDF anticipates Climate Change impacts, seen in an increase in the severity and frequency of natural storm events and flooding. A change in rainfall pattern is also expected, leading to periods of increased rain followed by prolonged periods of drought (CoCTa, 2012: 22).

WSUD and SUDS are mentioned in the introduction of parking policies, and in reducing the impact of urban development on 'river systems, wetlands, aquifers, aquifer re-charge areas and discharge areas' (by taking the WSUD principles into account). These are:

- maintain the natural hydrological behaviours of catchments;
- protect 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.

The SDF incorporates the importance of landscaping recreational space in a way that promotes stormwater retention and detention ponds, and that 'creates an

awareness of our natural heritage, instils pride in our communities, and reduces maintenance requirements'

(CoCT, 2012a: 75).

These objectives could pave the way for the implementation of SUDS in the future. However, there is no mention of how planners should or could facilitate conversations with water professionals as we seek to tackle water challenges for the City of Cape Town together. The map does not highlight water routes as a core layer of the environment (Figure 53).

The revised SDF (2017d) has very little mention of water, which is alarming in light of the current drought in Cape Town. It speaks to the need to provide utilities for water sanitation, but considers the economy and households as 'resource efficient', using less 'electricity, water and land relative to the size of the economy or population' (CoCTd, 2017). It does not grapple with the fact that dam levels are incredibly low and that Water Restriction levels have been upgraded to Level 5. Level 5 entails 'a ban on all use of municipal drinking-quality water for outside and non-essential purposes' (CoCT, 2017a; 2017c).

Despite stating that 'sound planning and adaptation of City systems and structures ensures that Cape Town and its residents are resilient' (CoCTd, 2017: 28), no specific mention is made of the need to create a City that respects and reveres water, nor one that focuses on using all aspects of the urban hydrological cycle. This is quite startling in the present drought situation, and arguably even without the

The City of Cape Town SUDS pamphlet, illustrating how they work and what they could look like. There remains a lack of guidance towards their implementation.

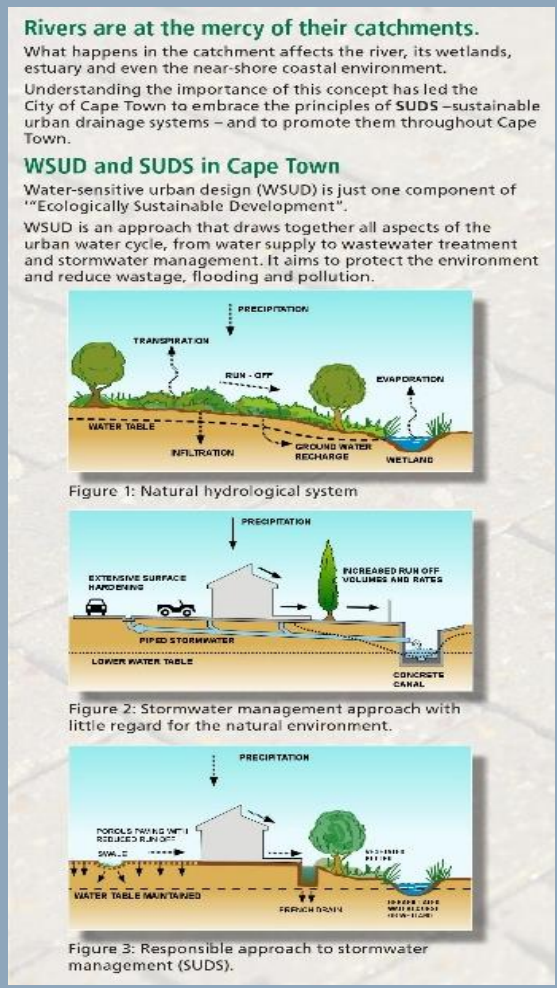


Figure 53: City of Cape Town SUDS advice

context of the drought. Considering Cape Town's natural beauty, and the strong sense of place that is stirred through water being a part of us and the city, both physically and emotionally, losing it will mean losing much.

Water should be at the core of the SDF, as without it, there is no environmental, social or economic growth, or indeed, life.

Rather the Cape Town City Council is taking great lengths to remind its citizens that it is still a 'well-run' City, and that the water restrictions are in keeping with the 'Water Conservation and Water Demand Management (WCWDM) programme, which minimises water loss and promotes the efficient use of water.

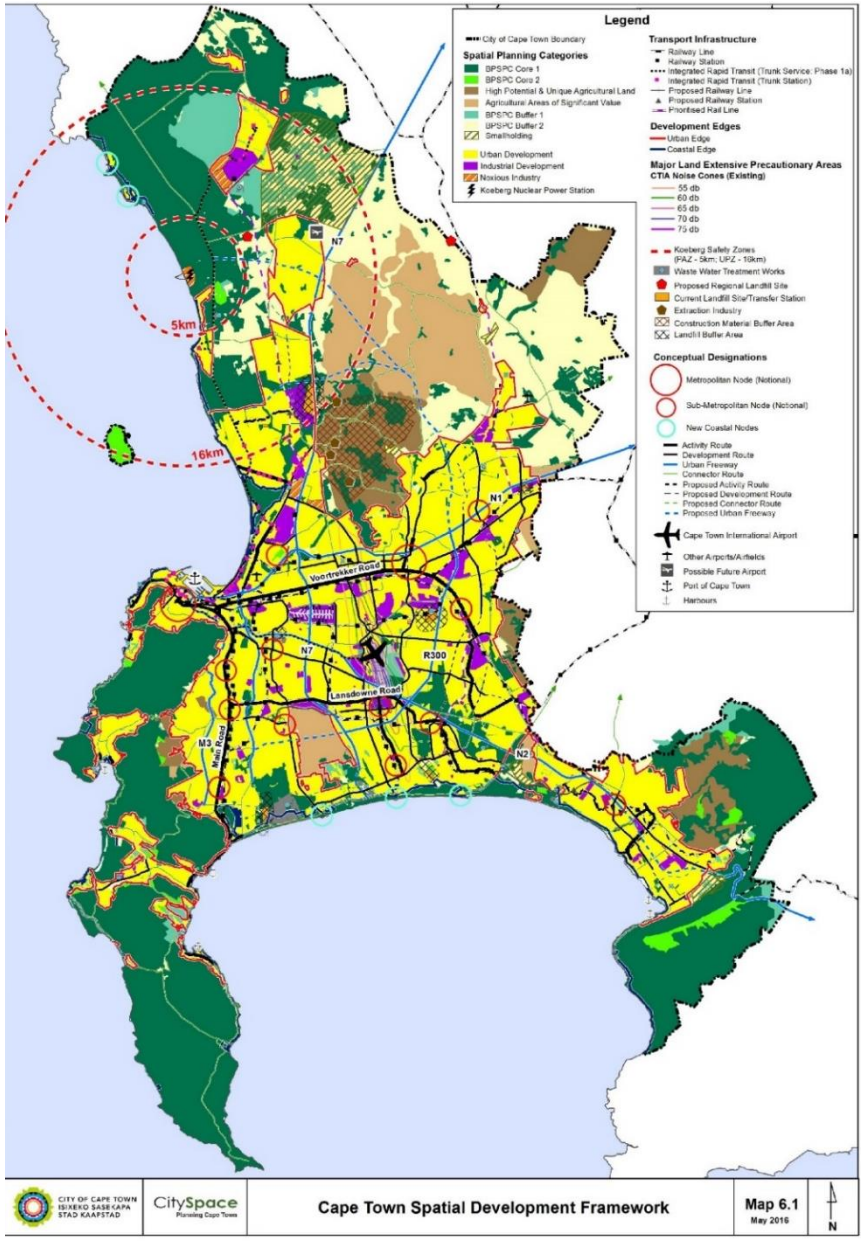


Figure 54: Cape Town metropolitan SDF (City of Cape Town, 2012)

3.8.4 Integrated Development Plan (IDP) (2017 - 2022): City of Cape Town

The Integrated Development Plan (IDP) is the 'principle strategic planning instrument which guides and informs all planning, development and decisions in the municipality, and must align with national and provincial strategies' (CoCT, 2017B: 5).

The vision for Cape Town is:

- To be an opportunity city that creates an enabling environment for economic growth and job creation, and to provide assistance to those who need it most;
- To deliver quality services to all residents; and

- To serve the citizens of Cape Town as a well-governed and corruption-free administration.

The IDP is more explicit in its dealing with Climate Change and the present drought, noting that 'water conservation and demand management will become increasingly important for everybody in Cape Town' (CoCTb, 2017: 21). It suggests that households and businesses work together to conserve water and that the systems and structures in Cape Town are resilient' and thus able to 'withstand and recover from economic, environmental and social shocks or disasters (CoCT, 2017b: 28).

The IDP credits the Water Demand Management Strategy with helping the City make progress in terms of water conservation thus far. The strategy initiated a large leak repair programmes, and oversaw the replacement of ageing infrastructure, as well as education and communication about the environment (CoCTb, 2017: 37). The need to maintain the existing surface and groundwater sources is mentioned, as well as the need to manage the existing and future water supplies in a sustainable manner. This is crucial, as this is mindful of the integrated nature of the hydrological cycle. Encouragingly, the IDP speaks to planning for a water –scarce future in depth, however the path to this is focused on strengthening the bulk water supply system, and not by re-using or recycling water. The existing and future water supplies in a sustainable manner. This is crucial, as this is mindful of the integrated nature of the hydrological cycle. Encouragingly, the IDP speaks to planning for a water –scarce future in depth, however this is deemed doable by working on strengthening the bulk water supply system, and not by re-using or recycling water.

The essential link to Green Infrastructure is made (see Chapter 2), with projects expected to 'serve as a planning and management tool for natural open spaces and natural systems' (CoCTb, 2017: 79). The specific focus of this will be the a 'ecosystem services that these natural assets provide, such as flood attenuation, waste absorption, air and water purification, resource provision and recreational and cultural benefits' (CoCTb, 2017: 79). SUDS should be incorporated into this.be the 'ecosystem services that these natural assets provide, such as flood attenuation, waste absorption, air and water purification, resource provision and recreational and cultural benefits' (CoCTb, 2017: 79). SUDS should be incorporated into this, building on from the suggestions outlined

in Figure 55, which has been supplied by the City.

According to the IDP, the City is also looking to make use of 'the significant excess flow that some of the streams and springs in Cape Town offer' (CoCT, 2017b: 92). This has been studied by the non-profit organisation 'Reclaim Camissa'.

However, the City claims this potential is has been explored. Xantha Limberg (spokesperson for water and informal settlements) stated that the City has found it to be unviable:

"filtration and disinfection barriers would be required to protect community health, as would a pressure feed into the adjacent network and additional staff to control the treatment process" (Wimberly, 2017).

Stormwater is only mentioned with regards to alleviating pressure on the sewage system, avoiding reaching an overloaded capacity, but is not once referred to either as an integrated part of the urban hydrological cycle, or, as a potential resource.

Both the IDP and SDF are strategic opportunities to consider green and blue networks in relation to developments, provision of services and economic activity meant to provide employment and alleviate poverty (Cadman, Petersen, Driver, Sekhran, Maze & Munzhedzi, 2010: 49). Whilst the City of Cape Town has to consider a number of different stakeholder interests, potentially meaning that the green spaces tend to compete with the need for housing or business development (Cilliers, Diemont, Stobbelaar & Timmermans, 2011: 695-698), it should nevertheless consider a combination of the two.

3.9 Local level

3.9.1 Table Bay Spatial Development Plan and Environmental Management Framework (2012): City of Cape Town

The District Plan for Table Bay (within which the focus area of the study – the City Bowl – is found, area highlighted pink in Figure 55) - aims to inform spatial development processes for the next 10 years.

In terms of green and blue networks (Figure 56), the plan notes that there are a number of present challenges faced in the Table Bay District such as:

- 'development pressure on open space and environmentally sensitive areas, as well as alongside water courses and wetlands and within their floodplains and ecological buffers

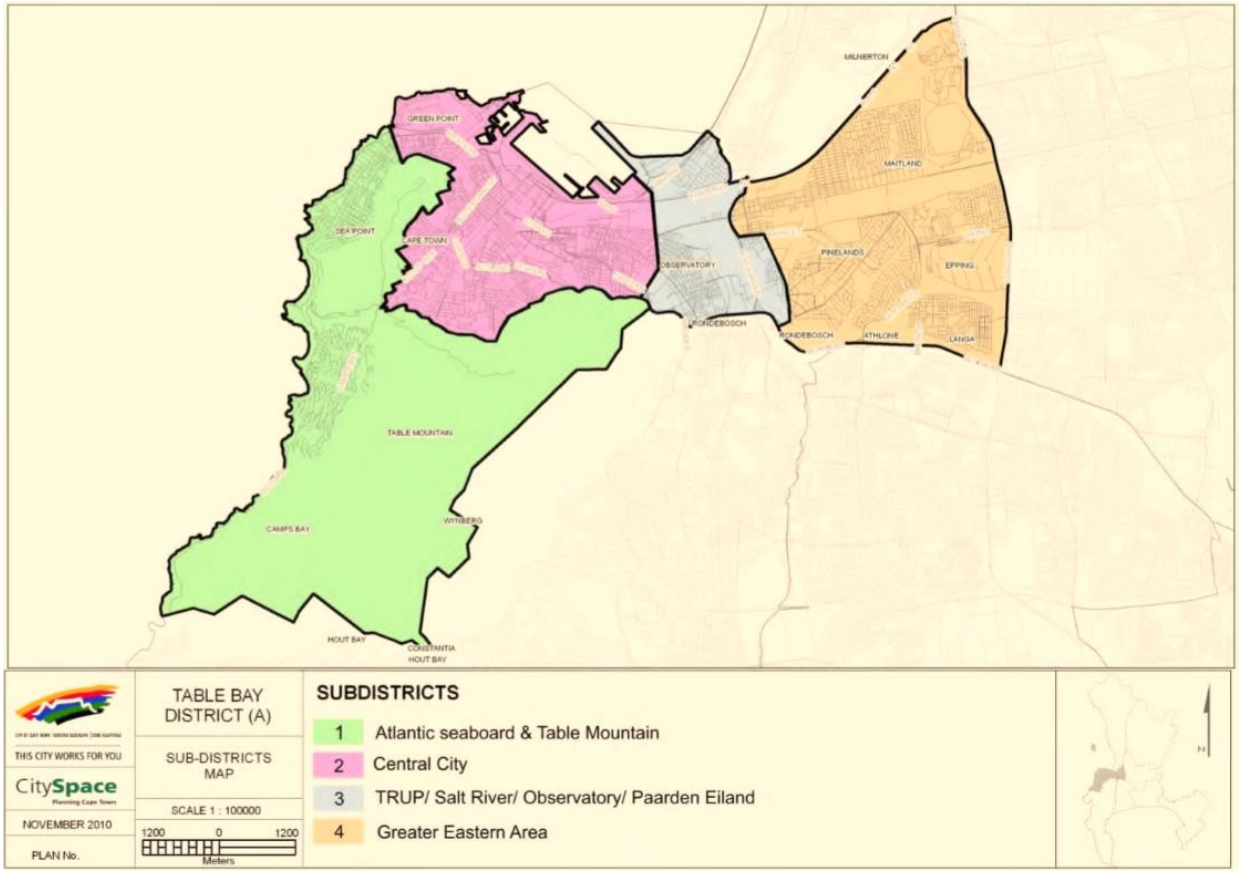


Figure 55: Table Bay Districts (City of Cape Town, 2010)

- the threat of climate change to biodiversity, urban infrastructure and livelihoods
- the impact of pollution from urban stormwater run-off'.

The plan outlines that the response should be:

- to consolidate open space
- protect the key resources of environment and economic value by

effectively managing and guiding urban development towards appropriate areas

- protect floodplain areas from inappropriate development
- capitalise on areas where latent potential exists and support and enhance the natural environment and open spaces in these areas
- integrate biodiversity remnants within the urban edge into the urban fabric, ensuring sustainable conservation and access to natural resources

The plan notes that the 'recreational functional integrity and connectivity of ecosystems must be improved, and an interlinking network of linear parks with foot and cycle paths should be established to facilitate easy movement of fauna and flora' (CoCT, 2012:32). Urban development must respect the presence, role and function of natural assets, and

Figure 56: The research area (black circle) and the surrounding green network (City of Cape Town, 2012)

should make the most of possible benefits residents and visitors can derive from them. The language neglects the idea that humans cannot function without various natural assets, and suggests that nature is merely there from which to derive benefits. This indicates that humans are separate from nature, and does not allow for a line of thinking which recognises how entangled, inter-connected and reliant we are on natural systems. The plan categorises 'ecological corridors and ecological support areas, as well as river corridors and waterbodies' as Core 2, noting that it demands a unique management approach (Figure 57).

In terms of spatial approaches, the key structuring elements in terms of natural assets are determined as being 'retaining and developing continuous open space corridors associated with the stormwater systems' as well as 'ensuring the public accessibility of the coastline and re-establishing the central city's connection with the water's edge' (CoCT, 2012b: 34). This appears to be intended in the spirit of allowing stormwater to run out to sea without re-integrating it into the hydrological cycle.

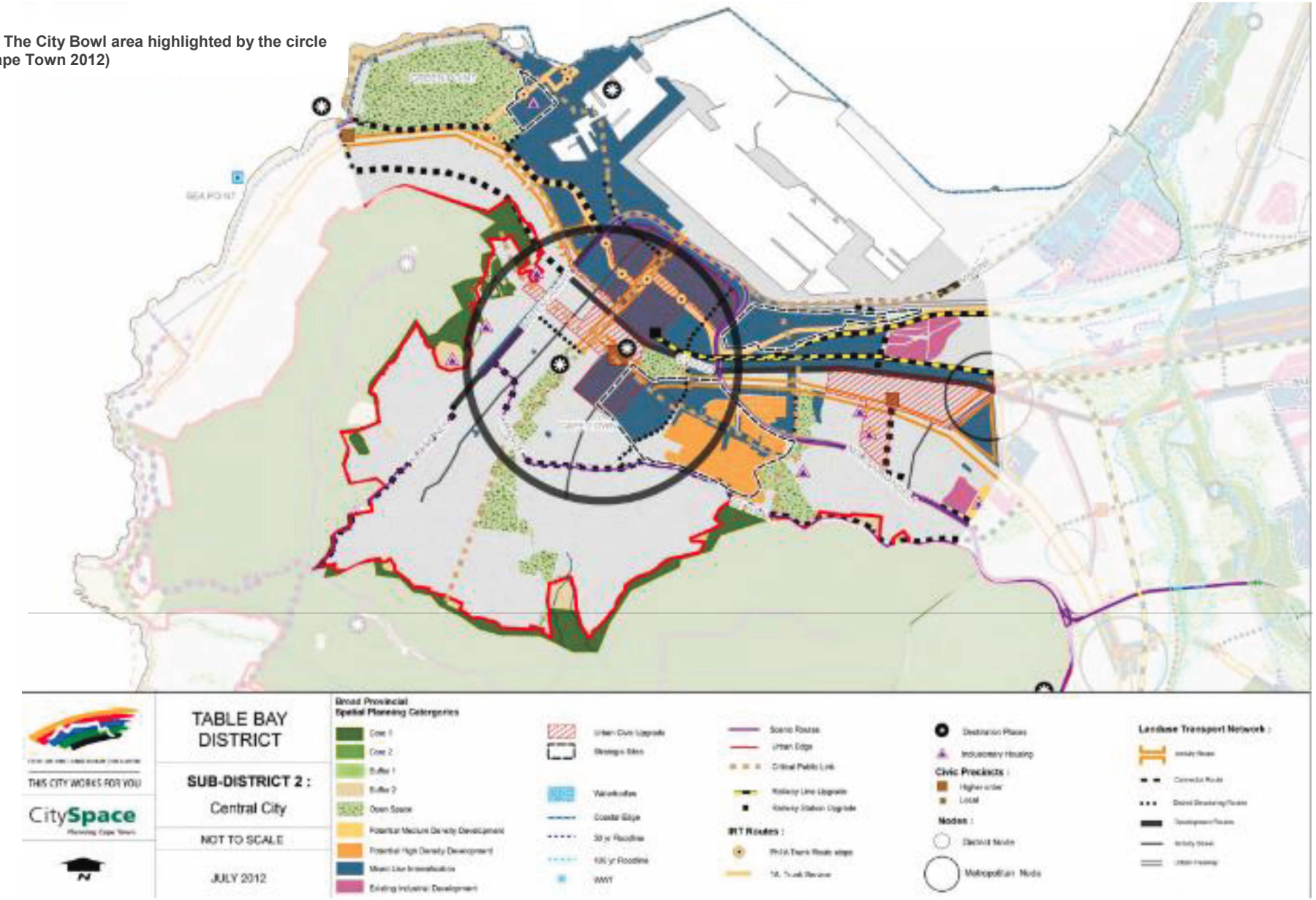
The plan draws on Cape Town's historic sites and routes as attributes to the creation of a compelling and attractive city. It mentions the need to 'maintain green corridors extending from the mountain into the City' (e.g. parks and public spaces located in the upper reaches of the City Bowl), but makes no specific mention of the important historical links to water. This is surprising considering that many of the areas in the City Bowl were settled on because of the very presence or proximity to the Varsche River.

The stormwater drainage system that serves the City Bowl largely constitutes of an underground pipe network. This discharges into Table Bay at 16 separate points. The pipe networks runs concurrently with the road network, with the roads acting as the outflow channel in events of larger storm events. There are a number of natural storm gulley's that drain the steep upper slopes of Table Mountain directly into the drainage system that serves the central city (CoCT, 201b2: 108).

The upper City Bowl sewage system struggles during storms, with 'surcharge and overflows occurring regularly' (CoCT, 2012b: 109). Incorrectly designed stormwater systems on individual erven are attributed to the resulting water ingress, particularly in Oranjezicht. This excess water is discharged into the sewer system, which seems incredibly wasteful, and linear.

At the time the report was prepared (2012), Cape Town was not experiencing as such a sever water shortage as present, and thus it writes that there is no 'immediate problem with water as a source' (CoCT, 2012b: 107).

Figure 57: The City Bowl area highlighted by the circle (City of Cape Town 2012)



3.10 Municipal Policy

3.10.1 Catchment, Stormwater and River Management Strategy (2002- 2007): Department of Transport, Roads & Stormwater, City of Cape Town (CSRM)

This attempts to approach the management of urban drainage systems in an integrated manner, seeking to balance the 'competing and often divergent needs of the community' in aspects such as flood protection, ecological enhancement and opportunities within cultural, recreational and economic spheres.

The aim was to provide a 'framework to guide management of Stormwater systems for the sustained benefit of the city's residents, business concerns and visitors alike' (CoCT, 2002). It was a response to the shift towards the philosophy of integrated catchment management.

The document places a strong focus on understanding local needs and values, and the important link between human health, the environment and development. It notes the past function of 'green corridors' between the mountains and coastline as a way to convey urban waste and storm runoff, canalising rivers and draining wetlands in the process (often in pursuit of development), and attempts to move away from this line of thinking, which has compromised the ecological integrity of the city's natural systems.

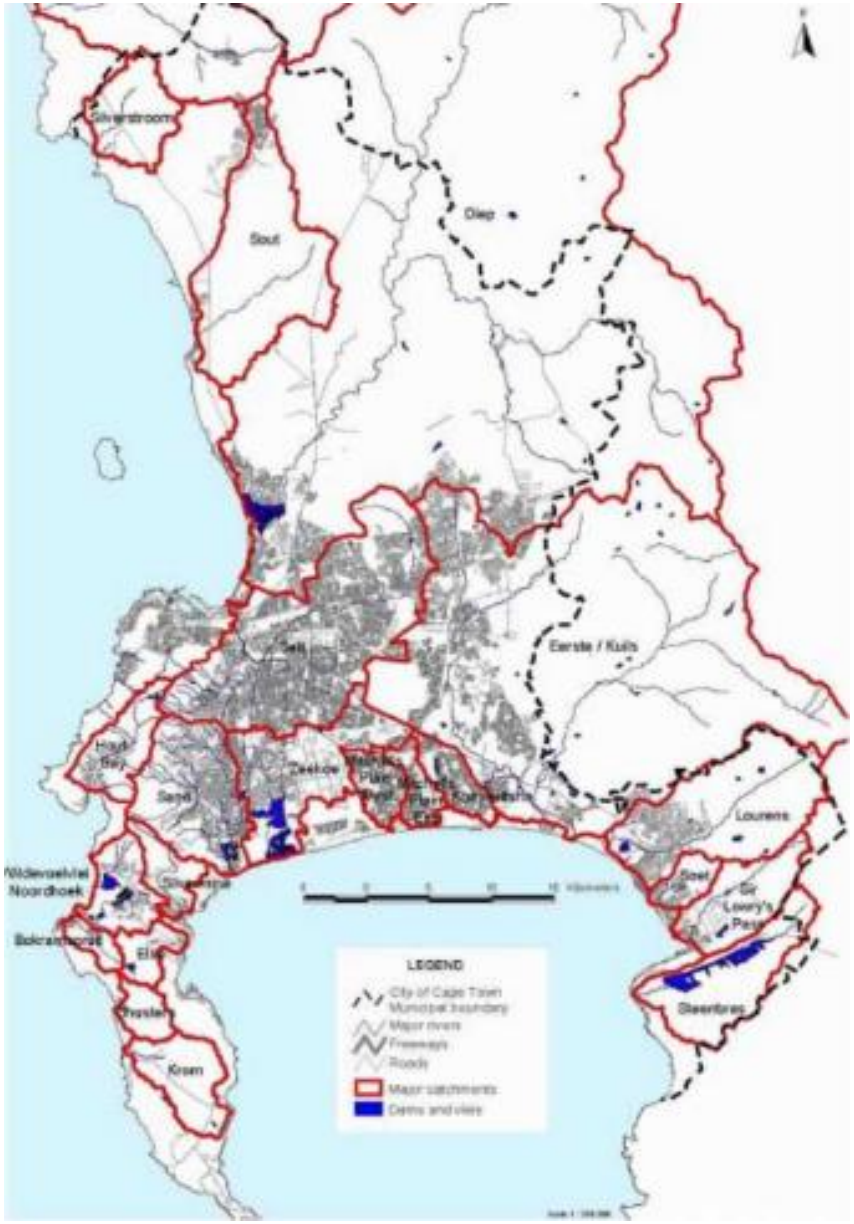


Figure 58: Drainage catchments of Cape Town (Catchment, Stormwater and River Management Strategy, 2002)

Emphasis is on:

- 'Integrated and co-ordinated catchment based planning approach founded on good understanding of local needs and values' with focus on supporting broader city objectives
- Protecting urban water resources
- developing innovative infrastructure solutions
- involving communities in the management of river systems through catchment forums (CoCT, 2002)'.

Both the vision and mission are focused on effective stormwater drainage to minimise flooding and reduce risk (CoCT, 2002: 13).

The core of the strategy lies in the systems approach, 'combining the constructed and natural components of the stormwater system' as an 'indivisible, mutually dependent whole' (CoCT Town, 2002: 15).

