GUIDELINE ON COMPILING WATER-SENSITIVE SPATIAL PLANS

Werner Fourie, Hildegard Edith Rohr, Juanee Cilliers, Werner Mostert

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Report to the

Water Research Commission

by

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The publication of this report emanates from a project entitled Securing water sustainability through innovative spatial planning and land use management tools: A case study of two local municipalities in South Africa (WRC Project No. K5/2587).

This report forms part of a series of two reports. The other report is titled Framework towards water-sensitive spatial planning and land use management (**WRC report no. TT 809/1/19**).

EXECUTIVE SUMMARY

BACKGROUND

Over the past five years, South Africa has woken up to the reality that access to resources such as water is neither absolute nor guaranteed. Several regions within the country were declared drought disaster areas during 2018. The effects of this will be felt for many years to come. According to Wong and Brown (2008), conventional water management approaches have become highly unsuited in addressing current and future sustainability issues due to the physical and institutional compartmentalisation of municipal systems. In recent years, water sensitivity gained global awareness as the risks associated with climate change, increasing resource demands and environmental degradation continues to escalate at an alarming rate.

In response to the above, the aspirational concept of the water-sensitive city emerged in scientific, policy and practical domains as an alternative and sustainable approach to water resource planning and management in cities specifically. A water-sensitive city is defined as a city that interacts with the urban hydrological cycle in ways that provide for water security that is essential for economic prosperity by efficiently using the diversity of water resources that are available, enhancing and protecting the health of watercourses and wetlands, mitigating drought and flood risk and creating public spaces that harvest, clean and recycle water. It is widely accepted that the process to become a water-sensitive city involves a transition, driven by radical shifts in the structures, cultures and practices that are currently locked into unsustainable development paths.

In 2016, the Water Research Commission (WRC) of South Africa launched a new research project aimed at securing water sustainability through innovative spatial planning and land use management tools. This document is one of two outputs of this process and presents a guideline to compile water-sensitive spatial plans.

OBJECTIVES

In 2009 (prior to the enactment of the Spatial Planning and Land Use Management Act, Act No. 16 of 2013 (SPLUMA)), the Department of Rural Development and Land Reform (DRDLR) published a guideline for the development of a Municipal Spatial Development Framework to assist municipalities with the formulation of metropolitan, district and local spatial development frameworks (SDFs). The document distinguishes between the scope of SDFs for different municipalities, provides guidance on who should write and illustrate reports, and assigns a process for developing an SDF, comprising seven phases with approximate timelines, outcomes and technical notes.

In 2014, after the enactment of SPLUMA, the DRDLR once again published guidelines for the development of provincial, regional, and municipal SDFs and precinct plans. The guidelines clarify the roles and responsibility of government spheres in preparing SDFs at a provincial, regional, municipal and local scale, as legislated by SPLUMA (DRDLR, 2014). The guidelines offer insights on proposed planning timeframes, the procedural steps required in preparing an SDF, a proposed document structure and supporting products (DRDLR, 2014).

In April 2014, the WRC published its Water-sensitive Urban Design (WSUD) Framework and Guidelines, which set out a strategic framework for WSUD in South Africa. Part 2 of the document provides information and guidance on the selection and use of a sustainable urban drainage system (SUDS), sanitation and wastewater minimisation, groundwater management, sustainable water supply and various modelling tools for WSUD.

While the above planning legislation and accompanying guideline each states a preference for sustainable development and protecting the environment, it is silent about the more detailed aspects of achieving this.

Now that South Africa has its own framework and guidelines for WSUD, this document aims to guide planners on how to compile water-sensitive SDFs and a water-sensitive land use scheme (LUS) for local municipalities – in keeping with the founding spatial development principles, norms and standards as set by SPLUMA and any other relevant law. This guideline document provides step-by-step instructions on how to conduct a water-sensitive spatial analysis, guidance on stakeholders' identification, questions to be answered and documents to be assessed. Where possible, the guideline provides information on which spatial datasets are available for public use, and why and how to use this data in preparation of the two municipal planning tools.

This document aims to guide spatial planners in compiling water-sensitive spatial plans – specifically in reference to a water-sensitive SDF and a water-sensitive LUS. These plans should actively contribute to securing the availability of future water sources and improving the quality of water for future generations. Sustainable development is no longer a minor developmental issue, but a transdisciplinary challenge that must be placed at the forefront of the development agenda.

The target audience intended for the use of this document includes the following:

- Municipal officials and/or consultants responsible for developing a municipal spatial development framework and municipal LUS as mandated by SPLUMA.
- Municipal officials or authorities concerned with general spatial planning, water resource planning and environmental management, as well as those responsible for developing SDFs, integrated development plans (IDPs), catchment management strategies (CMSs), water services development plans (WSDPs), environmental management plans (EMPs), bioregional plans, municipal asset management plans and other sector plans related to land and water resources planning, either in-house or outsourced to a service provider.
- Property owners, community and business stakeholders within the selected study areas who have an interest in or are affected by an SDF or a municipal LUS.
- Traditional leaders and community members previously excluded from LUSs.

APPROACH

This guideline is structured into two parts:

- Part A provides background on water sensitivity in South Africa, as well as the notion of spatial planning
- Part B provides a detailed guideline on how to compile water-sensitive spatial development frameworks and land use schemes

Part A:

- **South Africa's concerns**
  South Africa is a semi-arid country that is not only characterised by low rainfall but also huge variations in the temporal and spatial distribution of precipitation, limited underground aquifers and a reliance on significant water transfers from neighbouring countries. Due to limited irrigable land and water-intensive (coal-fired) electricity generation, the strain on existing water resources is amplified (Goga and Pegram, 2014). The potential demand for water is expected to increase with economic growth, increased urbanisation, higher standards of living and population growth.

The recently published Long-term Adaptation Scenario (LTAS) report states that the climate change impacts on water in South Africa could exacerbate existing water-related challenges and create new ones related to climate variability, extreme weather events and changing rainfall seasonality (DEA, 2013). According to the analysis done by the Water Resources Group (WRG), based on growth projections and current efficiency levels, it is anticipated that a water supply-demand gap of 17% will exist by 2030 (WRG, 2009). With the competition for access to water expected to become even fiercer between domestic, recreational, agricultural and industrial land users, it is necessary to intervene not only through policy, but intentionally through spatial planning as well (Cameron, 2014).

- **Water sensitivity**
  The 21st century marks the first point in recorded history when the proportion of the world's population living in urban environments has surpassed those residing in the rural environment. This makes cities a critical focal point for realising sustainable practices. The majority of South Africa's population resides in urban areas. However, the sustainability and resilience of these urban areas have been in question for several years as city centres deteriorate and new developments have become favourable on the urban periphery. The result of this is low-density developments, which are energy-intensive and cause severe depletion in soil quality and loss of biodiversity. To address this, cities, towns and settlements should be designed and developed within the broader sustainability and resilience framework. The following pillars of practice for water-sensitive cities were identified from literature:

  - **Cities as catchments:** By utilising water from various portfolios within the city, the city becomes the catchment, and less strain is placed on centralised water and wastewater treatment works, which also reduces energy demand.
  - **Cities that provide ecosystem services:** The value of urban open spaces and landscapes must be evaluated in terms of their ecological functions that capture the essence of sustainable water management, microclimate influences, the facilitation of carbon sinks and their use for food production.
  - **Cities as water-sensitive communities:** New technologies must be socially embedded into the local institutional context, otherwise their development in isolation will be insufficient to ensure their successful implementation in practice.

The "Water-sensitive Urban Design for South Africa: Framework and Guideline" (Armitage et al., 2014) sets the foundation for future research, which revolves around the topic of urban water management and policy development in the integration of water cycle management into planning and design for the growth and development of water-sensitive settlements in South Africa. According to Armitage et al. (2014:viii), "there is untapped potential for more extensive coordination which could be facilitated by the urban and strategic planning fora." Information is still limited as to exactly how design and planning should engage with the concept of water-sensitive settlements, specifically within the South African context. Environmental management and improved land management practices are cross-cutting themes that also support the provision of green, resilient infrastructure and adaptation to climate change.

Households, industries and other land use activities consume water. Any new development must be planned (according to exact standards) and approved by the applicable municipality. This approval takes both the location and the extent of the development into consideration. This report establishes the linkage between development and water consumption while investigating planning instruments in more detail, specifically to investigate ways in which these planning instruments can be leveraged to ensure water sustainability.

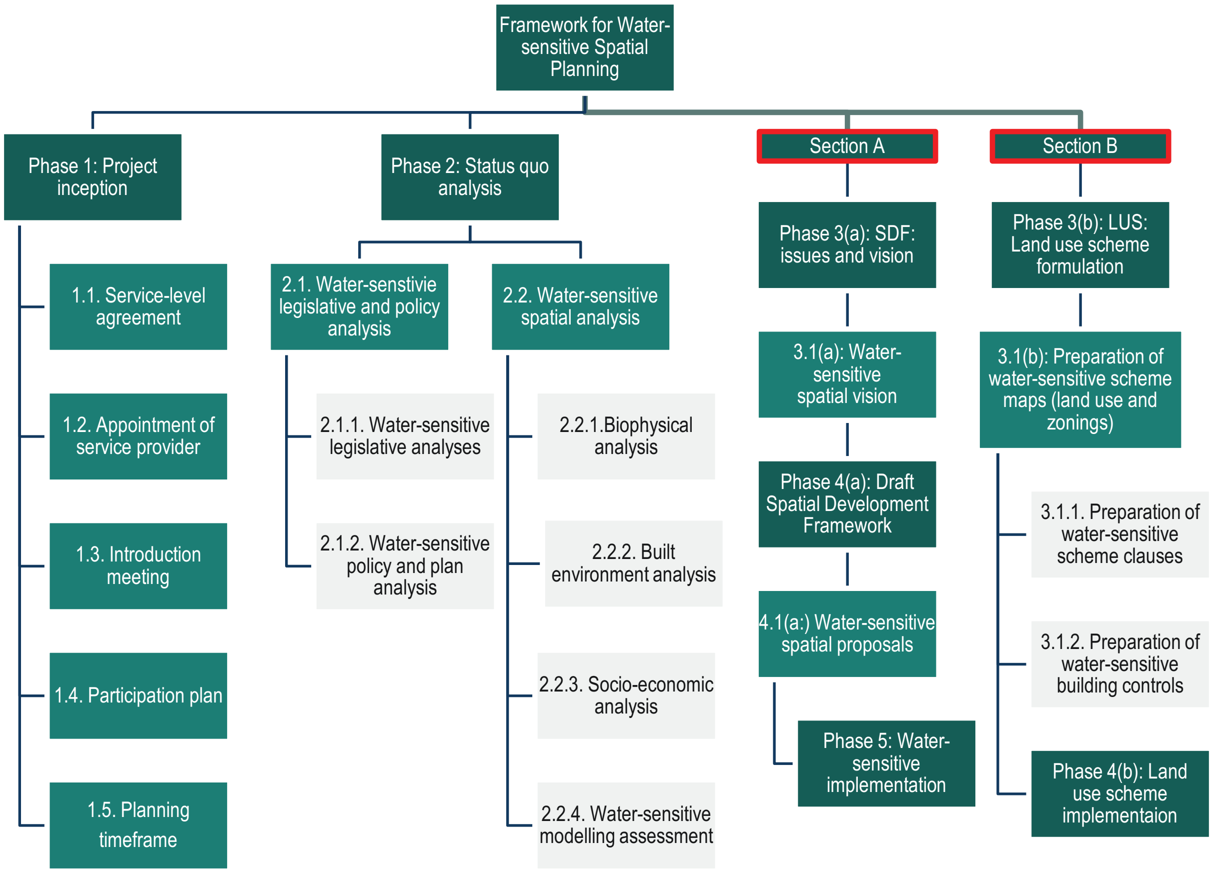
- **Spatial planning and land use management in South Africa**
  Planning comprises of the following distinct, yet interrelated processes (Van Wyk, 2012):

  - **Spatial planning:** The compilation of an initial plan or framework for future development. Known in South Africa as Spatial Development Framework or SDF, this type of planning is more concerned with the future shape of cities and towns. “Forward planning is a future-oriented exercise. It is concerned with the long-term future of a large area and identifying opportunities for growth and development so that land can be managed in the best interests of the public.” (Fiji Department of Town and Country Planning, 2015).
  - **Land use management:** This is the administration and regulation of changes to the use of land as determined in the original plan. This type of planning seeks to manage the legality of existing land uses and buildings through tools such as zoning codes (also referred to as town planning schemes, zoning schemes and use schemes in other parts of the world). This type of planning came about in the early 1900s to separate living areas and neighbourhoods from the negative effects of residing close to job opportunities such as industries (Elliot, 2008).
  - **Land development management:** This is the control of development that occurs after the land use has been determined (Ahmad and Bajwa, 2005).

By law, South African administrations have to plan for water, the environment and for future development. It is quite clear that these plans (required by law) are in place in most provinces, catchments and municipalities. With most of these plans requiring cross-sector alignment, one can almost assume that all issues are aligned and addressed in these documents. The SDFs and LUSs provide municipalities with tools to manage their land uses. Unlike other tools and policies developed at municipal level, the LUS can be enforced legally. If a specific land use is in contravention of the LUS, the municipality could use the scheme to force the land-owner to either become legally compliant or to cease the activity. To date, no local (or international) LUS has considered introducing clauses or elements that could allow them to manage resources (such as water) in a more effective way. This could be since resource management is typically the responsibility of a different sphere of government. Municipalities, however, are specifically mandated to decide what land use should be allowed on a property, as well as how “big” this land use should be. This basically means that indirectly municipalities also have a say in the quantity of water consumed (through land use decisions).

Part B:

This section is structured in several phases, sections and steps. The phases represent the typical project time frames that are mostly linked to a deliverable. This detailed guideline is set out as follow:



CONCLUSION

South Africans only recently woke up to the fact that we all stay in a relatively dry country. All indicators point to the fact that we can expect temperatures to rise because of global warming. At the same time, the population and corresponding water demand grow every day. Linked to rapid urbanisation, we can expect populated areas and cities to increasingly experience pressure to ensure reliable and safe water for its citizens and consumers. Planning for water and spatial planning have existed side by side for many years. To date, these two disciplines (although water is a key requirement of all development) fail to inform each other on a municipal scale. This guideline provides a detailed, step-by-step account of how to achieve water sensitivity in spatial plans. If successfully implemented, this guideline could pave the way to water sustainability in future.

ACKNOWLEDGEMENTS

The research in the report emanated from a project funded by the WRC entitled “Securing water sustainability through innovative spatial planning and land use management tools: a Case study of two local municipalities in South Africa”

The research group responsible for the project consisted of the following persons:

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LIST OF ABBREVIATIONS

ARC	Agricultural Research Council
BMP	Biodiversity Management Plan
CBA	Critical Biodiversity Areas
CMA	Catchment Management Agency
CMS	Catchment Management Strategy
CoGTA	Co-operative Governance and Traditional Affairs
DEAT	Department of Environmental Affairs and Tourism
DWS	Department of Water and Sanitation
EI	Ecological Infrastructure
EIA	Environmental Impact Assessment
EMF	Environmental Management Framework
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Area
GI	Green Infrastructure
GIS	Geographic Information System
IDP	Integrated Development Plan
ILI	Infrastructure Leakage Index
ISRDP	Integrated Sustainable Rural Development Programme
ISRDS	Integrated Sustainable Rural Development Strategy
IWRM	Integrated Water Resource Management
MLUS	Municipal Land Use Scheme
NBF	National Biodiversity Framework
NDP	National Development Plan
NEMA	National Environmental Management Act
NFEPA	National Freshwater Priority Area
NRW	Non-Revenue Water
NSDF	National Spatial Development Framework
NSDP	National Spatial Development Perspective
NWA	National Water Act
NWRS	National Water Resource Strategy
RDLR	Department of Rural Development and Land Reform
SANBI	South African National Botanical Institute
SDF	Spatial Development Framework
SPLUMA	Spatial Planning and Land Use Management Act
SuDS	Sustainable Urban Drainage Systems
VIP	Ventilated Improved Pit Latrine
WMA	Water Management Area
WRC	Water Research Commission
WSA	Water Services Authority
WSC	Water Sensitive Cities
WSDP	Water Services Development Plan
WSLUS	Water Sensitive Land Use Scheme
WSP	Water Services Provider
WSS	Water Sensitive Settlements
WSSDF	Water Sensitive Spatial Development Framework
WSSP	Water Sensitive Spatial Planning
WSUD	Water Sensitive Urban Design
WTW	Water Treatment Works
WWTW	Wastewater Treatment Works

DEFINITIONS

Table 0-1 provides a summary of words and terms relevant to the document:

Table 0-1: Glossary

Word / term	Description
Aquifer	A geographical formation which has structures or textures that hold water or permit appreciable water movement through them as defined in Act No. 36 of 1998.
Biodiversity / biological diversity	The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part and includes diversity within species, between species, and of ecosystems as defined in the Act No. 10 of 2004.
Buffer	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment	Means the area from which any rainfall will drain into the watercourse or watercourses or part of a water course through surface flow to a common point or common points as defined in Act No. 36 of 1998.
Critical Biodiversity Areas	Areas required to meet quantitative targets for biodiversity, as determined by an integrated terrestrial and aquatic systematic biodiversity plan. These areas are critical for conserving biodiversity and maintaining ecosystem functioning in the long term as defined in Act No. 10 of 2004.
Ecological infrastructure	Refers to naturally functioning ecosystems that deliver valuable services to people, such as healthy mountain catchments, rivers, wetlands, coastal dunes, and nodes and corridors of natural habitats, which together form a network of interconnected structural elements in the landscape. Ecological infrastructure is therefore the asset, or stock, from which a range of valuable services flow.
Ecological Support Areas	These are areas that play a significant role in supporting ecological functioning of Critical Biodiversity Areas and/or delivering ecosystem services as determined in a systematic biodiversity plan as defined in Act No. 10 of 2004.
Ecosystem	Means a dynamic system of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit as defined in the National Environmental Management Biodiversity Act No. 10 of 2004.
Ecosystem services	Are the benefits that people obtain from ecosystems, including provisioning services (such as food, water, reeds), regulating services (such as flood control, cultural services (such as recreational fishing), and supporting services (such as nutrient cycling carbon storage) that maintain the conditions for life on Earth.
Freshwater ecosystems	Are all inland water bodies whether fresh or saline, including rivers, lakes, wetlands, sub-surface waters and estuaries. The incorporation of groundwater considerations into the FEPA maps was rudimentary and future refinement of FEPA should seek to include groundwater more explicitly.
Land use scheme	Means the documents referred to in section 24 of Act No. 16 of 2013 for the regulation of land use.
Municipality	Is referred to as an entity, meaning a municipality as described in the Municipal Systems Act No. 32 of 2000, and a geographic area, means a municipal area determined in terms of Act No. 27 of 1998.
Spatial Development Framework	Means spatial development framework referred to in section 21 of Act No.16 of 2013
Systematic biodiversity planning	Systematic biodiversity planning is a strategic and scientific approach to identifying those areas that are the most important for biodiversity conservation.
Water Conservation and Water Demand Management (WC/WDM)	Is an approach in water resource management that seeks to improve water use efficiency through using available water more wisely and through seeking appropriate and cost-effective technologies that reduce wasteful use. Water demand

	management encourages efficient use by encouraging users to reduce their demands on the resource.
Water security	The reliable availability of an acceptable quantity and quality of water for health, livelihoods and production, coupled with an acceptable level of water-related risks.
Wetland	Means land which is transitional between terrestrial and aquatic systems where the water table is usually on the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

Source: South Africa (1998); South Africa (2004); South Africa (2013); DWAF (2005); Western Cape (2014); SANBi (2014c); DWAF (2006) and Grey & Sadoff (2007).

UNIT OF MEASUREMENT

ha: Hectare
km: Kilometre
km^2: Square kilometre
m^3: Cubic metre
m^3/d: Cubic metre per day
m^3/a: Cubic metre per annum
m: Metre
mm: Millimetre
mm/yr: Millimetre per year
R: Rand

CHAPTER 1: INTRODUCTION

Over the past five years, South Africa has woken up to the reality that access to resources such as water is neither absolute nor guaranteed. Several regions within the country were declared drought disaster areas during 2018. The effects of this will be felt for many years to come. According to Wong and Brown (2008), conventional water management approaches have become highly unsuited in addressing current and future sustainability issues due to the physical and institutional compartmentalisation of municipal systems. In recent years, water sensitivity gained global awareness as the risks associated with climate change, increasing resource demands, and environmental degradation has continued to escalate at an alarming rate.

In response to the above, the aspirational concept of the water-sensitive city emerged in scientific, policy and practical domains as an alternative and sustainable approach to water resource planning and management in cities specifically. The Cooperative Research Centre for Water-sensitive Cities (CRCWSC) defines a water-sensitive city as a city that interacts with the urban hydrological cycle in ways that provide for water security that is essential for economic prosperity by efficiently using a diversity of water resources available, enhancing and protecting the health of watercourses and wetlands, mitigating drought and flood risk and creating public spaces that harvest, clean and recycle water. It is widely accepted that, in becoming a water-sensitive city, the process involves a transition, driven by radical shifts in the structures, cultures and practices that are currently locked into unsustainable development paths.

The WRC of South Africa has formed a strong partnership with the Department of Water and Sanitation (DWS) as it undertakes water-related research activities. In 2011, the WRC started to focus on research related to water sensitivity. It initiated several lighthouse projects to give effect to water sensitivity. The first was “Lighthouse 1 – Water-sensitive Design”. The purpose of this project was to develop a critical mass of knowledge around the integration of planning activities for the adoption of water-sensitive design in South Africa.

Inspired by the Lighthouse 1 Project, as well as increasing awareness of the benefits of the water-sensitive city, the WRC launched a new research project in 2016, aimed at securing water sustainability through innovative spatial planning and land use management tools. The research team comprised mainly urban and regional planners (also referred to as spatial planners, urban planners or town planners). The objective was to understand the complex relationship between land, water and environmental resources. Once this relationship was well understood, the research team assessed the legal framework and institutional agreements adopted by government for each resource. The assessment focused specifically on the legislative requirements for strategic plans, policies and regulations affecting land, water and environmental resource planning and management. Furthermore, the research team reviewed several national strategies and key research projects and identified national spatial data sources applicable to the study.

South Africa had recently enacted SPLUMA, which was identified as a key mechanism to drive change in municipal spatial planning. The reason for this was that the Act mandates each municipality to adopt an SDF and an LUS for its entire municipal area within five years of the commencement of the Act. Furthermore, these plans should give effect to the development principle of spatial justice, spatial sustainability, spatial resilience, spatial quality and spatial efficiency, as set out in Chapter 2 of SPLUMA. Throughout the research process, it became progressively evident that spatial planning is a multi-dimensional practice with the potential to give effect to water sensitivity both strategically and legally.

Understanding the close relationship between land, water and the environment, as well as the legislative framework and institutional agreements governing each element, and lessons learned from international water-sensitive best practices, and local knowledge on specific challenges and opportunities in South Africa, two new research documents related to water sensitivity were made available:

- Framework Towards Water-sensitive Spatial Planning and Land Use Management
- A Guideline on Compiling Water-sensitive Plans

1.1. FOCUS OF THIS GUIDELINE

Prior to the enactment of SPLUMA in 2009, the DRDLR published guidelines for the development of municipal SDFs to assist municipalities with the formulation of metropolitan, district and local SDFs. The document distinguishes between the scope of SDFs for different municipalities, provides guidance on who should write and illustrate reports, and assigns a process for developing an SDF. This process consists of seven phases with approximate timelines, outcomes and technical notes.

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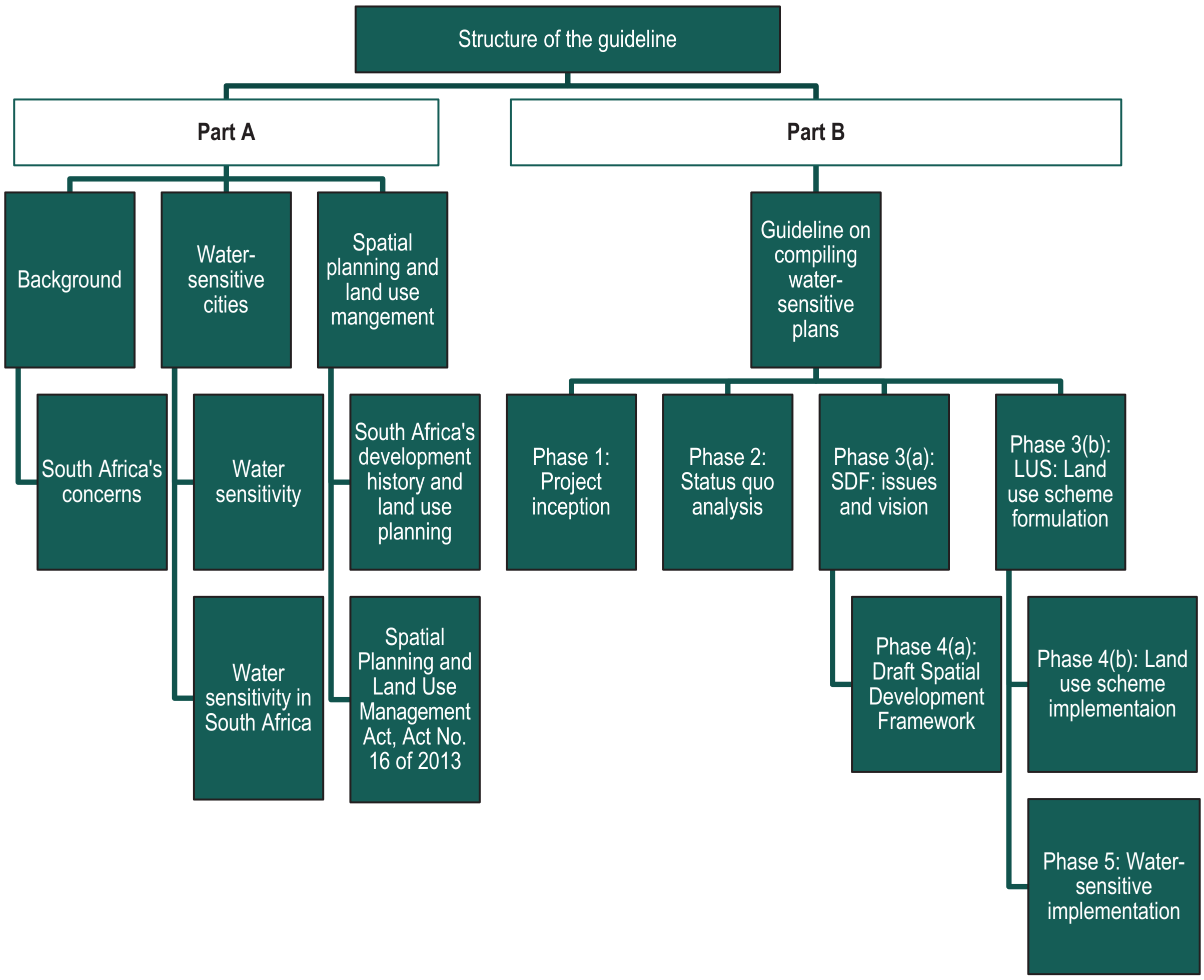
1.2. TARGET AUDIENCE

The target audience intended for the use of this document includes the following:

- Municipal officials and/or consultants responsible for developing a municipal spatial development framework and municipal LUS as mandated by SPLUMA.
- Municipal officials or authorities concerned with general spatial planning, water resource planning, environmental management and those responsible for developing SDFs, IDPs, CMSs, WSDPs, EMPs, bioregional plans, municipal asset management plans and other sector plans related to land and water resources planning, either in-house or outsourced to a service provider.
- Property owners, community and business stakeholders within the selected study areas who have an interest in or are affected by an SDF or a municipal LUS.
- Traditional leaders and community members previously excluded from LUSs.

1.3. STRUCTURE OF THE GUIDELINE



CHAPTER 2: BACKGROUND

Continents, countries, cities, towns, settlement and the people living in them experience different climates daily as their relative location to the earth's equator varies (Cai et al., 2017). Societies have become accustomed to their unique climates and have structured their day-to-day lives around historical and current climate conditions. The downside of this is that cities and settlements, and their accompanying communities, economies, infrastructure and natural resource base, are now accustomed to a normal range of conditions and may be sensitive to extremes that fall outside this range. With climate change, a reality, planning for sustainable and resilient settlements has become of primary importance to municipalities.

Everything society does, from its economy to its culture, depends – in part – on safe, stable access to water resources. When planning for sustainable and resilient settlements, planners must be aware of existing constraints and opportunities. As a point of departure, a brief background on South Africa's ecological infrastructure and available resource base is provided, followed by a brief overview of the country's physical infrastructure and how the location and density of settlements are affecting both its ecology and its physical infrastructure. This section also provides an overview of the existing economic water demand and how both physical development and water use have affected the country's natural environment.

1.4. SOUTH AFRICA'S CONCERNS

2.1.1 Ecological infrastructure

2.1.1.1 Relative location and geographical entity

Situated between 22°S to 35°S latitude and stretching over 17°E to 33°E longitude, also referred to as the southernmost part of the African continent, lies South Africa (Statistics South Africa, 2011a). The northeastern corner of the country lies within the tropics, astride the Tropic of Capricorn, and borders Zimbabwe and Mozambique. The remaining northern border shares an international boundary with both Botswana and Namibia. The rest of the country's eastern, southern and western boundaries are defined by an extensive coastline of approximately 3,200 km. South Africa's total surface area is calculated at 1,219,090 km^2, divided into nine provinces (Limpopo, 123,910 km^2; Mpumalanga, 79,490 km^2; North West, 116,320 km^2; Northern Cape, 361,830 km^2; Gauteng, 17,010 km^2; Free State, 129,480 km^2; KwaZulu-Natal, 92,100 km^2; Eastern Cape, 169.580 km^2; and Western Cape, 129,370 km^2) (Schulze, 2011). In addition, the kingdoms of Lesotho (29,558 km^2) and Swaziland (17,404 km^2) are also situated within the eastern interior of South Africa. For reporting purposes and to highlight the hydrological importance of both Lesotho and Swaziland to South Africa, the extent of these areas will form part of the geographical entity covered by this document. This amounts to a total surface area of 1,266,052 km^2.

2.1.1.2 Altitude and temperature

The county's topography, an invariant feature of the physical landscape, explains a lot of South Africa's climate features and hydrological responses (Schulze, 2011). South Africa has generally low altitudes, ranging between 0 and 400 m along the coastline, with generally cooler maximum summer temperatures ranging between <24 °C and 26 °C. As the altitudes increase along the east and south coast towards the Great Escarpment, maximum annual summer temperatures decrease to below 24 °C. This is where peak altitudes, ranging between 2,000 and 2,500 m, are found in KwaZulu-Natal and Lesotho, forming part of the Drakensberg mountain range. The vast interior plateau inland of the Great Escarpment drops gently from the east at around 1,500 m to the west at around 1,000 m (Schulze, 2011).

With decreasing altitudes, maximum annual summer temperatures increase from 27 °C in the east to extreme highs of over 31 °C to the west. According to the maximum summer temperature database of the Agricultural Research Council (ARC), 27% of the Northern Cape experiences maximum annual summer temperatures of over 31 °C. The ARC's spatial data also reveals that 22% of South Africa experiences an average maximum summer temperature between 29 °C and 31 °C, followed by 18% of the country with a slightly higher average maximum summer temperature between 31 °C and 33 °C.

2.1.1.3 Rainfall and evaporation

Due to the gradual north to south, yet slightly rapid east to west altitude and temperature change, spatial and temporal variations in mean annual precipitation (MAP) can be observed. South Africa has an average MAP of less than 500 mm yr^{-1} (Nel and Driver, 2015; Colvin and Muruven, 2017), which is less than half the world's average. Between the eastern coastline and the Great Escarpment, irregularities in altitudes cause severe fluctuation in MAP, ranging between 600 mm yr^{-1} to 1,000 mm yr^{-1}, decreasing to a low of 200 mm yr^{-1} towards the south of the coastline. Naturally, the highest MAP, ranging between 800 mm yr^{-1} to >1,000 mm yr^{-1}, is found along the high altitude areas of Amatole, the Boland Mountains, the Eastern Cape Drakensberg, the Groot Winterhoek, Kougaberg, Langeberg, the Maloti Drakensberg, Mbabane Hills, Mfolozi Headwaters, the Mpumalanga Drakensberg, the Northern Drakensberg, Outeniqua, the Phongola Drakensberg, the Pondoland Coast, the Southern Drakensberg, the Soutpansberg, Swartberg, Table Mountain, Tsitsikamma, Wolkberg and the Zululand Coast. According to Schulze (2011), the overall feature of the distribution of MAP over South Africa is that it decreases uniformly westwards from the escarpment across the interior plateau from approximately 1,000 mm yr^{-1} to less than 200 mm yr^{-1}. King et al (2011) noted that 21% of the country receives less than 200 mm yr^{-1}. Most of the 21% is found within the warm interior plateau towards the west in the Northern Cape. The combination of low altitudes and high temperatures is causing South Africa to experience high evaporation rates averaging 1,800 mm yr^{-1} (Colvin and Muruven, 2017). According to the ARC's mean annual evaporation database, the lowest evaporation occurs along the eastern to the southern coastline, remaining relatively low towards the Great Escarpment. Like the temperature observations and in contrast to the rainfall observations, evaporation increases uniformly westwards from the escarpment across the interior plateau from approximately 1,601 mm yr^{-1} to 2,400mm yr^{-1}, increasing rapidly towards the Northern Cape to >2,401mm yr^{-1}.

2.1.1.4 Surface water runoff

In most regions across South Africa, the evaporation rate is three times the precipitation rate resulting in a very low MAP: MAR ratio (the rate at which precipitation is converted into runoff) of 8.6% (Davies et al., 2006). According to the WRC, 75% of the country's catchments have a mean annual runoff (MAR) potential of less than 100 mm yr^{-1}, found mostly northwest of the Great Escarpment across the country's vast interior. Only 25% of catchments have relatively high volumes of runoff, ranging between 100 mm yr^{-1} and >500 mm yr^{-1}. These areas are limited to Swaziland, Lesotho and most of the Eastern Cape, decreasing southwards over KwaZulu-Natal and Western Cape, with some catchments producing less than 20 mm yr^{-1}. Disproportionately high volumes of runoff, at least three times more than that of the primary catchment, is produced by several catchments across the country and are referred to as South Africa's strategic water source areas (SWSAs). The DWS (2013) describes SWSAs as "…foundational infrastructure on which a great deal of built infrastructure for water services depend" (DWS, 2013, p. 42), which should be treated as "strategic national assets that are vital for water security and need to be acknowledged as such at the highest level across all sectors" (DWS, 2013, p. 42).

The SWSAs are found within the high-altitude areas of Amatole, the Boland Mountains, the Eastern Cape Drakensberg, Groot Winterhoek, Kougaberg, Langeberg, the Maloti Drakensberg, Mbabane Hills, Mfolozi Headwaters, the Mpumalanga Drakensberg, the Northern Drakensberg, Outeniqua, the Phongola Drakensberg, the Pondoland Coast, the Southern Drakensberg, the Soutpansberg, Swartberg, Table Mountain, Tsitsikamma, Wolkberg and Zululand Coast.

The SWSAs take up less than 8% of the geographic entity and produce over 50% of the country's surface water. The bulk (80%) is generated by 3.9% of land found in South Africa alone (Nel et al., 2013; Driver et al., 2012).

2.1.1.5 Groundwater baseflow

Runoff also recharges groundwater aquifers and, like SWSAs, South Africa's aquifer recharge potential does not occur uniformly across the country as it is mainly dependent on rainfall and geological permeability. Much of the country's high recharge potential is found in Gauteng, Mpumalanga, the Free State, and scattered zones across the Western Cape. Preferential recharge areas (like the SWSAs) exist, however, the mapping of these areas is still underway (Nel et al., 2011). The baseflow calculation determines the dry-weather flow in streams and rivers, which results largely from groundwater seeping into rivers. The country's groundwater baseflow is generally high in KwaZulu-Natal and Mpumalanga, with Gauteng ranging between 6,001 m^3 per km^2 per annum to 65,576 m^3 per km^2 per annum, decreasing rapidly towards the north of Limpopo. Baseflow in Limpopo is highly irregular as some catchments have a high baseflow between 15,001 m^3 per km^2 per annum and 65,576 m^3 per km^2 per annum, while the rest of the country has a 0 m^3 per km^2 per annum baseflow. Along the international border and down to the western interior of the country, baseflow is 0 m^3 per km^2 per annum. The countrywide low baseflow is typical of a semi-arid to arid climate as groundwater tables are too deep to contribute to river baseflow.

2.1.1.6 Water resource availability

Under natural undeveloped conditions, South Africa's average total mean runoff is estimated at just over 49 000 million m^3 per annum (WRC, 2016). According to Colvin and Muruven (2017), an estimated 9% (or 4 410 million m^3 per annum) of the runoff ends up in rivers, causing high variability of water flow and very low to zero levels of river flow, while 4% (or 1,960 million m^3 per annum) recharges groundwater or aquifers. According to DWS, of the estimated 49,000 m^3 per annum, only 30% (or an estimated 15,000 million m^3 per annum) of the average annual runoff can and has already been allocated at a high 98% assurance of supply. The estimated 15,000 million m^3 per annum comprises 68% (or an estimated 10,200 million m^3 per annum) surface water; 13% (or an estimated 1,950 million m^3 per annum) groundwater; 13% (or an estimated 1,950 million m^3 per annum) return flow; and 6% (or an estimated 900 million m^3 per annum) from other sources such as desalination. Of this estimated 15,000 million m^3 per annum, 98% (or an estimated 14,700 million m^3 per annum) is already allocated, meaning that the country has only 2% (or an estimated 300 million m^3 per annum), which is currently unallocated.

However, the recently published 2016 Groundwater Strategy indicated that the initially estimated groundwater contribution of 13% (or 1,950 million m^3 per annum), is less than the current usage. The strategy reports that the current groundwater usage is between 3,000 million m^3 per annum and 4,000 million m^3 per annum, and that the utilisable groundwater exploration potential (UGEP) is 7,500 million m^3 per annum, allowing for factors such as physical constraints on extraction, potability and maximum allowable drawdown (DWS, 2016a). It is evident that groundwater is an underutilised resource, mostly because it is also a misunderstood resource.

2.1.2 Physical infrastructure

2.1.2.1 Water engineering system

The spatial location of economic activities, coupled with complex population distribution patterns, underpinned by the promise of "Water for all", calls for a sophisticated water engineering system. South Africa has constructed thousands of small dams and 320 major dams, each with a full supply capacity of more than 1 million m^3 and a total capacity of 32,400 m^3, currently storing more than 66% of the country's MAR.

Part of the water engineering system is 29 inter-basin and inter-river system transfer schemes with a total capacity of 7,000 million m^3 per annum. South Africa has an estimated 1,300 water treatment works (WTW) operating at close to 80% of their collective capacity (DWS, 2015). Furthermore, the country boasts with 1,363 registered wastewater treatment works (WWTW), 879 of which are municipally owned, 393 privately owned, and 73 owned by either the national Department of Public Works or the national Department of Health (DWS, 2015). In 2013, the national Blue Drop Report was released. This report provides information on how well WTW comply with the South African National Standards for drinking water (SANS 241). According to the report, 43% of WTWs were performing on average, followed by 24% performing very poorly and 17% being in a critical state. The 2013 Green Drop report, which assesses the performance of WWTWs, reported that only 16% of WWTWs were performing well to excellently; 34% were rated as average, while 20% were preforming poorly; and 30% were rated as being in a critical state. The report also confirmed that a total operational flow of 5,128.8 Mℓ is treated daily. However, the collective hydraulic design capacity is 6,509.7 Mℓ per day. This means that 78.8% of the existing design capacity is accounted for by the current operational flows, leaving a theoretical surplus of 22.2% as the available capacity for future demand (although many individual plants have no surplus and run at full capacity). According to DWS, more than 50% of settlements in five out of nine provinces have potable water (DWS, 2016a).

2.1.2.2 Built environment

For many years now, conventional water engineering systems have been operating in both urban and rural settlements as this remains the most sought-after solution to distributed water and wastewater over thousands of kilometres to where it is required at selected volumes as determined by consumer demand and resource availability. However, conventional infrastructure is often criticised as being fragmented, lacking flexibility, being energy-intensive and often implementing measures that are not cost-effective or sustainable in the long term. In South Africa, these challenges are exaggerated by the low density, sprawling characteristics of urban areas, where higher densities are often found on the outskirts of cities. These peri-urban settlements exhibit characteristics such as having affluent residential areas (high-end residential development that often consumes resources unsustainably), low-cost, social housing estates (Reconstruction and Development Programme (RDP) housing on degraded land with a low market value and often poorly planned) and high-density, unplanned, informal and illegal settlements (DEA, 2014).

Rural settlements, on the other hand, typically refer to unplanned and sparsely populated rural areas that contain small pockets of higher density areas associated with some form of economic and transportation activity. These settlements frequently suffer from inadequate municipal support and services due to low budgets and capacity constraints (DEA, 2014). South Africa also has settlements located within the former homelands that have combined features of urban and rural settlements (DEA, 2014). These areas are "governed" by either tribal chiefs, traditional authority or a council that also allocates land and land use. These allocations and land use decisions are often uninformed due to a lack of adequate planning land use management systems (DEA, 2014).