The strategy aims to play an active role in achieving the objectives of Integrated Urban Water Management agenda, believing that it will benefit both customers and the environment. It is interesting to note how people are rendered as customers rather than citizens, and with the hydrological cycle essentially reduced to a business transaction.

The CSRM outlines the need to develop, upgrade and maintain current stormwater and river systems to ensure 'sustainable social and economic development in Cape Town' (City of Cape Town, 2002: 16). It also speaks of the need to work with the Disaster Management team with regard to identifying flood prone zones, thereby fostering an attitude of proactive response to flooding, with a 'particular emphasis on prevention and mitigation' (CoCT, 2002: 17).

In terms of planning, the programmes are divided into categories, see Figure 59.

Plan Category (Level)	Purpose
Catchment and River Management Plan (CRMP)	Sets overall management objectives and recommends key management actions with respect to runoff quantity, quality and other associated environmental and social issues.
Stormwater Management Master Plan (SMMP)	Identifies bulk infrastructure required within developing areas where applicable.
Local Stormwater Management Plan (LSMP)	Details how stormwater is to be managed within proposed or existing developments focussing on localised issues.

Figure 59: Plan Categories (Catchment, Stormwater and River Management Strategy, 2002)

3.10.2 Management of Urban Stormwater Impacts Policy (2009): Department of Transport for Cape Town, City of Cape Town

This policy recognises the importance of wetlands and watercourses in relation to the stormwater management system, noting the importance of cultivating a strong biodiversity network.

Its aim is to support the Roads and Stormwater Department objectives.

It focuses on the principles that have evolved out of the approach known as Water Sensitive Urban Design (WSUD) – explored in chapter 2.

WSUD 'recognises that the primary reasons for deterioration of urban waters is the disruption of the natural water cycle' (CoCT, 2009: 5). The policy notes that this is a result of urbanisation. The policy speaks directly to Sustainable Urban Drainage Systems (SUDS), as a branch of WSUD, which aims to 'as far as possible maintain or mimic the natural flow systems' (CoCT, 2009: 5). It further narrows the definition by classifying them into two groups; structural controls and non-structural controls (see Chapter 2). It recognises that a combination of different methods implemented sequentially or concurrently, which varies 'from preventative measures at source' to 'development site and regional controls', before the water is discharged would be necessary in order to adequately treat the stormwater (CoCT, 2009: 6).

The policy statement claims that to improve the quality of stormwater on receiving systems, that the management of stormwater should follow plans and designs that engage WSUD principles (CoCT, 2009: 8).

The first two points are part of SUDS aims too (see chapter 2).

In terms of implementation, the policy suggests that WSUD principles should be incorporated into both new urban developments and existing development areas.

The policy ultimately stresses the importance of considering 'Stormwater drainage, nutrient management, WSUD, protection of water resources, water efficiency, recycling and re-use' as elements of holistic and integrated planning for the City (CoCT, 2009: 9). The policy recommends that the aforementioned should be included in the Cape Town Metropolitan SDF, and that

Catchment and River Management Plans should be developed to inform regional and local planning processes' (CoCT, 2009: 9).

However, the policy appears to have been created in isolation, failing to use the process of creating the plan to create a shared ownership nor understanding of what SUDS entails or why it is essential to urban areas.

3.11 Frameworks

3.11.1 WSUD framework for South Africa

The framework is instrumental in paving the way for communicating a conceptual understanding as to how WSUD can work in a South African context.

It acknowledges that South Africa is a water scarce country (Armitage et al., 2014) and that it faces many challenges in terms of transformation, as it seeks to overcome the legacy of Apartheid whilst dealing with an unsustainable and resource intensive economy. It speaks to the need to focus on water in urban areas, as these are 'hubs of economic growth' (2014:i) and drivers for increased water demand and consumption.. In South Africa, water sensitivity is a recognition that water is scarce, and that access to potable water is a basic human right, as well as considering water as an economic good that is vital to sustaining all life and supporting the environment. Thus water sensitive design seeks to manage the country's 'urban water resources through the integration of the various disciplines of engineering, social and environmental sciences' (Armitage et al., 2014).

WSUD is defined by Brown et al., (2008) as 'an approach to urban planning and design that integrates land and water planning and management into urban design. WSUD is based on the premise that urban development and redevelopment must address the sustainability of water' (Armitage et al., 2014). The researchers found that, considering the history of development in South Africa, that the critical terms of 'urban design and planning' and 'urban management' needed a specific definition:

Urban design and planning – whilst the terms urban design and urban planning are intrinsically linked, in the RSA context urban planners generally undertake planning (which is very often site-focused and does not consider the broader system); whilst engineers, architects, landscape architects and scientists

undertake design. Urban planning should be seen as the technical, iterative process which is used to guide and set the design for an appropriate urban form, i.e. it considers the 'bigger picture'; while urban design refers to the local design (or form) of an area, and should fit in with existing urban plans.

Importantly the framework recognises that the management of water in South Africa is complex, and falls into a constrained social-ecological and political-economic context. It strongly promotes the development of a Learning Alliances to facilitate the collaboration of various stakeholders. Learning Alliances are understood to be 'platforms that bring together stakeholders from a range of institutions… to think, act and learn together' (Butterworth et al., 2011; Armitage et al., 2014). WSUD is argued to have the potential to 'act as the mechanism to address and enhance the objectives of the NDP and the NWRS-2' (Armitage et al., 2014: vi).

3.11.2 South African Guidelines for Sustainable Urban Drainage Systems (SUDS)

The objective of the framework is to identify affordable and practical stormwater management technologies for South Africa, which are in line with the aforementioned WSUD principles, and to develop practical guidelines that are user-friendly, for the implementation of WSUD in both new developments, and instances of retrofitting (Armitage et al., 2013). The framework outlines the benefits of SUDS, the need for them (the relationship to growing urbanisation) and their associated processes, working towards achieving the philosophy of **quantity, quality, amenity and biodiversity**. It details their selection basis process too, and speaks to the ecosystem service that they provide. It recognises that 'different projects will require different combinations of professionals to be successful' (Armitage et al., 2013: 6).

One key influencer in the development of the framework is the CSIR (2012), which states:

- The need to protect the health, welfare and safety of the public, and to protect property from flood hazards by safely routing and discharging stormwater from developments;
- The quest to improve the quality of life of affected communities;
- The opportunity to conserve water and make it available to the public for beneficial uses;
- The responsibility to preserve the natural environment;

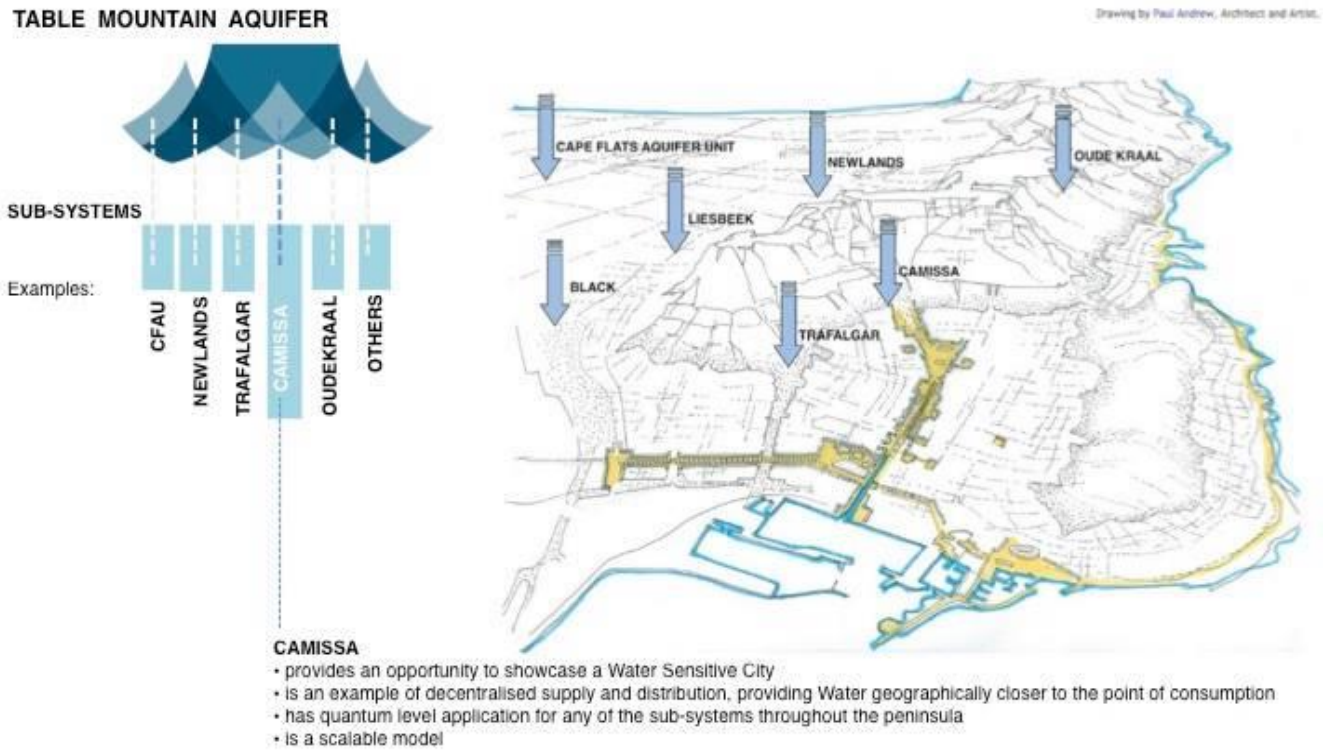
- The need to strive for a sustainable environment while pursuing economic development; and
- The desire to provide the optimum methods of controlling runoff in such a way that the main beneficiaries pay in accordance with their potential benefits.

Thus, the CSIR helps to establish a foundation for identifying possible sites of SUDS intervention.

3.11.3 Reclaim Camissa

The Reclaim Camissa project recognised many of the opportunities presented within the City Bowl (Kotze, 2011). It aims to reconnect the springs from Table Mountain to the ocean, and in doing so restore physical and mental connections to the water (Figure 60). Yet as mentioned in the analysis of the SDF, the project is not being explored further.

Figure 60: Reclaim Camissa: reconnecting springs to sea (Reclaim Camissa)



3.12 Potential City Bowl intervention sites

This section will return briefly to the literature explored in the Literature Review (chapter 2), exploring the theories examined through the lens of water in the City Bowl. It will discuss the role of the planner and draw on the analysis of the legislative environment and the physical and demographic dimensions of the City Bowl to offer opportunities and constraints for spatial and policy interventions.

It will then present possible sites of SUDS intervention in the City Bowl and conclude.

3.13 Green Space in Cape Town context

Green spaces in the City Bowl not only offer an ascetically pleasing environment, but importantly contribute to ensuring the optimal functioning of ecosystem services (such as improving water quality, reducing the urban heat island effect, reducing noise and removing pollutants from the air, Figure 12). This can lead to indirect and direct economic benefits for the area, and contribute towards a positive social environment too. Using the multi-functionality aspect of SUDS to construct local areas that not only enable and support active and healthy lifestyles, but which also provide functionality in terms of water resource management, could transform the City Bowl.

Figure 61: Khayelitsha (AP Photo/ Schalk van Zuydam)

Cape Town has a large number of complex issues to navigate, and it could be argued that care for the environment should not come before people, nor that money that could technically be spent on economic improvements be spent on natural systems. Yet, there is strong argument countering this, as links between green spaces and improved quality of urban life have appeared in recent studies (Casperson et al., 2006; Wolf, 2004).

The City Bowl faces a challenge of providing quality green spaces, and yet in the midst of increasing urbanisation, there is an ever-growing need to re-introduce green and blue aspects to these spaces, that are respectful to the history of the area. Residents from other parts of the city, who do not have ample access to green spaces in their neighbourhoods, could use these spaces in the City Bowl.

SUDS ultimately come down to the combination of the principles 'Reuse, Capture, Clean, Recharge' (Klitzner, 2017). The advantage is that the different SUDS components all work differently, and can be implemented in different places. This means that 'one can be emphasised more than other in different places' (Klitzner, 2017).

This is an advantage to the City Bowl, as it means that the SUDS can be chosen specifically according to the space determinants of sites, which in in the urban landscape, are often small and contain an identity already.

3.14 Opportunities

Areas within the City Bowl were identified as sites of possible intervention with these findings in mind. The dissertation does not explore in depth a number of SUD dependent specifications such as geology, slope gradients, runoff volume or infiltration rate. The suggestions are rather based on knowledge of the sites' current characteristics, and the amenity requirements - as suggested in the framework for SUDS, (Armitage et al., 2013). They also feed into the creation of a landscape system that 'links parks and reinforces movement routes', and 'facilitates the strengthening of a continuous green link between mountain and sea' (CCDI, 2012). The CSRI Human Settlement Guidelines (2012) suggests that the design of public open space should be 'integrated with the design utility infrastructure networks' (2005). Soft open spaces should be connected to the system of stormwater management and SUDS interventions such Bioswales or retention ponds can be used as 'landscaping features within the amenity network' (CCID, 2012).

The following map highlights the cultural and historical layers of the City Bowl. Using these as connectors between SUDS sites could be particularly powerful, and in keeping with the aforementioned site criteria.

1. Buitengracht Street connects the city from Kloof Nek Road and Table Mountain to the Bo-Kaap and Green Point

2. Waterkant Street is a popular and vibrant pedestrian walkway in the City Bowl

3. Dorp Street sits on top of a freshwater spring, used by some buildings for their internal water supply

4. Long Street is a diverse part of the City Bowl, from restuarants and clubs to the city's first public baths and swimming pool

5. The Company Gardens are a green gem in the City Bowl. The remnants of half of the garden planted in the 1650s by the Dutch settlers, it offers space to reflect, and enjoy shade in the urban environment. it is an important historic site too, and its landscape is surrounded by the reminders of the City Bowls slave labour past

6. The surrounding area is home to:
The National Library of South Africa
St George's Cathedral
The Supreme Court
The Izikio South African Museum
The Izikio Planetarium
The Izikio South African National Gallery

7. Addereley Street connects the Company Gardens to the old canal routes, and links to the popular St George's Mall. This is a leafy pedestrian thoroughfare that used to tbe known as Berg Street. The foundation stone for the St George cathedral was laid at the top of the street, hence the name change. It was one of the first streets of Cape settlement, with houses built on the street from 1693 onwards.

8. Church Square was used as a car park from 1970 to the 1990s, and only in 2004 did this change to a multifunctional green space. Today the square is a quiet space that commemorates the space in which slaves used to wait for the Masters to finish church at the Groot Kerk. The Slave Lodge is located on the square too, historically home to slaves until 1811, and now a muesum on the history of slavery.

9. The City Hall is one of Cape Town's iconic buildings. Built in 1905, it was the centre of the city administration and was used until 1979 for this purpose.
The Central Library is found here too

10. District Six museum is a significant site of memory in the City Bowl, sharing the history and stories of residents displaced in apartheid.

CITY BOWL: Base Map

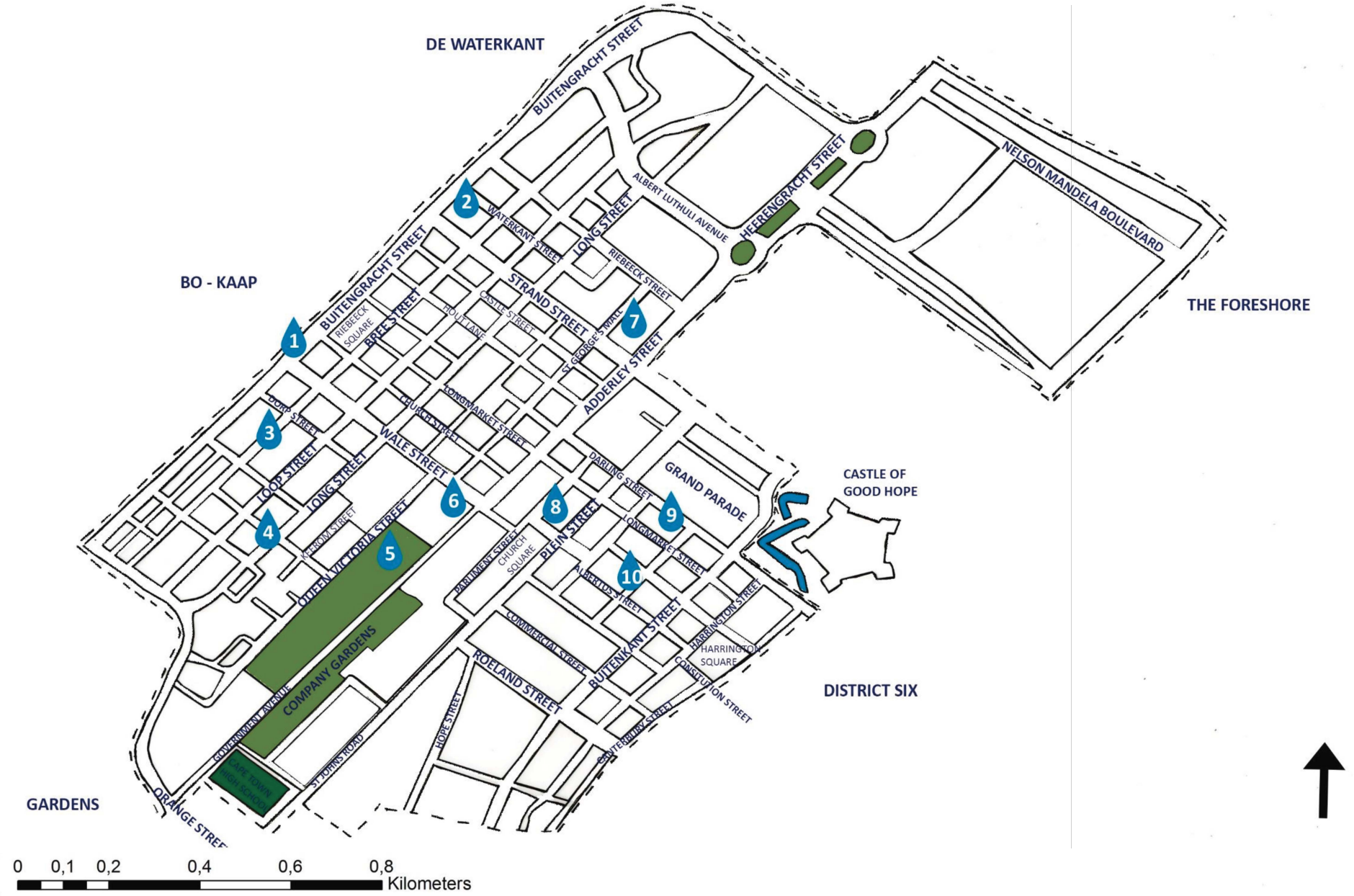


Figure 62: City Bowl points of attraction (Data source CoCT, 2009; Base Map ArcGIS 2017)

3.14.1 Buitengracht Spine

Using this in conjunction with the City Bowl's areas of cultural and historical significance showcased in Figure 63, three spines were identified:

1. Buitengracht Street
2. Adderley/ Heerengracht Street and the Company Gardens
3. Buitenkant Street

Historically water used to flow down from Table Mountain in canals here (figure).

Intervening with SUDS would present the opportunity to bring water to the City Bowl in a manner that works with the existing urban landscape, and makes use of valuable open spaces such as road reserves.

Raised road medians exist largely as a safety measure, to prevent traffic from jumping across from one lane to another, but vegetation can enable the same barrier (Armitage, 2017).

Planting trees on an island in isolation is not a solution – but combining it with a bioretention systems means that the vegetation is able to be naturally irrigated and fertilised (through bird faeces), rather than relying on a separate irrigation system. This can also allow for the elimination of a pipe, as the ground is holding the water, as well as provide ecological benefits (such as ecosystems services, see Chapter 2). See Figures 83 and 84.

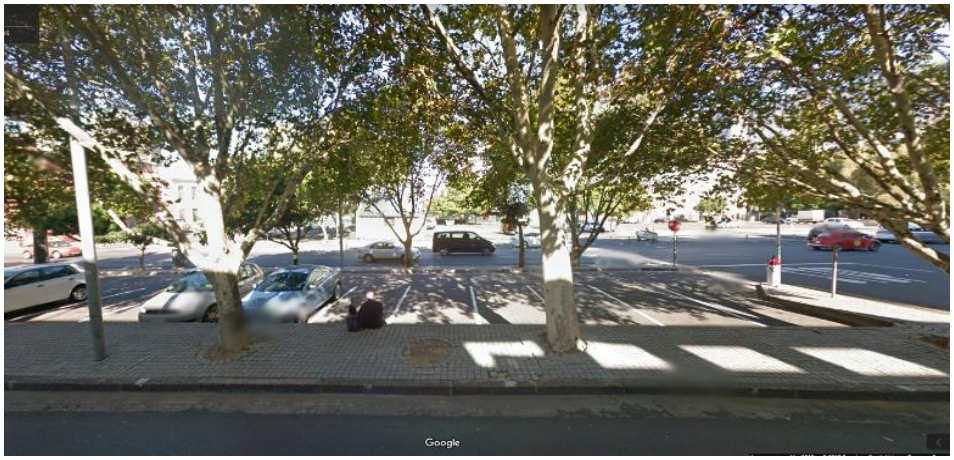


Figure 63: Buitengracht Street with Riebeeck Square in the background (Google Maps 2017)

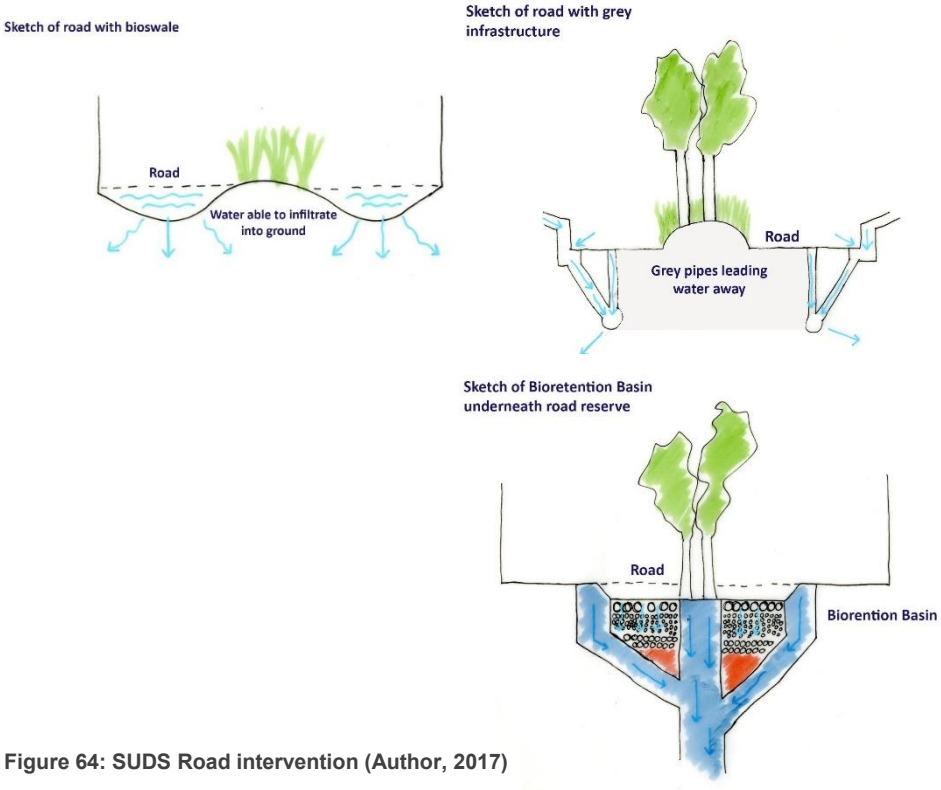


Figure 64: SUDS Road intervention (Author, 2017)

3.14.2 Company Gardens and Adderley/ Heerengracht Street

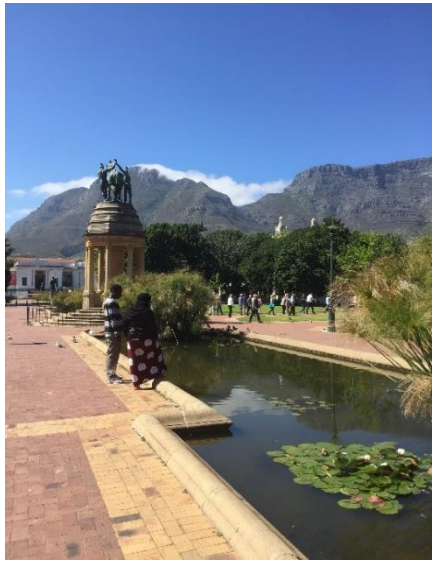
The rich heritage and memories of the City Bowl almost culminate in the Gardens. The Garden's creation resulted in the displacement of the hunter gather settlers and pastoralists (who migrate and farm seasonally), and led to the dispossession of the people who first used the land. The Garden layout shaped the early city grid and were renowned internationally for their indigenous species (Figure 65). This combined with the historical route of the Varsche River down Adderley meant that this site would be an inspiring place to potentially spatially intervene.

The Gardens are dominated by the instantly recognisable features of Table Mountain, rising to more than a thousand metres above sea level (Figure 66), with Lions Head to the west and Devil's Peak to the east. The springs that once sustained the Gardens could sustain users of the City Bowl once more. SUDS could be integrated thoughtfully into the Gardens, as a way of embracing the future of Cape Town as a Water Sensitive City.

The proximity to the Izikio Slave Lodge, Church Square, St James Mall, the Cape Town Library, and Houses of Parliament, amongst others, strengthen the cultural pull of the site, offering a place to learn about the past, and the new (the new being Water wise and using SUDS) (Figure 65). They also bear witness to significant moments in the City Bowls past, with the buildings which

Company Gardens entrance (Author's, 2017)

Vegetable Garden with the Planetarium in sight, (Author's, 2017)



Company Gardens pond (Author's, 2017)

Company Gardens indigenous flowers (Author's, 2017)

Figure 65: Company Gardens

surround them largely constructed from slave labour.

Using the fountains (Figure 66) as sources of recycled water (from SUD interventions in the Garden) would not only help mildly regulate the temperature of the City Bowl but encourage a celebration and respect of water in this well used space.

As explored at the beginning of the chapter, Adderley and Heerengracht Street were initially streets with canals ('grachts') running along them. Returning water to these roads with SUDS would further enable the recycling and rejoicing of water in the City Bowl as we re-connect. The link to St George's Mall would strengthen the pedestrian network of the City Bowl (Figure 37).

The road reserve on Heerengracht Street: potential for Bioswales or rain gardens instead of paving underneath the trees (Google Maps 2017)

Adderley Street traffic circle: potential to intervene with SUDS (Google Maps 2017)

Figure 66: Adderley Spine Street

3.14.3 Harrington Square

Focusing on the eastern fringe of the City Bowl provides an important opportunity to connect to the traumatic past of the area, linking to District Six. Forced removal of the residents in 1966 during apartheid left a landscape that remains sacred today.