Apartheid spatial planning, as well as efforts to fix the development trend, can largely be blamed for this unsustainable development pattern. Today, the typical South African city is resource-intensive and suffers from inefficiencies across sectors (energy, food, water, waste and transport) (Turok and Borel-Saladin, 2014). The direct water-related impact is seen in the volume of water that is lost in the distribution network, which increases as densities decrease. As a result, the country's infrastructure leakage index is calculated at 5.3 on average, resulting in a 37% physical loss of water resources within the country's urban water infrastructure network.

2.1.3 Water demand

A combination of South Africa's ecological and physical infrastructure has kept the country's economy and social development alive. As indicated in Chapter 2.1.2**,** the current need or demand for water is estimated at 15,000 million m^3 per annum. This demand is mainly driven by three major sectors: agriculture (63% or 9,450 million m^3 per annum), municipal (26% or 3,900 million m^3 per annum) and industrial (11% or 1,650 million m^3 per annum).

2.1.3.1 Agricultural demand

The major agricultural water uses include the irrigation of crops and the water-intensive grazing of livestock. Compared to other countries, the agricultural demand for water is generally higher, due to the country's climate and soil characteristics, which are extremely vulnerable to degradation and have low recovery potential. Thus, even the smallest mistakes in land management can be devastating, with little chance of recovery (Galdblatt, 2014). According to Goga and Pegram (2014), only an estimated 12% (or 146,291 km^2) of the country is suitable for growing rain-fed crops, while only about 3% (36,573 km^2) is considered truly fertile. Even though irrigated agriculture is by far the largest consumer of water, only 1.5% of agricultural land is under irrigation, producing 30% of the country's crops (GCIS, 2009, cited by Goga and Pegram, 2014), while 67% is used for grazing and livestock farming (DWS, 2015a). According to Nel et al. (2011), many of South Africa's rivers are over-abstracted for agriculture, and several naturally perennial rivers are now seasonal.

2.1.3.2 Municipal demand

The major municipal water uses include water for gardening, toilet flushing and personal hygiene in homes, schools, hospitals, commercial centres and businesses. According to Colvin and Muruven (2017), domestic water use is split between garden use (35% or 3,307 million m^3 per annum), toilet flushing (29% or 2,740 million m^3 per annum), personal hygiene (20% or 1,890 million m^3 per annum), laundry (13% or 1,128 million m^3 per annum) and other uses such as cooking (3% or 283 million m^3 per annum). According to the 2016 household statistics, 90% of all households in South Africa have access to piped water, while the remaining 10% use water from other sources. Government allocates 6,000 ℓ (or 6 m^3 per month) of "free" water per month per household. With an average household consisting of 3.3 people (Stats SA, 2016a), this means that each person has an allocated 60 ℓ of free basic water per day. This is known as government's promise to provide a free basic water supply for all. However, according to DWS, South Africa's gross average water consumption is estimated at 229 ℓ per person per day (or 0.229 m^3 per day). Using the average household figures of 2016 to determine the volume of gross average household water consumption gives 22,671 ℓ per month per household, which is 3.7 times the volume of government's free basic water supply.

2.1.3.3 Industrial demand

Industrial water demand is roughly split between 53% manufacturing, 27% mining and 2% power generating. The high demand for water by manufacturing companies is mainly for processing minerals and crops, textiles and chemical refinement, and, in some instances, a component of auto manufacturing. However, the required volume and impact of manufacturing on the water depends largely on the type of manufacturing industry. Several industries in South Africa have been identified as high-water users, e.g. Nestlé, Coca Cola, Sasol and SABMiller. One of the major concerns of industrial water use is the high level of contaminated water generated by most industries. Gold, coal, platinum and diamond mining are four major mining sectors in South Africa. Water demand for mining is mainly for extraction, often resulting in acid mine drainage. South Africa's energy supply is mainly generated in water-intensive coal-fired power stations. These stations require water mostly for cooling. Furthermore, DWS (2015) reported that return flows from irrigation, urban domestic use and bulk industrial and mining effluents could offer re-use opportunities of up to 1,900 million m^3 per annum, which is double the current return flow.

2.1.4 State and quality of water resources

The state of ecological infrastructure and water quality is largely affected by two major factors: the introduction of hydrological control sources, and land cover change.

2.1.4.1 Hydrological control source

The construction of hydrological control sources such as dams, weirs and large-scale water transfers has caused severe flow alterations in the form of over-abstraction, inter-basin transfers and high return flows from urban areas. Alteration of the flow regime (e.g. timing, frequency, speed or volume of flow) changes the channel characteristics and habitats, which ultimately affect the quality of water and the integrity of aquatic life in rivers and wetlands (Nel et al., 2011; DWA, 2011). In several catchments, the discharge of partially treated or untreated effluent back into the natural hydrological system is a major concern. These unlawful actions can be traced back to the 50% of WTW that are already in a poor or critical state and operating at full design capacity. Treating effluent to an appropriate quality will become increasingly more difficult as water demand continues to grow.

2.1.4.2 Land cover change

Land-based activities are much to blame for the state of the country's ecological infrastructure and water quality. As natural land cover undergoes change to accommodate man-made infrastructure, the soil's infiltration potential or capacity decreases significantly, resulting in high volumes of stormwater runoff. As stormwater travels over the impervious surfaces and interacts with land-based activities, it becomes contaminated by nutrient and sediment pollutions. Major sources of impacting sources of sediment and nutrient pollution include agricultural drainage and wash-off (irrigation return flows, fertilizers, pesticides and runoff from feedlots), urban wash-off and effluent flows (bacterial contamination, salts and nutrients), industries (chemical substances), mining (acids and salts) and areas with insufficient sanitation services (microbial contamination) (WRC, 2016; Nel et al., 2011; DWS, 2013).

2.1.4.3 Sediment pollution

Sediment pollution is caused by accelerated erosion due to human activities such as deforestation, poor agricultural practices, road construction and landscaping. It causes high levels of turbidity, which limits the penetration of sunlight into the water column, thereby limiting or prohibiting the growth of algae and rooted aquatic plants. Elevated levels of sedimentation in rivers lead to the physical disruption of the hydraulic characteristics of the channel. This can have serious impacts on navigation by a reduction in the depth of the channel and may result in increased flooding because of reductions in the capacity of the river channel to efficiently route water through the drainage basin.

2.1.4.4 Nutrient pollution

Nutrient pollution is caused by fertilizers, animal waste, organic matter and septic tanks, which produce excess nitrogen (N), nitrates (NO_3), ammonia (NH_3) and phosphorus (PO_4) in the air and water. Agriculture is considered to be the largest source of nitrogen and phosphorus pollution, followed by urban stormwater, which carries pollutants into local waterways. Wastewater treatment works, which do not operate properly or remove enough nitrogen and phosphorus before discharging it into waterways, also cause nutrient pollution in water sources, whereas electric power generation, industry, transportation and agriculture have increased the amount of nitrogen in the air through the use of fossil fuels. Fertilizers, garden and pet waste, and certain soaps and detergents used in and around the house contain nitrogen and phosphorus and can contribute to nutrient pollution if not properly used or disposed of. Too much nitrogen and phosphorus in the water causes algae to grow faster than ecosystems can handle it. Significant increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other forms of aquatic life need to survive.

Large growths of algae are called algal blooms, and can severely reduce or eliminate oxygen in the water, leading to illnesses and death of fish. Other pollutants commonly found in stormwater include organic matter, pathogens, hydrocarbons, metals, toxic chemicals and solids such as debris and refuse.

2.1.4.5 Protection levels

The previous section highlighted that 8% of land forming part of South Africa's SWSAs produces over 50% of surface water resources. Unfortunately, only 18% of the country's SWSAs are formally protected (Driver et al., 2012). The lack of legal protection continues into South Africa's rivers, wetlands and estuaries, as only 14% of the country's 223 river ecosystems (Driver et al., 2012) are well protected, and one third is poorly protected, leaving more than half of all river ecosystems entirely unprotected (Driver et al., 2012). As for South Africa's 791 wetland ecosystem types, which only take up an estimated 2.4% of land, 11% is well protected, while 71% is not protected at all (Driver et al., 2012). Only 33% of estuary ecosystem types are well protected, while 59% have no protection at all (Driver et al., 2012). The lack of legal protection, coupled with rising pressure to fulfil socio-economic needs, has resulted in a looming water supply crisis, fed by widespread destruction and pollution of freshwater ecosystems.

The above threats have caused 57% of the country's river ecosystems to become threatened, 26% to be critically endangered, 19% to be endangered and 13% to be vulnerable (Driver et al., 2012). Furthermore, 48% of wetlands are critically endangered, 12% are endangered, 5% are vulnerable and 35% are least threatened (Driver et al., 2012). However, the hidden nature of groundwater resources makes it prone to misunderstanding and mismanagement. To date, the clear and effective regulation of subterranean groundwater resource areas remains absent, placing this resource under severe threat (DWS, 2016a). According to Nel et al. (2011), many of South Africa's rivers are over-abstracted for agriculture, and several naturally perennial rivers are now seasonal. With a movement towards more intensive farming, as well as the farming and irrigation of marginal areas, there has been pollution of ground and surface water, loss of biodiversity, loss of soil fertility and erosion. The costs of these have largely not been factored into planning and decision-making in South Africa. Agricultural production in South Africa can be divided broadly into two categories, which typically refer to well-developed commercial farming and smaller-scale farming, largely on communal land and predominantly in the former homeland areas. Invasive alien species and climate change also contribute to the destruction of the natural habitat (Nel et al., 2011).

2.1.5 Population growth and urbanisation

Municipalities are faced with a continuous game of catch-up, as access to infrastructure and services falls behind population demand. The country grew by 2.5 million households from 2011 to 2016 (Statistics South Africa, 2011b). Table 2.2 indicates that, in 2016, 2% more households were residing in urban areas compared to 2011 – a clear indication of urbanisation.

Table 2.2: Number of households per geo-type (2011 to 2016)

Geo type	2011		2016	
	Households	Percentage	Households	Percentage
Urban area	9,779,826	68%	11,824,674	70%
Tribal or traditional area	3,911,208	27%	4,377,709	26%
Farm	759,127	5%	720,926	4%
Total	**14,450,161**	**100%**	**16,923,309**	**100%**

Source: STATS-SA (2001) (2006)

With more people flocking to our cities and towns, ensuring that everybody will have a place to stay with enough resources is becoming a priority for planners worldwide.

2.2 CONCLUSION

The fact that South Africa is a semi-arid country, characterised by not only low rainfall but also huge variations in the temporal and spatial distribution of precipitation, limited underground aquifers and a greater reliance on significant water transfers from neighbouring countries, has made this challenge even more complicated. Due to limited irrigable land and water-intensive (coal-fired) electricity generation, the strain on existing water resources is amplified (Goga and Pegram, 2014). The potential demand for water is expected to increase with economic growth, increased urbanisation, higher standards of living and population growth. The recently published LTAS Report states that climate change impacts on water in South Africa could exacerbate existing water-related challenges and create new ones related to climate variability, extreme weather events and changing rainfall seasonality (DEA, 2013). According to the analysis done by WRG, based on growth projections and current efficiency levels, it is anticipated that a water supply-demand gap of 17% will exist by 2030 (WRG, 2009). With the competition for access to water expected to become even fiercer between domestic, recreational, agricultural and industrial land users, it is necessary to intervene not only through policy but intentionally through spatial planning too (Cameron, 2014).

CHAPTER 3: WATER-SENSITIVE CITIES

3.1 INTRODUCTION

A global response to the water crisis has led to the development of an alternative approach to conventional water resource management. This chapter looks at the recently famed concept of water-sensitive cities and provides a brief overview of South Africa's achievements to date.

3.2 WATER SENSITIVITY

The concept of integrated water resource management (IWRM) is defined as "the process which promotes the coordination, development and management of water, land and related resources, to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000). The definition of IWRM explicitly refers to the integrated management of land and water. The report of the Global Water Partnership (GWP) describes this relationship as follows, "Land use developments and vegetation cover influence the physical distribution and quality of water and must be considered in the overall planning and management of the water resources. Another aspect is the fact that water is a key determinant of the character and health of all ecosystems (terrestrial as well as aquatic), and their water quantity and quality requirements, therefore, have to be considered in the overall allocation of available water resources." (GWP, 2000, p. 24). South Africa is no stranger to this concept. In fact, IWRM was adopted in early 1990 in new water policies and legislation drafted after the fall of the apartheid regime.

Even though the concept of IWRM was included in water policies, it was primarily focused on infrastructure provision, water pricing and governance as South Africa embarked on an ambitious programme to eradicate water backlogs as envisioned by the RDP. Although well-intentioned, literature points out that, during the transition period from apartheid to democracy, and in the restructuring of local government, limited integrated development planning took place (Asmal, 2000; Dewar, 1998; Donaldson & Marais, 2002). During this transition period, according to Dewar (1998), policies were formulated "within discrete national line function departments, with little reference to the activities in other departments" (Dewar, 1998, p. 369). He claims that this approach contributed to a fragmented and distorted urban planning and development phase. Unfortunately, planning for land and planning for water still lack critical integration in South Africa. As stated by Woltjer & Als (2007), "the majority of decisions around water management are made without reference to spatial planning issues related to urbanisation and population growth, and conversely, development and land-use decisions are made with little consideration of their effects on water systems." According to Thomson-Smeddle and Roux (2016), this is primarily due to the continued predominance of outdated approaches to township planning, infrastructure and housing design, and a lack of cross-sector integration and collaboration.

The acknowledgement of major global issues of environmental degradation and resource depletion, as well as the deterioration of living standards, have contributed to the collective agreement that sustainability is no longer a minor developmental issue, but a transdisciplinary challenge that must be placed at the forefront of the development agenda. The delivery of more sustainable development requires a shift in thinking for all sectors, which cuts across traditional disciplinary, professional and administrative boundaries. Spatial planning comes to the fore as a tool that can and must be used in South Africa when planning for the security of water and land resources.

3.2.1 Water-sensitive cities

The 21st century marks the first point in recorded history when the proportion of the world's population living in urban environments has surpassed those residing in the rural environment, making cities a critical focal point for realising sustainable practices (Brown et al., 2008).

The majority of South Africa's population resides in urban areas that, according to the National Development Plan (NDP), has created a reasonably balanced spatial structure consisting of a network of metropolitan municipalities, cities, large towns and service centres, all linked by an established network of connecting infrastructure (National Planning Commission, 2011). However, the sustainability and resilience of these urban areas have been in question for several years as city centres deteriorate and new developments have become favourable on the urban periphery. The result of this is low-density developments that are energy-intensive and cause severe depletion in soil quality and loss of biodiversity. The sustainability debate continues into the rural environment as a substantial number of people still reside within these landscapes where settlement patterns are dysfunctional and inequitable due to the sheer scale of unregulated development (National Planning Commission, 2011).

Investing in conventional infrastructure in these settlement areas is challenging as the cost associated with construction, operations and maintenance is financially unsustainable for most municipalities. In addition to the infrastructure-related implications, it is essential to recognise that the impact of development spreads far beyond the actual extent of developed areas; specifically via the requirement for large (upstream) land areas to supply, capture and store water for urban and rural use, and the discharge of a cocktail of wastewater and stormwater to downstream receiving waters. This has caused a significant modification of the natural hydrological regimes and associated ecological processes in waterways upstream, within and downstream of the urban and rural settlement areas. According to DWS, the country's future challenge will be to ensure that there is fair and equitable redistribution of water resources across the various sectors, considering the country's socio-political and economic transformation agenda (DWS, 2016b).

To address this, cities, towns and settlements should be designed and developed within the broader sustainability and resilience framework. According to Cilliers and Cilliers (2016), the close relationship between human and natural systems implies that cities and settlements cannot be sustainable or resilient until their dependence on ecosystem services has been recognised. This is a well-recognised theory, known as the Ecological Socio-economic Relationship (ESER) Framework, which indicates the dependency of the economic efficiency on human capital and social justice, which, in turn, are both dependent on ecological integrity. In addressing the above, pioneered by Brown et al. (2008), the aspirational concept of a water-sensitive city was introduced in 2008 at the 11th International Conference on Drainage. Although there is no universally accepted definition for a water-sensitive city, the CRCWSC defines it as "a city that interacts with the urban hydrological cycle in ways that provide the water security essential for economic prosperity by efficiently using a diversity of water resources available; enhance and protect the health of watercourses and wetlands; mitigate flood risk and damage; and create public spaces that harvest, clean and recycle water" (CRCWSC, 2019). A transitioning framework, which emanated from a six-year social research programme, was developed by Brown et al. (2008). It clarifies the hydro-social contracts currently operating across cities and sets a roadmap towards transitioning into a water-sensitive city. The roadmap depicts a typology of six city-states: the water supply city, the sewered city, the drained city, the waterway city, the water cycle city and the water-sensitive city. The transitioning framework takes into consideration the "temporal, ideological and technological context that cities transition through when moving between different management paradigms and is sensitive to other influencing conceptual variables such as city-specific history, ecologies, geographies and socio-political dynamics" (Brown et al., 2008, p. 2).

According to Brown et al. (2008), no one city can be directly compared to any other city as each city is in its own transitioning stage due to differing socio-political and biophysical conditions. It is widely acknowledged that the process of becoming a water-sensitive city will involve a transition, driven by radical shifts in structures, cultures and practices, underpinned by urban planning and water resource management. It calls for integrated development planning between all spheres of government and many diverse stakeholders to enable change that would result in a more sustainable system, notably by overcoming resistant cultures, structures and practices that are "locked-in" to a current unsustainable path.

Facilitating transitions is not easy. It requires dedicated attention to disrupt the dominant paradigm (in this case, urban planning practices) so that the emerging alternative of a water-sensitive city can become influential. Wong and Brown (2008) refer to the three “pillars of practice” of a water-sensitive city, which must be seamlessly integrated into the built environment.

3.2.1.1 Pillars of practice: water-sensitive cities

The “pillars of practise” for a water-sensitive city include cities as catchments, cities providing ecosystem services and cities as water-sensitive communities.

Cities as catchments

Most cities are almost exclusively dependent on water supply from a single source where water is extracted either from rivers or dams, treated and distributed from a centralised water treatment plant to the city. This treated water is used for almost all purposes, including drinking, cooking, cleaning, toilet flushing and gardening, even though not all uses require water of potable quality. As a response, cities must break their dependency on a single water source and access a diversity of water sources, underpinned by centralised and decentralised infrastructure. A diversity of water sources for cities could potentially include the utilisation of groundwater, stormwater and rainwater harvesting, recycled wastewater (greywater and black water) and desalinated water. These water sources can be harvested and treated through green infrastructure technologies or natural systems, and reused on-site or pumped to the centralised wastewater treatment plant and redistributed.

By utilising water from various portfolios within the city, the city becomes the catchment, and less strain is placed on centralised water and WWTWs, which also reduces energy demand. Initiatives for creating cities as catchments include the following:

- Rainwater and stormwater harvesting for non-potable use
- City-scale indirect potable reuse schemes and the pipeline grid linking regional reservoirs
- Large-scale centralised desalination plants and indirect potable substitution schemes (treated recycled water returned to water supply schemes)
- Secondary supply pipelines for non-potable water (third pipeline system or duel pipeline); non-potable water from a variety of local sources (e.g. stormwater, groundwater, recycled wastewater) can replace the use of potable water for uses such as toilet flushing, laundry, garden watering and open space irrigation

Cities providing ecosystem services

The value of urban open spaces and landscapes must be evaluated in terms of their “ecological functions” that capture the essence of sustainable water management, microclimate influences, the facilitation of carbon sinks and use for food production. Protecting the environment from polluted stormwater is one of the primary objectives of sustainable water resources management, which can be achieved through land use management and by implementing SUDS, such as constructed wetlands and bio-retention systems on a range of spatial scales. It also calls for new principles in spatial planning in developed areas through higher-density development, less built coverage and greater utilisation of public open spaces for multiple functions.

Initiatives for creating cities that provide ecosystem include the following:

- Health management initiatives to protect freshwater ecosystem priority areas through buffer zone waterways
- The enhancement and improved utilisation of ecological infrastructure through the urban landscape design of large open spaces and connected blue-green corridors with both an aesthetic and functional role
- Limiting the expansion of built footprints through development boundaries and by promoting higher densities and less floor coverage

Cities as water-sensitive communities

New technologies must be socially embedded in the local institutional context, otherwise, their development in isolation will be insufficient to ensure their successful implementation in practice. New governance approaches towards policy, legislative and regulatory frameworks that guide the activities, roles and responsibilities of local governments, water utilities and government agencies, households and communities must be informed by the principles of water sensitivity.