Buitenkant, Harrington and Canterbury streets run through the section in a north-south direction, with Buitenkant being a main traffic artery for the City Bowl. Buitenkant terminates in The Parade and the Castle (Figure 63). Harrington Street is a service street (The Fringe, 2012) and the square is a parking lot.

Historically, water flowed down Canterbury Street from Table Mountain (The Fringe, 2012) and thus using SUDS here would offer another point to return the water which gave the city life to the surface. The recycled water from the SUDS could reconnect residents to the blue network, and the streams that once ran down the adjacent Canterbury Streets.

Urban art used to create emotive and responsive public space (seen on the corner or Constitution and Canterbury Street (Google Maps 2017)

The nature of Buitenkant Street (Google Maps 2017)

Canterbury Street (Google Maps 2017)

Figure 67: Buitenkant spine streets

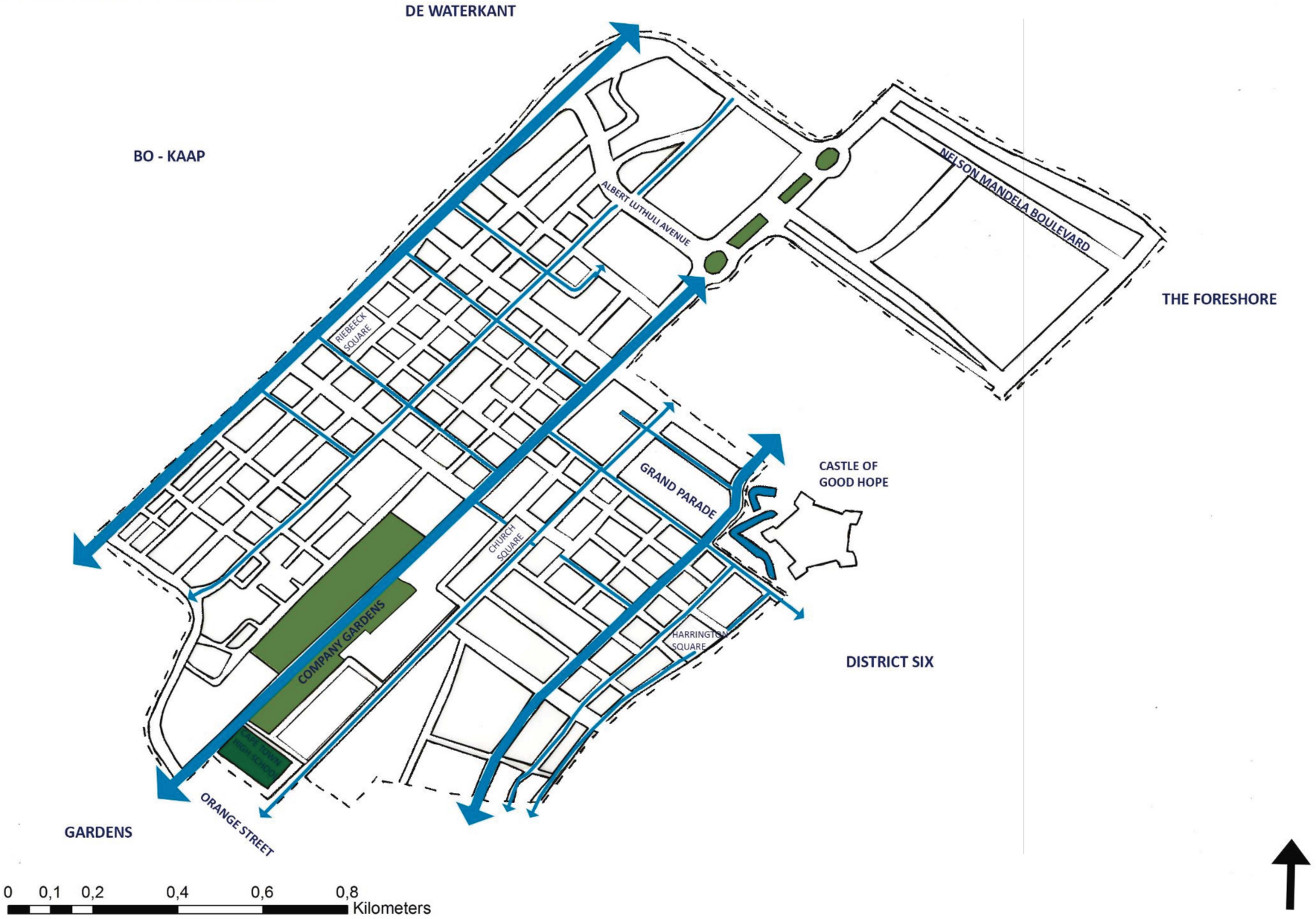


Figure 68: Map of City Bowl Blue Routes (Data source CoCT, 2009; Base map ArcGIS 2017)

The map in Figure 69 spatially conceptualises how these three sites could be connected through a network of blue paths through the City Bowl.

3.15 Constraints

There is the challenge of requiring different departments within the municipality to work together, overcoming institutional boundaries and red tape processes which can encumber even the best intentions. Projects need planners who are willing to take risks, and facilitate a conversation about reaching a collective vision that respects and reveres water.

Using the streets of Buitenkant, Buitengracht and Adderley, there is potential to showcase water through SUDS. These sites could demonstrate too how SUDS recognises the value of all aspects of the hydrological system. Education and knowledge are the crux of crossing the gap of implementing SUDS (McLachlan, 2017).

'To people who are familiar with SUDS, it is not a hard sell; but people who look at the disparity in social and economic circumstances of Cape Town' (McLachlan 2017; Klitzner 2017; Cameron 2017; Winter 2017) would perhaps consider it not a necessary intervention.

By embracing a learning-by-doing approach that allows for failure, and encouraging a degree of experimentation and the creation of new knowledge, there is an opportunity to foster a nature of mutual learning on the road to success or failure.

The City Bowl could showcase water in through SUDS components, celebrating it and encouraging people to enjoy it. This could and should be incorporated into the planning process, showing that **water really does matter**. By viewing the landscape with stormwater in a positive way, with beautiful and functional features, a huge amenity value would be demonstrated.

3.16 Conclusion

Though lots of Cape Town existing policy has mentioned SUDS, and the known implications of running out of water, there nevertheless appears to be a water literacy gap in the planning documents gap missing as how to better work across departments, and embrace WSUD and SUDS. The urban fabric of the City Bowl has become an entangled web of infrastructure and concrete, and the natural streams dismissed to a mere memory in street names. Intervening with SUDS in the City Bowl recognises that natural systems cannot and should not remain fragmented or disrupted. SUDS can strengthen the resilience of the City Bowl and its people.

4
Planning for Uncertainty in the City Bowl

"Try to picture the city without water. So intimately have the mountain, the water, the sky, been grafted onto our lives that its almost impossible to imagine what would be left over if the natural world were removed. From 'A City Imagined'

(Galgot, 2005:15).

4.1 Water Future for the City Bowl

The drought that has encapsulated Cape Town in the last few months has, to many of Cape Town's citizens, been a reality for much longer than this. An unequal distribution of wealth in the city has perpetuated an unequal distribution of services too, and access to water is one of them (as discussed in Chapter 3).

Future imagining the City Bowl helps to stretch imaginations as to what the future may hold, focusing on a positive outcome. The explorations of the City Bowl as described in Chapter 3 present the area as a significant place to intervene within the context of the wider city. Not only do a large number of people use it, but the diversity in users' presents the space as one in which awareness can be raised on the need to revere and respect all aspects of the urban hydrological system.

Cape Town is facing a crisis. Insufficient winter rain has left the city grappling with an uncertain future, one that is likely to be marked by the unpredictable nature of climate change and almost certainly a lack of water. The City has constructed a 'new normal' scenario (as mentioned in Chapter 3), one in which 'we do not bank on water security ending' (Xanthea Limberg, Mayor Committee member for informal settlements, water and water services, and energy) (News24, 2017).

The City is now currently pursuing a combination of alternative water resources (desalination, groundwater and water reclamation) in conjunction with an aggressive campaign to reduce the consumption of water. This is believed to be enough to get Cape Town through to winter 2018. The Council has created a Water Resilience Task Team. As communicated by Mayor Patricia De Lille, 'resilience means in an urban environment that we have capacity as individuals, communities, institutions, businesses and systems within a city to survive, adapt and grow no matter what kind of acute stresses and shocks we experience' (De Lille, 2017b).

However, resilience is entwined and inter-linked to 'reducing inequality, reducing poverty and advancing participatory democracy whereby all citizens have agency to improve their lives (Wilson & Pereira, 2017; De Lille, 2017a). This is a compelling link because for many residents of Cape Town, a non-guaranteed water supply is already their normal. As far back as 2009, Water-Management Devices were installed in informal settlements in Cape Town, with the intention of dispensing a pre-determined amount of water in order to assist 'poorer households in managing

water usage' (Donne, 2009). These devices were protested, with parallels drawn to the apartheid days of walking to fetch water with a bucket. No such installation happened in wealthier suburbs until this year (2017). On the surface, this feels as though poorer communities were made to pay more for using less water than wealthier suburbs were (Wilson & Pereira, 2017). When 'wealthy households are allowed to us water freely during a drought while poor households have no choice but to live with severe water restricting technologies, this does not build long term resilience in our society' (Wilson & Pereira, 2017)

Therefore, this begs the question of looking to the future – in 40 years' time, where will Cape Town be?

What will the City Bowl look like? The future is likely to be one with less water and a reduced supply.

Will the city have recognised that water is a life giver, to ecological systems, to humans, everyone and everything reliant on its every form?.

Will it have resisted the decades and histories of neglect, and be driven by a collective vision; ensuring future water management does not create divides and further inequality?

4.2 Future imagining

Imagine Cape Town reconnected, the mountain to the sea, through the City Bowl. People reconnected to the Camissa streams that first brought humanity here, reconnected to the landscape, recognising that nature is an intrinsically part of us.

Where the attitude towards water is one of rehabilitation, restoration. Where SUDS in road reserves are the norm, with every aspect of the urban water cycle respected and viewed as precious.

Where the attitude towards water is one of rejuvenation, reverence, rejoicing.

Where the attitude towards water has evoked a re-storying of water. Where children from across the city come to delight in clean and safe water, their laughs reverberating off the buildings. Green pockets of relief providing shade in Buitengracht Street, a place for families to dwell, a place to stop and think. Thoughtful actions to govern life. An attitude of stewardship.

A City Bowl that recognises that water is far from being a passive background on which human ideas and desires are played out, but rather that water and urban nature plays an important role in the creation and evolution of the desires. A

City Bowl that re-invents water and nature in urban areas.

A City Bowl where people can reflect upon the bold decisions, the failures and trials, and tribulations that brought us here. Reflections that invoke pride at the forefront of runners that embarked on a path towards a new future. That responds to nature, and provides room for cities to be messy. For infrastructure to be living, breathing, recycling.

A City Bowl where careful considerate behaviour values the life giver. That has read the history books and says: no more. No more building of dams and pipes and tunnels to channel in water from afar. No more manipulation of waterways, no more thinking water is infinite.

A City Bowl that say yes. Yes to new, yes to bold, yes to change. Yes to children playing in fountains of recycled water, to green foliage lining streets, to safe public open spaces that knit together communities in the spirit of co-habitation. A City Bowl that says yes to a place for children to be children. Yes to appreciating the precious resource that flows through our bodies and cities, giving life.

Yes to a city that sees its first rivers, and knows that they are the lifeblood of human civilisation, that the water we drink is the same water that the dinosaurs had. Yes to a City Bowl that demonstrates an ethics of care, which is home to an alive civil society, environmental and social care groups.

Yes to a City Bowl that is creative, intelligent and positive in its vision for water. That embraces the flows, swirls, dances of water. The sounds: heavy rain pouring, gentle stream trickling, life sustaining. A vision that allows for a diversity of social and ecological visions, welcoming a plurality of values.

Yes to a City Bowl that creates a narrative with water, where everyone's story is different.

Water is so influential in lives.

As you read this chapter, I invite you to reflect; what is your water story?

4.3 Introduction

The findings in Chapter 3 indicate that within the context of the City Bowl there is need for a concerted effort by urban planners to draw on their strengths and tools and enable a transition to SUDS particularly in light of the current drought. It is with increasing urgency that a new approach to the urban hydrological cycle is necessary. Addressing this will require different stakeholders to realise that all aspects of the cycle are valuable and should be designed into the City Bowl landscape and infrastructure.

To begin with, the chapter will reconnect briefly on the role of Spatial Planning in Green Infrastructure transitions. This guides the following proposals, from theory to context, to intervention and action.

The spatial concept is introduced and used to provide an understanding of which sites were chosen for intervention. A reminder of the SUDS treatment train aims to guide the reader to imagining the intervention type.

The proposed spatial and policy interventions for the City Bowl are then proposed. These are drawn from mapping the fundamental elements and systems that make up the urban landscape of the City Bowl in Chapter 3 (Figures 29, 39, 45, 46, 47). These layers helped formulate several key ideas that inform both the spatial and policy proposals.

Combined, these interventions are imagined as being part of the first step taken towards achieving a Water Sensitive City (as per the Department of Water and Sanitation vision).

Further recommendations are outlined before the conclusion.

The key ideas conveyed through both realms is that of reconnection to water, the restoration of water quality, the rehabilitation of green networks, and the reverence and celebration of water through a ‘re-storying’. They are part of a bigger idea; this chapter will articulate and focus on the planning dimensions.

4.4 Spatial Planning and Green Infrastructure

As explored in the Literature Review, Spatial planning can play a key role in the building of urban resilience by creating an environment for innovative interventions. The suggested strategies in Figure 69 are ‘increasingly being used locally and globally as a basis for_basis for planning and design of cities’ (Cilliers & Cilliers, 2016).

Green Infrastructure includes 'all natural, semi-natural and artificial ecological systems within, around and between urban areas and at all spatial scales' (Sandström, 2002, Tzoulas et al., 2007). Such an infrastructure network can provide similar services and functions as traditional 'hard' (grey) infrastructure (Schäffler et al., 2013:3; Boyle et al., 2012:5) and increase the resilience of the ecosystems and people of the City Bowl.

As discussed in Chapter 3, Cape Town's urban landscape is rich in biodiversity and is characterised by a cultural diversity that contain sharp socio-economic differences (Cilliers et al., 2014). Therefore in navigating the transition to the implementation of SUDS in the City Bowl, planners cannot ignore the apartheid legacy of a divided economic structure that is perpetuated by a spatial disconnect of people from jobs. That the City Bowl is used by a diverse group of people was important, as the intention of implementing SUDS in the area was to demonstrate how important ecological systems are to human health and quality of life, regardless of social or economic circumstance.

Strategy	Definition	Example
Multi-functionality	Spaces are planned and developed to provide multiple ecosystem services (combining functions).	• Combining functions: football field has mainly a recreational function but also have regulating functions such as stormwater infiltration and softening the urban heat island effect. • Stacking: Vertical integration of functions, e.g. crossings for wildlife over or under roads; green roofs on office buildings; and water infiltration systems underneath parking lots. • Time-shifting: Restrict recreational use of habitat during breeding seasons of frogs, birds, other animals; less use of hydrological systems during high flow periods, or by closing certain roads at night for nocturnal animals.
Redundancy and modularisation	Redundancy refers to alternative sources that is needed for aspects such as human resources, water resources, energy supply, waste disposal and transport options, by municipalities. Urban green infrastructure is decentralized and not concentrated. It is spread over time, location and systems and therefore tends to be relatively resilient to disturbances.	• Water provision and purification, critical services provided by grey infrastructure, can be assisted by green areas in the catchment such as wetlands, riparian areas, urban forests and urban grasslands.
Diversity: biodiversity and social diversity	Diversity implies variety, with different components performing different functions, or performing the same functions differently. The higher the functional diversity (the more species fulfilling the same function), the greater the chance that these species will react differently to disturbance (response diversity). Some will not survive but others will, continuing to play their part in the ecosystem and in resilience.	• Features of urban bio-physical systems such as permeable pavements, vegetated bioswales, raingardens, green roofs and tree canopy intercepting rainfall add to the response diversity of the urban stormwater system. May reduce the amount of grey infrastructure needed for drainage and its related management costs and enhances resilience capacity.
Multi-scale networks and connectivity	The urban landscape should consist of interconnected systems, with built systems often being better connected than natural systems. Each component contributes to the functionality of the system. Urban green spaces are often fragmented which negatively impacted upon species dispersal and movement.	• Connectivity in a city should focus on blue-green networks that support biodiversity, hydrological processes, pedestrian transportation, climatic modification, neighbourhood identity and aesthetic enhancements.
Adaptive planning and design	Decision-making relating to planning and design takes place based on imperfect knowledge but with the notion to "learn by doing" through experimentation and with the realisation that the experiment may fail (the "safe to fail concept").	• Transdisciplinary adaptive design and planning framework (among relevant stakeholders)- to achieve the goal of innovation in planning and design and thus improve multiple ecosystem services. This should include experimental design guidelines, monitoring and assessment protocols and strategies to achieve specific ecosystem services. Climate adaptation has been the focus in several cities. Durban is one of the first developing country cities with adaptation plans. Adaptation plans will vary between cities, but planners should look for standardized indicators and metrics that are understandable, transferable, robust and defensible.

Figure 69: Translating urban resilience concepts into practice (Cilliers & Cilliers, 2016)

The City of Cape Town has a key role to play in this, as local governments become primarily responsible for municipal planning.

The recent Spatial Planning and Land Use Management Act 16 of 2013 (SPLUMA) states that "sustainable development of land requires the integration of social, economic and environmental considerations in both forward planning and ongoing land use management to ensure that development of land serves present and future generations".

Planning at a local scale is recognised increasingly as a 'strategic way for the conservation sector to influence land transformation' (Wilhelm-Rechmann & Cowling, 2013: 2). This is founded on the reference to "the principle of spatial sustainability" and "spatial resilience" in Section 7 of SPLUMA. There are however, challenges when dealing with green infrastructure planning and provision.

The perception of "green" Spatial inequality greatly influences the perceived importance of and need for "green" infrastructure (Watson & Agbola, 2013). Whilst the need to provide water for the residents of the city is growing daily, there has thus far been no explicit reference to GI as a way of approaching the drought by the City), with a strong focus on desalination plants. 'While the linkages between human well-being and environmental preservation are known, socio-economic pressures often take precedence' (Cilliers & CIlliers, 2016).

That the governance and management of urban areas should include 'resilience – thinking' is no 'new phenomenon' (Schäffler and Swilling 2013); nor is the importance of participatory planning approaches in contemporary democratic contexts (Aylett, 2010; Pfeffer et al., 2013; Winkler, 2011; Connelly, 2010). Planning embodies crucial tools to the implementation of successful green infrastructure planning, as it creates a

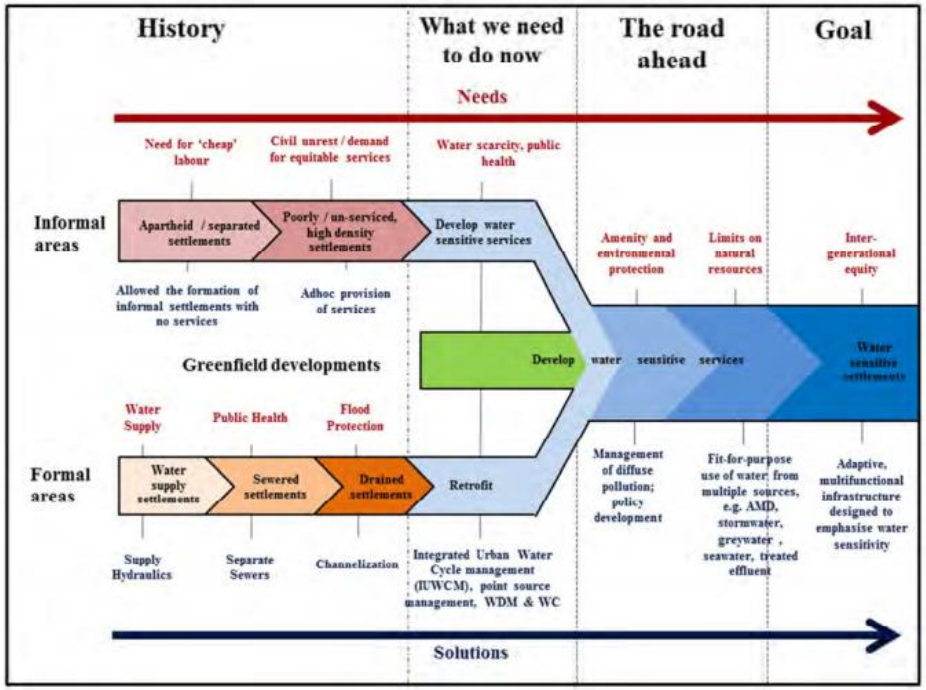


Figure 70: 'Two Histories, one future': illustrates how SUDS and WSUD can help Cape Town and the City Bowl transition to SUDS and a Water Sensitive City in the local context (Armitage et al., 2014).

platform for implementing policies, objectives and visions. Cities that integrate the environment in spatial planning are more liveable and, equitable (Luttik, 2000; Defrancesco et al., 2006; Van den Berg et al., 2007; Cities Alliance, 2007). Implementing SUDS in the City Bowl can help to these qualities for the users of the space.

4.5 Consequences of Not Having Water

These consequences are so dire, with the possibility of schools having to send children home, the tourist industry collapsing, hospitals having to send patients away and high-rise buildings unable to ensure fire safety. Without water there is no economic nor social health (Parsons, 2017).

4.6 Spatial Concept

Beginning by looking at the larger Central City from a hydrological perspective, Figure 71 and 72, illustrates the existing streams and open water bodies. The key landmarks and existing built environment features are marked in Figure 62 in Chapter 3. These maps were used to create the journey to a Reimagined City Bowl.

Figure 71: Conceptualising the blue and green networks of the City Bowl (Data source CoCT, 2009; Base Map ArcGIS 2017)

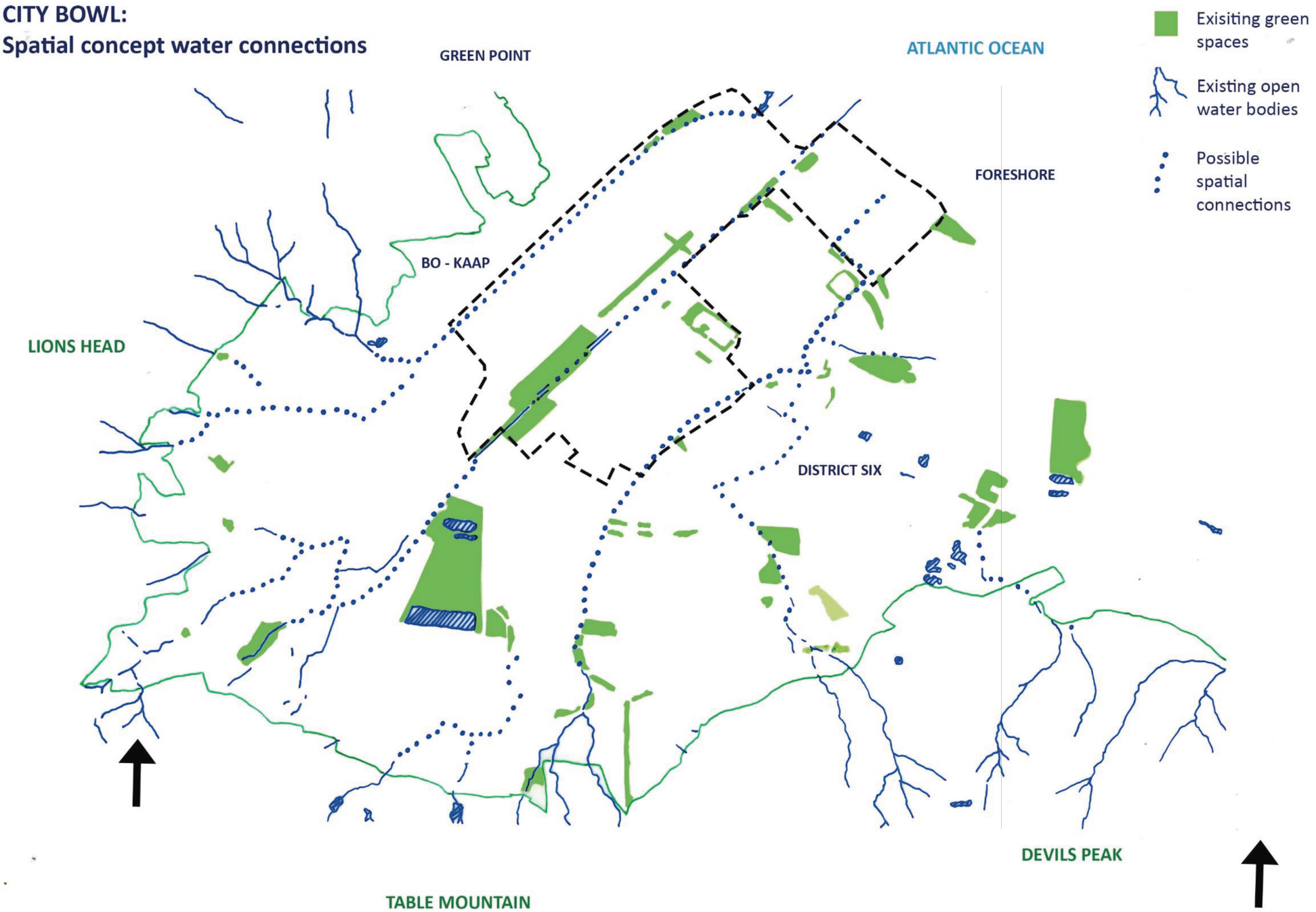


Figure 72: City Bowl spatial water connections

Within the City Bowl, using the structuring spines of Buitengracht, Adderley and Buitenkant was a clear starting point as the three streets have strong historical ties to water. These form the landscape framework for intervention (Figure 72).

Building from the idea that SUDS need to be show cased more, their intervention would need to take place in well-used parts, public open spaces within the City Bowl.

Understanding the network of public open spaces or green spaces on the underground streams which run through the City Bowl, combined with road verges (there is often open spaces next to them) offered the potential space to re-charge or detain water (Klitzner, 2017). This was the primary informant for the concept of SUDS along Buitengracht Street. Buitengracht Street is currently a car transport artery, and the premise of SUDS here is based on the concept of using large road verges to recycle and clean stormwater.

Riebeeck Square connects Buitengracht to Longmarket Street, Long Street, both important pedestrian roads.

The most significant green space in the City Bowl is undoubtedly the Company Gardens. The experience of the Gardens, and the diversity of its users translated it to a core spine in the concept of a Water Journey. By focusing on an existing green landscape, SUDS interventions here could work with the water features and the strong historical links to harness a new energy and story for the future (Figure 65).

Buitenkant Street is an important linking to the East City (Figure 36), with the need to recognise and integrate the vision of re-connection to areas of haunted pain. Focusing on streets like Canterbury, where water used to flow (see Chapter 3) would be key to SUD interventions in terms of keeping with the site's characteristics.

Building on from these small-scale spatial SUDS interventions, the idea of a Water Journey to connect the interventions was considered as a powerful way to knit a new story. Routes that connected people to the City Bowls' rich ecological, cultural and historical stories could create a multi-level experience for people of all ages and backgrounds. They message throughout the journey would be that SUDS can and do make a difference to both the built environment form and function, and to people's lives.

The Water Journey is a physical representation of the metaphor of re-connection and re-imagining, helping and supporting people to more actively engage and connect with natural systems. Figure 73 below illustrates the

routes and patterns of movement conceptually:

BLUE SPINES

The three spines of Buitengracht, Adderley and Buitenkant (illustrated by long wide blue arrows) highlight the paths that water and people could use through the City Bowl as part of the journey. The smaller arrows represent the interlinking roads and routes.

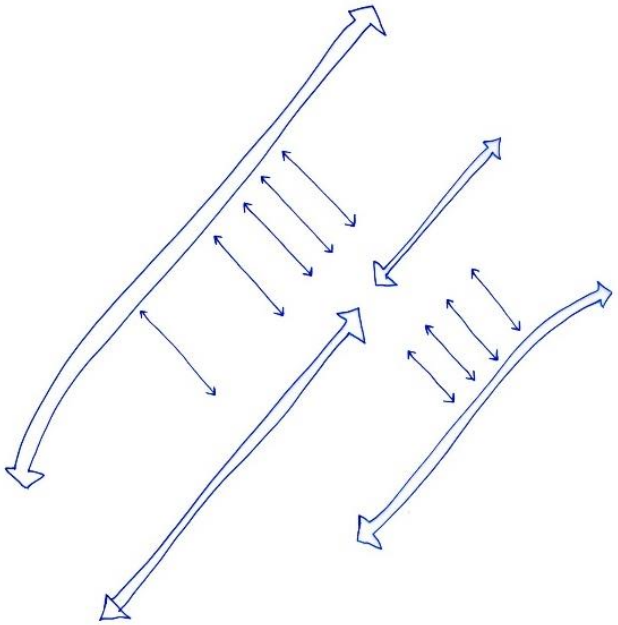
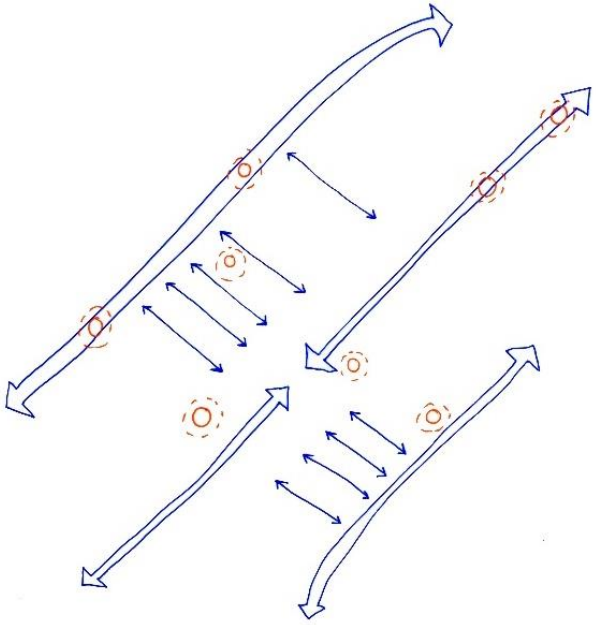


Figure 73: Conceptualising blue spines

BLUE SPINES and SUDS

Buitengracht is currently typified by parking lots and cars (Figure 63). SUDS interventions would be suited to the road reserve (Figure 64), which provides potentially enough space to transform the existing paved area underneath the shady trees, to a Bioretention basin or bioswales.



Adderley (Figure 67) connects to the famous green space of the Company Gardens, and SUD interventions could range from bioretention basins along the road reserve, to rain gardens in the traffic circles and retention ponds in the Company Gardens.

Buitenkant (Figure 67) offers the opportunity to bring small- scale SUD interventions into the eastern side of the City Bowl.

WATER JOURNEY

The Blue dots represent the connecting streets between the SUD intervention spines in the City Bowl.

WATER JOURNEY AND ACTIVITY NODES

Following these streets, pockets of existing activities were highlighted in green. These are museums such as the Iziko Slave Lodge and District 6, St George's Mall and the Company Gardens (see Figure 62).

Building on the existing fabric of the City Bowl helps to create an understanding as to how the experience of the water journey may be enhanced by, or adapted to, create great public spaces.

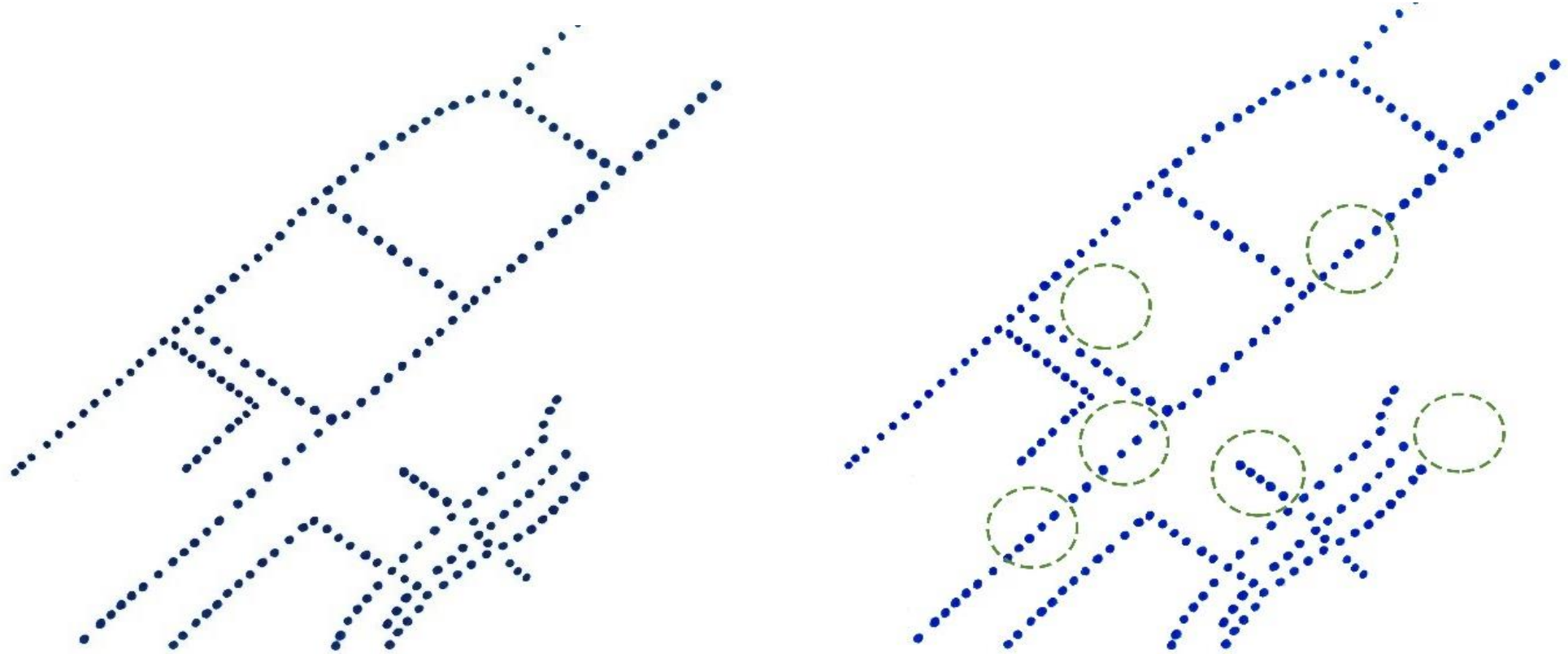


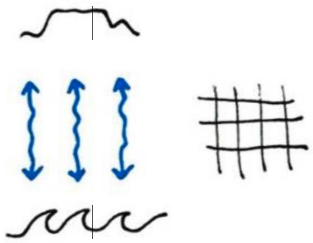
Figure 74: Blue routes and activity nodes (Author, 2017)

BLUE ROUTES

1. Reconnecting water cycle → source to sea
2. Reconnecting people to water → celebrating it through public spaces
3. Re-using and valuing all aspects of water

STREETS

BUITENGRACHT
ADDERLEY
BUITENKANT
CANTBURY



SQUARES

RIEBEECK
CHURCH
HARRINGTON

↓

COMPANY GARDENS

ART

TEMPORARY INSTALLATIONS
GRAFFITI
INTERACTIVE

↓

BENCHES
PLAYGROUNDS

* PERSONALISATION OF SPACE

↓

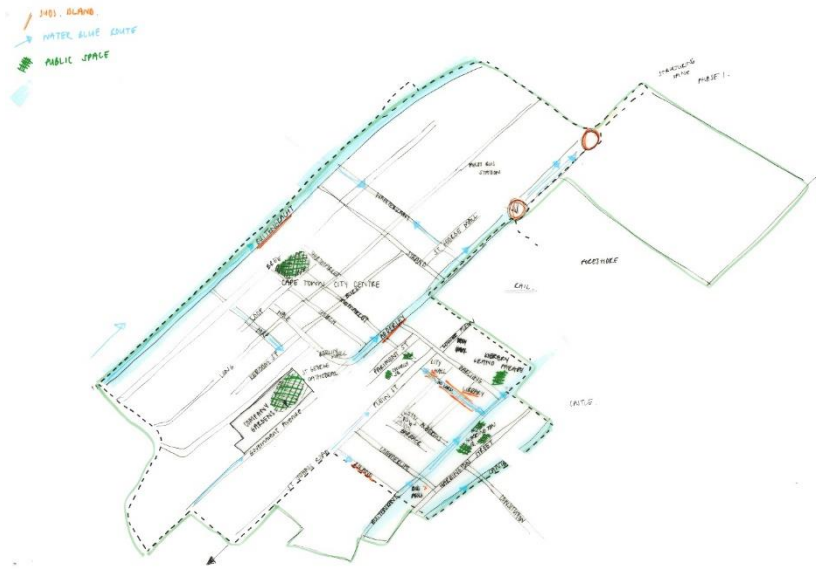
MULTI-FUNCTIONAL | ROBUST | VISUAL | APPROPRIAT

Considering the location of the streets to the public spaces and creativity networks fed into the key ideas behind the creation of a Water Journey.

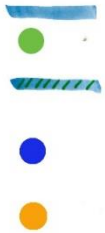
Out of the key aspects, the core aims of the spatial concept were established:

- To return visible water paths to the City Bowl, teaching people about the history of water in the City, and about present and future challenges to water supplies
- To use existing heritage sites to invite people to form, shape and create their own narrative and story towards water, sharing memories, visions, experiences
- To create spaces that connect the blue and green network in the urban landscape of the City Bowl
- To use different components of SUDS in order to create a treatment train
- To celebrate water together

The following sections provides a more in-depth look at the Water Journey routes and specific SUD interventions.



Rough working: maps of the site, considering how to incorporating the spine structures of Buitengracht, Adderley and Buitenkant streets with SUDS.

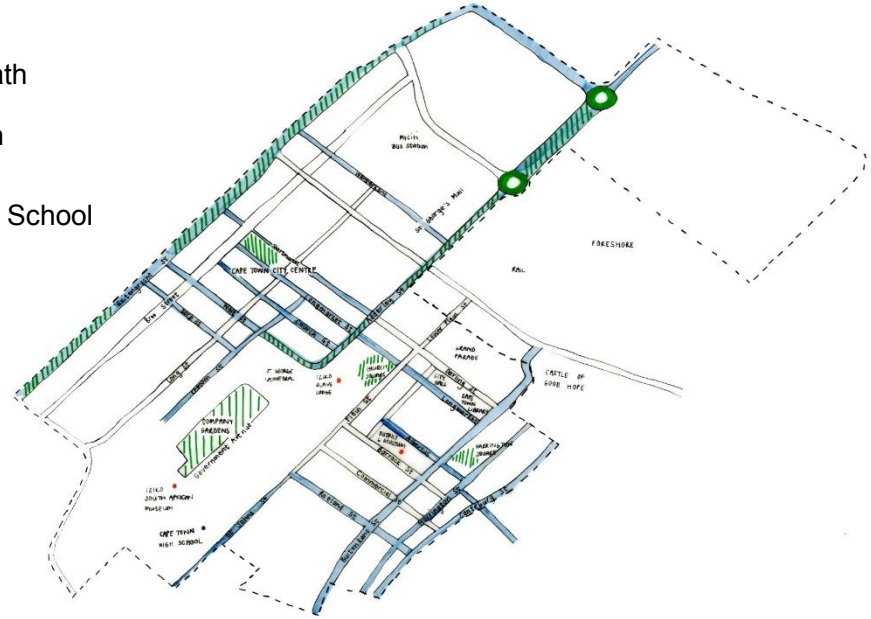


Water journey path

SUD Intervention

Cape Town High School

Museum



4.7 Spatial Interventions

Stormwater is a natural asset, and should be regarded as an essential part of the recharge of the water supplies of a city (Haskins, 2012 in Armitage et al. 2014). The aim and intent of SUDS in urban areas comes down to slowing water down (quantity), improving its quality, and bringing amenity value to the area.

By focusing on the concept of place making, and using it as a part of the tool of spatial planning, there is opportunity to consider the important role that inviting public spaces can have. These should be at the heart of every community, in every city (Goosen, 2015). Ownership of these spaces from the public should be encouraged, inspiring them to create and improve, as well as look after these spaces. This would help strengthen the connection between them and the space itself (Goosen, 2015). Integrating the implementation of SUDS with the notion of creating positive public space for users of the City Bowl in Cape Town would help create an inspiring area, where water is made visible, that improves the livelihoods of all that use or travel through it. These spaces should be enjoyable, safe spaces, which celebrate water as a resource, and provide education about SUDS and the interconnected systems at work. The place-making concept combines an attitude that works towards enhancing attractiveness and improving sustainability (Goosen, 2015).

4.7.1Water Journey

To embrace and achieve a radically different vision of the City Bowl in 40 years time, the concept of a embarking on a collective journey resonated with me as a way to describe the necessary transitions, both metaphorically and physically. Water naturally shapes and carves out landscapes; re-integrating it into the City Bowl would shape people's lives, contributing to a shared narrative that combines and balances collective and individual value systems.

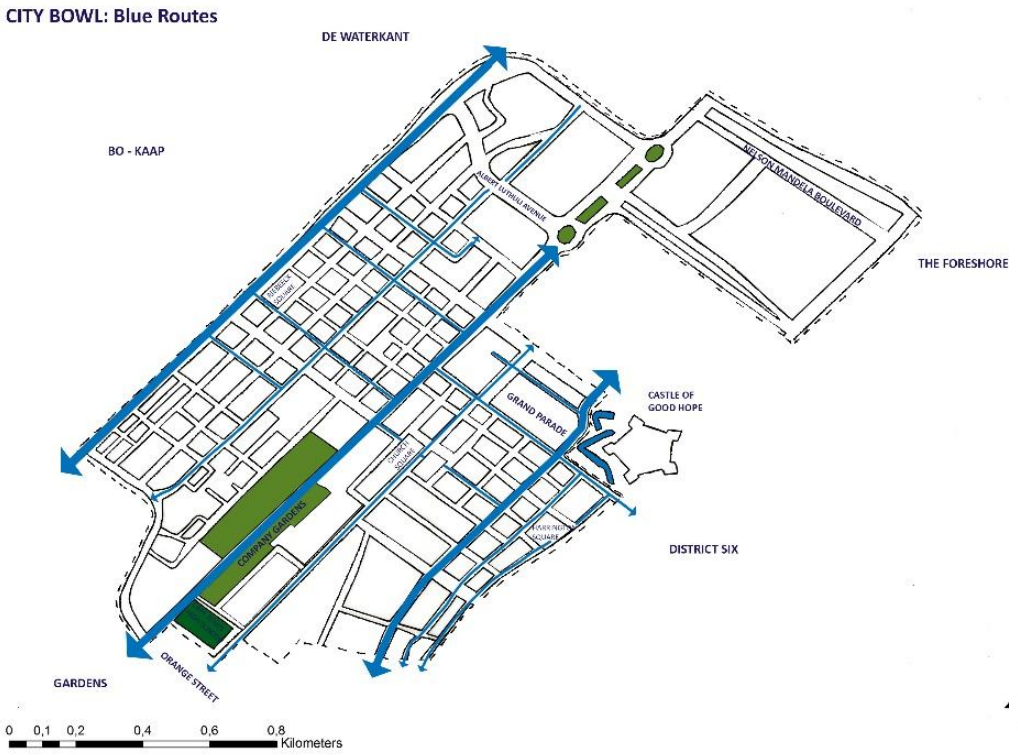
The Journey is an opportunity to consider infrastructure as a living thing, a messy thing, and embrace this. Water connects across places, people, sectors, as well as geographic scales. The journey brings this connection into focus. People like to 'walk, move, and circulate through a space' (Kemp, 2008); wayfinding material

and structural elements should be used to ‘create broad frameworks that encourage movement and interaction’ (Kemp, 2008).

4.7.2 The route

The route is both permeable and legible (building on information from maps in Figure 37, 68, 75, 76 and 77). It draws on existing landmarks to guide the user. The route encourages learning together (about water, how to save it, how we are connected inherently to it), working together (to create beautiful spaces and strong communities), and playing together (celebrating water and ecological systems).

The journey through the City Bowl would focus on the structuring spines of Buitengracht, Adderley, and Buitenkant streets. Historical records indicate that water followed along both Buitengracht and Adderley (and Heerengracht) streets; the journey builds on this and introduces SUDS interventions at various points along them. These interventions would



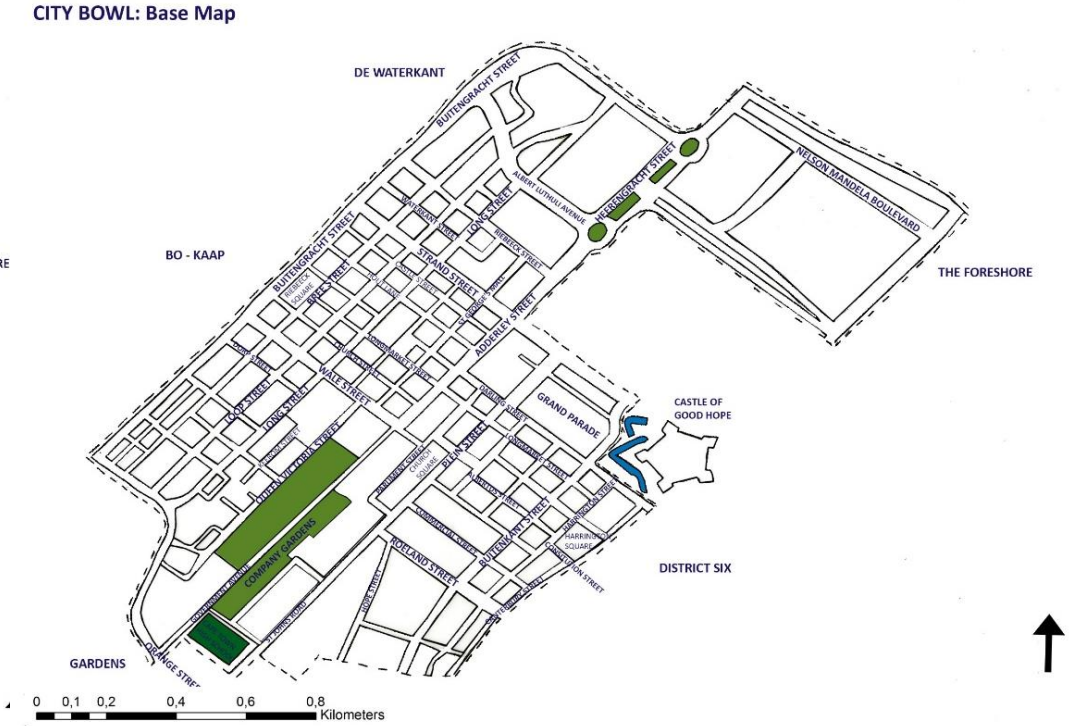


Figure 75: City Bowl Base and Blue Routes

take the form of a number of SUDS components, from bioretention basins, to bioswales and retention ponds; this would help ensure that the SUDS treatment train (Figure 77 and 78) (as examined in the Literature Review) is utilised.

The intervention of SUDS brings the green element to the hard, urban space of the City Bowl, where the focus has often been on providing space for cars, with people coming second and natural systems an afterthought. Sites of SUDS interventions should be signposted and marked out to draw attention to them. Educational boards in the public squares should be displayed with information about SUDS, and the benefits they bring – both evident and unseen, to everyone's lives, and the Earth.

Using the lines established in Figure 73, the Journey is conceptualised in Figure 76. Journeying down Buitengracht and the transformed road reserves would bring people to Riebeeck Square: currently a car park, this could be transformed into a soft public space (figure). From Buitengracht Street, the route connects through Waterkant Street, Dorp street (where water from the spring which runs underneath should too be brought to the surface), and Shortmarket street, traversing the dynamic Long Street and continuing the second spine of Adderley and the Company Gardens.

From here the green of the Gardens allures, a welcome strip of trees and gardens; using the existing structures, SUDS could intervene to ensure that water within this site is stored and re-used where applicable.

The Gardens link to cultural and historical layers in the City Bowl, with the nearby St George's Cathedral and the Slave Lodge offering a different place to be reflective and appreciate Cape Town's past. When moving out of the Company Gardens towards the Atlantic, Church Square presents another site for intervention (see Figure 85). The journey then continues along Adderley, with the popular St George's mall as an activity hub to the left, and the transformed road verge a place to appreciate the interjection of green into grey infrastructure.

Longmarket Street connects to the third spine, Buitenkant Street. As seen in Figure 68, Harrington Square and the surrounds are particularly hard, with sporadic inserts of green. Figure 90 illustrates how Harrington Square could be transformed with SUDS. SUDS could connect to the streams that flow underneath Canterbury Street (which used to flow from Devil's Peak, through the area and into the Castle of Good Hope moa)t. This could connect the water journey to the Castle, and then to the Ocean.

The District Six Museum acts as a strong pull for this area, offering poignant stories of inspiring people, and reflections on the dark past of South Africa.

This, in conjunction with the Cape Town Library, the Grand Parade, and of course, the Castle, bring a powerful presence of Cape Town's early and recent history, to the water journey.

Displaying, celebrating, journeying with the water in the City Bowl provides the opportunity to realise how SUDS interventions bring health back to the area's water, and creates a meaningful addition to the public realm. Restoring the water, reflecting on it, and learning about it creates a strong response and pushback against the current grey infrastructure and harshness, which dominates the City Bowl. The journey offers a multi-layered experience, encompassing commemoration, education, playfulness and developing social resilience.

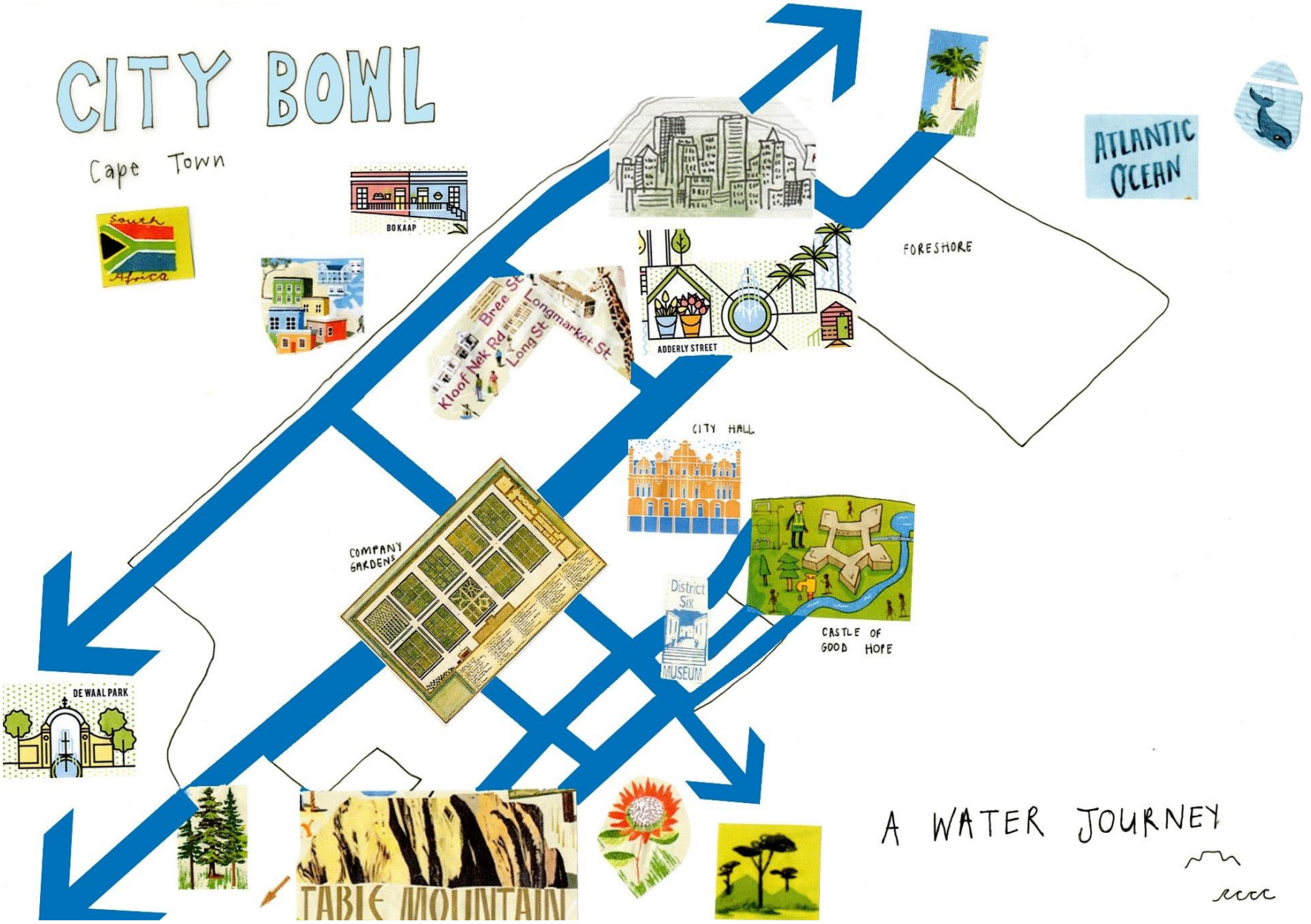


Figure 76: Visualising some of the historical and cultural links in the City Bowl in conjunction with the water routes

SUDS TREATMENT TRAIN

As introduced in the Literature Review, SUDS work best if they are part of a treatment train. The different components chosen for the proposed intervention were considered according to each site's characteristics, and with the aim of using spatial planning to ensure that the complete train is used in the City Bowl.