Initiatives for creating water-sensitive communities include the following:

- Water sensitivity should feature in government and municipal policies
- Planning provisions should address water sensitivity, e.g. set specific water quality targets
- Water conservation and demand management strategies can be implemented through adjusted tariff structures (although not entirely related to spatial planning)
- Stormwater quality objectives can be regulated through municipal by-laws
- Tools and guidelines can be developed for water-sensitive planning

3.3 WATER SENSITIVITY IN SOUTH AFRICA

The WRC undertakes water-related research activities and plays a fundamental role in securing future water resources for economic, environmental and social development. In 2011, the WRC solicited a research proposal aimed at guiding urban water management decision-makers on the use of WSUD in a South African context.

3.3.1 The South African Guidelines for Sustainable Urban Drainage Systems

In 2013, the WRC published the South African Guidelines for Sustainable Drainage Systems, which emanated from a project entitled "Alternative technologies for stormwater management" (WRC Project No. K5/1826). The guidelines primarily focus on stormwater management in South Africa's urban areas and the effect of urbanisation on both stormwater quality and quantity. The guideline document provides detailed information on calculations and technical illustrations for alternative approaches, including bio-retention areas, detention ponds, filter strips, green roofs, infiltration trenches, multi-purpose detention ponds, permeable paving, rainwater harvesting, retention ponds, wetlands and soakaways. Collectively, these systems are referred to as SUDS.

Introducing SUDS into the urban environment will reduce the flow rate and volume of stormwater quantity, improve the stormwater quality and enhance the amenity and maintenance of biodiversity.

Key points from the guideline document that are applicable to spatial planning and land use management include the following:

Maintaining pre-development conditions

In an attempt to maintain pre-development conditions:

- Stormwater should be controlled and treated as close to its source as possible. The collection, storage, use, infiltration and evapotranspiration processes inherent in many source SUDS controls (green roofs, rainwater harvesting, soakaways and permeable pavements) are particularly useful in mimicking natural drainage characteristics.
- If stormwater cannot be handled on-site, the next link in the management train is local SUDS controls that attempt to manage all the stormwater generated in a local area. Where stormwater is to be conveyed from one place to another, more "natural" channels (filter strips, swales, infiltration trenches, bio-retention areas and sand filters) should be used instead of pipes and concrete-lined canals, which speed up the flow and provide little water quality benefits.

- Regional SUDS controls (detention ponds, retention ponds and constructed wetlands) represent the last line of defence for the management of stormwater before it is discharged to the receiving waters.

Spatial planning and land use management (source control)

In an attempt to achieve pre-development conditions:

- Building controls and development incentives should promote rainwater and stormwater harvesting:
  - The material used and the angle of the roof can increase or decrease the harvesting potential of a building. However, this is subject to rainfall patterns, as well as the availability of space for storage tanks.
  - In large-scale developments such as shopping centres, business and industrial precincts or apartment blocks, storage solutions can be accommodated underground, beneath building and parking areas. This should also be enforced by development controls.
- Reduce coverage:
  - Increase development densities and building heights (go "up" instead of "wide"). Increasing densities within the existing development footprint will reduce the need to expand the development edge, protecting natural vegetation from land cover change. Increasing building heights can reduce the impact of development on the surface.
  - Floor area ratio (FAR) refers to the percentage of land that may be developed. This does not include driveways, parking areas or verandas. These surfaces are mostly impervious and affect stormwater quality and quality. The FAR should be recalculated to include these surfaces so that a recommended permeability percentage can be prescribed to a site.

Transporting stormwater (local control)

- Road design:
  - Contour planning is an age-old method that is used mainly in agricultural practices (contour ploughing) to reduce the runoff volumes that may cause erosion. Contour road design means that the road should follow the natural contour structure of the areas.

Preserving natural environments (regional control)

- Master planning for ecological infrastructure:
  - Land use schemes and layout plans should protect the ecological infrastructure and plan for connected corridors and open spaces.
- Protective zonings for ecological infrastructure:
  - The municipal land use scheme can legally protect the ecological infrastructure with a protective zoning or development overlay.

3.3.2 Water-sensitive urban design for South Africa: framework and guidelines

Following the 2013 publication of the South African Guidelines for Sustainable Drainage Systems, the WRC published the Water-sensitive Urban Design for South Africa: Framework and Guidelines. The publication emanated from a project entitled "Water-sensitive urban design for improving water resource protection/conservation and re-use in urban landscapes" (WRC Project No. K5/2071). This comprises two parts:

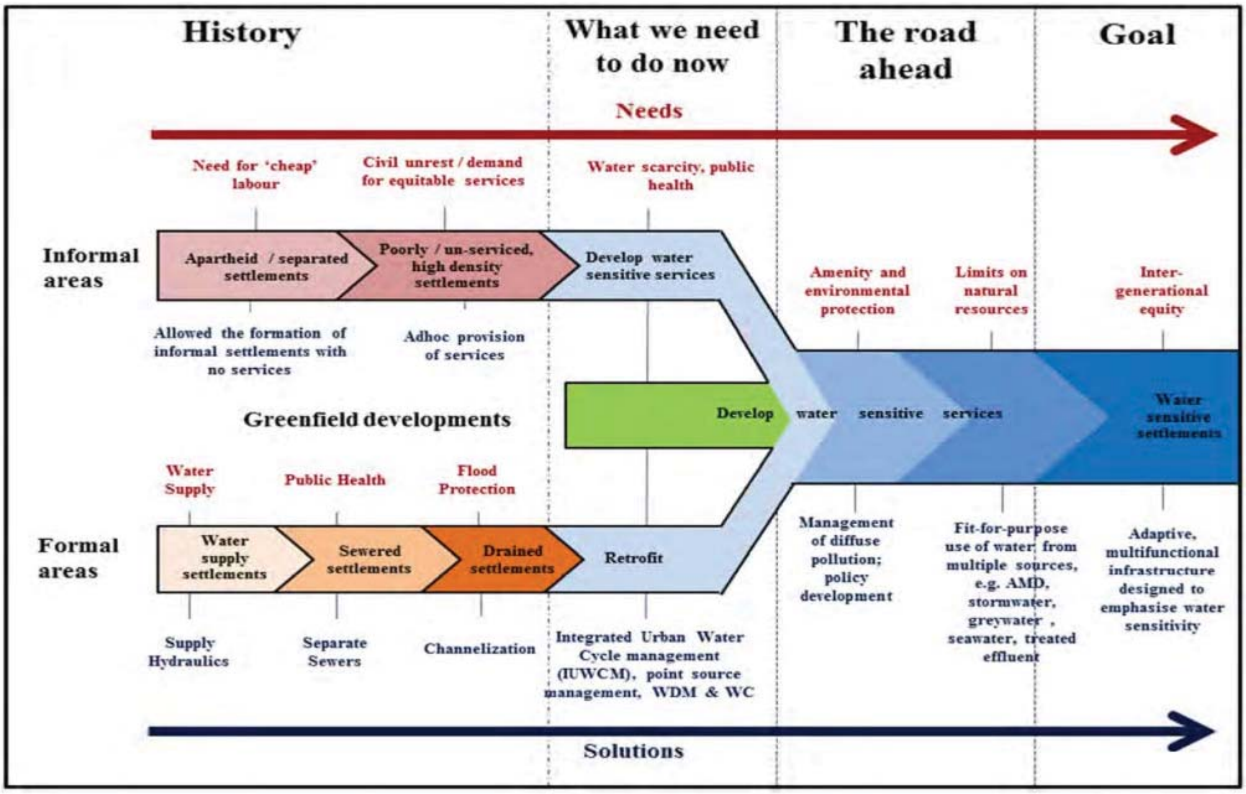
- Part 1: The Framework
- Part 2: The Guidelines

The Framework (Part 1) introduces the philosophy of WSUD in South Africa and defines what water sensitivity means within the South African context. The framework defines water sensitivity in South Africa as "… the management of the country's urban water resources through the integration of the various disciplines of engineering, social and environmental sciences while acknowledging that South Africa is a water-scarce country; access to adequate potable water is a basic human right; the management of water should be based on the participatory approach; water should be recognised as an economic good; and water is a finite and vulnerable resource, essential to sustaining all life and supporting development and the environment at large" (Armitage et al., 2014:ii).

The framework highlights three areas of intervention, which include formal areas, greenfield developments and informal areas where high densities and limited infrastructure are common (Armitage et al., 2014). For this reason, the framework adopted the term "water-sensitive settlements" instead of "water-sensitive cities" to include the non-urban, but densely populated rural settlement areas.

Figure 3.1 captures the essence of South Africa's framework towards water-sensitive settlements. Considering South Africa's history, the framework shows "where we are now" and labels formal areas as drained settlements, and informal areas as poorly serviced/unserviced high-density settlements. Figure 3.1 also illustrates the roadmap towards the "goal" of creating water-sensitive settlements. In reaching this goal, the framework suggests that formal areas will have to retrofit existing infrastructure and focus on integrated urban water cycle management, point source management, water demand management and water conservation. The framework also suggests a leapfrog approach to development in the poorly serviced/unserviced informal settlement areas by developing water-sensitive services. The framework highlights the various components required for managing the transition towards water-sensitive settlements, which includes policy development, institutional structures, community participation, as well as the construction, operation and maintenance of centralised and decentralised wastewater treatment systems and green infrastructure. The framework suggests that a water-sensitive settlement is one where the management of the water cycle is undertaken in a water-sensitive manner with the overall objective of ecologically sustainable development. The framework highlights that water-sensitive settlements consist of three components: water-sensitive urban design, water-sensitive urban planning and water-sensitive urban management, but should be considered in an integrated manner.

Figure 3.1: Water-sensitive Urban Design Framework for South Africa



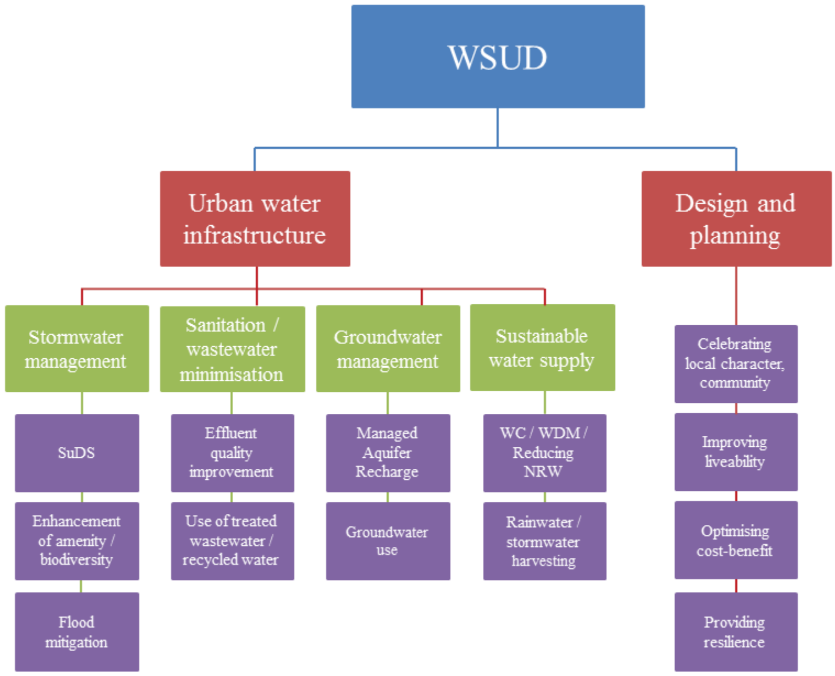
Source: (Armitage et al., 2014)

The Guidelines (Part 2) illustrate that WSUD brings together a range of activities under one umbrella. However, the two main components of WSUD refer to the urban water infrastructure, and design and planning (Armitage et al., 2014). The guidelines provide detailed information on technical illustrations and approaches to the urban water infrastructure component. However, research on the design and planning component was beyond the scope of work at the time.

The guidelines focused on the following:

- Stormwater management, taking a SUDS approach, which incorporates elements such as the enhancement of amenities and biodiversity, and flood mitigation. SUDS selection applicable to South Africa includes bio-retention areas, detention ponds, filter strips, green roofs, infiltration trenches, multi-purpose detention ponds, permeable paving, rainwater harvesting, retention ponds, wetlands and soakaways
- Sanitation/wastewater minimisation, including effluent quality improvement and the use of treated wastewater/recycled water
- Groundwater management, including artificial recharge and the use of groundwater
- Sustainable water supply options, including water conservation/demand management, the reduction of non-revenue water, and alternative water sources, e.g. rainwater/stormwater harvesting.

Figure 3.2: Water-sensitive urban design activities



The Water-sensitive Urban Design for South Africa: Framework and Guideline set the foundation for future research that revolves around the topic of urban water management and policy development in the integration of water cycle management into planning and design for the growth and development of water-sensitive settlements in South Africa (Armitage et al., 2014). According to Armitage et al. (2014, p. viii), "there is untapped potential for more extensive coordination, which could be facilitated by the urban and strategic planning fora." Information is still limited as to exactly how design and planning should engage with the concept of water-sensitive settlements, specifically within the South African context.

Spatial planning and land use management

- **Stormwater management**

  Refer to the previous section.

- **Sanitation/wastewater minimisation**

  Level of wastewater services:

  – Providing a sustainable level of services is the municipalities' mandate. However, not all settlements or households can have the same level of services due to the natural availability of the resource, the affordability of the resource and the spatial location of the settlement. Dry sanitation solutions should not be a lower level of service but should be a sustainable level of service.

  Location of (wet and dry) sanitation solutions:

  – Groundwater is a highly vulnerable resource as it is often unseen. Spatial planning and implementation requirements should be enforced when selecting the location of wet and dry sanitation systems.

Access to sanitation systems:

- One of the major concerns with alternative sanitation solutions is maintenance. Maintenance is often jeopardised by a lack of access to these systems due to the unplanned nature of informal settlements.

Greywater reuse:

- Duel-piped systems in household and building.

- **Groundwater management and surface water resources:**

  Protection of high groundwater recharge areas:

  - With 98% of its surface water already developed, the demand for surface water outstrips supply in most catchments.

  Reduce coverage

  Buffer zone on boreholes

  Managed aquifer recharge

- **Sustainable water supply:**

  Level of services of potable water:

  - Providing a sustainable level of services is the municipalities' mandate. However, not all settlements or households can have the same level of service due to the natural availability of the resource, the affordability of the resource and the spatial location of the settlement.

  Water conservation and demand management:

  - Review tariff structure
  - Water-efficient fixtures
  - Water reuse technologies: Water harvesting may not be as feasible as water reuse options, as the previous section explained that rainfall is distributed unevenly and temporally throughout the country. Alternatively, water reuse is supported by the improved efficiency of treatment processes, reduced cost and within proximity to the point of application.

  Rainwater and stormwater harvesting:

  - Unconventional sources of water could include water recycling/reuse and rainwater harvesting, which has become an attractive option for water resource managers and planners.

3.4 CONCLUSION

Information is limited as to how exactly spatial planning strategies and practices should be developed and implemented in a water-sensitive manner. Yet, the WRC played a significant role in producing an abundance of research and technical support on the topic of water-sensitive design.

CHAPTER 4: SPATIAL PLANNING AND LAND USE MANAGEMENT IN SOUTH ARICA

4.1 INTRODUCTION

The approach taken by world-class countries and cities to maximise the opportunities and minimise the challenges of population growth and rapid urbanisation is to place a high emphasis on spatial planning and land use management. South Africa's planning history has seen a considerable array of legislation, most of which, until recently, pre-dated 1994. Today, spatial planning and land use management in South Africa takes place within the legislative framework as mandated by SPLUMA. The primary motivation for the enactment of this "new" planning law lies within the need for a new planning regime; one which replaces the apartheid-era laws with a coherent legislative system that is designed to spatially transform the country in its democratic era; a transformation that addresses spatial justice, spatial sustainability, efficiency, spatial resilience and good administration – all of which should take place within the proposed water-sensitive settlement framework.

Unfortunately, many municipalities still struggle to integrate informal and traditional development processes into formal systems of spatial planning and land use management, leading to harmful – and in many cases irreversible – degradation of land and water resources. This chapter provides a brief background on South Africa's development history (a more comprehensive history review is presented in Chapter 2 of the framework document), followed by a detailed description of South Africa's newly adopted spatial planning framework, as set out in SPLUMA.

4.2 SOUTH AFRICA'S DEVELOPMENT HISTORY AND LAND USE PLANNING

Worldwide, the "apartheid" city is cited as a case study where politics had a detrimental impact on spatial planning. Little did planners and politicians know at the time that this city model would also have a detrimental impact on the country's natural resource base.

Segregated racial planning or apartheid legislation started in early 1900 with the Native Land Act, Act No. 27 of 1913 (subsequently renamed the Bantu Land Act of 1913 and the Black Land Act of 1913, as well as the Union Land Act) (Magubane, 1996). The Act set aside approximately 7.3% of the country's land area as reserves to accommodate the "native" population. The Act also created a system of land tenure, meaning that land under "communal" tenure was vested in African chiefs. This Act was followed by the passing of the Native Urban Areas Act, Act No. 21 of 1923, which gave local authorities the power to demarcate and establish African locations on the outskirts of white urban and industrial areas.

Both the Native Land Act, Act No. 27 of 1913, and the Native Urban Areas Act, Act No. 21 of 1923, had a major impact on the way in which urban and rural areas are structured today. According to Davenport (1989), during the Great Depression in 1930, a significant number of Afrikaner farmers moved to town as the persistent drought continued. The migration called for a formal institutional framework for settlement building. The idea of "reconstruction" for the post-war period saw the increasingly enthusiastic acceptance of central precepts of the modernist movement, such as the separation of land uses, the concept of the inwardly oriented neighbourhood units, and the dominance of the private motor car (National Development and Planning Commission, 1999).

South Africa followed the movement of the British Town Planning Institute, which called for a structured approach by introducing land use regulations as a national socio-economic planning tool (Herbert, 1983). In the early 1930s, the first Provincial Town Planning and Settlement Establishment Ordinance was passed, which required municipalities to exercise greater control over town planning in terms of land use, building size and housing density.

According to Martienssen (1941) and Muller (1996), the modernist architects of the time noted that unplanned city planning and development, and the utilisation of natural resources needed to be stopped and replaced with rational spatial development based on science and ingenuity (cited by Oranje and Merrifield, 2010). The Department of Physical and Regional Planning was established to conduct national and regional planning and zoning and to ensure the enforcement of a strict set of spatial planning rules and regulations (Union of South Africa, 1944). It was clear that the agencies that administered town planning had “racial zoning” on their agenda. In 1936, the Native Trust and Land Act (Act 18 of 1936) increased the “native reserve” land area from 7.3% to almost 13% of the total land area of the Union. More specifically, the Act prohibited any ownership and/or purchase of land by “natives” outside the stipulated reserves, thereby formalising the separation of white and black rural areas. The Native Urban Areas Act, Act No. 21 of 1923, was amended several times (in 1930, in 1937 and in 1944) until the Native Urban Areas Consolidation Act of 1945 was passed, giving government “tightened influx control” over the “natives” in urban areas.

The planned use of natural resources for national interests (refer to Martienssen, 1941, and Muller, 1996) led to the passing of the 1947 Natural Resource Development Act, developed by the Natural Resources Development Council. The Council had the power to proclaim “controlled areas” where the utilisation of resources and use of land had to be coordinated by the relevant minister. This included planning for housing and township establishment. The Group Areas Act, Act No. 41 of 1950, was yet another Act that invested in segregated apartheid spatial planning. According to Mabin (1992, p. 429), “the practice of implementing the Act depended on the existence and growth of planning bureaucracies whose origins were wider than those of the Act itself” (cited by O’Malley, 2016). Between 1950 and 1960, as the intense spatial and racial segregation continued, an additional 22 “apartheid laws” were passed.

The so-called grand-scale apartheid projects took place during the 1960s and 1970s as the Nationalist Government established 10 homelands for most black people. These areas were ultimately intended to be self-governing states, independent in all respects of “white” South Africa. These areas were later given legal status by the passing of the Bantu Homelands Constitution Act of 1971. According to Oranje and Merrifield (2010), two sets of development instruments were introduced to bring some form of economic rationale to the ideology of apartheid. This included the development of “border industries”, followed by “homeland towns” with heavily incentivised industrial estates. Several regulations (R293/1962 and R188/1969) were passed in terms of the 1927 Native Administration Act, which provided for the national control of land uses in these areas. This was followed by the passing of national planning legislation in 1967. The Physical Planning Act, Act No. 88 of 1967, controlled African urbanisation by placing limitations on the extent of new industrial land that could be proclaimed in the main urban areas. According to Davenport (1987: 252), the act “provided positive incentives in the form of tax holidays, tariff rebates and the prospect of cheaper labour to induce industrialists to move, together with negative constraints such as a ban on the enlargement of black labour forces if they elected to remain in the existing areas of industrial concentration” (cited by O’Malley, 2016).

Between 1910 and 1990, urban segregation came to be implemented over several decades under a wide range of legislative measures, some directly and others indirectly. However, the early 1990s marks the beginning of the end of South Africa’s apartheid era as then President FW de Klerk abandoned the unsustainable apartheid system towards a non-racial and democratic South Africa. The first step towards a more inclusive and united country was to redefine the country’s racially segregated landscape into nine provinces (South Africa, 1993). However, the process of physically changing the structure of cities, townships and settlements was one of the biggest challenges faced by government as towns and cities had been divided into townships without basic infrastructure for blacks and well-resourced suburbs for whites (Republic of South Africa, 1994). One such programme, developed to eradicate the inequalities of the past, was the RDP of 1994.

The White Paper on the Reconstruction and Development Programme (South Africa, 1995a) was seen as the primary socio-economic programme, defined by five broad policy programmes, of which Policy Programme 1: "Meet basic needs" was introduced to facilitate the practices and procedures of redistributing land to landless people, build over one million houses, provide clean water and sanitation to all, electrify 2.5 million new homes and provide access for all to affordable health care and telecommunications (Republic of South Africa, 1994). As many homelands became overpopulated, the soil became increasingly eroded with signs of soil crusting, soil acidity, soil alkalinity, densification and environmental pollution. Ultimately, agricultural land became vastly deteriorated and threatened food security at large. Government was also under pressure to provide land for residential purposes in urban areas. According to Oosthuizen (2000), this could only be done by either "filling up" open space in large cities, or by expanding the cities' borders into adjacent rural areas. The latter resulted in large-scale low-income housing settlements for the poor on the urban periphery. Reasons for the choice of location included the nature of the low-income housing subsidy that required a single detached dwelling on its own stand of defined size, the availability of large tracts of inexpensive land on the periphery, and the administrative preference for larger developments (Boshoff, 2014). The Development Facilitation Act, Act No. 67 of 1995 (South Africa, 1995b) helped to facilitate the RDP and the rapid implementation of housing schemes (on the urban periphery). Although the Act echoed the principles of Agenda 21 of integrated planning, optimal use of existing resources and the promotion of sustainable development, the ambitious programme to eradicate backlogs gave little consideration to the fact that single-use, low-density patterns tend to consume significant amounts of land per capita and generate larger per capita infrastructure installation and maintenance costs (UN-Habitat, 2013: 70-73).

The abolition of the fragmented South African state and the demarcation of municipal boundaries created confusion regarding the powers and authority of municipalities to take land development decisions in certain areas. In most of South Africa's rural municipalities, spatial planning was limited or non-existent and, in some established urban municipalities, proper planning practices and functions were neglected or ignored as development pressure escalated. Literature points to the fact that, during the transition period from apartheid to democracy, and in the restructuring of local government, limited integrated development planning took place (Dewar, 1998) as policies were formulated "within discrete national line function departments, with little reference to the activities in other departments." This approach contributed to a fragmented and distorted urban and rural development phase. Unfortunately, many parts of South Africa's urban and rural areas still have no proper or integrated spatial planning and land use management systems, practices and legislation in place and are therefore excluded from the benefits of spatial planning and land use management. Informal and traditional land use development processes are poorly integrated into formal systems of spatial planning and land use management, leading to harmful and – in many cases – irreversible degradation of land and water resources.

4.3 SPATIAL PLANNING AND LAND USE MANAGEMENT ACT NO. 16 OF 2013

In recent years, calls for cross-sectoral coordination and integrated planning approaches echo across different fields of planning. On 1 June 2015, the spatial planning system in South Africa underwent dramatic reform as the long-awaited Spatial Planning and Land Use Management Act (Act No. 16 of 2013) commenced in terms of Section 155(7)[1] and Section 44(2)[1] of the Constitution (Act No. 108 of 1996). SPLUMA is the first legislative measure to provide a unified spatial planning and land use management system for all South Africans at all government levels (Nel, 2016). SPLUMA creates a spatial planning system that integrates policy, spatial planning and land use management, especially

[1] Section 155, subsection 7 of Act No. 108 of 1996 regulates municipal planning.
[1] Section 44, subsection 2 of Act No. 108 of 1996 regulates provincial planning.

at local government level, to address the inclusion of people and spaces that were previously excluded from the development framework (Strauss and Liebenberg, 2014).

It defines the spatial planning system in South Africa as consisting of SDFs to be prepared and adopted by national, provincial and municipal spheres of government, and the management and facilitation of land use management through the mechanism of a municipal LUS.

Planning is concerned with where to go (Ahmad and Bajwa, 2005). Originally, planning focused more on urban design and the actual layout of streets (e.g. Paris in 1852 and Central Park, New York, in 1856). From these beginnings, planning evolved into a science that aimed to solve various problems found in cities and towns, for example solving the problems created by the industrial city (separating noxious land uses), or in reaction to pestilence and plague (e.g. the yellow fever outbreak in Memphis in 1879) (Elliot, 2007). From there, planning started to focus on social issues such as the plight of people living in poverty and slums (Elliot, 2007).

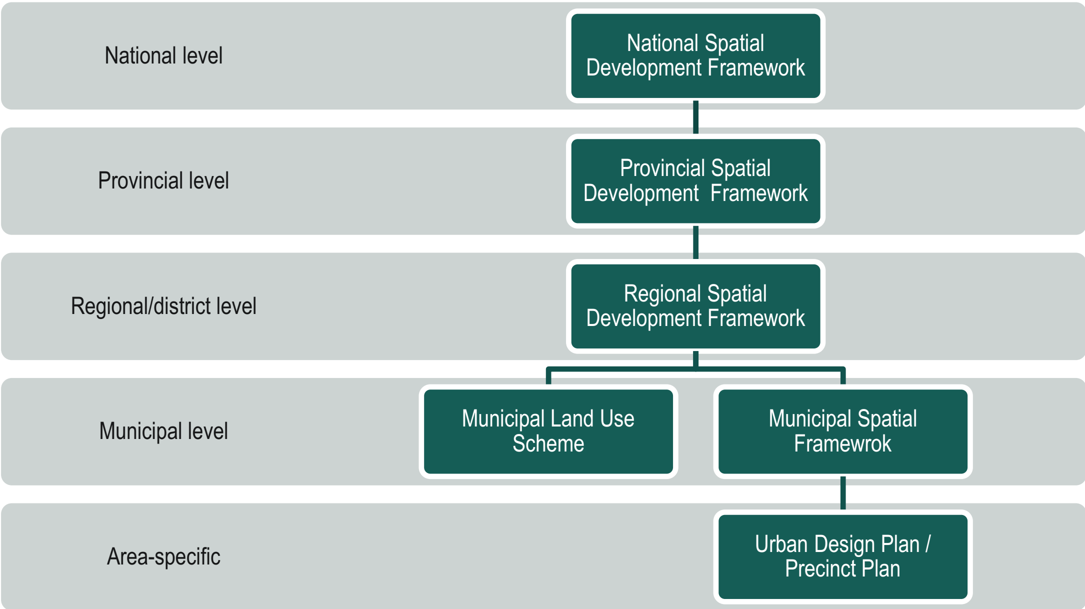
Planning became professional (and legally enforceable) in the early 1900s through various laws and zoning codes (the very first land-use schemes) (Elliot, 2007). As more and more people flocked to the cities, urban problems (and therefore the scope of planning) became more intricate. The concept of planning shifted from addressing only a specific sector to comprehensive planning (Ahmad and Bajwa, 2005). In South Africa, the profession of planning is defined as “areas of expertise which involve the initiation and management of change in the built and natural environment across a spectrum of areas, ranging from urban to rural and delineated at different geographic scales (region, subregion, city, town, village, neighbourhood) in order to further human development and environmental sustainability” (Republic of South Africa, 2002). With the urban environment under considerably more pressure due to increasing urbanisation, there was a call for planning to become more proactive, focusing on sustainability “and making the connections between people, economic opportunity and the environment” (Farmer et al., 2006:2).

Planning comprises the following distinct, yet interrelated processes (Van Wyk, 2012):

- **Spatial planning:** This is the compilation of an initial plan or framework for future development. Known in South Africa as SDFs, this type of planning is more concerned with the future shape of cities and towns. “Forward planning is a future-oriented exercise. It is concerned with the long-term future of a large area and identifying opportunities for growth and development so that land can be managed in the best interests of the public.” (Fiji Department of Town and Country Planning, 2015).
- **Land use management:** This is the administration and regulation of changes to the use of land as determined in the original plan. This type of planning seeks to manage the legality of existing land uses and buildings through tools such as zoning codes (also referred to as town planning schemes, zoning schemes and land use schemes in other parts of the world). This type of planning came about in the early 1900s to separate living areas and neighbourhoods from the negative effects of residing close to job opportunities such as industries (Elliot, 2008).
- **Land development management:** This is the control of development that occurs after the land use has been determined (Ahmad and Bajwa, 2005).

In South Africa, spatial planning is done at various levels:

Figure 4.1: Planning at various geographic levels



4.3.1 Municipal Spatial Development Framework

An SDF is the principal strategic planning instrument that guides and informs all planning and development, and all decisions concerning planning, management and development within the municipality. The aim of the SDF is to provide an overview of the future spatial form of the municipality. It is the primary tool used to decide if a change in land use rights (through the amendment of the LUS) should be allowed. SPLUMA calls for spatial proposals that align with capital budgets, and identify priority intervention areas and associated land development programmes. While an SDF provides an indication of acceptable land uses or intensity of land uses in some geographical regions, land use rights are managed through an LUS.

Section 21 of SPLUMA provides an outline of what a municipal SDF should contain.

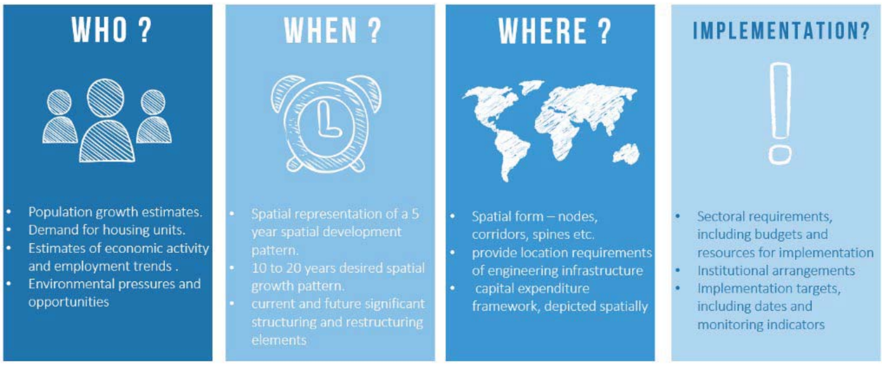
Table 4.1: Legislated content of a municipal SDF

S(21)	A municipal Spatial Development Framework must:
(a)	…give effect to the development principles and applicable norms and standards set out in Chapter 2;
(b)	…include a written and spatial representation of a five-year spatial development plan for the spatial form of the municipality;
(c)	…include a longer-term spatial development vision statement for the municipality;
(d)	…identify current and future significant structuring and restructuring elements of the spatial form of the municipality, including development corridors, activity spines and economic nodes where public and private investment will be prioritised and facilitated;
(e)	…include population growth estimates for the next five years;
(f)	…include estimates of the demand for housing units across different socio-economic categories and the planned location and density of future housing developments;
(g)	…include estimates of economic activity and employment trends and locations in the municipal area for the next five years;
(h)	…identify, quantify and provide location requirements of engineering infrastructure and services provision for existing and future development needs for the next five years;
(i)	…identify the designated areas where a national or provincial inclusionary housing policy may be applicable;
(j)	…include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of environmental sensitivities, high potential agricultural land and coastal access strips, where applicable;
(k)	…identify the designation of areas in the municipality where incremental upgrading approaches to development and regulation will be applicable;

S(21)	A municipal Spatial Development Framework must:
(l)	…identify the designation of areas in which i. more detailed local plans must be developed; and ii. shortened land use development procedures may be applicable and land-use schemes may be so amended;
(m)	…provide the spatial expression of the coordination, alignment and integration of sectoral policies of all municipal departments;
(n)	…determine a capital expenditure framework for the municipality's development programmes depicted spatiality;
(o)	…determine the purpose desired impact and structure of the land use management scheme to apply in that municipal area; and
(p)	… include an implementation plan comprising: i. sectoral requirements, including budgets and resources for implementation; ii. necessary amendments to a land use scheme; iii. specifications of institutional arrangements necessary for implementation; iv. specifications of implementation targets, including dates and monitoring indicators; and v. specifications, where necessary, of any arrangements for partnerships in the implementation process.

The following diagram summarises the content of Municipal SDFs:

Figure 4.2: Content of SDFs



An SDF is a long-term (10- to 20-year plan) development framework with a vision, goals and objectives expressed spatially through strategies designed to address physical, social and economic defects. The SDF is therefore concerned with the future shape of the city or town that its deals with. It is a framework that strives to be consistent with mayoral development priorities. The SDF functions at a municipal scale and exists in a multidisciplinary environment. It is therefore not confined to IDP-related projects and programmes but integrates and coordinates the development proposals and related strategies of all projects and programmes of sector plans within various spheres of government and adjacent municipalities.

4.3.1.1 Spatial planning and growth

The previous section mentions that the SDF is concerned with the future shape of a city or town. It is also the primary instrument that a municipality can use to address growth. Understanding who and what a municipality planning for is a critical component of its SDF. These SDFs have been criticised in the past for being too broad and not providing enough detail for other disciplines (such as engineers) to adequately plan for service delivery. SPLUMA aims to remedy this situation by making it a statutory requirement that planners quantify growth. SPLUMA establishes the following components of a municipal SDF[2], among others:

- **Clearly define who and what are being planned for:** Prior to SPLUMA, many SDFs did not clearly specify the quantum of who and what are being planned for (e.g. the number of households, or

[2] SPLUMA Section 21

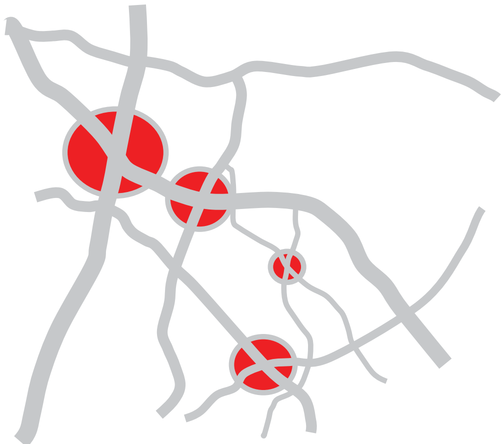
square metres of a specific type of land use). In addition, few SDFs included specific time frames of when development is expected to occur. SPLUMA includes specific requirements to address this:

- Include a five-year population growth estimate and indicate how this growth will translate into a need for housing across different socio-economic groups (and where in space this will occur).
- Include five-year estimates of economic activity and employment trends and locations in the municipal area.

- **Determine where growth should occur:** Not only does the SDF have to quantify growth, it must also indicate where and when the development will occur:
  - Identify current and future significant structuring and restructuring elements of the spatial form of the municipality, including development corridors, activity spines and economic nodes (see Figure 4.3 for more detail), where public and private investment will be prioritised and facilitated.
  - Include a written and spatial representation of five-, 10- and 20-year spatial development patterns (in other words where the quantum of the residential and non-residential land uses identified above will occur spatially overtime at specific locations within the municipality).

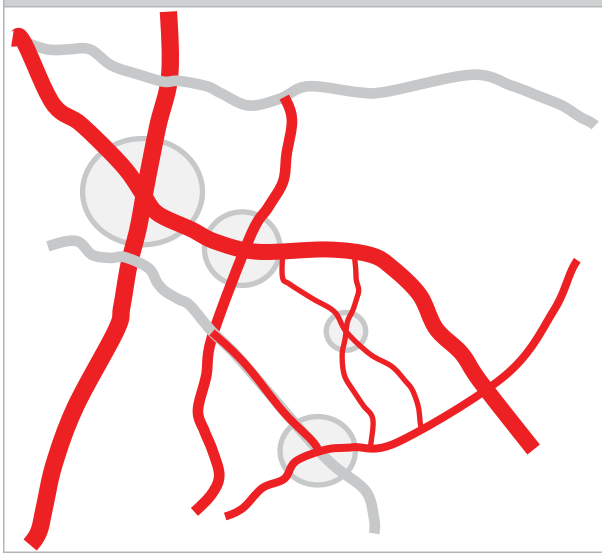
Figure 4.3: Spatial structuring elements: examples and descriptions

Nodes



Economic and mixed-use development is concentrated in nodes in specific locations. The nodes are usually separated by residential activity.
The spatial form of any city consists of a hierarchy of nodes connected by corridors (discussed below). This hierarchy is made up of one anchor (or primary node) in the form of a central business district where activities are concentrated. This, in turn, is supported by secondary nodes and local nodes (such as local shopping centres).
Nodes can also be classified by function (e.g. industrial node, tourism node, mixed-use node, transport-orientated development node, etc.).
Like cities, nodes are also subject to a life cycle: new node, growing node, mature node, decaying node, etc.

Corridors



Corridors are areas of street-oriented uses that incorporate a mix of retail, employment and residential uses, developed at overall greater densities, located along arterial roads serving as major transit routes. Corridors link nodes and important areas of activity within a city and are intended to be key locations for the intensification of land uses. In some instances, a hierarchy is also introduced in corridor developments: an activity corridor and an activity spine:
Activity corridor: An area of generally higher-intensity urban use or land suitable for intensification, parallel to and on both sides of an activity spine, and including any associated higher-order transportation routes such as railway lines and through roads.
Activity spine: A public street, incorporating an existing or planned public transport route, and adjacent land used or intended for mixed-use development.

4.3.1.2 Managing growth through an urban edge

Land, like other resources, is finite. As a country's population grows, the natural trend is the migration of people towards service centres and places where there are more job opportunities. As a result, our cities and towns experience a higher population density. With more people in a city, another natural trend is for the city to sprawl towards its edges. In South Africa, in particular, there has also been a specific trend of locating large housing areas for the poor towards the periphery of the city. In addition, relatively affluent, self-contained "estates", such as Silver Lakes (in the City of Tshwane), Serengeti and Midstream Estates (in Ekurhuleni), have also arisen on the edges of our cities. Many view this development as a form of urban sprawl, which can be defined as "unplanned, uncontrolled and uncoordinated single-use development that does not provide for a functional mix of uses and/or is not functionally related to surrounding land uses, and which variously appears as low-density, ribbon or strip, scattered, leapfrog or isolated developments" (PENDALL, 1997:71).

Recent attempts to combat urban sprawl (either as a means to achieve sustainability or as an attempt to integrate previously segregated communities into the urban fabric) have given rise to the concept of compact cities. The type of urban form differs from the conventional urban development by focusing on urban intensification, creating limits to urban growth, encouraging mixed-use development and placing greater focus on the role of public transportation and urban design. Neuman (2005:14-15) lists the following characteristics of both the compact and the sprawling city:

Table 4.2: Characteristics of compact and sprawling cities

Compact cities	Sprawling cities
• High residential and employment densities • A mixture of land uses • Fine-grain of land uses (proximity of varied uses and small relative size of land parcels) • Increased social and economic interactions • Contiguous development (some parcels or structures may be vacant or abandoned or used for surface parking) • Contained urban development, demarcated by legible limits • Urban infrastructure, especially sewerage and water mains • Multimodal transportation • High degrees of accessibility: local/regional • High degrees of street connectivity internal/external), including sidewalks and bicycle lanes • A high degree of impervious surface coverage • Low open-space ratio • Unitary control of the planning of land development, or closely coordinated control • Sufficient government fiscal capacity to finance urban facilities and infrastructure	• Low residential density • The unlimited outward extension of new development • Spatial segregation of different types of land uses through zoning • Leapfrog development • No centralised ownership of land or planning of land development • All transportation dominated by privately owned motor vehicles • Fragmentation of governance authority of land uses among many local governments • Great variances in the fiscal capacity of local governments • Widespread commercial strip development along major roadways • Major reliance on a filtering process to provide housing for low-income households

Unplanned or poorly planned growth also impacts on the efficiency of the transportation system, which, in turn, will impact on the local economy as commercial vehicles and workers are caught in congested traffic. Meeting the infrastructure needs of a rapidly growing population can also overwhelm the capacity of a city to pay for new infrastructure while maintaining its existing stock of roads, water and wastewater facilities, schools and other public facilities and services.