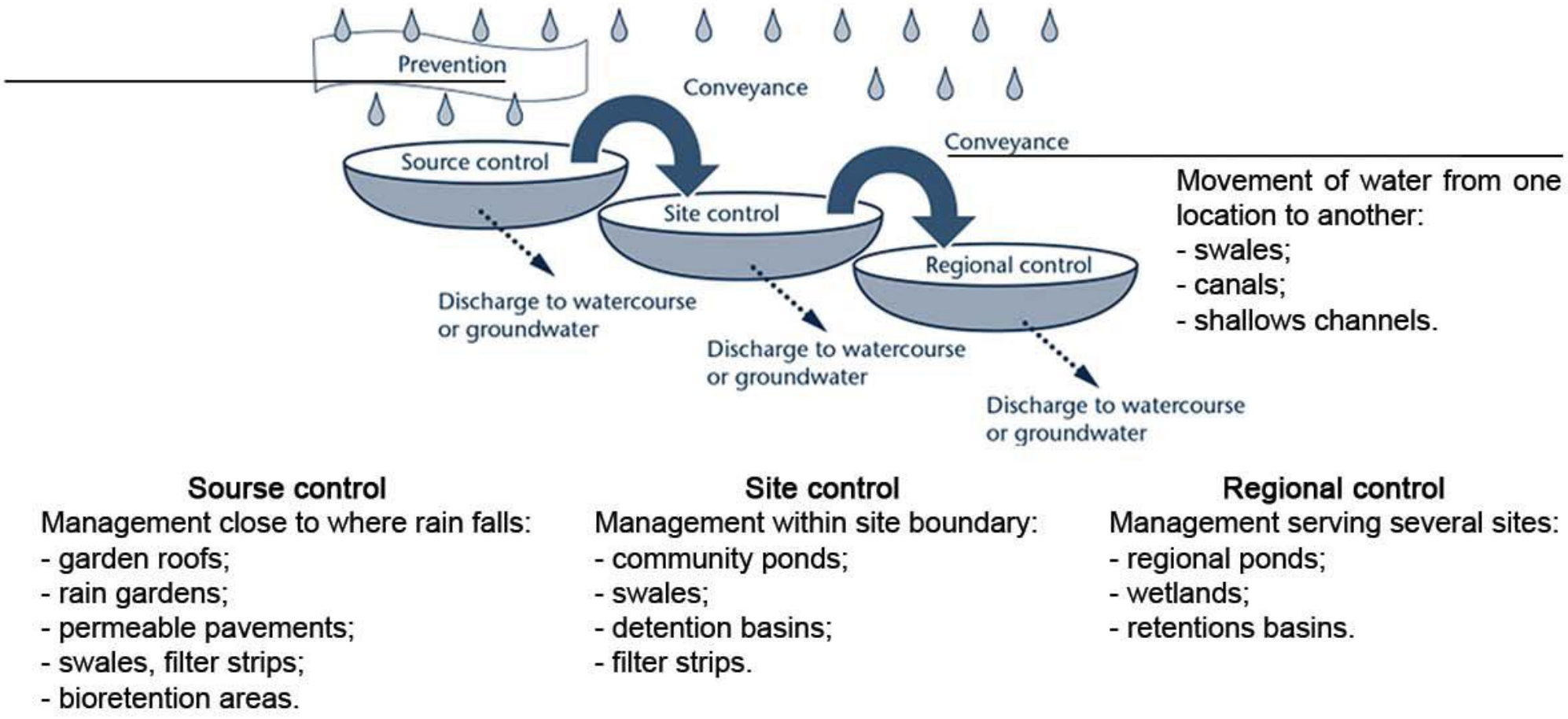


Figure 77: SUDS Treatment train: functions of the components (Future Glasgow, Re-Clyde)

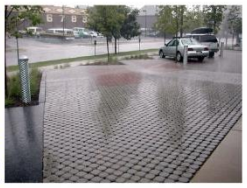
SUDS TREATMENT TRAIN

SOURCE CONTROL

Green Roofs

1. Green roofs may be established on both existing and new buildings
2. Help to reduce UHI
3. Green roofs can significantly improve amenity and biodiversity where they are implemented
4. Increase visual and physical access to green spaces

Permeable Paving



1. Reduce stormwater discharges rates and volumes from impervious areas. Ideal in urban areas
2. Stormwater runoff stored in permeable pavements can be used to recharge the groundwater table and for several domestic purposes

Soakaways

1. Handle relatively high volumes of groundwater recharge. Decrease both the runoff volume and rate
2. Effective in removing stormwater runoff pollutants

LOCAL CONTROL

Bioretention Areas

1. Effective removal of most stormwater runoff pollutants.
2. Flexible application characteristics so are easily incorporated into a wide variety of landscapes
3. Aesthetically pleasing

Swales

1. Normally less expensive and more aesthetically pleasing then kerbs and their associated concrete- and stone-lined channels;
2. Reduce stormwater runoff volumes and delay runoff peak flows
3. Impractical on steep topography areas

Infiltration Trenches

1. Infiltration trenches increase stormwater infiltration and corresponding groundwater recharge help reduce flooding
2. Suitable to urban areas due to narrow nature

REGIONAL CONTROL

Detention ponds

1. Temporarily store large volumes of stormwater
2. Relatively inexpensive to construct and easy to maintain
3. Multifunctional: during drier seasons, used for sports fields, play parks or commons

Wetlands

1. Efficient removal of pollutants compared to regional controls of equal volume;
2. When incorporated into the urban landscape has the potential to add aesthetic value provided there is an appropriate level of maintenance

Retention ponds

1. Amenity and biodiversity benefits; can be used for recreational purposes
2. One of the most cost-effective SUDS options with high community acceptability
3. Stormwater runoff that is captured can be reused for secondary domestic purposes and for various irrigation requirements.

Figure 78: SUDS Components

4.8 Spatial Interventions

Combining the Blue Routes identified in Chapter 3 with SUD interventions along the structuring spines allowed the formation of the map in Figure:

The following tables communicate the intervention in relation to the characteristics of the site and the proposed type of SUDS component (Figure 78). Relevant policies and objectives from existing the SDF 2012- 2017, which was analysed in Chapter 3 are included in support of the suggestions.

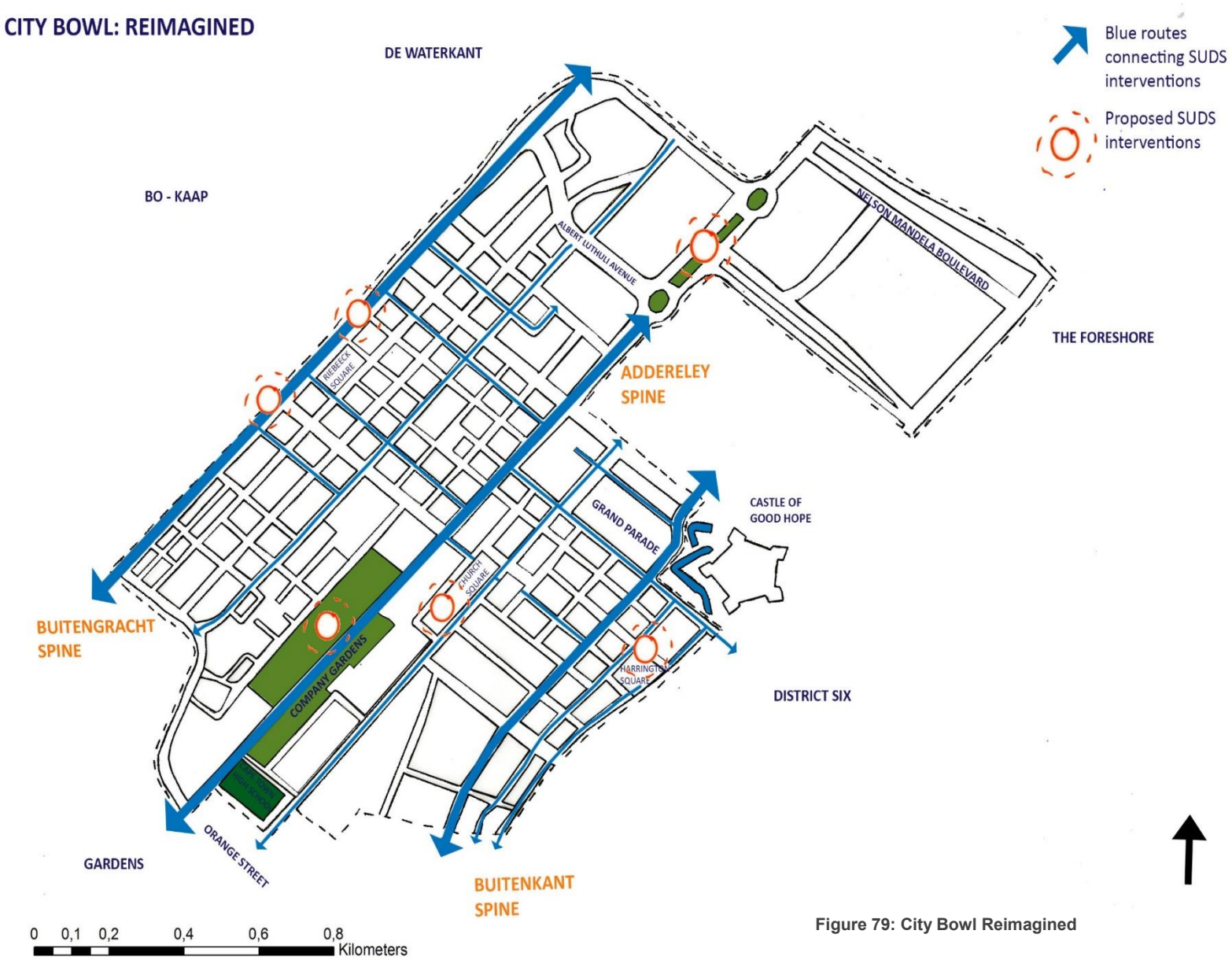


Figure 79: City Bowl Reimagined

4.8.1BUITENGRACHT SPINE

Figure 82 illustrates the spatial proposed interventions.

Location	SUDS Component	Intervention	Supporting Existing Spatial Policy for Intervention
Buitengracht Street	Bioretention Basins	Replace the impermeable paving underneath trees: beginning with the dropping of the curb on one side and keep it one the other, lettings the water run into the vegetated area, making it more porous. Growing local indigenous vegetation in the road verge can help strengthen green systems network, whilst feeling back into the blue network, and creating a beautiful space. In some areas, the vegetation could perhaps be harvested and the City Bowl could be part of a productive landscape. As well as transforming the landscape, SUD interventions along road verges would mean that there is no need for an additional irrigation system. The Bioretention basins filter pollutants from surface water runoff (Figure 81).	Cape Town SDF 2012 Policy 14: All parking areas and transport depots should comply with water sensitive urban design principles Policy 26.1: Reduce the impact of urban development on river systems, wetlands, aquifers, aquifer recharge areas and discharge areas. In addition the policy states that: Land use management decisions should take the following WSUD principles into account: • maintain the natural hydrological behaviours of catchments; • protect 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
Riebeeck Square	Swales Permeable paving	Re-imagining of the car park in Riebeeck Square as an attractive urban plaza, by using a combination of vegetated **swales** and **patterned permeable paving.** The current impermeable paved area can be changed to form the primary part of Green Infrastructure. Transforming the car park to a public square or park could provide a great open green space for residents, visitors, workers to interact with water, and one another (Figure 80).	Cape Town SDF 2012 Policy 14 (as above) Policy 26.1 (as above) Policy 30: Promote a culture of sustainable development and living. This is focused on encouraging the public and private sector to utilise sustainable practices and technologies that assist in reducing carbon emissions, reduce energy and water demand, promote public transport and supporting the recycling of water and waste materials. Policy 42: Promote good contextual urban design fit, and ordering of the relationship between people, urban space and the environment (built and natural).

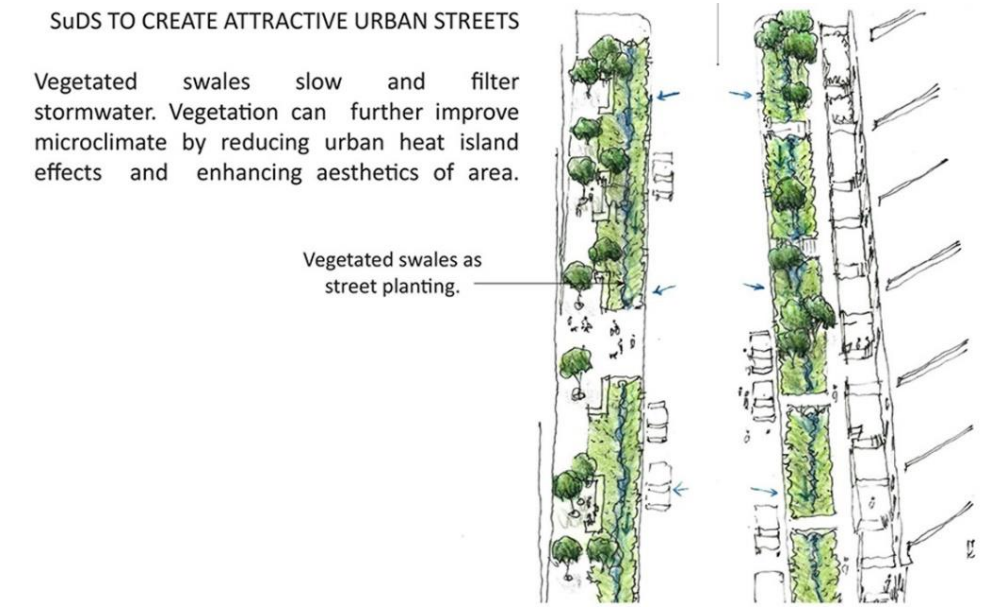


Figure 81: SUD designs illustrating how SUD interventions could look along Buitengracht Street (McLachlan, 2013)

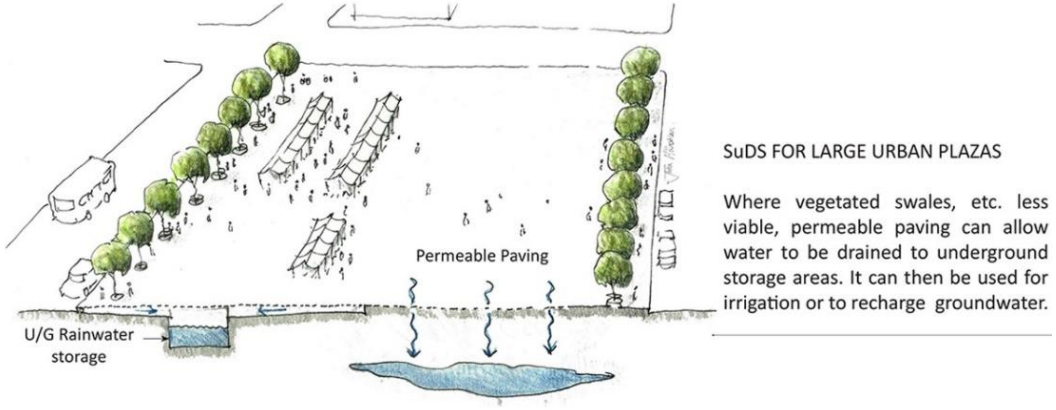


Figure 80: SUD designs illustrating how SUD interventions could look on Riebeeck Square (McLachlan 2013)

NEW YORK CITY, USA

New York City has created a Green Infrastructure Program, a multiagency effort led by the Department of Environmental Protection (DEP).They design, construct and maintain a variety of sustainable green infrastructure practices such as green roofs and rain gardens on City owned property such as streets, sidewalks, schools, and public housing. Green infrastructure promotes the natural movement of water by collecting and managing stormwater runoff from streets, sidewalks, parking lots and rooftops and directing it to engineered systems that typically feature soils, stones, and vegetation. In addition to the benefits to water quality, green infrastructure also beautifies City streets and neighbourhoods while improving air quality" (NYC Green Infrastructure Plan, 2012).

The simple and attractive bioswales on pavements and traffic islands can be seen in the images above.

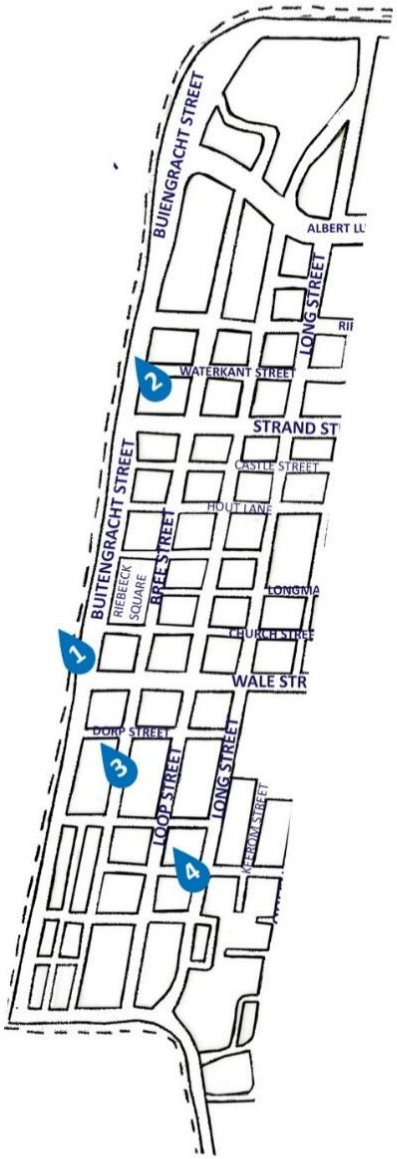
STRUCTURING SPINE: BUITENGRACHT

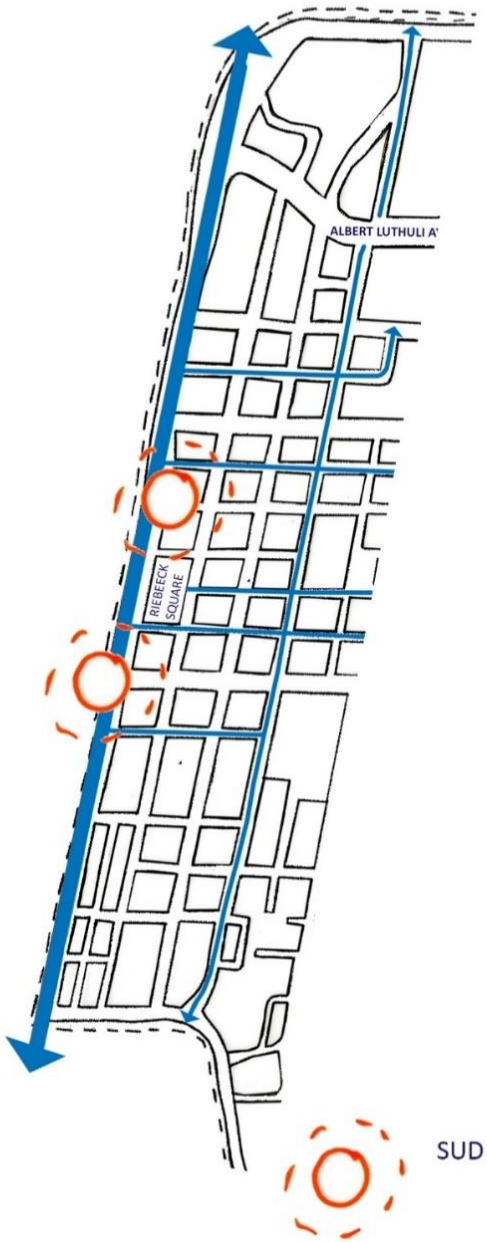
1 Buitengracht and Riebeeck Square

2 Waterkant Street

3 Dorp Street

4 Long Street





0 0,1 0,2 0,4 0,6 0,8 Kilometers

Figure 82: Buitengracht spine

4.8.2Additional Points of Interest

Long Street Baths

The personal stories of people learning to swim could become intertwined in the water journey, with the inclusion of the Long Street Baths and the public swimming pools there. The baths have always included a cross –section of city residents and are frequented by tourists, locals, children and pensioners alike (De Greef, 2015). In addition the Camissa waters are believed to run somewhere in the front of the building, providing a future opportunity to connect, and show case the water perhaps in front of the building 9figure 84).

Figure 84: Long Street Baths as seen from the road (De Greef, 2015)

Wagenaar Reservoir in the Golden Acre

The ruins of Cape Town's first reservoir (The Wagenaar –referred to in Chapter 3) can be seen just off Adderley Street. The reservoir drew its water supply from the Varsche River, and was built in 1663. The construction of the shopping mall, Golden Acre, in 1975 led to the discovery of the ruins of the reservoir (Figure 83).

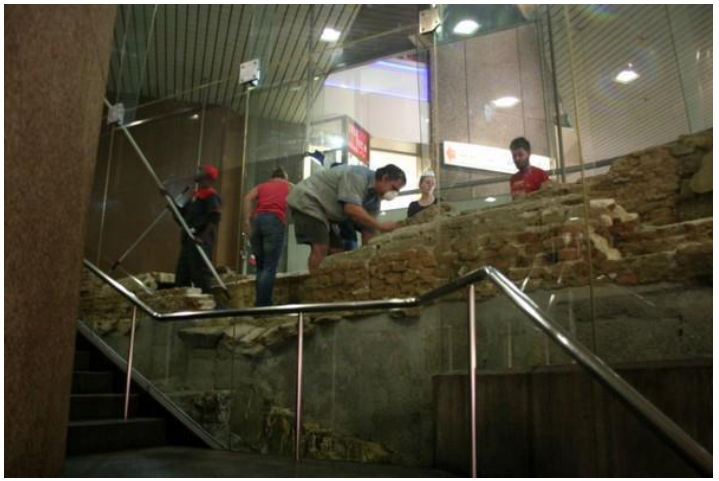


Figure 83: The archaeological find of the Reservoir can be seen behind glass from all levels of the mall (heritage.co.za)

4.8.3ADDERLEY SPINE

This spine is illustrated in Figure 86.

Location	SUDS Component	Intervention	Supporting Existing Spatial Policy for Intervention
Heerengracht Street	Bioretention Basin Filter Strip	To transform the existing space and vegetation in the road reserve with a **filter strip.** The spine of Adderley and the historic linkages to water flowing in canals along the road when European settlers first arrived could be re-visited here; bringing the water to the surface in the fountain, through the use of SUDS, could visually represent a strong blue vein flowing through the centre of the City Bowl. The road verges and traffic circles could house a bioretention basin, as the space is large enough to hold the infrastructure. Providing a soft landscape in place of the hard impermeable surface, which currently lines the ground around the trees, and the fountain. The fountain should be designed as part of the SUD intervention, using recycled stormwater in way that celebrates it.	Cape Town SDF 2012: Policy 42 (as in previous table)
Company Gardens	Soakaways Infiltration trenches	To re-story the Company Gardens by using **soakaways** and **infiltration** alongside the original water grachts. Planting **bioterntion basins** on the perimeters of the Company Gardens to catch surface water and clean it.	Cape Town SDF 2012 Policy 25: Increase efforts to protect and enhance biodiversity networks at all levels of government. The City will lead

		To restore a sense of celebration through a **retention pond** that provides amenity and biodiversity value to all who journey through the gardens. The link to Company Gardens would be emphasised with water used as a focal point of reverence within the Gardens (Figure 62 and 89). Strong historical linkages are evident here, with the close proximity of the Iziko Slave Lodge, and the South African Museum. Sydney Stormwater re-use park (precedence below) is an example of how a green public space can be configured to celebrate the natural hydrology and cycle of water too. The sports fields for Cape Town High School, adjacent to the Gardens, could be used as a detention pond, storing water when it does rain. This is perhaps necessary in the future, if large communal water collection sites are needed to distribute water to people. It is also an opportunity to link education, and learning sites to SUDS, and why they are an important intervention within the City Bowl. As monitoring of the effectiveness of SUDS continues, the quality of the water collected should improve, and hopefully be able to be usable in the surrounding buildings, as well as potentially as drinking water.	by example by protecting and enhancing its biodiversity networks. Policy 26: Reduce the impact of urban development on river systems, wetlands, aquifers, aquifer recharge areas and discharge areas Policy 43: Identify, conserve and manage heritage resources, including cultural landscapes

Church Square	Detention area Bioretention area	To create a pocket park in Church Square through the construction of a **detention area**, as well as vegetated **bioretention** vegetated area. The area could be transformed into a well-used public space, connecting the Company Gardens to the remainder of Adderley. Green spaces help to soften the 'architectural landscape' and 'provide natural gathering places and anchor points' (Kemp, 2008) (Figure 85).	Cape Town SDF 2012

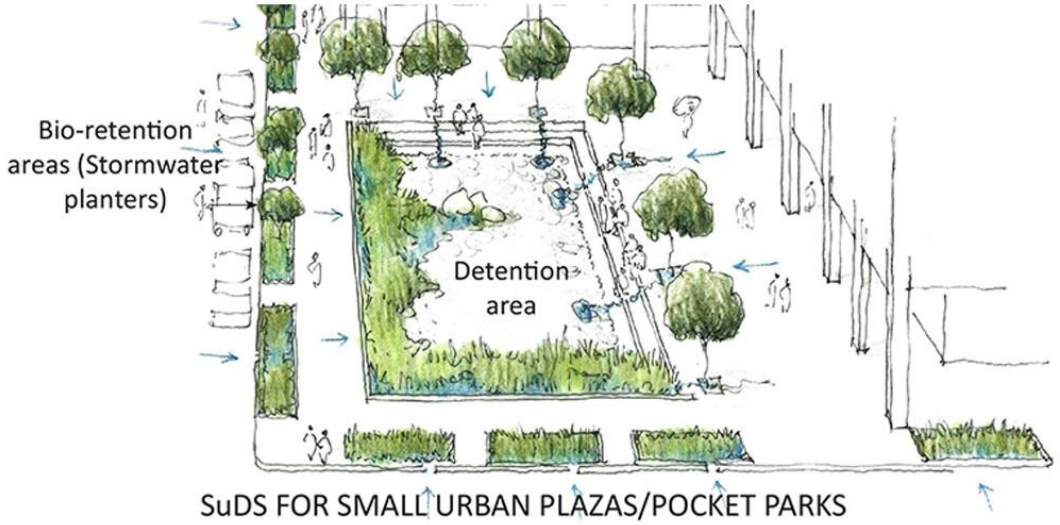


Figure 85: SUD designs illustrating how SUD interventions could look in Church Square (McLachlan, 2013)

Church Square is currently a space that lacks greenery. According to Dr Pippin Anderson (Molo, 2016), the square should ideally feature 'indigenous greenery; and also some soil, to soak up the rain'. The square 'offers no place for anything to take root, to sink into soil, to nest, to hide, to burrow' (Molo, 2016: 8).

The Square currently functions as a 'blank canvas for the various communities of Cape Town to insert their own narrative'. With SUDS interventions, this can be one that includes the original fresh water aspect of the Square: the water that was used in the Company Gardens would have been visible in the well currently found here (Dean Muruven, in Molo, 2016).