Urban growth management is a set of techniques used by government to ensure that, as the population of a city grows, there are services available to meet their needs (CIDA, 2012:1). Services can include the protection of natural areas and the provision of parks and open spaces, sufficient and affordable housing, adequate land for business and industry, and the delivery of utilities (water, wastewater, roads and transit). Compact city growth can lead to a substantial saving on infrastructure costs. In Calgary (Canada) and Los Cabos (Mexico), savings of 33% and 38% were identified on the capital cost of roads, transport, water and other infrastructure, while saving on operational costs were 14% and 60% respectively (Ibid, 2012:3).

Techniques for growth management include fiscal tools such as taxes, levies and bonuses, as well as the allocation of public funds for infrastructure. Planning tools include the introduction of an urban growth boundary (or urban edge or urban development boundary) or other regulatory tools, such as zoning and development controls. The terms urban edge, urban growth boundary or urban development boundary are used interchangeably in spatial planning documents.

The following are some definitions from the literature:

- An urban edge is a demarcated line to manage, direct and control the outer limits of development around an urban area. The intention of an urban edge is to establish limits beyond which urban development should, as a rule, not occur, and to promote urban and environmental efficiency, effectiveness and economies in the interest of all (Western Cape Department of Environmental Affairs and Development Planning, 2005:8).
- An urban growth boundary is a zoning tool that maintains a relatively high density of housing and commercial development inside the boundary and a rural density outside the boundary.
- The boundary controls urban expansion onto farm and forest lands. Land inside the urban growth boundary supports urban services such as roads, water and sewer systems, parks, schools and fire, and police protection services that create thriving places in which to live, work and play. The urban growth boundary is one of the tools used to protect farms and forests from urban sprawl and to promote the efficient use of land, public facilities and services inside the boundary.
- An urban growth boundary is a mapped line that separates land on which development will be concentrated from land on which development will be discouraged or prohibited.
- The urban edge is a virtual development boundary and inter-related policy that serves to control urban sprawl by mandating that the area inside the boundary should be used for higher density urban development and the area outside should be used for lower density, green open spaces and/or no development. Outside the urban edge, development should only be permitted within existing small towns and rural nodes, and where the environment and agriculture are not compromised. The urban edge forms the boundary between urban development and the valuable natural and agricultural hinterland in order to contain the lateral growth of the urban areas.

4.3.2 The municipal land use scheme

Section 25 of SPLUMA mandates all local municipalities to develop and adopt a single land use scheme that gives effect to the municipal SDF and promotes economic growth, social inclusion, efficient land development and minimal impact on public health, the environment and natural resources. A land-use scheme adopted in terms of SPLUMA must consist of regulations setting out the procedures and conditions relating to the use and development of land in any zone, a zoning map, and a register of all amendments to such a land use scheme. Section 24(2) of SPLUMA provides an outline of what a municipal LUS should contain.

Table 4.3: Contents of a municipal LUS

S(24)(2)	A land-use scheme adopted in terms of subsection (1) must:
(a)	…include appropriate categories of land use zoning and regulations for the entire municipal area, including areas not previously subject to a land use scheme;
(b)	…take cognisance of any environmental management instrument adopted by the relevant environmental management authority, and comply with environmental legislation;
(c)	…include provisions that permit the incremental introduction of land use management and regulation in areas under traditional leadership, rural areas, informal settlements, slums and areas not previously subject to a land use scheme;
(d)	…include provisions to promote the inclusion of affordable housing in residential land development;
(e)	…include land use and development incentives to promote the effective implementation of the spatial development framework and other development policies;
(f)	…include land use and development provisions specifically to promote the effective implementation of national and provincial policies; and
(g)	…give effect to municipal spatial development frameworks and integrated development plans.

Unlike other plans, the land use scheme is a legal instrument that grants developmental rights on each registered land parcel or erf. It gives effect to an SDF by granting development controls associated with the SDF initiatives. An LUS records permissible use zones and provides other standards and procedures that can be employed in case of land use under a permissible use zone is to be amended. Thus, any amendment to the use of a property or an erf must be consistent with an SDF and a land development application must be submitted to a municipality for approval so that land-use changes and developmental rights granted are registered for accountability and to assess the performance and effectiveness of proposed SDF strategies.

A land-use scheme is a planning tool that allows or restricts certain types of land uses to certain geographic areas. A municipal land use scheme consists of three parts, scheme regulations and a map setting out the procedures and conditions relating to the use and development of land in any zone (SPLUMA section 25, subsection 2(a)), as well as a register of all amendments. Every property in the municipality is subject to a set of development parameters (often called "scheme regulations") that set out all procedures and conditions associated with the use of land on any property. This includes the type of land use or activity that will be exercised on the property, as well as other parameters that determine the extent of the development.

SPLUMA declares that a municipal land use scheme adopted in terms of Section 24 of the Act has the force of law and all landowners and users of land, including a municipality, a state-owned enterprise and organs of state within the municipal area, are bound by the provision of such land use scheme (section 26, subsection 1(a)). The Act states that land may only be used for the purposes permitted by a land-use scheme (section 26, subsection 1(c) and subsection 2(a)). SPLUMA also provides municipalities with the ability to pass by-laws (section 32) aimed at enforcing its land use scheme, and if the land is used in contravention of its user rights, the relevant municipality may apply to the court for a court order (section 32, subsection 2(b)). Section 24(2) guides the development of a municipal land use scheme and translates these development principles into certain requirements of schemes.

Section 25 of SPLUMA mandates all local municipalities to develop and adopt a single LUS, which gives effect to the municipal SDF and promotes economic growth, social inclusion, efficient land development and minimal impact on public health, the environment and natural resources. An LUS adopted in terms of SPLUMA must contain regulations setting out the procedures and conditions relating to the use and development of land in any zone, a zoning map, and a register of all amendments to such an LUS.

Some clarity is needed regarding different terms being used worldwide relating to the management of land use. Internationally, the term "zoning code" or "zoning ordinance" is used widely. This basically refers to local laws that define how property in specific geographic zones can be used.

In South Africa, prior to the enactment of the new planning legislation in 2013, the land was managed using town planning schemes. After the promulgation of SPLUMA, the term was amended to LUSs. In KwaZulu-Natal and the Western Cape, however, the term “zoning scheme” is still used. All these terms refer to the same instrument, which will be discussed below.

In more practical terms, a well-informed LUS can designate desirable land uses and provide clarity on what may or may not occur on a property, and what may be considered at the discretion of the municipality. A municipal LUS must aim to balance the interests of individuals with those of the public, resolve conflicts between different land uses, control negative externalities, and promote economic growth and social inclusion. It can legally promote and protect amenities such as natural resources, and unique areas or features in the municipality, and enable the efficient use of land, which has a minimal impact on public health, the environment and natural resources. Most importantly, an LUS provides a means of enforcement, which makes it the ideal instrument to achieve spatial aims highlighted in other planning documents (e.g. EMPs and SDFs). Hence, today, with the municipality being the foremost spatial planning authority, the legally binding municipal LUS is the central land use management instrument.

4.3.2.1 Components of a land use scheme

An LUS is basically a document (referred to as the scheme clauses) accompanied by a set of maps that spatially indicate many of the restrictions. It is important to note that municipalities are mostly left to themselves to compile these scheme clauses, it can, therefore, be as simple or as complicated as the municipality wishes it to be. The complexity of scheme clauses can be discussed at length. For the purposes of this document, only certain aspects will be highlighted.

4.3.2.2 Zonings

Two words are used concurrently: “land use” and “zoning.” However, it is critical to understand that they do not mean the same thing. Land use refers to a type of activity that occurs on a piece of land. Zoning is a process of planning for land use by allowing or restricting certain land uses in a certain geographic area. A “zoning” is not necessarily restricted to single land use and typically includes several related land uses. Zoning also includes restrictions (referred to as development controls) in different zoning areas (e.g. the height of buildings). In a zone, one can distinguish between permitted land uses and secondary land uses.

- Permitted land use is a land use that will be allowed in a certain geographic area without the need to apply to the municipality for permission. Note, however, that certain limitations still apply to the extent of this land use (see Chapter 4.3.2.3).
- A secondary land use requires permission from the municipality (as well as landowners in the immediate vicinity) and is subject to an administrative process before the land use can be exercised.
- A non-permitted use applies to land uses that may not be exercised in a specific zone. Any member of the public can still apply for such a land use, but the administrative process (referred to as a re-zoning) is more stringent and subject to comments from the public, the municipality (e.g. the Town Planning Department and the Infrastructure Department) and external government departments (e.g. the Department of Agriculture).

Figure 4.4: Example of zonings: Lephalale Land Use Scheme (2017)

Code: R2	RESIDENTIAL 2	
Objectives of this Zone: • To provide adequate land for residential purposes at a medium density. • To create integrated, safe and sustainable residential environments for all communities. • To protect the residential use and amenity by limiting the compatible uses allowed to those that can be accommodated within the residential fabric with minimal impact or disruption.		
RULES REGARDING THE USE OF LAND AND BUILDINGS		
What land may be used for:		**Land uses that are prohibited:**
Primary Uses:	**Consent Uses (application and concept SDP required):**	
Dwelling Units, Town Houses/Group Housing.	Institution, Residential building (Bed and breakfast establishment, Guest House, Boarding House, Guest Lodge), Place of Instruction, Home occupation practice, Places of Public Worship, Social Halls.	Any use not mentioned under Primary, or Consent uses.

These zonings are depicted spatially on maps of various scales that allow anyone to identify the zoning (and therefore allowable land uses and other development controls on any property).

Figure 4.5: Example of a zoning map: Lephalale Land Use Scheme (2017)

4.3.2.3 Development controls

A municipality manages development through a series of development parameters or scheme controls (often also referred to as development controls) relating to each zoning that detail the requirements in respect of buildings, built forms and subdivisional matters.

The following typical development parameters are included in a scheme:

- Density as the number of dwelling units per erf/lot or per hectare
- Height restrictions expressed as the number of storeys or in metres above ground level or above mean sea level
- Floor area ratio or the ratio of the total floor area of the building to the total area of the subdivision on which the building is or is to be erected
- Coverage – the percentage of the plot that may be covered by a building or roofs
- Parking and vehicle loading requirements
- Building lines/space around buildings

Other development parameters may also include the following:

- Space around the buildings – side and rear spaces
- External appearance of buildings
- Urban design criteria
- Signage and advertising

Figure 4.6: Example of development controls: Lephalale Land Use Scheme (2017)

<table>
<tr><th colspan="6">RULES REGARDING THE EXTENT OF DEVELOPMENT</th></tr>
<tr><th>Maximum Density:</th><th>Maximum Coverage:</th><th>Maximum FAR:</th><th colspan="2">Maximum Height:</th><th>Other:</th></tr>
<tr><td>Maximum of 40 dwelling units per hectare.</td><td>60%</td><td>1.00</td><td colspan="2">3 storeys</td><td>As may be approved by the municipality from time to time.</td></tr>
<tr><th colspan="4">RULES REGARDING BUILDING LINES</th><th colspan="2">RULES REGARDING PARKING AND LOADING</th></tr>
<tr><td colspan="2">Street boundary:</td><td colspan="2">▪ 5 metres for municipal streets.
▪ 2 metres along internal streets.</td><td colspan="2" rowspan="3">1 covered and 1 uncovered spaces per dwelling unit.
For non-residential uses, refer to Chapter 8.</td></tr>
<tr><td colspan="2">Rear boundary:</td><td colspan="2">▪ 2 metres for municipal streets.
▪ 1 metre along internal boundary.</td></tr>
<tr><td colspan="2">Side boundary:</td><td colspan="2">▪ 2 metres for municipal streets.
▪ 1 metre along internal boundary.</td></tr>
</table>

4.3.2.4 Buildings

Buildings are regulated in terms of the National Building Regulations and Building Standards Act. Building control is simply concerned with the manner in which buildings are erected. It regulates the standards of buildings for safety purposes as it looks at issues such property dimensions, scale drawn at, slope of the ground, the strength of the building in case of double or more storeys and material used, building elevations and the direction (north-facing for light purposes), direction of windows, possible encroachment to other adjoining properties and location of service lanes (water, sewer).

The building specification and designs are to be satisfied before any building can be erected. Every building must meet building standards as set by the National Building and Regulation Standards Act and no building can be approved if the developmental rights (in terms of an LUS) on that property to be built are not approved or granted by the municipality. The building is approved or satisfied through a building plan submitted to the municipality.

An LUS can make recommendations for buildings in a specific area. One such example has to do with the heritage status of buildings older than 65 years. Specific permission is required before the façade of such old buildings may be altered. This interaction between the LUS (which, in turn, is influenced by the SDF) and the SDF allows for a practical way of implementing certain policy decisions.

Examples of the above include the City of Tshwane Metropolitan Municipality, which introduced changes to its Building Regulations in 2013, specifically aimed at the conservation of energy. Building plans of new buildings have to conform to certain energy efficiency values (mostly obtained through fitting a specific type of window glass) before the plan is approved. This could, in future, also apply to water efficiency in buildings. The City of Cape Town already has certain “guidelines” regarding water efficiency (City of Cape Town, 2012:19-22):

- Ensure that only water-efficient devices, such as low-flow taps, low-flow showerheads, washing machines and dishwashers are used.
- Ensure that all toilets are low volume (9.5 ℓ or less), with dual-flush or multi-flush.
- Ensure that public buildings and outside taps and showers are fitted with metering tap buttons, which have set timers to prevent taps being left on or dripping.
- Design the layout of the plumbing system to avoid long pipe runs between the geyser and supply points.
- Reduce hard surfacing to encourage rainwater to seep back into the ground rather than being carried away into the sea by drainage systems.
- Design paved areas so that water run-off is slowed down and, where possible, use soakaways and permeable paving that allows water to filter into the ground.
- Ensure that the optimum pipe size and water pressure is used. A pressure-reducing valve can be installed at a point nearest to where the supply enters the building to ensure that all water supplies in the building are balanced.
- Encourage rainwater harvesting and the re-use of grey water where appropriate. However, ensure that the local ecological system is not polluted and that it is managed correctly.
- Encourage the use of indigenous planting and efficient irrigation methods, such as drip irrigation.
- Consider the use of a pool blanket to reduce water loss through evaporation.
- Introduce waterless sanitation and alternative greywater systems that clean black and grey water, while providing useful by-products such as fertilizer and biogas.

4.3.2.5 Other scheme clauses

Municipalities may populate their LUS clauses with any matter that they feel requires management. They can, therefore, be as restrictive or flexible as required, considering the complexity of their municipality, as well as the capacity to give effect to the scheme.

Some of these may include the following:

- Use and development of land applications
- Existing buildings, the existing use of buildings and land, and non-conforming and existing use of buildings and land
- Temporary uses
- Siting of buildings and access

- Restriction on areas likely to be subject to flooding, landslides, etc.
- Declaring, diverting, improving or closing streets or roads
- Splaying of corners, widening of streets
- Car parks and malls
- The external appearance of buildings
- Advertisements (signage)
- Exemptions and exceptions
- Loading and parking accommodation
- Protection of indigenous flora, fauna, habitats and natural systems
- Procedures, serving of notices and powers of entry as per the relevant legislation or were additional to legislative requirements.

This section of an LUS could also deal with very specific matters. In many municipalities, land uses that are often subject to interpretation (e.g. guest houses) or problematic land uses (taverns or establishments selling alcohol) are specifically dealt with.

Note: This could be the ideal section to include a specific policy regarding water sensitivity.

4.3.2.6 Significance of an LUS regarding water sensitivity

Land use schemes (in their previous form as town planning schemes) are not new to South Africa. In fact, many schemes still being used today are decades old. SPLUMA introduced additional requirements for LUSs that could have far-reaching implications on water resource management. Table 4.4 summarises the SPLUMA requirements for schemes in comparison to what was previously required.

Table 4.4: SPLUMA requirements for land use schemes

Elements required by SPLUMA that can typically be found in South African LUSs today	Elements required by SPLUMA that are new to South African LUSs
Appropriate categories of land use zoning and regulations (section 24(2)(a)).	One land use scheme for the entire municipal area (section 24(1)).
Take cognisance of any environmental management instrument adopted by the relevant environmental management authority and comply with environmental legislation (section 24(2)(b)).	Include provisions that permit the incremental introduction of land use management and regulation in areas under traditional leadership, rural areas, informal settlements, slums and areas not previously subject to an LUS (section 24(2)(c)).
Provisions relating to the use and development of land only with the written consent of the municipality (section 24(3)(a)).	Include provisions to promote the inclusion of affordable housing in residential land development (section 24(2)(d)).
Scheme regulations setting out the procedures and conditions relating to the use and development of land in any zone (section 25(2)(a)).	Include land use and development incentives to promote the effective implementation of the SDF and other development policies (section 24(2)(e)).
Map indicating the zoning of the municipal area into land use zones (section 25(2)(b).	Include land use and development provisions specifically to promote the effective implementation of national and provincial policies (section 24(2)(f)).
A register of all amendments to such LUSs (section 25(2)(c)).	Give effect to municipal SDFs and IDPs (section 24(2)(g)).
	Specific requirements regarding any special zones identified to address the development priorities of the municipality (section 24(3)(b)).

New requirements for schemes introduced by SPLUMA can be categorised as follows:

- Additional geographic areas should be covered (a wall-to-wall municipal land use scheme)
- Informal settlements and areas under traditional leadership should be introduced into LUSs
- Mechanisms should be designed to give effect to policies, frameworks and plans developed by the municipality or other spheres of government

Each of the above can have far-reaching implications for water. These will inform later chapters of this document but will be discussed briefly in this section.

Table 4.5: SPLUMA LUSs and water

New SPLUMA requirements for land use schemes	Implications on water
One LUS for the entire municipal area.	In the past, town planning schemes managed land uses in the urban area or “town”. The requirement to have wall-to-wall LUSs now includes land uses that typically do not occur within the urban fabric. These include large tracts of land in a natural environmental state, areas used for all forms of agriculture and forestry, mining, as well as traditional authorities. Mining and agriculture account for a combined 74% of water consumption. Although applications for water use licenses are still required for both these activities, the LUS can now further manage these land uses considering water.
Include provisions that permit the incremental introduction of land use management and regulation in areas under traditional leadership, rural areas, informal settlements, slums and areas not previously subjected to an LUS.	Some 27% of all households in South Africa reside in traditional authorities (accounting for 11% of the surface area of the country). Little or no formal land use management has ever been exercised in these areas. A lack of land use management certainly impacts on the amount of water consumed by these land uses, but more importantly the quality of water. In its simplest form, the allocation of land by traditional chiefs has, in the past (in some instances), happened in the wrong place. Keep in mind that these traditional land allocation practices are guided by what can be observed on the ground in real life (without the benefit of complex and expensive information systems). A freshwater ecosystem protection area, for example, has little meaning to traditional authority in Lephalale that cannot observe its demarcation in their immediate surroundings.
Specific requirements regarding any special zones identified to address the municipality’s development priorities.	The protection of resources (such as water) has often been ignored in spatial planning. This requirement allows for the introduction of any policy that aims for the protection of water resources or the improvement of the quality of water into the LUS. Due to the legal status of the LUS, including such a policy means that the policy now has the force of law.

The WRC Project No. K5/2071 conducted a policy review (including institutional and legal issues) that identified obstacles regarding implementing WSUD in South Africa. Armitage et al. (2014:iii) said that “it is evident that there is a lack of an enabling Council-approved policy and guidelines (with political backing and the force of by-laws).” Section 26(1)(a) of SPLUMA states that “an approved land use scheme has the force of law, and all landowners and users of land, including a municipality, a state-owned enterprise, and organs of state within the municipal area, are bound by the provision of such land use scheme.” Section 26(2)(a) further states that “land may only be used for the purposes permitted by a land-use scheme” (DRDLR, 2013).

Thus, planners can develop and enforce water-conscious land use planning with political backing, which can facilitate changing settlements from water wasteful to water sensitive. Strategic planning should prioritise water source areas and prevent incompatible land uses. According to Nel et al. (2011), where land has been degraded, restoration and compatible land uses can stimulate the rural economy in water source areas and provide jobs.

From a planning perspective, SPLUMA can and must be used as the enforcement of a policy-driven approach towards water-sensitive settlements.

4.3.3 The relationship between the SDF and the LUS

Other documents that form part of this study discussed the SDF as a component of municipal planning and, more specifically, how the SDF can influence the quality of water, as well as the quantity consumed by various land uses. A municipal SDF must contribute to and form part of the municipal IDP, and assist in integrating, coordinating, aligning and expressing development policies and plans emanating from the various sectors of the spheres of government as they apply within the municipal area. Spatial development frameworks must also outline specific arrangements for prioritising, mobilising, sequencing and implementing public and private infrastructural and land development investment in the priority spatial structuring areas identified in the SDFs. A municipal SDF must also determine the purpose, desired impact and structure of the land use management scheme to apply in that municipal area.

An LUS must give effect to and be consistent with the municipal SDF and determine the use and development of land within the municipal area to which it relates to promote economic growth, social inclusion and efficient land development, and to have minimal impact on public health, the environment and natural resources. As mentioned earlier, property rights are managed through "zoning" as indicative rights of what land use can be exercised on a property. These property rights are assigned, managed and amended though the controls and mechanisms of an LUS.

Schemes may be amended in the following manner:

- Land development applications that amend the scheme by changing the rights applicable to properties (e.g. a rezoning from residential to business rights). These amendments are decided by a municipal planning tribunal or a land development officer. This tribunal cannot decide on an amendment of an LUS (called a development application) that is inconsistent with a municipal SDF (unless site-specific circumstances justify such a departure).
- Changes to the scheme that affect the regulations (which set out the procedures and conditions relating to the use and development of land) may only be authorised by the Municipal Council.

4.4 CONCLUSION

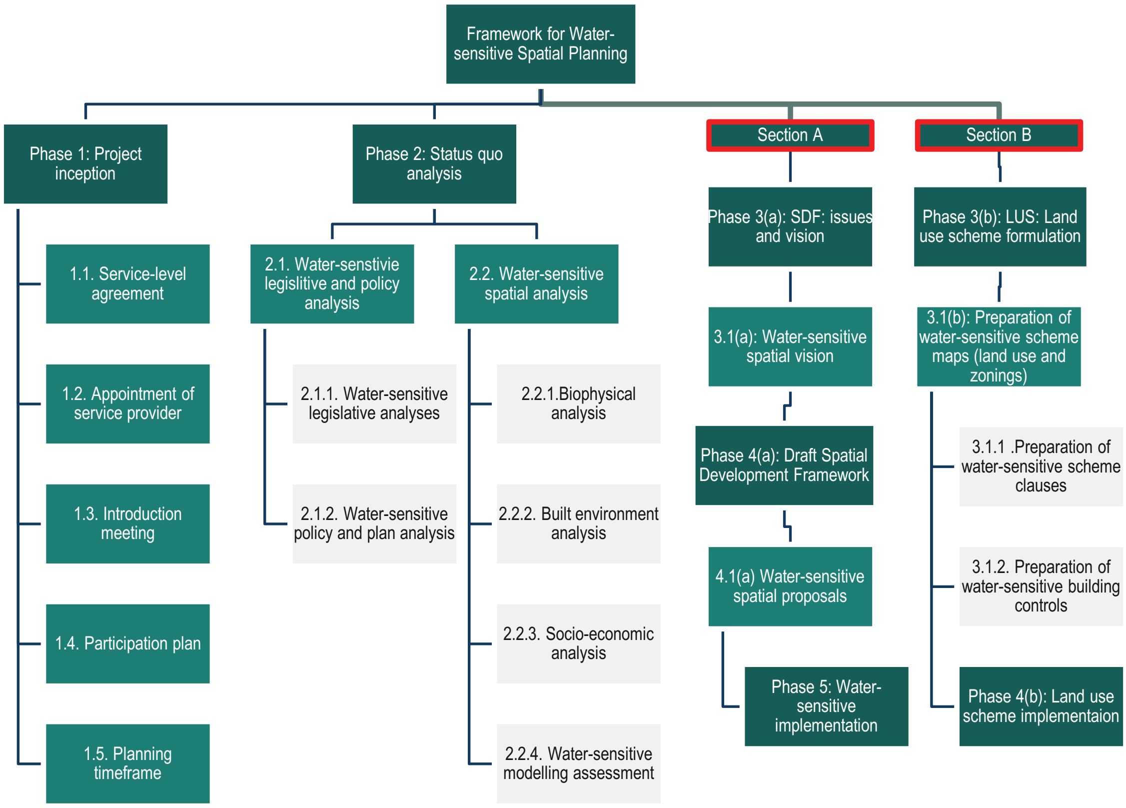
In the above chapter, it is quite clear that one has to (by law) plan for water, the environment and future development. It is furthermore quite clear that these plans (required by law) are in place in most provinces, catchments and municipalities. With most of these plans requiring cross-sector alignment, one can almost assume that all issues are aligned and addressed in these documents. The next section will investigate two case studies to identify if this is happening. The SDFs and LUSs provide municipalities with a tool to manage their land uses. Unlike other tools and policies developed at the municipal level, the LUS can legally be enforced. If a specific land use is in contravention of the LUS, the municipality could use the scheme to force the landowner to either become legally compliant or to cease the activity. To date, no local (or international) LUS has considered introducing clauses or elements that could allow them to manage resources (such as water) in a more effective way. This could be since resource management is typically the responsibility of a different sphere of government. Municipalities, however, are specifically mandated to decide what land use should be allowed on a property, as well as how "big" this land use should be. In other research, the parallel between land use and water consumption has already been drawn. This basically means that – indirectly – municipalities also have a say in the quantity of water consumed (through land-use decisions).

CHAPTER 5: GUIDELINE ON COMPILING WATER-SENSITIVE PLANS

5.1 BACKGROUND

This chapter is structured in several phases, sections and steps. The phase represents the typical project timeframe mostly linked to a deliverable. The guideline document recommends that Phase 1 and Phase 2 are conducted when both an SDF and an LUS are being developed. Even though SPLUMA mandates each municipality to develop and adopt an SDF and an LUS to guide and regulate spatial planning within its boundary, a municipality will seldom release tender bids for both planning tools and appoint the same consultant for both projects. For this reason, Phase 3 and Phase 4 are divided into two sub-sections:

- Phase 3 (Section A): Guidelines for Developing a Municipal Water-sensitive SDF
- Phase 3 (Section B): Guidelines for Developing a Municipal Water-sensitive LUS



5.1.1 Tender process

Local government's mandate to administer municipal planning is set out in Part B of Schedule 4 of the Constitution of the Republic of South Africa, Act No. 108 of 1996 (Republic of South Africa, 1996). In terms of sections 20, 21, 22, 23 and 24 of the Spatial Planning and Land Use Management Act, Act No 16 of 2013 (Republic of South Africa, 2013), local government must establish a uniform, recognisable and comprehensive system of spatial planning and land use management in its municipal area to maintain economic unity, equal opportunity and equal access to government services, and to promote social and economic inclusion.

The SDF and the LUS are two municipal planning tools used to achieve this. In some instances, municipalities lack the skills, knowledge and capacity required to develop such tools. In the event that municipalities are incapable of performing certain duties in-house, the Constitution gives them the authority to procure goods and services from an outside body. Government entities (municipalities) need to follow several procedures when they issue a request for a quotation or a competitive bid (tender). These procedures are governed by different Acts, such as the Preferential Procurement Policy Framework Act, Act No. 5 of 2000, and the Public Finance Management Act, Act No. 1 of 1999, as amended by Act No. 296 of 1999. Section 21(1) of the Constitution (Act No. 108 of 1996) provides that organs of state must comply with five principles when procuring goods or services. Procurement procedures must be fair, equitable, transparent, competitive and cost-effective.

SPLUMA (Act No. 16 of 2013) requires all local municipalities to adopt a municipal SDF and a wall-to-wall LUS within five years of enactment of this new planning law. Since the legislation went "live" in 2015, local municipalities had until 2020 to develop SPLUMA-compliant SDFs and LUSs, which should also be reviewed every five years. This led to the publication of numerous tender advertisements since 2015. Municipalities can advertise tenders for the review of existing planning documents or for the development of new ones. Budgets wil,, therefore, vary, depending on the amount of work required. Budgets will also vary based on the size of the municipality and the available funds. Bidders must comply with the terms of references (TOR) of the tender document. In most instances, the TOR for the development of municipal SDFs and LUSs are standard and refer to Sections 20 and 21 of SPLUMA.

5.1.2 Procurement process

Only after the tender has been advertised and the briefing session attended (if compulsory), can private consultants submit tender documents to the municipality. The submitted tenders will go through a rigorous adjudication process, also referred to as the procurement process. Only then will the tender be awarded to the successful bidder. The following are key among the municipalities' many considerations in the procurement of companies to develop a municipal SDF or LUS:

- The project leader must have a tertiary qualification in Town and Regional Planning and be registered as a professional planner with the South African Council for Planners (SACPLAN) in terms of the Planning Profession Act, Act No. 36 of 2002.
- Companies must have an understanding of the legislative and policy requirements in developing a municipal SDF or LUS (depending on the appointment).
- Companies must have a proven track record in strategic planning (when appointed for an SDF).
- Companies must have a proven track record in regulatory and administrative land use management (when appointed for an LUS).
- Companies must have knowledge of Geographic Information Systems (GIS).
- Companies must have an understanding of the municipal planning processes.

Technical team SDF: A typical project team for developing an SDF will consist of the following:

Table 5.1: Typical technical team

Technical team	Roles and responsibility
Professional registered town planner and project manager	Spatial planning inputs, project management
GIS specialist	Spatial data analysis

In developing a water-sensitive SDF, it is recommended that the expertise of other professionals be included.

Table 5.2: Additional technical team members

Technical team	Roles and responsibility
Civil engineer	Location, extent, condition and capacity of existing infrastructure networks. Quantification of additional infrastructure required to give effect to spatial proposals.
Environmentalist	Environmentally sensitive inputs, location of water resources, inputs to planning (what should be conserved, where it is located, etc.).
Landscape architect	Detail site-specific considerations with regard to the landscaping of green spaces in a water-sensitive manner.
Stormwater engineer	Inputs into large-scale natural stormwater features that may affect the future shape of the town or city.

Technical team LUS: A typical project team for developing an LUS will consist of the following:

Table 5.3: Typical technical team

Technical team	Roles and responsibility
Professional registered town planner and project manager	Spatial planning inputs, project management
GIS specialist	Spatial data analysis

In developing a water-sensitive LUS, it is recommended that the expertise of other professionals be included.

Table 5.4: Additional technical team members

Technical team	Roles and responsibility
Legal specialist in land, water and environmental law	Analyse the rights and responsibilities of certain land uses, etc.
Environmentalist	Environmentally sensitive inputs, location of water resources, inputs into planning (what should be conserved, where it is located, etc.)
Stormwater engineer	Inputs into large-scale natural stormwater features that may affect the future shape of the town or city.
Green infrastructure specialist	Detail site-specific considerations with regard to the landscaping of green spaces in a water-sensitive manner.
Building specialist	Evaluate and consult on building control clauses, specifically related to water-sensitive urban design.

Table 5.5 sets out the generic composition of a typical work plan for developing a municipal SDF.

Table 5.5: Typical work plan for the development of a municipal SDF

Ref No.	Actions
1.	**Phase 1: Project inception**
1.1	Appointment of the service provider for the preparation of an SDF
1.2	The signing of the service-level agreement for SDF
1.3	Introduction meeting
1.4	Stakeholder identification
1.5	Inception meeting
1.6	Participation plan
1.7	Inception report
2.	**Phase 2: Status quo analysis**
2.1	Synthesise policy context (sector departments and national and provincial policy directives)
2.2	Review IDP, all municipal sector plans and surrounding sector plans
2.3	Conduct a strategic analysis of the biophysical elements
2.4	Conduct a strategic analysis of the built environment
2.5	Conduct a strategic analysis of the socio-economic situation: demographic analysis, population and customer forecast

Ref No.	Actions
2.6	Produce a status quo report
2.7	Steering committee meeting and presentation
3.	**Phase 3: Issues and vision**
4.	**Phase 4: Draft SDF report**
4.1	Current structuring and restructuring elements
4.2	Develop a spatial concept based on the synthesis of the key challenges and opportunities
4.3	Long-term spatial vision: spatial development pattern over five, 10 and 20 years
4.4	Spatial proposals
4.5	Compile a draft municipal SDF report.
4.6	Steering committee meeting and presentation
5.	**Phase 5: Consultation and achieving support**
5.1	Sector department consultation
5.2	Public meeting
5.3	Traditional authority engagement
5.4	Report summarising the inputs obtained from consultation and the implications for the draft SDF
6.	**Phase 6: Final report**
6.1	Submission of final SDF
6.2	Steering committee meeting and presentation
7.	**Phase 7: Implementation**
7.1	Notice of proposed municipal SDF in Provincial Gazette and the media
7.2	Finalisation of SDF (after 60 days)
7.3	Council meeting (adoption)

Table 5.6set out the generic composition of a typical work plan for developing a municipal LUS.

Table 5.6: Typical work plan for the development of a municipal LUS

Ref No.	Actions
1.	**Phase 1: Project inception**
1.1	Appointment of the service provider for the preparation of an LUS
1.2	The signing of the service-level agreement for LUS
1.3	Introduction meeting
1.4	Stakeholder identification
1.5	Inception meeting
1.6	Participation plan
1.7	Inception report
2.	**Phase 2: Status quo analysis**
2.1	Prepare updated cadastral information of the municipal area
2.2	Undertake a detailed land use survey of all properties within the jurisdiction of the municipality
2.3	Identify and map all properties affected by environmental restrictions such as dolomites, protected areas, significant heritage sites, wetlands, dams, rivers, etc.
2.4	Identify and map all illegal land uses in the whole municipal area of jurisdiction
2.5	Prepare a strategy for addressing illegal land uses in the proposed LUS
2.6	Submit final land use rights verification report
2.7	Steering committee meeting and presentation
3.	**Phase 3: Land use scheme formulation**
3.1	Preparation of scheme maps (land use and zonings)
3.2	Preparation of scheme clauses
3.3	Preparation of building controls
3.4	Compile draft land use scheme maps and scheme clauses
3.5	Steering committee meeting and presentation
4.	**Task 4: Land use scheme adoption and approval**
4.1	Sector department consultation
4.2	Public meeting
4.3	Traditional authority engagement
4.4	Report summarising the inputs obtained from consultation and the implications for the draft LUS
5.	**Task 5: Land use scheme implementation and project closure**
5.1	Submission of the final document
5.2	Steering committee meeting and presentation
5.3	Proclaim land use scheme in the Provincial Gazette on behalf of the municipality and submit proof of proclamation to the Department of Cooperative Governance and Traditional Affairs (CoGTA)
5.4	Prepare an implementation plan for the LUS
5.5	Finalisation of land use scheme
5.6	Council meeting (adoption)

5.2 GUIDELINE

Phase 1: Project inception

Phase 1 of the SDF and LUS are relatively similar, as indicated in Table 5.5 and Table 5.6.

Phase 1.1: Appointment of the service provider for preparation of an LUS

The municipality will appoint a service provider after all the submitted tender documents have been through an adjudication process. An appointment letter will be sent to the service provider stating that they have been appointed according to the bid number.

Phase 1.2: Signing of the service-level agreement for LUS

The appointment is, however, subject to the signing of the service-level agreement (SLA), as per the municipality's specifications and/or conditions of the contract. The SLA will in most cases confirm the timeframe for the appointment, as well as the budget. The signing of the SLA should (if possible) take place at the first introduction meeting.

Phase 1.3: Introduction meeting

The introduction meeting is set to be the first engagement between the municipality’s project coordinator and the service provider. As mentioned in Phase 1.1, the signing of the SLA should take place at this meeting. The introduction meeting also presents an opportunity for the service provider and the municipal or district project coordinator to discuss possible stakeholders to be invited to the inception meeting. This meeting should also be used as an opportunity for the project coordinator to share existing documents and data applicable to the project.

Phase 1.4: Stakeholder identification

Section 28(3) of Local Agenda 21 introduced the notion of stakeholder involvement as “each local authority should enter into a dialogue with its citizens, local organisations and private enterprises and adopt a “local Agenda 21”. Through consultation and consensus-building, local authorities would learn from citizens and from local, civic, community, business and industrial organisations and acquire the information needed for formulating the best strategies…” (United Nations CSEA, 1992). Managing land and water in a holistic manner is not possible without engaging those who are either using or responsible for taking care of the individual elements thereof via policymaking, legislation, regulation, construction, operations and maintenance (Philip et al., 2011, p. 25). Not all stakeholders can be consulted and engaged in the same manner. Therefore, a stakeholder classification could be a useful exercise. Different levels of stakeholder involvement are yet another factor to be addressed as part of the stakeholder classification exercise.

Rohilla et al. (2017, pp. 12–13) differentiate between primary and secondary stakeholders or users. Primary stakeholders would typically include government bodies as they are involved in both land and water resource management by legal definition. Public and private institutions and agencies can also be classified as primary stakeholders if they have a legally defined mandate delegating their roles and responsibilities associated with land and water resources. Secondary stakeholders in this regard typically include traditional authorities, community members, large water and land users (agriculture, mining, regional development) and research institutions. During the stakeholder identification process, the consultant should gather as much information and documentation as possible that is relevant to the study area, specifically water resources planning and management information, as this is information that is not typically found in any spatial planning and land use management documents. Table 5.7 should be used as a guide for stakeholder identification.

Table 5.7: Primary and secondary stakeholder identification

Primary stakeholders	Secondary stakeholders
Municipal Spatial Planning Department: Chief Town Planner	Community members
Municipal IDP Officer	Major water users (business, farm, industries)
Municipal Department of Infrastructure Development	Traditional authorities
Water Services Authority: Representative	Water Research Commission
Water Services Providers: Representative	SANBI
Catchment Management Agency: Representative	Biodiversity GIS
Environmental Conservation and Protection Agency	ARC
National or provincial DRDLR	Provincial Growth and Development Agency
National or provincial DWS	Land Claims Commissioner: Regional Offices
National or provincial DEA	Rural Development Plan Steering Committee
National or provincial Department of Housing and Human Settlements	Transnet
National or provincial Conservation and Protection Agency	Eskom
National or provincial Department of Agriculture	National or provincial Department of Education
National CoGTA	National or provincial Department of Health

Phase 1.5: Inception meeting

An inception meeting, coupled with an inception report, is required to launch the project. This meeting will serve the following purpose:

- Introduce project participants
- Confirm the scope of work, asset scope, level of detail, methodology, timeframe and milestones
- Identify stakeholders and confirm arrangements for their participation in the project, including finalisation of the skills transfer plan
- Request and secure copies of relevant existing data and information (water-specific plans: WSDPs, CMS, reconciliation strategies, water catchment development management strategies, water policies, tariff structures, by-laws relating to water, billing systems information)
- Confirm project management arrangements (e.g. roles and responsibilities, communication protocols, progress reporting)

5.2.1.6 Phase 1.6: Participation plan

A detailed work plan will be prepared to structure the development of the different elements of the project. All the relevant authorities and communities that will be affected by this project will be identified, and the level of consultation will be determined.

A detailed participation plan will be prepared that will involve arranging interaction with all interested and affected parties as identified in the stakeholder analysis. It should be noted that water-related role-players hardly ever play a role (or may not have been invited) in the preparation of a municipal SDF or LUS. This is something that needs to be rectified.

5.2.1.7 Phase 1.7: Inception Report

The service provider will submit an Inception report to the municipality.

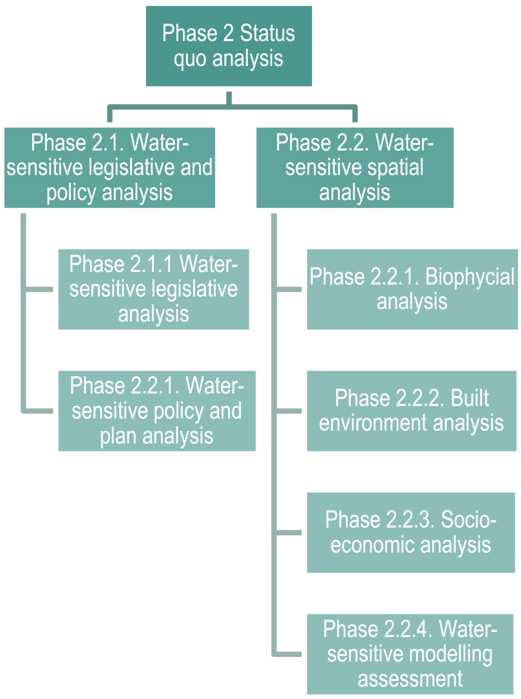
Phase 2: Status quo analysis

According to Table 5.5 and Table 5.6, Phase 2 of developing an SDF and LUS is to conduct a status quo analysis. However, the sub-phase (according to the workplan) differs quite a lot. As part of Phase 2 of the SDF, the status quo analysis consists of four main assessments, including policy analysis, a biophysical analysis, a built environment analysis and a socio-economic analysis. As part of Phase 2 of the LUS, it consists mainly of conducting a land audit for the entire municipal area and assessing the legality of the land use.

However, since the enactment of SPLUMA, SDFs and LUSs are required to cover the full extent of the municipality in question. Due to the lack of spatial planning practices in rural areas (due to apartheid planning laws), very limited data on rural land use is readily available. This guideline,, therefore, recommends that a land audit be conducted as part of Phase 2 of developing an SDF. Furthermore, the impact of land use on water is both quantitative and qualitative. Therefore, this guideline document recommends that a comprehensive spatial analysis be conducted as part of Phase 2 of the LUS. For this reason, Phase 2: Status quo analysis will be applicable to both planning tools.