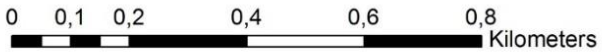
STRUCTURING SPINE: ADDERELEY STREET

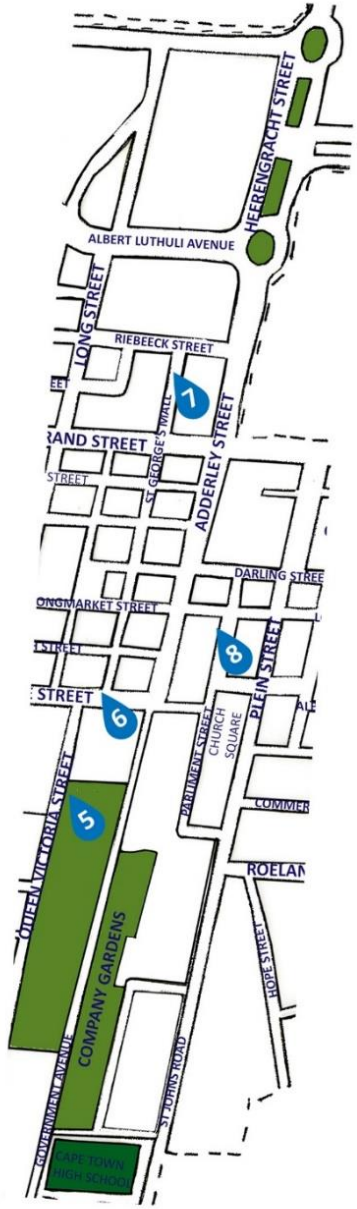
5 Company Gardens

6 National Library of South Africa
Izikio Planetarium
izikio South African Museum
Supreme Court

7 St George's Mall

8 Church Square





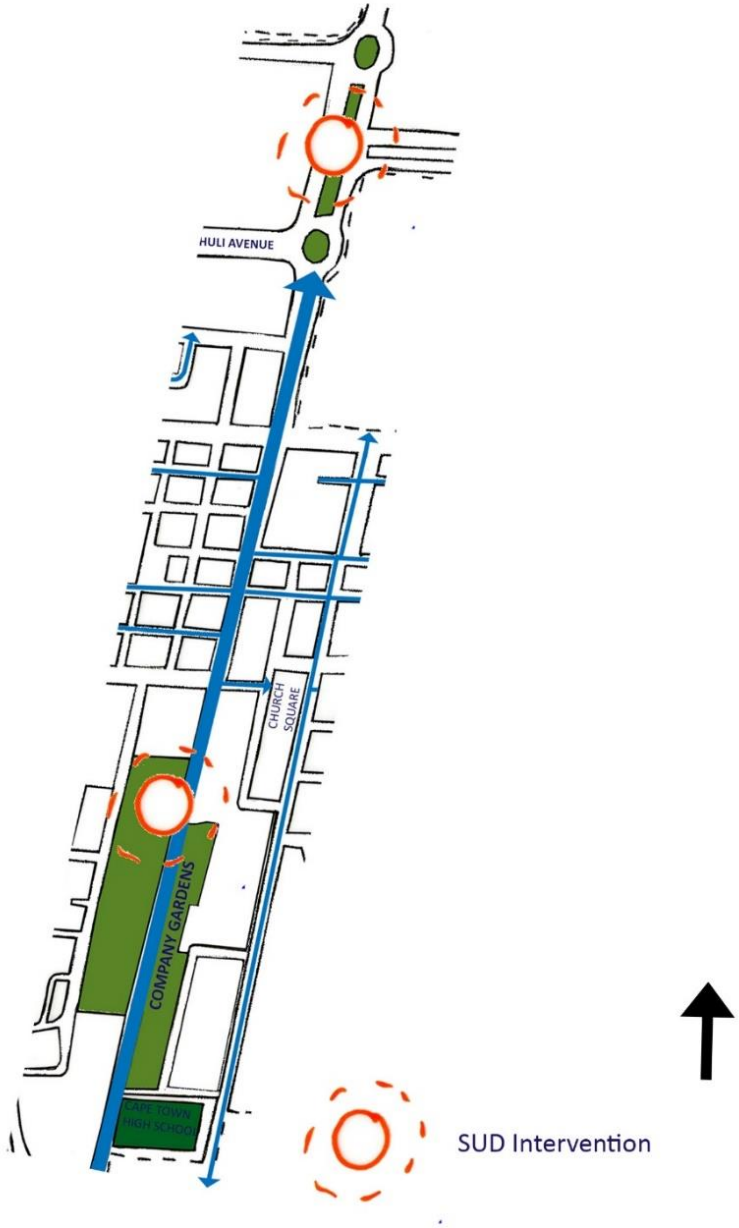


Figure 86: Adderley Spine

SYDNEY, AUSTRALIA – STORMWATER REUSE PARK

The core of the project was to share a story of water by demonstrating the processes which enable urban stormwater to be harvested, and made good for reuse within and beyond the Park (City of Sydney).

Making these processes **visible** was important as they highlight the **intrinsic relationship** between water and urban life, topography, people, plant life and fauna. The project is a seamless intersection of design, art and science; an outcome only achieved by the devoted collaboration between those involved (City of Sydney).

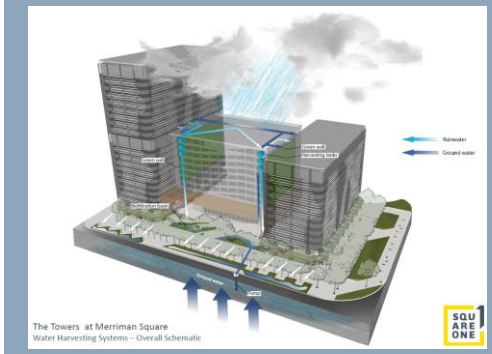
The project **reinvigorates** the view of the park's landscapes, by creating **intrigue** and **dialogue** as park users explore and discover 'moments' in the landscape, that can be at times **playful**, **dramatic** and **peaceful**, but at all times **connected** to the story of capture, movement, and cleansing. The installation of picnic areas, paths and recreational spaces are interwoven through the new park landscape; 'enhancing amenity and accessibility for all park users' (City of Sydney, 2016).

The park offers inner city residents and the wider community a new place to relax, play and gather in, as well as educating users on the importance of water management (City of Sydney, 2016).

Precedence of Sydney Stormwater re-use park, a possibility for the Company Gardens to incorporate stormwater water as the main design feature and structuring element for public space

Precedence Merriman Square Towers; an example of how the water from the Heerengracht **proposed** intervention can fit into **existing** water re-use features

CAPE TOWN CITY BOWL, SOUTH AFFRICA, MERRIMAN SQUAR



'The site was an opportunity to radically think about how we make space. The stormwater wasn't previously dealt in a meaningful way. Here, landscape is used as infrastructure, to create a social environment The successful aspects of the project were:

1. The project was able to capture all the stormwater from the top of the building and store this in rainwater tanks which was then used to irrigate giant green walls in between the two towers. This enabled a green view.
2. All the water that is not used for the green walls is piped down into relaxation chambers that reduce the force of the water and incorporate into biofiltration chambers.
3. Most buildings (used to) pump out ground water from basements (due to Foreshore location)– we were able to convince the client the harvest the ground water – instead of pumping this water out into the sea. This water is pumped up into the tanks and used for irrigation on the site, although some of it can also be used for flushing toilets in the building.

The project also connects from the civic centre to the city. We wanted to take it a step further and show that the entire boulevard could be used as an education space for how we could use water. The rainwater basins were not full permanently and so the client requested that a permanent water feature be installed but this caused problems as it was used for public washing. The space incorporates a lot of indigenous plant material that can cope with inundation as well as dry periods' (St Pol, 2017)

SUD designs in Figure 86 illustrate how the City Bowl could use SUD intervention's to both store and infiltrate water (Armitage 2017) through the form of retention and detention ponds. These could be incorporated into the Company Gardens and used for recreational purposes, whilst being considered part of living infrastructure that helps the City Bowl become more resilience (a fluctuating water table due to sea level rise could be mitigated by these ponds).

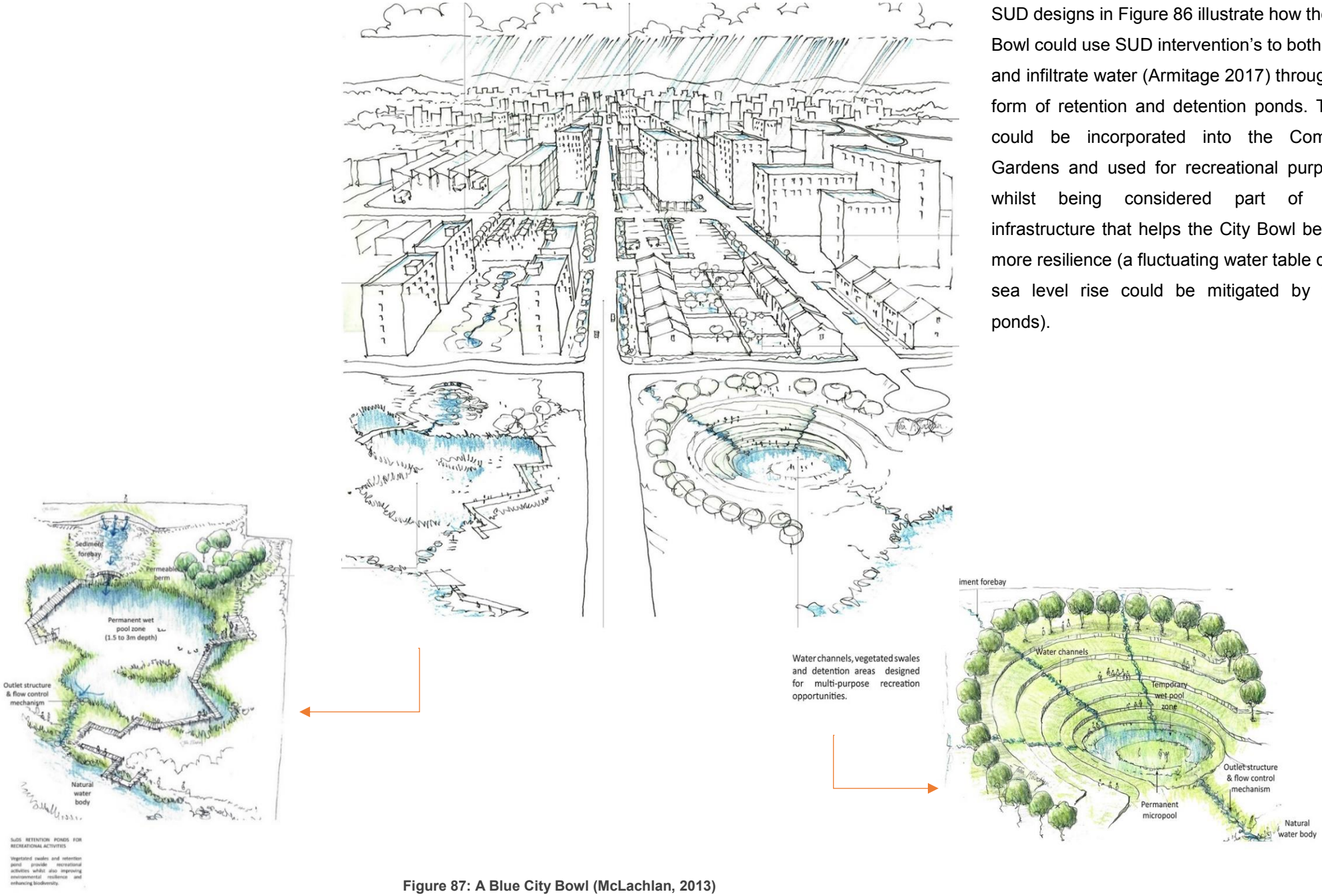
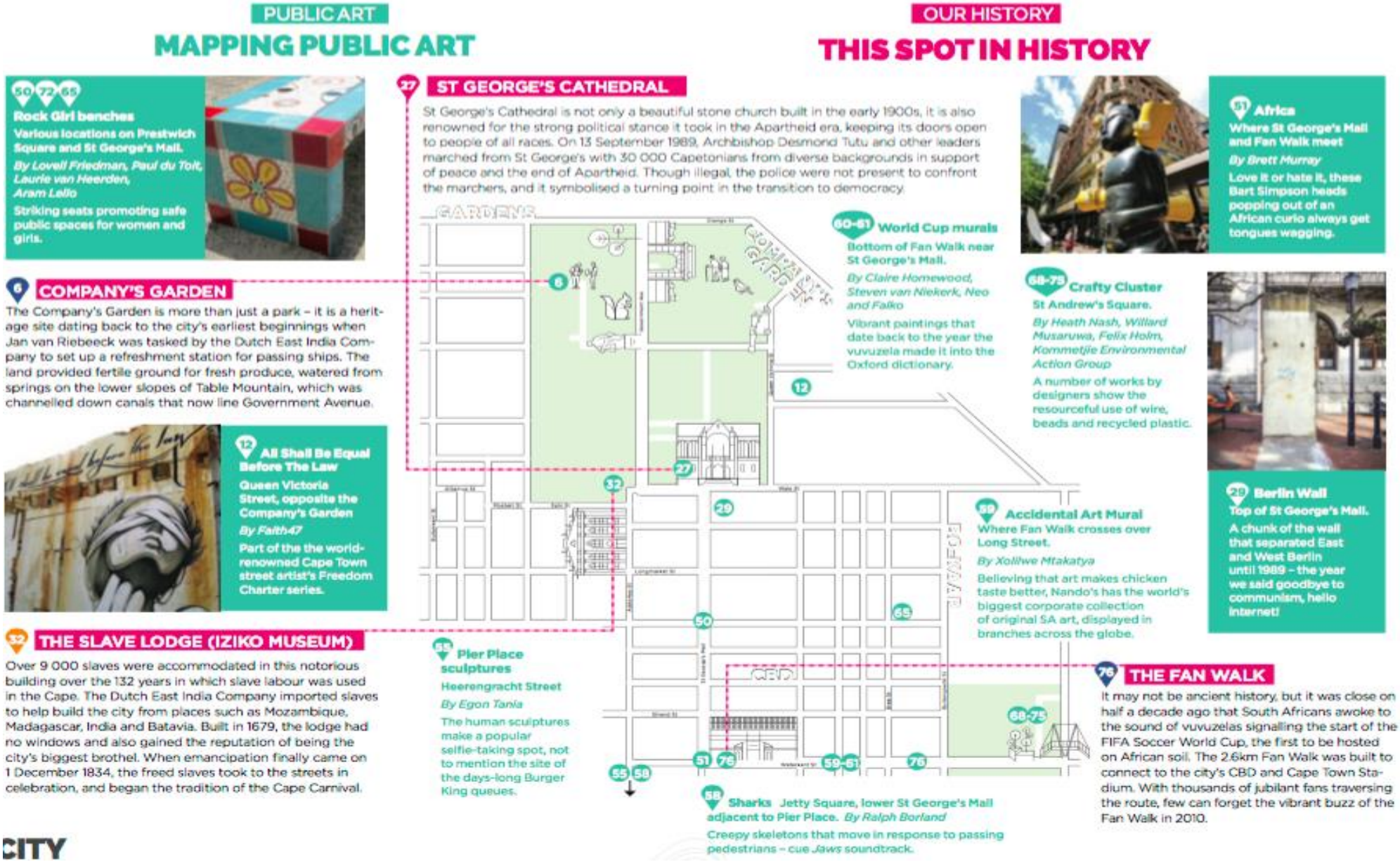


Figure 87: A Blue City Bowl (McLachlan, 2013)



City Magazine detailing the links between the depth that public art can bring to an area, particularly when connected to poignant places in history, and significant memories of the City and City Bowl's past

Figure 88: Connecting water stories to cultural heritage of City Bowl (Molo magazine: Join the City Walk, 2015)

4.8.4 BUITENKANT SPINE

The following interventions are illustrated in the figure below.

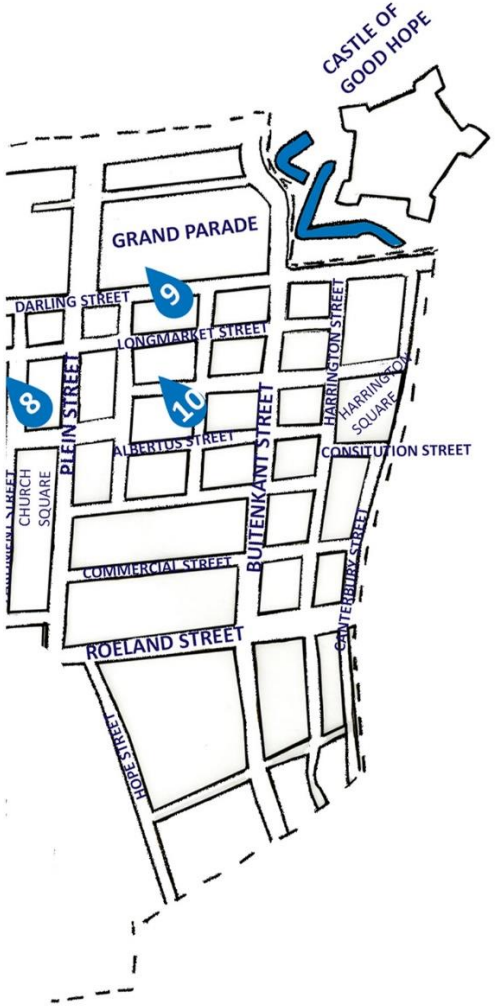
Location	SUDS Component	Intervention	Supporting Existing Spatial Policy for Intervention
Harrington Square	Swales Bioretention Areas	To rejuvenate through the addition of a green space to the existing car park, using systems of **vegetated swales** and **bioretention areas**. These interventions could bring an injection of green to a hard space, which again focuses on providing space for cars. Figure 90 illustrates how Harrington Square could become permeable, creating a strong pocket of green and blue in the midst of grey infrastructure and streetscapes. The Square could serve as a meeting point between water and human stories, past and present, old and new.	Cape Town SDF 2012 Policy 14: All parking areas and transport depots should comply with water sensitive urban design principles Policy 48: Carefully manage land uses and interventions along identified scenic routes, and in places of scenic and visual quality

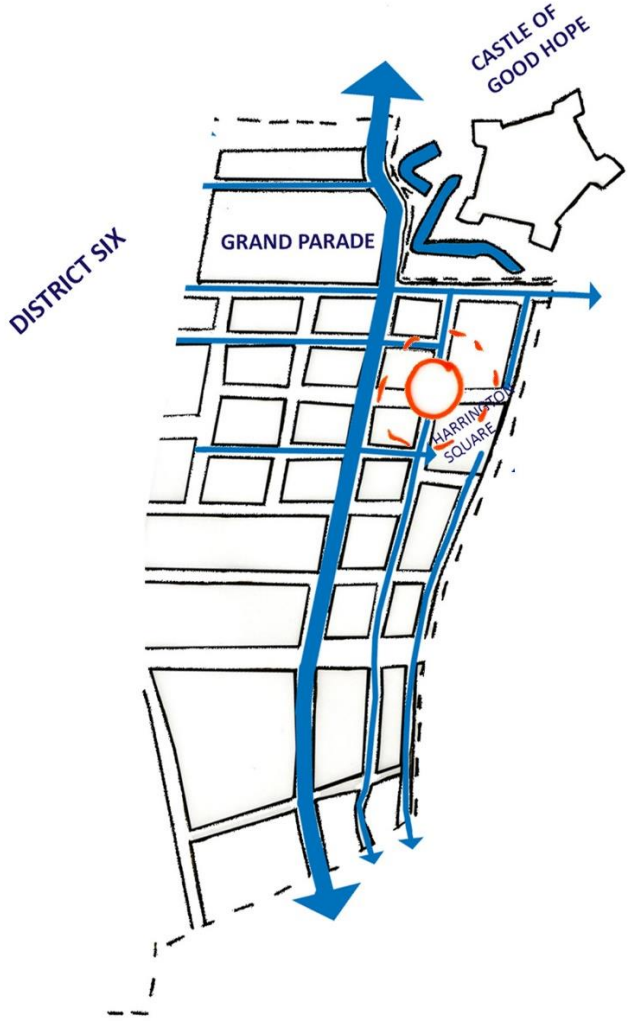
Canterbury Street	Soakaways	To reconnect with a green corridor through the small street, using **soakaways**. The Cape Town Library and City Hall would serve as places of learning and are City wide recognisable features, helping to orientate and locate users of the City Bowl. The District Six Museum is an important part of the site, acknowledging the haunted past of the City of Cape Town. The area could be re-connected to the historic water streams that flowed along Canterbury Street by using SUDS to display the water along the hard surfaces of the road. Chicago Green Alley programme (figure) illustrates how effective small-scale interventions can be. Art installations – both temporary and permanent – and of varying forms would be instrumental in changing how pedestrians and users of the public spaces feel. Features that are interactive, as simple as a bench, as provocative as graffiti, and beautiful, play a considerable role in shaping a place. Transforming streets with SUDS interventions creates a positive outdoor experience for people, who can use this to shape vibrant places, through social, commercial and cultural exchanges.	Cape Town SDF 2012 Policy 26 Policy 46: Celebrate and reinforce Cape Town's diverse historical legacies through urban form, architectural design, signage and, where appropriate, artwork

STRUCTURING SPINE: BUITENKANT

9 City Hall
Cape Town Central Library

10 District Six Museum





SUD Intervention

0 0,1 0,2 0,4 0,6 0,8 Kilometers

Figure 89: SUD designs illustrating how SUD interventions could be used in conjunction with the demand for car park space in Harrington Square (McLachlan, 2013)

CHICAGO, USA – GREEN ALLEYS

“With approximately 1,900 miles of public alleys, Chicago has one of the most extensive and important pieces of infrastructure of any city in the world. That is approximately 3,500 acres of paved impermeable surface that provides an opportunity to better manage resources and improve the environment. Imagine if all of the alleys in Chicago were green alleys. Up to 80% of the rainwater falling on these surfaces throughout the year could pass through permeable paving back into the earth, thereby reducing localized flooding, recharging groundwater and saving taxpayer money that would otherwise be spent treating stormwater.”

“Alleys provide a great benefit for the City, but like all infrastructure, they also require maintenance and periodic reconstruction. Flooding is often an issue in alleys because many alleys in the City were built without a connection to the City’s combined sewer and stormwater system. While one solution to this problem is to install expensive connections to the City sewer system, the Green Alley Program also looks at other more sustainable solutions. In particular, where soil conditions are appropriate, water is allowed to infiltrate into the soils through permeable pavement or infiltration basins, instead of being directed into the sewer system or onto adjacent property. This not only solves a persistent problem, but it also provides an environmental bene fi t by cleaning and recharging the ground water”. "Furthermore, by not sending additional water to the combined sewer system a green alley can help alleviate basement and other flooding issues” (Chicago Green Alley Program, 2007).

4.9 Policy Interventions

Tackling the provision of water, and attitudes towards water in Cape Town, South Africa, is complex as residents of the city have different experiences, stories and histories of it. Cape Town remains a deeply divided and unequal City, and the patterns of provisions and supply of water are perpetuated by the stain of the apartheid legacy.

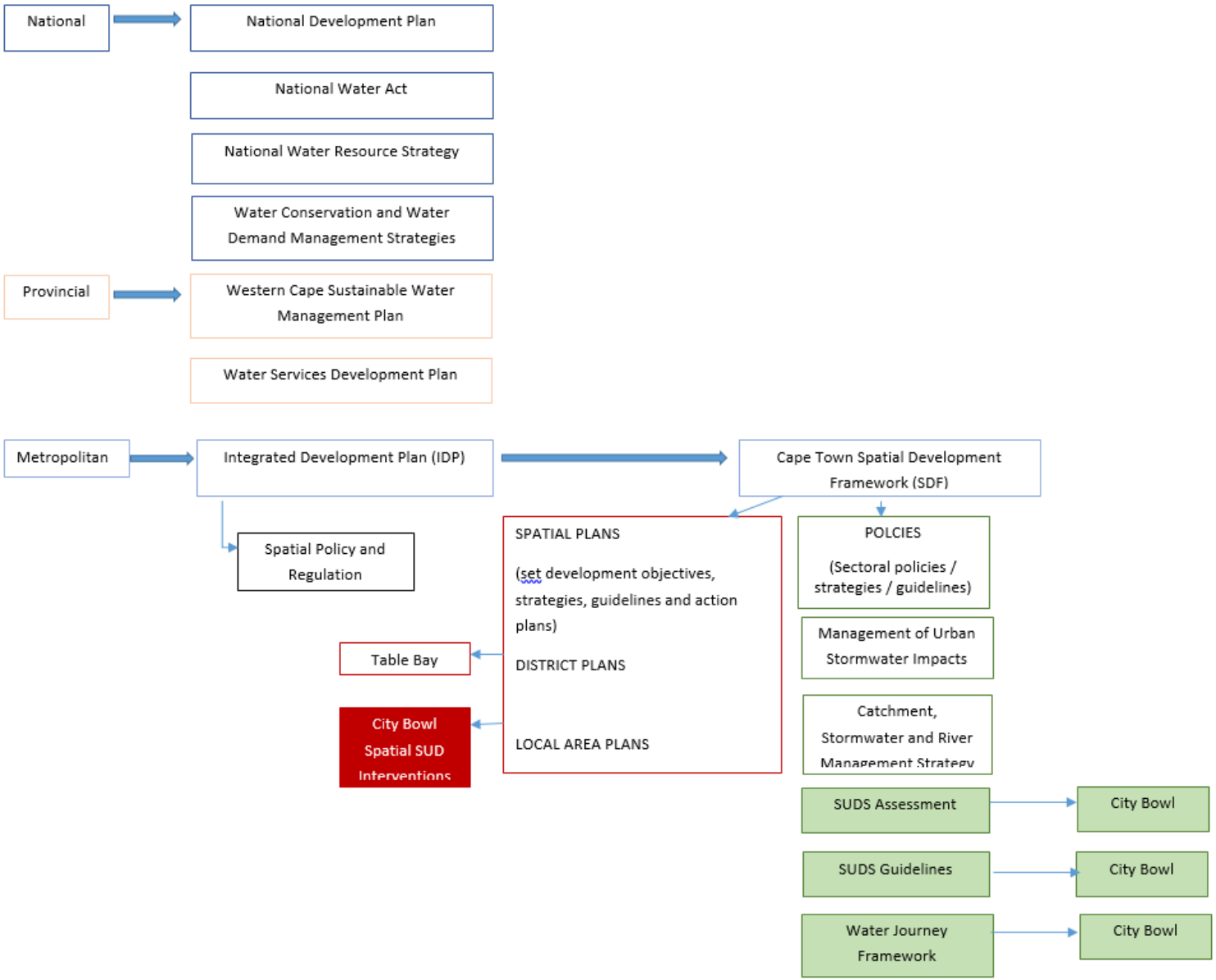
Therefore, in the context of poverty and tremendous inequality, 'greening' measures are sometimes perceived as an elite concern. It is important that WSUD and SUDS principles and concepts are communicated as benefiting all members of society. Though values are embedded in different ways in communities, ecosystems and their health have effects that reach across social, political and economic systems. In fact, ecosystems in poor health are inextricably linked to people in poor health, whether it be through the harmful air quality we breathe, or the polluted water we drink.

The City Bowl focus is perhaps too an opportunity to use SUDS as a way of challenging the over-privileged who use the area in particular, to reconsider their attitudes towards water as a finite resource, and consider embracing a different value system.

As the provision of stormwater services is in the hands of the municipality (Constitution reference in Chapter 3), there is undoubtedly an opportunity to make use of SUD infrastructure, to 'green the grey'. The current Cape Town SDF (2012 -2017) is explicit in the need to create a spatial organisation of Cape Town that is resilient and adaptable. SUDS and the Water Journey route could provide the basis for exactly that. Both could contribute to concerns raised in the SDF over the need to stimulate economic development and protect the environmental resources and systems. The Water Journey speaks to SDF's desire to improve on the recreational functionality and functional integrity and connectivity of ecosystems. Rather than an explicit focus on the facilitation of aiding the movement of flora and fauna (Policy 25 in the SDF - increase efforts to protect and enhance biodiversity networks at all levels of government), The Water Journey focuses on the blue aspects of natural systems first, incorporating biodiversity and indigenous vegetation into the route as they form an important aspect of the SUDS aesthetic appeal. The route and SUDS would contribute to the City Bowl's place making qualities.

However, additional planning policies could straighten the SUDS interventions further.

These draw on precedence and on the ideas generated through the research thus far. The intention was to create policies that are directly applicable to the City Bowl. The current legislation that was explored in Chapter 3 is outlined here, in order to understand how proposed policy interventions may fit into the existing governance structures. The proposed policy interventions are colour blocked. For the purpose of this dissertation the policies are specific to the City Bowl; the hope is that they provide inspiration for other local areas in the city to implement SUDS too.



4.10 SUDS Guidelines for the City Bowl

The aim of the Guidelines is to emphasise that all water streams in the urban hydrological cycle are a resource, not just drinking water. They should be set in accordance with the community vision and objectives.

Drawing on precedence from other countries, namely North Carolina in the United States (examined in Literature Review), the creation of a SUDS guideline would be to create an overarching document to guide the intervention of SUDS in the City of Cape Town. The guidelines would inform City of Cape Town council staff, residents and developers on how to apply SUDS and WSUD principles to urban developments. The document would detail and expand on the core principles of SUDS (achieving improved water quality, water quantity, improving amenity and biodiversity). It would combine the technical aspects (as presented in SUDS Guidelines for SA, 2013) with the conceptual ideas from WSUD Guidelines (Armitage et al., 2014), in order to provide a practical handbook for professionals, government officials and council operators in the City Bowl area. The guidelines re-iterate the importance of SUDS in light of both the Cape Town drought context, whilst being mindful of the stain that the apartheid legacy has left in terms of adequate water provision.

The guidelines would make the case for the need for SUDS in the City Bowl, as a powerful representation of what water in the larger City could look like: all aspects of the urban hydrological cycle valued, in conjunction with the creation of a multi-functional space used by all. The purpose would be to help the City Bowl achieve the best long-term results, particularly with regard to future uncertainty induced by climate change. By building the resilience of water resources and the aquatic environment in a pressured urban area, climate change may have less of an adverse impact on these systems.

The guidelines would provide information, strategic advice, and practical tips on the implementation of SUDS in a structured and clear way.

Firstly, it would highlight **the existing policy** (Catchment Management and Urban Stormwater) necessary to achieving SUDS in the City Bowl, and explain to both designers and developers how to implement a SUDS treatment train, as part of a project management framework. It would provide the aspects of design, risk, construction, maintenance and monitoring that the intervention of SUDS entail.

Secondly it would include a section on the human benefits of SUDS (for example recreational strengths and UHI lowered), as well as the ecological ones (creating safe

habitats for animals, planting indigenous vegetation, and strengthening biodiversity networks). Three checklists would be included in the framework: essential requirements for SUDS projects, designing the project, and beneficial actions for a successful project

Thirdly, it would outline how community participation is key to the progression of future SUD interventions. The Guidelines would describe the process in terms of public participation, offering practical tips and advice as how to construct the process and mould them to local contexts. Community participation should begin with the conceptual stage of SUD interventions and move all the way through the various stages. Fourthly, the Guidelines would illustrate how SUDS could be integrated into the local planning processes at all stages (visioning, goal setting, strategy formation, plan adoption, implementation and investments and monitoring, evaluating and adapting). At each stage of the process, the community of the City Bowl would be involved. The process would begin with the vision and values for the project site. Finally yet importantly, the Guidelines would contain a section of small-scale case studies that showcase the application of SUDS within other urban areas - the precedence to inspire further action. It would demonstrate the practical applications of SUDS principles though different building types found within the City Bowl. The adaptability of SUDS to site's context would be emphasised.

It would ultimately aim to communicate that SUDS can incorporated into many different open space sites, of differing sizes and scales.

4.11 Water Journey Framework for the City Bowl

This would be specific to the spatial intervention of a Water Journey (Blue Route) which traverses the City Bowl. The framework would spatialize the route, creating a visual guide and detailed map of the journey, highlighting the SUD intervention points as sites of particular interest. The SUD interventions would demonstrate the concept of valuing stormwater as a resource, and describe the amenity and biodiversity benefits that Green Infrastructure can bring to the hard areas within the City Bowl. The Framework would communicate the vision and objectives for the City Bowl in 40 years' time. This would be shaped through a public participation process, and would feed into the design of the route, ensuring that it aligned with local knowledge, and that it considered the long

term uncertainty that climate change will bring to the City Bowl (see Chapter 3).

It would provide information on the ecological, historical and cultural layers along the journey, and present the proposed spatial interventions the key example as to how SUDS can be knitted further into the City Bowl area.

The Framework would indicate the various organisations and actors with which the route would be devised in conjunction with. These would include planners, community members, landscape architects, different City of Cape Town council departments, local ward councillors, the Resilience officer, and various museums and public institutions involved along the route.

It would provide additional details (such as timeline, budget) necessary to ensuring that the Water Journey route is taken from the conceptual phase to the creation, intervention and maintained phases.

The Framework would encourage a positive conversation around water in the City Bowl, effectively demonstrating how SUDS are an essential aspect of urban spaces, which bring a multitude of benefits to an area currently comprised of a diverse social and economic fabric.

4.12 SUDS Assessment for the City Bowl

This would be a City of Cape Town council policy, specific to the City Bowl in this instance, with the intention that it be replicated in other small scale, local areas throughout the metropolitan.

Based on research thus far, the construction of SUDS requires the consideration of a number of technical elements.

In order to ensure that these do not become a hindrance to the intervention of SUDS in the City Bowl, the spatial aspect of planning should be harnessed to facilitate the creation of a visual (perhaps GIS) map and database.

The Assessment could function as a one-stop site for people interested in the intervention possibility.

It would firstly spatialize the open spaces within the City Bowl using GIS. It would record their size, type, and ownership. Secondly, it would outline constraints to the site, e.g. heritage, flood lines. It would include layers of man-made elements (the stormwater pipe connections and outlets), as well as natural influencers (geology, soil, groundwater level and groundwater flow). Attribute tables per site would include the runoff rate, infiltration rates, indigenous vegetation, flood lines and whether the site is a potential source or sink. The assessment would be influenced by factors such as Climate change, associated effects of UHI and the need toc create green spaces

for children who frequent the City Bowl to play in.

The planners in the SUDS Assessment team should work to ensure that the information from the map is easily translated for every user (whether residential homeowner, or developer, or business). The assessment team would present the derived benefits from SUDS per site and the linkages to the positive impacts that Green Infrastructure can have in urban areas such as the City Bowl. For example, SUDS on Adderley Street could help the City prepare for a potential sea level rise as a result of climate change.

4.13 Further recommendations

A resident's manual for different scaled SUDS interventions, should be produced for residents of the larger Central City. This could help foster a sense of collective responsibility, and push back on the mind-set that Council are the only ones responsible for new initiatives. Buildings and properties should support SUDS and green infrastructure in way that contributes towards the improved quality of life for the surrounding society and natural environment.

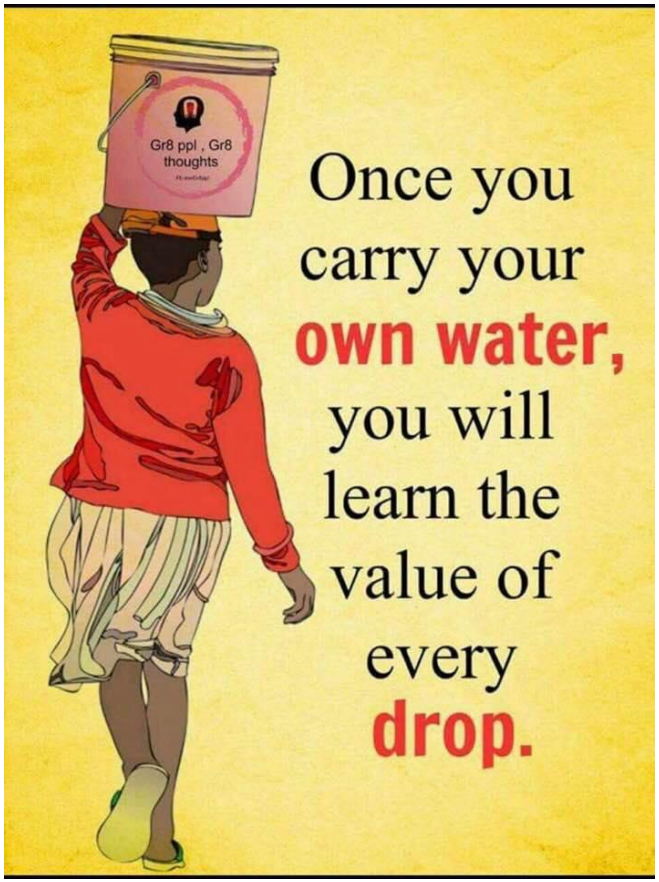
4.14 Conclusion

In the short time that this dissertation has progressed, water restrictions

have increased from level 3b to level 5, and in recent weeks, Phase 1 of a dramatic new disaster plan has been rolled out. The 'new normal' is perhaps not even a sufficient term, as Chapter 3 illustrated how Cape Town has faced these shortages before. Perhaps there should be a challenge as to what new normal means - less reliance on conventional grey drainage systems. This could be changed in the City Bowl, using the city's historical water routes as a structuring spine of intervention. Returning stormwater back to the hydrological cycle instead of out to the Atlantic.

In addition to transitioning to new technologies, transformation has to take place in, user practices, attitudes, and institutional structures. By illustrating a collective, inspiring and thoughtful vision for the future of the City Bowl, we can intervene with the knowledge gained thus far about SUDS. The following chapter will provide guidance on how these interventions can be implemented.

5
The weight of water



Water Restrictions

The dams are low in the Cape,
we are told
not to fill the swimming pool,
not to water the garden,
not to wash the car,
not to take a bath.
We've never –
never had a swimming pool to fill,
never had a garden to water,
never had a car to wash,
never had the privilege of taking a bath
to soak away the aches and pains
that flood our cups and bowls,
otherwise empty.
Seems the dams have been low
for us, forever.

Athol Williams

5.1 Introduction

Moving from theory to action is often one of the most challenging aspects of planning. Chapter 4 presented the spatial and policy interventions as an invitation to visualise and dream together a different future for the City Bowl, Cape Town. This future is one of a City Bowl where water is revered, recycled and rejoiced in. Phase 1 of the Disaster Management Plan is rationing water supply to residents in Cape Town; this indicates the severity of the water resource situation, and presents an urgent need for a call to action. Phase 2 however, is a far direr situation; with water collection points established around the city, controlled by the army and the police force (Blom, 2017). Is it only then, that we will feel the value of water? When it no longer flows out of a pipe? The proposed SUDS interventions in Chapter 4 hoped not.

The current context of the drought is used as a foundation for the refocusing of attitudes and governance structures, working towards positive and enlivening change in the City Bowl. SUDS interventions here can help nurture a relationship to the reverence of water. In light of great inequality in the city, it is important to recognise that certain SUDS options may not be appropriate under certain conditions.

Focusing on the City Bowl provides a site of hope and inspiration, of what can be done. Instead of focusing only on reducing water demand and saving the supply, the implementation process embraces the uncertainty of the drought, and draws on positive engagement with water as the crux of the suggestions

The City Bowl with SUDS could be a place of enabled healing, that focuses on allowing the contributions of 'innovative, spontaneous solutions' to the solving of old problems (Dr Geci Karuri-Sebina, 2017, Epropnews.co.za)

The role player suggestions are by no means deterministic but are rather an initial suggestion as to how the implementation of SUDS could begin to take shape in the context of the City Bowl. The intention is to resist the fragmented nature of the tendency of different departments and sectors, both in private and Council, to work in silos. Rather than a competitive sector approach, a humbling and appreciating of other departments is inspired. This should craft a genuine understanding of what it means to walk in one another's shoes, understanding that there are many different stories hopes and dreams for the City Bowl.

The phasing and priority of the proposals are provided, along with an explanation as to what informed these decisions. Phasing is a key aspect of implementation as it helps create a coherent and flexible strategy to guide the implementation process. Considering limited capacity and resources is not possible nor realistic to do everything

at once. Phasing also allows for time to co-ordinate the different stakeholders and partnerships required.

As mentioned in the Literature Review, urban areas have to move from letting water from the urban hydrological cycle be piped away. Using SUDS, under the over-arching principles of WSUD, would put the City Bowl on a trajectory towards a Water Sensitive City (see figure).

The implementation of SUDS is inspired in the spirit of harnessing the tools that both Spatial Planning and SUDS provide, to create a reimagined City Bowl. This chapter specifically connects the articulated ideas to action.

This chapter draws further from the Literature Review in taking ideas explored and examined from other cities around the world. Their approaches to policy and spatial implementation processes help to take the key actions proposed in Chapter 4 and make them implementable, whilst bearing in mind that the context of Cape Town and the City Bowl is radically different to many of the precedence.

The Chapter will be structured in three parts. First, the spatial and policy priority system is explained. This is followed by thoughts on why public participation is key to the process of implementing SUDS in the City Bowl.

Then the proposed spatial key actions from Chapter 4 are linked to the specific role players (figure). These are followed by the

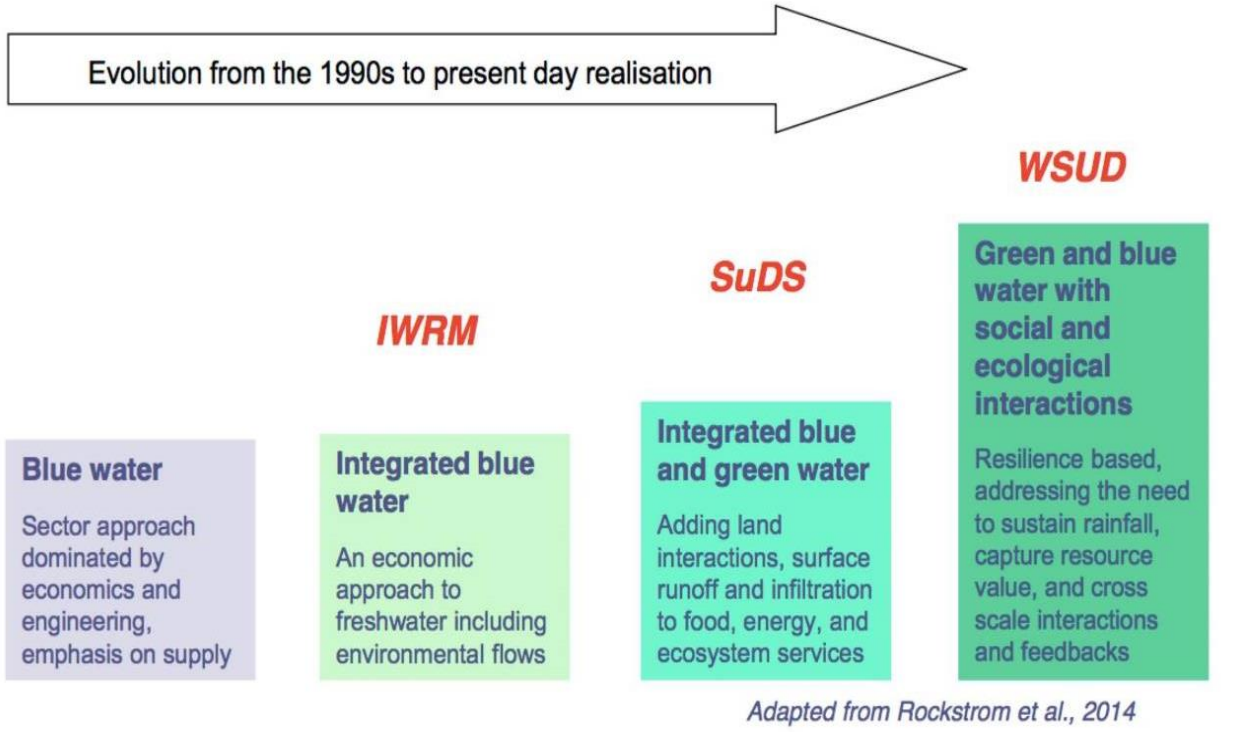


Figure 90: Transitioning to WSUD

proposed policy interventions and their role players (figure).

Finally, a more detailed table provides the combined phasing and time frames for the implementation.

5.2 Explanation of Priority

The structuring spines cannot realistically be implemented all at once. Constraints in terms of available resources, local knowledge and a technical understanding of SUDS and their maintenance are some factors that will need to be tackled by the role players.

5.2.1 Spatial implementation:

HIGH PRIORITY:

The Adderley Spine is given highest priority. This was based on the presence of the Company Gardens within the spine. This space is an existing well used public place, traversed by visitors and residents alike from within the City Bowl and further afield, including a large number of tourists. Focusing on an established green open space in the City Bowl that is presently a popular site of relaxation, reflection and historical significance would showcase SUDS to a diverse range of people. Pedestrian traffic from the Company Gardens and Heerengracht Street link to the proposed spatial interventions of Buitengracht and Buitenkant spines.

MEDIUM PRIOIRTY:

Buitenkant Spine is given medium priority in implementation. Time between projects allows for space to learn – for both the role players and those using the sites. It also provides space to fail and re-trial the interventions. The connection to the old historic streams from Table Mountain here anchors the intervention; the proximity to District 6 strengthens in terms of heritage. SUDS here creates a connecting space that can lead to a healing landscape through spaces that reunite people to each other and to water.

LOW PRIOIRTY:

Buitengracht Spine is given low priority. The site would benefit from lessons taken from the previous spatial interventions in the City Bowl. The traffic dominated road and Square could provide inspiration for other hard urban spaces in the City Bowl.

5.2.2Policy Implementation:

HIGH PRIOIRTY:

Water Journey Framework is of high priority as it represents a conversation that has begun in the City Bowl which is focused on creating positive and reaffirming experiences with water. Rather than only encouraging the saving of water, it encourages a celebration of it.

The Framework requires bold thinking with brave actions, and a committed team of determined members, representing a multi department approach. The planners should be energetic and hopeful, and guide the process of reimagining the City Bowl.

HIGH PRIORITY:

The SUDS Assessment Policy should be done immediately, drawing on existing stormwater data bases to focus on the City Bowl and the proposed sites of spatial intervention. The priority given is high as this information is necessary to inform the implementation of many of the SUDS proposed spatial interventions. It helps determine the feasibility of the suggested spines.

MEDIUM PRIORITY:

The SUDS Guidelines would be an on-going process, updated in five years' time, as the understanding of SUDS becomes more refined, as monitoring of the water quality and quantity on the site is continually conducted. Hence, they are a medium priority intervention. The initial version would focus on informing the implementation of the proposed spatial Spines of Adderley, Buitengracht and Buitenkant. The updated version would build on those, in conjunction with the proposed Water Journey Framework, and include newly identified sites of intervention in the City Bowl.

5.2.3Public Participation

The generation of a collective vision should be one of the guiding criteria for the implementation. Involving the community from the beginning is important as their ideas and concerns should be incorporated into the design and construction of the SUDS. The interventions seek to amplify voices that have been side-lined or invisible before. This allows the space for an understanding of the lived experience of the site to be incorporated into the reimagined vision for the City Bowl. The process would knit together personal stories related to water, and cultural heritage and history, enabling a collective approach to implementation.

As humanity is ' inextricably embedded in a physical context, we are compelled to understand the nature of our relationships to place'; 'Our thoughts, feelings, and beliefs about our local community places impact our behaviours toward such places, thus influencing whether and how we might participate in local planning efforts' (Manzo and Perkins, 2006). Thus, community engagement, particularly in the context of water and green infrastructure in South Africa, is an essential component to the journey of implementing SUDS in the City Bowl, particularly in the Buitenkant Spine with its proximity to District 6. Emotional attachment to the area should be flagged as an essential consideration. This can 'motivate cooperative efforts to improve one's community' (Manzo and Perkins, 2006) and be an intervention which has ownership within the community too.

When engaging on the technical realms that SUDS entails, the process of public participation should not neglect the importance of valuing local knowledge. The so-called 'expert theory' should not be perceived as the defining element of the intervention; the process should elevate the common democratic engagement. Drawing on the diverse community of the City Bowl, particularly members who have encountered or lived through drought, should be encouraged to share their stories and experiences. This would help the City Bowl to become a learning community.

5.3 Implementation of Interventions

“Drought is a teacher. This is a learning space” Dave Crombie (Water Institute of Southern Africa).

The implementations in the table below speak to the spatial interventions introduced in Chapter 4, and are the realisation of lessons learnt thus far in research. Some will rely on local planners to drive the initiatives, whilst some are more reliant on other departments within the City of Cape Town. Many rely on partnerships to amplify the democratic involvement. The three detailed below are an effort to capture some of the existing organisations whose support and work would be invaluable to the implementation.

Future Water: an inter-disciplinary research institute at the University of Cape Town (UCT).Their research addresses issues of water scarcity, and is ‘based within an over-arching systems framework supported by strong sociological, technical, environmental, legislative and governance expertise’ (uwm.uct.ac.za). Their work is aimed at generating new knowledge and understanding different perspectives in light of a water scare local context.

UCT Urban Water Management team: The research team is based on UCT but works with other universities in South Africa. They have developed the South African Frameworks for SUDS and WSUD (referred to in Chapters 3 and 4).

Cape Town Partnership: This organisation seeks to bring people together around ‘common goals for Cape Town’s transformation’, who work together to help find a ‘common language and shared set of priority specific projects that can make a positive impact in people’s lives’ (capetownpartnership.co.za).

Water Resilience Task Team: their task is ‘to ensure that the “acute water shortages are avoided” (De Lille, 2017a). The team has partnered with water industry specialists to ‘hammer out “a new water resilience approach to water management in the city”, which is less reliant on surface water’.

The tables below outlines the key spatial interventions and the suggested role players to move to action. It draws from the existing structure of the City of Cape Town departments.

Many interventions require spatial planning and environmental players; both of these are housed under the Transport Development Authority (TDA) in the City of Cape Town. The Spatial Planning Department is formally known as ‘Urban Development and Planning. It houses urban Integration and Land Use Development Departments (Figure 92).

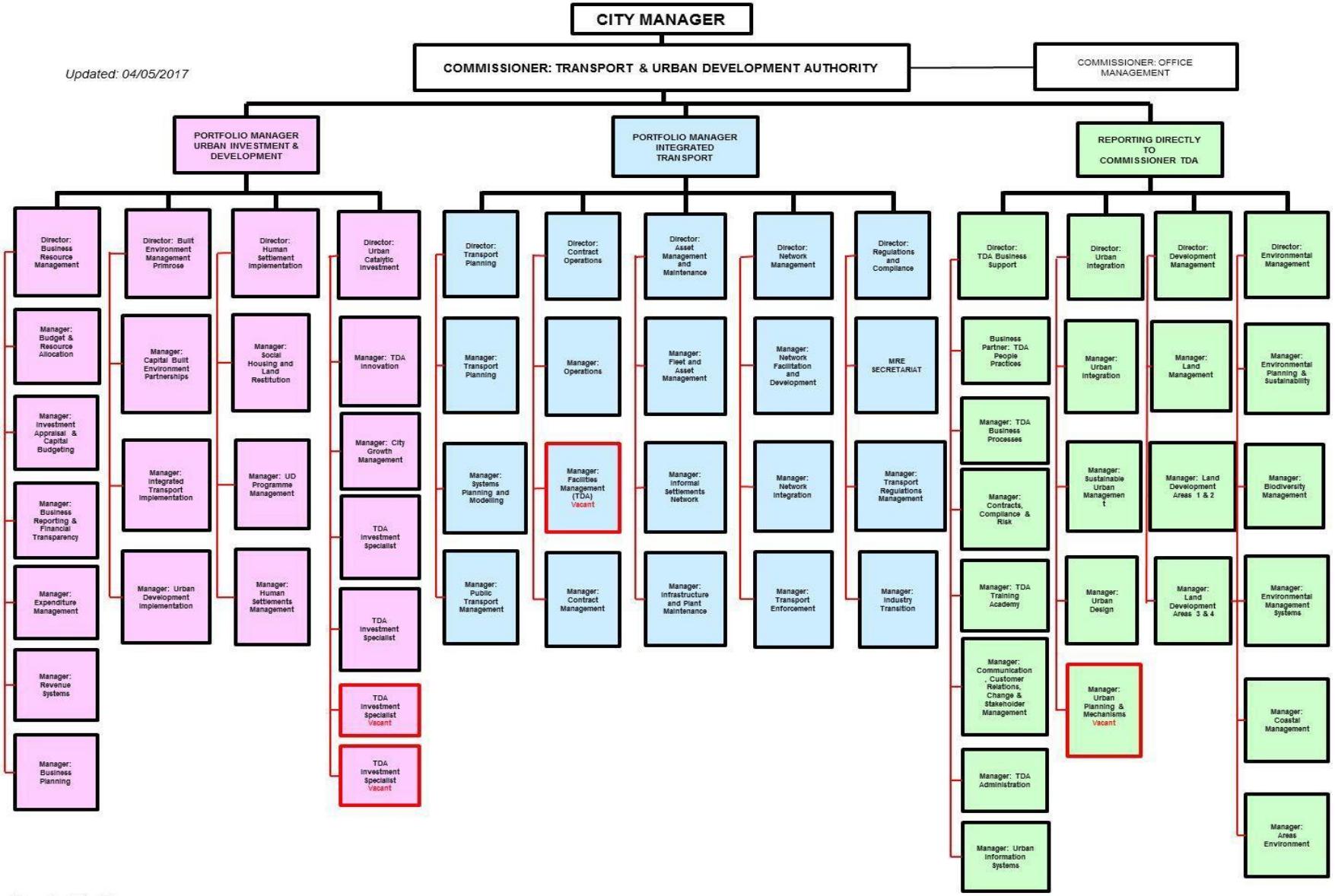
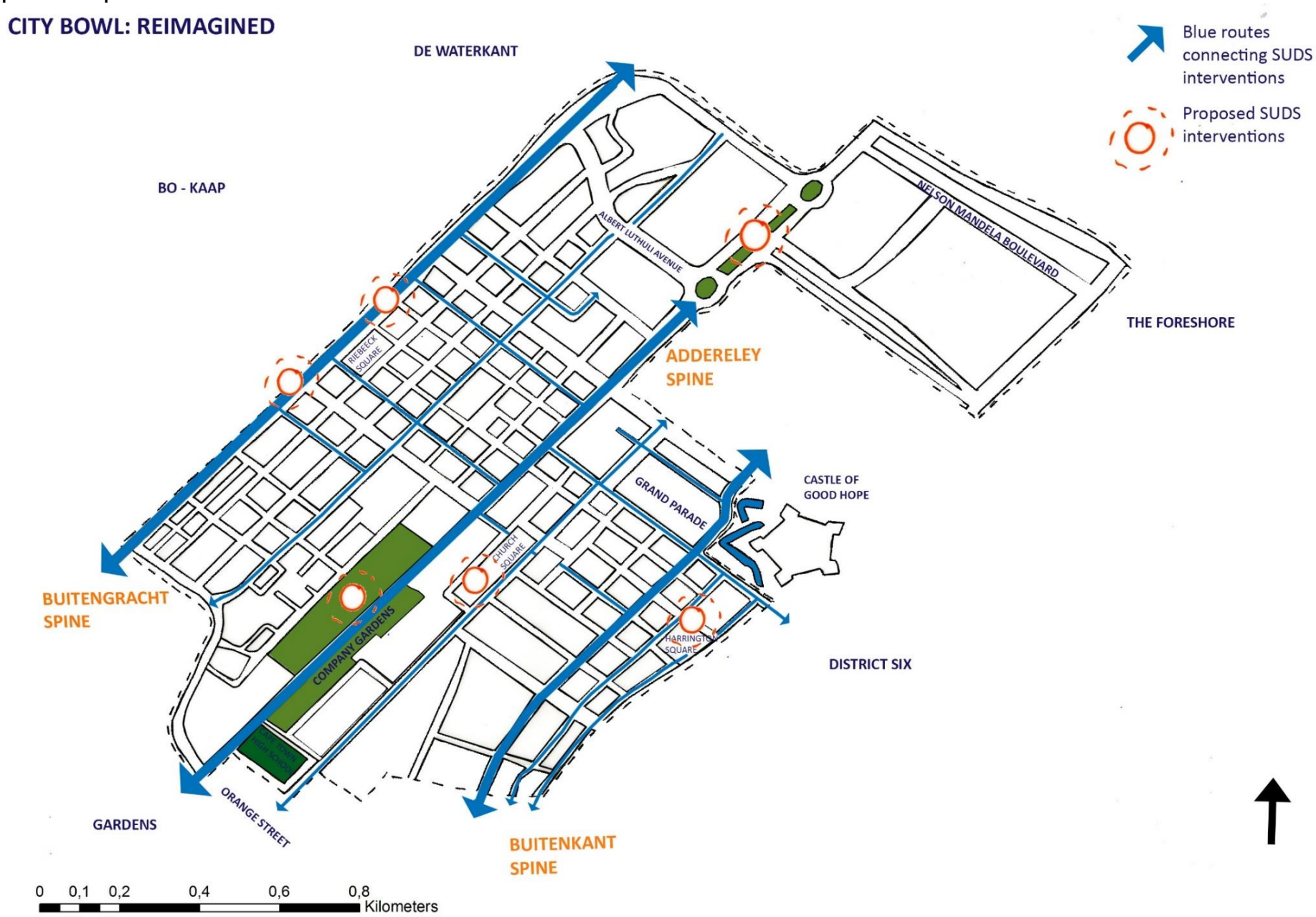


Figure 91: TDA's Organisational Structure (TDA, 2017)

5.4 Spatial Implementation



The table below links the interventions (figure) to the role players and the priority of the project.

SPATIAL INTERVENTIONS	ROLE PLAYER	PRIORITY
Water Journey	Though its Priority is high, its implementation is the culmination of the implementation of the proposed SUDS components in the City Bowl (detailed below). However, it marks an important part of the transformation of attitudes and encouraging reverence and recycling of water at the heart of the City Bowl. It also communicates that a 'water literate' approach is being used to guide governance of water resources in the area. - The Spatial Planning team should oversee the routes suggested in Chapter 4, considering the surrounding site's characteristics and significant ties to points of interests and cultural attractions. - The planning team would be supported by the Department of Tourism and Heritage, who would promote the journey and provide information boards on the proposed SUDS sites, encouraging a shared learning in the City Bowl. They could also provide signposts along popular pedestrian routes in the journey, indicating the location of SUDS. - The Department of Recreation and Parks should oversee green links that connect the SUDS sites link to the wider city; and oversee the maintenance of the SUDS - The Environmental Management Department would help care for the site, looking after biodiversity concerns - The Department of Stormwater should oversee the SUD components - Future Water, Cape Town Partnership and Reclaim Camissa are integral to the realisation of the journey, with invaluable experience and understanding of how people, space and water are connected, intertwined and interrelated.	HIGH

	- Using the proposed SUDS Assessment, SUDS Policy and Water Journey Framework to guide the route and frame the narrative for a Reimagined City Bowl. The route should be championed by the Mayor's Office and highlighted as a priority in the City's agenda. It should be the beginning of a conversation that sees water take the focus of planning in the City Bowl.	
Company Gardens	- Under the TDA, all divisions of the Environmental Management Department should work with the Company Gardens management to firstly ensure that the integrity of the site, in terms of cultural and historical heritage and in terms of vegetation, be protected. Secondly, landscape architects from the Urban Development and Planning Department would design site-specific SUDS components for the Gardens. - The Department of Water and Sanitation should work closely with the City Health Department to ensure that the stored water quality from the proposed bioretention area and retention pond is not harmful to the users of the Gardens, or the interrelated natural systems (e.g. contaminating soil). - The Department of Tourism can promote the location of the SUDS within the Gardens; the SUDS should be included on the existing 'self –guided walk' that visitors are encouraged to take through the Gardens. - The Department of Recreation and Parks contribution to maintenance would be essential to the optimal functioning of the SUDS. - Cape Town Partnership and Future Water would be vital partnerships to this site. The invitation to contribute to the project is extended to other tertiary education places of learning. The different players bring different strengths to the intervention; by drawing on these, learning from each other and working together, the Company Gardens could be an inspiring example of recycled water in the City Bowl.	HIGH

Heerengracht Street	- Led by the Stormwater Department, working closely with landscape architects, the traffic circles would be an effective site of small-scale, visually attractive, road reserve. - The proximity of the Street to the reclaimed Foreshore is of importance: if sea levels rise as predicted (see Chapter 3), then the proposed filter strip and bioretention area may help regulate the water tables, avoiding floods. Therefore, the Environmental Planning team should be involved to combine their knowledge of climate, with the impact on the City Bowl built environment. - The proposed policy intervention of the SUDS Assessment Policy to guide the project in terms of spatializing the site and its characteristics. - The Department of Environmental Management would oversee that the site is developed as part of the continuous link between mountain and sea (see Chapter 4, potential sites) - As the street once was home to the historic Varsche River, non-profit Reclaim Camissa (Chapter 3) and their in-depth knowledge of the site and appreciation of water in the City Bowl should be involved.	HIGH
Church Square	- Led by the Heritage team, working with the Urban Designers and Landscape Architects, a new story layer could be added to the historically significant square. - The Department of Tourism could engage with the new story layer by inviting people to the site to learn about old and new stories of the City Bowl - The team should be supported by the Stormwater Department. Making use of the proposed SUDS Assessment would ensure that the stormwater runoff and infiltration rates are in accordance with the site's character, as well as the surrounding hard nature of the area. - Cape Town Partnership are already involved in the site; inviting them to participate would add a depth of knowledge on how the site functions, and how the proposed bioretention area can add to this.	HIGH

Harrington Square	- The Department of Recreation and Parks would work with the Spatial Planning team to create an active urban public space that brings joy to the area. A playground would ensure that children are attracted to the site (speaking to the vision dreamed in Chapter 4). - The Department of Environmental Management should guide the heritage and cultural landscape considerations of the site, ensuring that the proposed vegetated swales and bioretention areas are designed with Landscape Architect's attention to detail. - The Department of Stormwater would use the proposed SUDS Assessment policy and consider linking the recycled water to the Castle Moat.	MEDIUM
Canterbury Street	- The Spatial Planners would be the drivers of this project, considering the site in context of both District 6 and the historic streams from Table Mountain. There is a need to ensure that the proposed soakaways are appropriately in keeping with the site's characteristics. - The Department of Environmental Management should guide vegetation choice - The Stormwater Department should draw from the proposed SUDS Assessment policy, as the street gradient is steep, influencing the position of the proposed soakaways. - The Urban Water Management team from UCT should be involved to incorporate their knowledge of the SUDS and WSUD (analysed in Chapter 3) to the site.	MEDIUM
Buitengracht Street	- Led by the Spatial Planning team, co-ordinating with the landscape architects and urban designers. - Guided by the proposed SUDS Assessment policy and developed in conjunction with the Stormwater Department. - The Spatial Planning team would work with the City Directorate to monitor the quality of water from the site.	LOW

	- The Environmental Management Branch would ensure that the vegetation on the proposed swales and bioretention areas creates a landscape system that strengthens the City Bowl's green network, adding a missing link to the landscape. The increased vegetation could help clean the pollution from the traffic, and contribute towards the UHI effect (as discussed in Chapter 3).	
Riebeeck Square	- Driven by the Spatial Planning Team in conjunction with the Department of Environmental Management. The team must ensure that the Square is recognised as part of the larger natural open space system of the City Bowl and surrounds. - The proposed swales and permeable paving should be designed by Landscape Architects and Urban Designers. They would have an in-depth understanding of how these components work in urban areas to create an attractive urban plaza. - The Department of Recreation and Parks would promote the site, supported with the Department of Tourism to encourage visitors and users.	LOW

5.5 Policy Implementation

The next table suggests role players relevant to enabling the supporting proposed policy interventions from Chapter 4. The implementation of the policies provide the realms to implement the proposed spatial interventions. They help guide interventions in City Bowl by providing specific information to the area. The policy suggestions would communicate a new water literacy orientation in the role of spatial planning. They recognise that water is not just another environmental layer; it is the key to life. It is necessary to social and economic advance and the documents therefore outline water in the City Bowl as their key focus.

POLICY INTERVENTION	ROLE PLAYERS	PRIORITY
SUDS Assessment	This is a high priority intervention, carried out in the immediate short term - Led by the Spatial Planning Department and the Stormwater Department, the team would work with the existing GIS team (from the Information and Knowledge Management Department) to spatially identify the proposed sites of interventions. The GIS data should present specific information on the technical details of the site such as stormwater volume runoff, the rate of infiltration and the slope aspects, as well as the level of groundwater and geology. These help inform the site's underlying characteristics, which in turn influence the type of SUDS component chosen for the site. - The involvement of the teams from the existing WSUD and SUDS Frameworks (from chapter 3) would be essential to the implementation. - Local community involvement and participation would ensure that the identified site's existing water story is not reduced; rather it is re-united with the recycling of stormwater. - It is supported by the existing Management of Urban Stormwater Impacts Policy (2009)	HIGH

	- The Environmental Management Department should closely assist, ensuring that vegetation, existing cultural and ecological landscapes are not damaged but rather strengthened.	
Water Journey Framework for the City Bowl	The Framework ties together the proposed spatial interventions in the table above. It should be drawn up concurrently with the SUDS Assessment Policy and help inform the SUDS Guidelines for the City Bowl. The physical route (figure 79) is a result of the spatial spine interventions and thus requires a team that comprises of the Departments involved with these projects. As mentioned in the Spatial Intervention table above, the Journey should be championed by the Mayor of the City, with support from planners who embrace risks more, and who respect and engage with other City sectors. Key role players would again be the Environmental Management Department, the Tourism Department, the Stormwater Department and the Department of Recreation And Parks. Reclaim Camissa and the Cape Town Partnership, as well as the Water Resilience Task Team are key to the creation of the Framework. The Framework team should begin immediately and continue to guide implementation	HIGH
SUDS Guidelines for the City Bowl	These are developed in hand with the SUDS Assessment team, as their findings would influence the direction of the Guidelines in terms of outlining criteria for possible future SUDS interventions. The Guidelines would stress that water should be the planning focus of the City. - Community perspectives should be the building block of the Guidelines: hearing the stories and experiences of the proposed sites relationship to water and cultural heritage should shape the guidelines and provide the space to develop and communicate a collective vision for the City Bowl. - Led by the Spatial Planning Department, working with the Stormwater Department to communicate the importance of recycling water in the City Bowl. The Guidelines would outline	MEDIUM

	how SUDS can improve the quality and quantity of water of the proposed spatial intervention sites. - The Environmental Management Department, as well as Department of Recreation and Parks would guide the green systems networks. The Riebeeck and Harrington Square interventions, as well as Company Gardens interventions, would need careful attention and support to deliver on the SUDS aim of strengthening amenity value of the sites. - The Guidelines should be tightly connected to the existing Management of Urban Stormwater Impacts Policy (2009) and Catchment, Stormwater and River Management Strategy (2002-2007) - Future Water and the Cape Town Water Resilience Task Team should be involved.	

5.6 Priority and Phasing Table

Drawing on the earlier explanation of priority, the following table outlines how the **proposed spatial and policy interventions** would be implemented in terms of time. The given time frames for the projects are explained below.

Time frames

1-3 years:

Short Term – Using existing teams and resources, this timeframe should be used to begin the collaboration of role players for the proposed interventions.

3-5 years:

Medium Term - this applies to interventions intended to kick-start action, engagement, encouragement and nurture the creation learning spaces in the City Bowl.

5-10 years:

Long Term - projects that build on the experience and learning curves from the high priority interventions.

Intervention	Immediate Short Term (1-3 years)	Short Term (3-5 years)	Medium Term (5-10 years)
SPATIAL			
Water Journey			
Company Gardens			
Heerengracht Street			
Church Square			
Canterbury Street			
Harrington Square			
Buitengracht Road Reserves			
Riebeeck Square			

Intervention	Short Term (1-3 years)	Medium Term (3-5 years)	Long Term (5-10 years)
POLICY			
SUDS Assessment for the City Bowl			
Water Journey Framework for the City Bowl			
SUDS Guidelines for the City Bowl			

5.7 Conclusion

The chapter has outlined key role players tasked with enabling the implementation of SUDS in the City Bowl. It has outlined the time and phasing of the proposed interventions to provide a context of how the theory and context moves to action.

To reimagine a rejuvenated City Bowl, where water is revered and rejoiced in, the implementation requires a humbling within different departments and across sectors, to come together and learn from one another. For the proposed ideas to gain traction the, City Bowl needs to become more water literate with planners galvanised to ensure water is a focus of all planning agendas. The TOD (Transit Orientated Development) language that dominates the proposed SDF (see Chapter 3), should be equal, at the very least with mention to water in all planning documents. The chapter depicted the manner in which positive conversations and actions could begin to take shape and form. The implementation of the interventions presented in Chapter 4 offered an exploration of how spatial planning can enable transitions to the implementation of SUDS in the City Bowl. The phasing of the projects will encourage, inspire and stir hope as more learning and interaction with the SUDS spines occurs. The City Bowl reimagined could see SUDS embedded in the narrative, embracing the uncertain future of water in a positive way, by responding with resilience, respect and a re- composure of attitudes. That is the hope.

The collective vision of the City Bowl can become a collaboration between different sectors, stakeholders and communities, leading to collective ownership and collective action. The re-storying of the City Bowl will subsequently reflect this, with a narrative that respects water passed down to children, and their children's children, encouraging them to keep learning, and to keep celebrating.

That the implementation culminates in a Water Journey creates a platform for reflection, as well as a space to think creatively around the current and future water uncertainties. The journey creates space for debates, discussions and the courage to think beyond the typical infrastructure parameters that have confined and restricted us thus far. Indeed, the spatial interventions proposed are just the beginning of a journey towards recognising the intrinsic value of water - in all forms – to life.

6
Conclusion

6.1 Introduction

This chapter presents an overall conclusion to the research and suggested proposals considered in the dissertation. It returns to the research questions outlined in Chapter 1, and thereafter presents the research findings, offering thoughts towards future recommendations and possible questions stemming from the research. Aspirations and hopes for the City Bowl are conveyed, as well as personal reflections. The chapter then concludes, and in doing do, concludes this dissertation.

6.2 Overview of the Research

The research undertaken in the dissertation process focused on exploring the City Bowl, Cape Town, through the lens of water. In doing so, it aimed to illustrate the current water narrative in the area and establish the context for the implementation of Sustainable Urban Drainage Systems (SUDS).

The dissertation presented an introduction to the City Bowl, with a focus on the rapidly evolving drought conditions that Cape Town is facing, and the reality of running out of water in the near immediate future (Parson, 2017). It outlined my philosophical position of heeding our responsibility to stewardship of the natural environment; and embraced the environmental humanities approach with regard to avoiding silo governance structures. These were the foundations from which the research guided by.

The Literature Review explored the consequences of urbanisation, and the impact of land cover change with regards to the fragmentation of natural systems and ecological services, as well as the fragmentation between people and the environment, that can occur in urban areas. As infrastructure has evolved, the City Bowl has participated in the reduction of its water sources to the perception that it is something of infinite amounts, piping it from the ground, pumping it into buildings, and paving over it. The literature examined suggested a clear link between using the concepts and of Green Infrastructure (with a focus on SUDS) in conjunction with spatial planning to respond to this fragmentation and disconnection. It outlined the intertwined and interdependent relationship between access to water, and the ramifications on public health, food security, and industry, social, cultural and economic development. SUDS were examined both in terms of their opportunities and in terms of constraints.

The intent of using SUDS is to improve water quality, water quantity and amenity aspects, ultimately recycling polluted urban water; these were drawn from, and used with the contextual analysis of the City Bowl to guide

the proposed spatial and policy interventions which followed in Chapter 4. The interventions were proposed so as to provide an idea of how to Reimagine the City Bowl in terms of water and natural systems. They use the
Historic water routes through the City Bowl in conjunction with the existing cultural and heritage points as structures to create a Water Journey. An implementation framework was provided to suggest possible role players, time frames and priority of the proposed water journey, and the accompanying policy suggestions. The conclusion in this chapter concludes this research.

6.3 Research question revisited:

In concluding, it is important to return to the initial research questions so as to connect the subsequent findings with the original aims of the study.

The primary research question was:

How can Spatial Planning enable pathways to the implementation of Sustainable Urban Drainage Systems in the City Bowl, Cape Town?

The secondary questions were:

- What is Green Infrastructure and how is it linked to spatial planning?
- What is the intent of SUDS?
- What are the challenges faced in the implementation of SUDS?
- How can spatial planning help overcome these?

6.4 Findings of the study

Guided by the research questions, a number of findings were brought to light in the process.

Firstly, there is a need to be mindful, and respond thoughtfully and sensitively to the context of the uncertainty around water provision (the drought is gripping the city currently and shows no sign of abating), and secondly, to the context of a city that is still marked by the spatial divide and social segregation due to apartheid. There is a lack of equitable access to services, and water is amongst these. Therefore, using the City Bowl as a case study was intended to communicate an example of how different attitudes and values from residents and

visitors can be knit together, resulting in a showcase of water, that celebrates its every form and respects its gift of life to people and the earth. It invites a diversity of people to learn and encourage one another, building resilience.

Secondly, there is a growing embracement of the importance of designing and constructing green spaces and great public spaces into urban areas. Whilst there are some green spaces (notably the Company Gardens) in the City Bowl, the City Bowl is largely an impermeable urban space. SUDS could be used to transform these spaces, by focusing on reconnecting the residents and users of the space to the blue network, based on the historic streams which once provided to the Dutch and English settlers of the City Bowl. The biodiversity network need not end on Table Mountain; using SUDS offers the chance to connect both this green and blue network to the sea. Rather than using the stormwater drainage pipes which grid the city, running valuable water underneath roads and into the ocean, the City Bowl can use interventions that mimic natural cycles.

Reimagining the City Bowl with SUDS creates a platform for a positive and creative engagement to water resource use. Reconnecting to water through the celebration of it in Buitengracht Street, the Company Gardens and Harrington Square could provide inspiration and allow nature to run through the current paved and impermeable environment.

Thirdly, using the tools of spatial planning to enable green infrastructure in the form of SUDS presents a plethora of opportunities, which can be used to build resilience of both the City Bowl residents and spaces, and the surrounding natural systems. Green Infrastructure connects the natural ecosystems within and around and between urban areas, and at all spatial scales (Sandstorm, 2002; Tzoulas et al., 2007). Spatial planning brings the concept of place shaping and making into the picture, which in the City Bowl can be used to strengthen existing public spaces with the intervention of SUDS. Whilst the research highlighted that often natural green spaces are considered a luxury, they are in fact, essential to human health. SUDS bring the opportunity to create these spaces in the City Bowl.

Lastly, the implementation of SUDS requires a transdisciplinary approach. This goes hand in hand with a paradigm shift towards the releasing of the value of stormwater, no longer disregarding it as a nuisance or hazard. And rather, embracing the opportunities that it provides, communicating a respect and reverence of all forms of the urban hydrological cycle.

What emerged from research within the City Bowl was that this is beginning to take place, by reshuffling the stormwater department to sit under the Department of Water and Sanitation. This helps sets up stepping stone towards a more holistic attitude towards planning with water in mind. Planners in the City could be encouraged to expand their water literacy, and in doing so become well equipped to strengthening relationship with members of other Departments. This time of great climate uncertainty in the City Bowl is the time to avoid further fragmentation, both in terms of residents attitudes towards water, and in terms of fragmented and silo decision-making processes. There is a need for greater coordination across different spheres and departments of governance. are a number of civil organisations such as Future Water, Reclaim Camissa, and the Cape Town Partnership that can be engaged with on the journey towards implementing SUDS in the City Bowl. Academic institutions and their research can be used to deepening understanding around the technical and social aspects and implications of implementing SUDS. It is imperative that local knowledge and public participation processes are used in the implementation.

Whilst SUDS do in fact present a number of challenges in implementation, such as maintenance and monitoring, both of which require a specific skill set which is currently lacking in the City Bowl, there is room for hope - and indeed a need for hope - in their many opportunities and positive attributes.

6.5 Contribution of Research

This research seeks to make a contribution to the larger body of existing stormwater policies and frameworks that currently are found within the City and broader South African context. The focus on the City Bowl is intended to inspire and motivate the case for small-scale interventions in local neighbourhoods, using invaluable local knowledge and understanding of the local context, landscape and water story, to work towards meaningful interventions. The research further seeks to contribute towards a wider body of knowledge linking the relationships between urbanisation and fragmented landscapes, the subsequent consequences on ecosystem services, and the ramifications for human life if these are not integrated into governance approaches.

6.6 Recommendations for Future Planning and Research

Spatial planning should aim to guide these concepts and communicate a collective

vision with regards to SUDS. Further recommendations, which flag future questions are below:

- Recommended that future plans, policies, strategies for the City Bowl include a focus of the existing water bodies found on the site, noting possible of implementing SUDS there. Plans should be encouraged to include a SUDS element, regardless of whether retrofitting, or building new developments.
- Further sites of intervention should be identified in the City Bowl, using the SUDS Assessment intervention guide. This would ensure that a SUDS train is present on site, and builds from lessons learnt in the proposed interventions outlined in Chapter 4.
- The proposed Water Journey route should be expanded to incorporate these new sites. They should link to other significant sites of cultural and historical memory in the City Bowl such as the Bo- Kaap.
- The Department of Education should be encouraged to enage with the SUDS intervention sites along the spines, and invite children to learn more about recycling stormwater.
- Further research on suitable plants used with the SUDS components should be conducted, ensuring that that are responsive to both the current climate, adaptable to future climate uncertainty, and that they contribute to the greening of the hard urban spaces.
- Further research and monitoring on the effectiveness of SUDS ability to clean water in the City Bowl should be carried out to determine whether one day this water could be used for drinking.
- Active engagement with the SUDS sites, stemming from the public squares of Harrington and Riebeeck, as well as Company Gardens, should be encouraged through community events and activities. These should include local faith organisations, researchers, residents and business owners.
- Further research should consider a forum for engaging with voices of the City Bowl who have previously been silenced, looking to interact and listen to stories of local experiences and narratives of water, which can be used in conjunction with SUDS to re-story the City Bowl and its relationship with water.

6.7 Reflections and hopes for the City Bowl

The re-storying the City Bowl through a reimagined attitude towards water is presented in a way that seeks to acknowledge the painful past of Cape Town spatial legacy, and in response to climate change, cultivate a positive new spatial legacy towards water, using SUDS as an enabling healer of communities and attitudes. The Water Journey is intended in the spirit of including all visitors and residents to the City Bowl. The hope is that all will gain an opportunity to walk in others footsteps, and leave with a sense of belonging to the re-story, and of feeling that their own personal story is represented through the various aspects of the Water Journey.

6.8 Personal Reflections

The research has provided a most appreciated opportunity to pursue an area that is considered urgently and passionately important, particularly at this point in the City Bowl's history. The process has been of immense challenge, and the cyclical nature of water has indeed felt reflected in the cyclical nature of the research. The journey has been one of great learning. It has deepened the belief that we are called to act in a responsible way that reflects the attitudes of stewardship for the environment, invoking a sense of responsibility towards caring for natural systems.

6.9 Conclusion

The dissertation sought to establish how spatial planning could enable SUDS implementation in the City Bowl, Cape Town. In doing so, it aimed to outline a proposed pattern of behaviour that responded to the understanding of the value that ecological systems and services contributes towards human life, and of these, not least water. Spatial planning is able to embrace this attitude, and illustrate where and how SUDS can begin to respond to these values within the City Bowl, through the structuring spines of Adderley, Buitengracht and Buitenkant streets. In terms of drought, they present a tangible response to planning with water at the heart of the city. Where SUDS and a Water Sensitive City approach are considered part of the 'new -normal'.

Using spatial planning to implement SUDS in the City Bowl offers an opportunity to collectively acknowledge that we all share roots.

7
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APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data.The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook**(available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/usr/ebe/research/ethics.pdf

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Catherine Harvey
Department		Department of Architecture, Planning and Geomatics
Preferred email address of applicant		Cathharvey101@gmail.com
If a Student	Your Degree e.g., MSc, PhD, etc.,	Masters of City and Regional Planning
	Name of Supervisor (if supervised)	Tania Katzschner
If this is a researchcontract, indicate the source of funding/sponsorship		Click here to enter text.
Project Title		How Spatial Planning can enable the implementation of Sustainable Urban Drainage Systems, in the Central Business District of the City of Cape Town

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	C Harvey		**23 Jun 2017**

APPLICATION APPROVED BY	Full name		Date
Supervisor (where applicable)	Tania Katzschner		**23 Jun 2017**
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section1, and for all Undergraduateresearch (Including Honours)	Click here to enter text.		Click here to enter a date.
Chair : Faculty EIR Committee For applicants other than undergraduate students who have	G SITHOLE Click here to enter text.		Click here to enter a date. 26/7/2017

Application for Approval of Ethics in Research (EiR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

answered YES to any of the above questions			