The discussion to follow is structured into several sub-phases and steps, see Figure 5.1.

Figure 5.1: Phase 2: Status quo analysis



Phase 2.1: Water-sensitive legislative and policy analysis

SPLUMA sets out several requirements to which the process of developing an SDF and/or LUS must conform. The Act states that national and provincial spheres of government and each municipality must prepare an SDF that guides planning and development decisions across all sectors of government in terms of this Act or any other law (including water-related legislation, policies and plans) relating to spatial planning and land use management.[4] The Act does not bluntly state that a policy review is a prerequisite for the preparation of an SDF or LUS. However, the SDF's mandate to give effect to and align with national, provincial and local government's policies, legislation, strategies and plans is captured in section 13(3)(a)(b), section 14(b), section 15(3)(a), (b) and (c), section 16(a), (c) and (f), section 19(b*)* and section 21(i) and (m). While a municipal LUS has the force of law, it must give effect to and align with national, provincial and local government legislation, policies, strategies and plans as set out in sections 24(2)(b), 27(1) and 29(1) of SPLUMA.

A water-sensitive legislative and policy analysis should identify and review all legislation, policies and sector plans relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management. As part of the review process, the planner should assess vision statements, development principles, norms and standards for service provision (if any)

[4] Act No. 16 of 2013, section 12, subsections 1(c), (d), (e) and (n), subsection. 2(b), subsection. 3, subsection. 4 and subsection 5.

and determine whether they impose any spatial development directive to the local municipality. The analysis should also identify the roles and responsibilities assigned to government spheres, sector departments or institutions as they relate to land, water and environmental resources planning and management. The policies and plans often set development targets. If possible, an SDF and LUS should give effect to these targets spatially.

WATER-SENSITIVE LEGISLATIVE AND POLICY ANALYSIS

The objective of a water-sensitive policy analysis is to establish a baseline legal and institutional framework for the planning and management of land, water and environmental resources.

The aims of a water-sensitive policy analysis are to do the following:

- Identify development principles and strategies, regulations, norms and standards, visions and goals, and, if available, development targets and other collaborative development initiatives by outlining the key spatial informants or directives.
- Strengthen the inter-governmental alignment of development priorities and ensure that the plans and programmes are coordinated, consistent and in harmony with each other.
- Ensure that the policy analysis acts as a platform for stakeholder identification.

Key questions to inform the policy analysis:

1. Which legislation, policy and plans should inform the development of a water-sensitive SDF and LUS?
2. Do the above-identified legislation, policies and plans impose any spatial directives or resource management guidelines?
3. Which roles and responsibilities (applicable to land, water and environmental resources) are assigned to national, provincial and local government, and to sector departments through national legislation?
4. Do the identified legislation, policies, strategies, frameworks and plans have a vision statement, aims, objectives or targets to which the municipal SDF and LUS must adhere, and can it be addressed spatially or achieved through development principles?
5. Will any of the above-identified sector plans have a physical impact on the municipality?

Water-sensitive spatial planning and land use management must give effect to and align with national, provincial and local governments' legislation, policies and sectoral strategies, applicable, but not limited to the land, water and environmental sector. The following simplified steps should be used as a guide for planners when conducting a water-sensitive legislative and policy analysis.

Phase 2.1.1: Water-sensitive legislative analysis

Step 1: Identify and list legislation applicable to the study

Step 1 of the water-sensitive policy analysis is to identify and list national, provincial and municipal legislation (by-laws) that govern land, water and environmental resource planning and management. Most of South Africa's national legislation requires various spheres of government, sector departments and institutions to prepare policies and plans as part of their mandates. These policies and plans, as they relate to land, water and environmental resource planning and management, should be identified as part of the water-sensitive legislative analysis. However, their assessment will form part of Phase 2.1.2.

Table 5.8 provides a generic list of suggestions to help guide the planner in identifying national, provincial and municipal legislation.

Table 5.8: Generic suggestions for the identification and assessment of legislation

Legislative hierarchy	Guiding suggestions
National legislation	1. Identify and review national legislation relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	2. Assess the vision statement and key principles and determine whether or not they hold any spatial directives and how they are applicable to the municipality.
	3. Identify and assess the roles and responsibilities mandated to various spheres of government or responsible authorities relating to land, water and environmental resources planning and management.
	4. Identify any regulations published in terms of the legislation identified above, which sets out norms and standards that hold development implications or opportunities.
	5. Identify any policies, strategies, frameworks and/or guidelines published in terms of the legislation identified above and list them for further discussion.
Provincial legislation	1. Identify and review provincial legislation relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	2. Assess the vision statement and key principles and determine whether or not they hold any spatial directives and how they are applicable to the municipality.
	3. Identify and assess the roles and responsibilities assigned to different authorities in land, water and environmental resources planning and management.
	4. Identify any regulations published in terms of the provincial legislation identified above, which set norms and standards for development and that may hold development implications or opportunities.
	5. Identify any policies, strategies, frameworks and/or guidelines published in terms of the provincial legislation identified above and list them for further discussion.
Review municipal by-laws	1. Identify and review all municipal by-laws relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	2. Assess the vision statement and key principles of the by-law and determine whether or not they hold any spatial directives.
	3. Identify and assess the roles and responsibilities assigned to different authorities in land, water and environmental resources planning and management by the by-law.
	4. Identify any regulations published in terms of the municipal by-laws identified above, which set norms and standards for development and that may hold development implications or opportunities.
	5. Identify any policies, strategies, frameworks and/or guidelines published in terms of the by-laws identified above and list them for further discussion.

Table 5.9 lists several pieces of national legislation identified and the policies and plans to be prepared by various spheres of government, sector departments and institutions that have land, water and environmental resources planning and management implications.

Table 5.9: Legislation, policies, strategies and plans

National legislation	**Policies and plans to be prepared by government sectors as per their legislative mandates**					
Legislation title	**National**	**Catchment**	**Provincial**	**Regional/ district**	**Municipal**	**Site-specific**
Spatial Planning and Land Use Management Act, Act No. 16 of 2013	National Spatial Development Framework (Section 13)		Provincial Spatial Development Framework (Section 15)	Regional Spatial Development Framework (Section 18)	Municipal Spatial Development Framework (Section 20)	
					Municipal Land Use Scheme (Section 23)	

National legislation	**Policies and plans to be prepared by government sectors as per their legislative mandates**					
Legislation title	**National**	**Catchment**	**Provincial**	**Regional/ district**	**Municipal**	**Site-specific**
National Water Act, Act No. 36 of 1998	National Water Resource Strategy (Section 5) National Groundwater Strategy (this should form part of the National Water Resource Strategy (NWRS)	Catchment Management Strategy (Section 8)				
Water Services Act, Act No. 108 of 1997					Water Services Development Plan (Water Services Authority (WSA)) (Section 12)	
National Environmental Management Act, Act No. 107 of 1998	National Environment Outlook Report (Section 16) National Environmental Management Framework (Section 24(2)) Environmental Management Plans (Section 11(1)) Environmental Implementation Plans (Section 11(2))		Environmental Implementation Plans (Section 16) Provincial Environment Outlook Report (Section 16)	Environmental Management Framework (Section 24(2) and EIA Regulations (Chapter 8, Part 1)	Environmental Management Framework (Section 24(3)) and EIA Regulations (Chapter 8, Part 1)	
National Environmental Management: Biodiversity Act, Act No. 10 of 2004	National Biodiversity Framework (NBF) (Section 39) National Biodiversity Assessment (as per NBF) National Biodiversity Strategy and Action Plan (as per NBF)		Provincial Spatial Biodiversity Plan (as per NBF Priority Action 16) Provincial conservation plans (as per NBF)	Bioregions and bioregional plans (as per NBF Priority Action 17)		
National Environmental Management: Air Quality Act, Act No. 39 of 2004	National Framework for Air Quality Management (Section 7) National Air Quality Management Plan (Section 15(1) as a component of		Provincial Air Quality Management Plan (Section 15(1) as a component of EIP/EMP)		Municipal Air Quality Management Plan (Section 15 as a component of IDP)/ Model Air Pollution Control By-law	

National legislation	**Policies and plans to be prepared by government sectors as per their legislative mandates**					
Legislation title	**National**	**Catchment**	**Provincial**	**Regional/ district**	**Municipal**	**Site-specific**
	Environmental Impact Programme (EIP)/EMP					
National Environmental Waste Act, Act No. 59 of 2008	National Waste Management Strategy (Section 6)		Provincial Integrated Waste Management Plan (Section 11(1))		Municipal Integrated Waste Management Plan (Section 4(a) as a component of the IDP)	
National Environmental Management: Integrated Coastal Management Act, Act No. 24 of 2008	National Estuarine Management Protocol (Section 33)		Provincial Coastal Management Programme (Section 46)	District Estuarine Management Plan (Section 33(3))	Municipal Coastal Management Plan (Section 48)	Coastal zones planning schemes (Section 56)
	National Coastal Management Programme (Section 44)		Provincial Estuarine Management Plan (Section 33(3)		Municipal Estuarine Management Plan (Section 33(3)	Declaration of special management areas (Section 23)
Disaster Management Act, Act No. 57 of 2002	National Disaster Management Framework (NDMF) (Section 6)		Provincial Disaster Management Plan (Section 28(3)(b))	Disaster Management Plan (Section 52)		
	National Disaster Management Plan (as per NDMF)					
National Land Transportation Act, Act No. 5 of 2009	National Land Transport Strategic Framework (Section 34)		Provincial Land Transportation Framework (Section 35)	District Integrated Transportation Plan (Section 36)	Municipal Integrated Transportation Plan (Section 36)	
Municipal Systems Act, Act No. 32 of 2000				District Integrated Development Plan (Section 27)	Municipal Integrated Development Plan (Section 25)	
				Local Economic Development Strategy (Section 25)	Local Economic Development Plan (Section 26)	
Municipal Finance Management Act, Act No. 56 of 2003					Service Delivery and Budget Implementation Plan (Section 53(1))	
					Medium-term Revenue and Expenditure Framework (Section 16(2))	
National Housing Act,	National Housing Code (Section 4(1))		Provincial Housing Policy and Multi-year		Municipal Housing	

National legislation	Policies and plans to be prepared by government sectors as per their legislative mandates					
Legislation title	National	Catchment	Provincial	Regional/ district	Municipal	Site-specific
Act No. 107 of 1997	Comprehensive Housing Plan (Section 4(c))		Housing Sector Plan (Section 7(2)(g))		Sector Plan (Section 9)	
National Environmental Management: Protected Areas Act, Act No. 57 of 2003						Protected Areas Management Plan (Section 39)

Step 2: Provide a comprehensive analysis of identified legislation

Once the legislation has been confirmed, a comprehensive legislative review should follow. Key to the analysis is to assess the impact of the legislation on land, water and environmental resources planning and management as it relates to the various Acts:

- Vision statement
- Aims and principles
- Institutional mandates and arrangements
- Implications for water resource planning and management
- Implications for spatial planning

By tabulating the content, a clear assessment is obtained of the vision statement, guiding principles, aims, roles and responsibilities assigned by the Act, and a summary are provided of how the Act impacts on land, water and environmental resources planning and management. See Annexure A, Table A1: Water-sensitive legislative analysis – template. The template is partially complete as the planner should use his own insights when conducting a water-sensitive legislative analysis. Provincial legislation and municipal by-laws are unique to each province and municipality. However, the same method of assessment as used for the national legislation can be used to assess provincial and municipal by-laws.

Step 3: Compile a synopsis of the water-sensitive spatial analysis

South Africa has a plethora of legislation geared toward sustainable development. Providing a summary of all this legislation will be an extensive and time-consuming exercise. In developing a water-sensitive SDF and LUS, the legislative analysis should include other national, provincial and municipal legislation, among others, the Intergovernmental Relations Framework Act, Act No. 13 of 2005, the Traditional Leadership and Governance Framework Act, Act No. 41 of 2003, the Infrastructure Development Act, Act No. 23 of 2014, and the Restriction of Land Rights Act, Act No. 22 of 1994. However, the focus in this regard should be on legislation that impacts on land, water and environmental resources planning and management. The final step is, therefore, to summarise the key implications of the relevant legislation, as it applies to the municipality.

Phase 2.1.2: Water-sensitive policy and plan analysis

Step 4: Identify policies and plans applicable to the study

Step 4 of the water-sensitive policy analysis is to identify and list national, provincial and municipal policies and strategic plans or strategies applicable to land, water and environmental resource planning and management. During 0, several mandated policies and plans were identified, which need to be prepared and implemented by certain of the government or sector departments, as mandated by the relevant legislative. By using Table 5.9, other policies and plans should also be identified and assessed accordingly. Table 5.10 provides a generic list of suggestions to help guide the planner in identifying national, provincial and municipal policies and plans application to land, water and environmental resources management.

Table 5.10: Generic suggestions for policy and plan identification and assessment

Hierarchy	Guiding suggestions
National policies and strategies	Identify and review national policies relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	Assess the vision statement and key development principles and determine whether or not they hold any spatial directives and how they are applicable to the municipality.
	Assess the aims, objectives and targets (if any) relating to land, water and environmental resources planning and management.
Provincial policies and strategies	Identify and review provincial policies relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	Assess the vision statement and key development principles and determine whether or not they hold any spatial directives and how they are applicable to the municipality.
	Assess the aims, objectives and targets (if any) relating to land, water and environmental resources planning and management.
Municipal policies and strategies	Identify and review municipal policies relevant to municipal spatial planning and land use management, as well as water and environmental resources planning and management.
	Assess the vision statement and key development principles and determine whether or not they hold any spatial directives and how they are applicable to the municipality.
	Assess the aims, objectives and targets (if any) relating to land, water and environmental resources planning and management.
National sector plans	Identify and review all strategic sector plans (water, environmental, economic, transportation, energy, etc.) adopted by the national departments and determine to what extent the plans will affect the municipality.
	Assess the vision, mission, objective and desired outcome of the plans.
	Identify and review development principles and highlight any spatial directives.
	Identify all projects that might have a physical, environmental and socio-economic impact on the municipality. This may include the physical development of new infrastructure, the expansion of protected areas, and other mega projects deemed to create socio-economic growth in investment opportunities.
	Identify all budgets allocated to the implementation of the plan and identify the potential beneficiaries (communities).
Provincial sector plans	Identify and review all strategic sector plans (water, environmental, economic, transportation, energy, etc.) adopted by provincial government departments and determine to what extent the plans will affect the municipality.
	Assess the vision, mission, objective and desired outcome of the plans.
	Identify and review development principles and highlight any spatial directives.
	Identify all projects that might have a physical, environmental and socio-economic impact on the municipality. This may include the physical development of new infrastructure, the expansion of protected areas, and other mega projects deemed to create socio-economic growth in investment opportunities.
	Identify all budgets allocated to the implementation of the plan and identify the potential beneficiaries (communities)
Regional or catchment plans	Identify and review all regional or catchment plans adopted by the relevant authority that affect the municipality.
	Assess the vision, mission, objective and desired outcome of the plans.
	Identify all projects that may have a physical, environmental or socio-economic impact on the municipality and identify the allocated budget.
	Identify existing development constraints (over-utilisation of resources, resource pollution, infrastructure integrity) and future development opportunities (groundwater potential).
	Identify which areas are prioritised for development (areas of future growth).
	Determine the existing levels of service targets.
	Evaluate the existing water tariff structure.
District or municipal sector plans	Identify and review all strategic sector plans (water, environmental, economic, transportation, energy, etc.) adopted by the district or the municipal council and determine to what extent the plans will affect the municipality.
	Assess the vision, mission, objective and desired outcome of the plans.
	Identify and review development principles and highlight any spatial directives.
	Identify all projects that might have a physical, environmental and socio-economic impact on the municipality. This may include the physical development of new

Hierarchy	Guiding suggestions
	infrastructure, the expansion of protected areas, and other mega projects deemed to create socio-economic growth in investment opportunities.
	Identify all budgets allocated to the implementation of the plan and identify the potential beneficiaries (communities).
	Assess the legal definitions of existing zonings.

Table 5.11 lists several of South Africa's existing national strategies and plans that hold development directed for land, water and environmental resources planning and management. It also provides several key questions to help the planner conducting a water-sensitive policy and plan analysis on a provincial and local government level, Table 5.11 lists generic plans (provincial SDFs, provincial growth and development plans, water services development plans and IDPs). However, each policy and plan will be unique to its study area. Several of the questions are geared towards identifying additional datasets or relevant information. Stakeholders should also assist with this process.

Table 5.11: Existing plans and policies related to land, water and environmental resources planning and management

Documents and information required	Questions to be answered
National Development Plan: Vision 2030	What is the overall strategic objective of the NDP applicable to spatial planning, water and environmental resources? Does it have any implications for the study area?
	How do the strategic objectives of the NDP relate to the study area?
	Are there any development targets on which land or water resources will have related implications?
	Are there any development targets on which land or water resources will have related implications?
National Infrastructure Plan and it's Strategic Integrated Projects (SIP)	Are there any specific goals and do they impose spatial implications?
	Are there any SIPs that will have an environmental, economic or social impact on the municipality?
Medium-term Strategic Framework (2015–2019)	Are there any strategies and action plans to be addressed in the SDF?
Integrated Urban Development Framework (IUDF) (2016–2019)	What is the IUDF's vision and how can it inform the municipal SDF?
	What are the development principles and how should the municipality address them spatially?
Cities Support Programme	Are there any Cities Support Programmes currently implemented or planned within the municipality?
Agri-park Initiative	Are there any strategic plans in place to address agricultural development within the municipality?
	Are there proposed agri-parks in the study area?
	Identify farmer production support units.
	Identify the Rural-Urban Market Centre.
	Identify the agri-hub
Comprehensive Rural Development Plan (2009)	Are there any specific goals and do they impose spatial implications?
	Does the plan have any water resources-related implication such as targets for service delivery?
Agricultural Policy Action Plan	How does localisation of agricultural practices apply to the municipality?
Land claims and status	Are there any land claims with accompanying spatial data that affect the municipality?
Agricultural datasets	Which agricultural datasets are available for public use?
	Which datasets should be incorporated into the SDF analysis?
	What is the water demand for agricultural practice in the municipality?
	Do the agricultural practices within the municipality impose water quality implications?
National Water Resources Strategy 2013	What are the vision, mission and aims of the NWRS?
	Which resource management initiatives relate to the municipality?
	Are there any national projects to be implemented within the municipality?
	Are there any water-sensitive planning approaches that can be implemented within the municipality?
	Which water-related datasets are available for public use?

Documents and information required	Questions to be answered
Water-related datasets and research findings that should be used to inform the SDF	Which datasets should be incorporated into the SDF analysis?
	Are there any studies or research papers that can be used to inform the SDF analysis or proposals?
National Biodiversity Assessment	Which maps and spatial datasets are applicable to the municipality (downloadable from Biodiversity GIS)
	Are there any critical biodiversity areas and ecological support areas within the study area?
National Biodiversity Strategy and Action Plan	Which strategies and actions can be implemented through spatial planning and vice versa?
National Protected Areas Expansion Strategy	Does the strategy identify areas eligible for the expansion of protected areas within the municipality?
	What is the recommendation for expanding protected areas that should form part of the SDF?
	Are there any areas currently under a biodiversity stewardship contractual agreement?
List of ecosystems that are threatened and in need of protection	Are there any ecosystems gazetted as critically endangered, endangered or vulnerable?
Integrated Waste Management Plan	What are the national norms and standards for waste management?
	Does the strategy have any management guidelines for the prevention of groundwater contamination?
	Does the strategy have any management guidelines for land rehabilitation?
	Does the national contaminated land register indicate areas of concern within the municipality?
	Does the national waste information system provide spatial data applicable to the municipality?
	Are there any licenses for hazardous waste within the municipality?
National Transport Master Plan (NATMAP) 2050	What is the Transport vision as per NATMAP 2050?
	Is there any transport infrastructure of national significance located within the study area?
	Does the Integrated Transport Development Plan for the short, medium and long term up to 2050 have any impact of the study areas?
	Is there any spatial data available for public use?
National Land Transport Strategic Framework (NLTSF)	What are the proposed NLTSF strategies?
	Does the NLTSF hold any implications for land and water resources development and planning?
Revised Housing Code: 2009	Are there any Financial Programme, Social and Rental Housing Programme, Incremental Housing Programme or Rural Housing Programme projects currently being implemented in the municipality?
	Are there any upgrading projects of the Informal Settlement Programme, the Social and Rental Housing Programme or the Integrated Residential Development Programme currently underway or planned within the municipality?
	Does the municipality apply the national norms and standards for the construction of stand-alone residential dwellings?
Provincial Growth and Development Strategy	Is there alignment between the Provincial Growth and Development Strategy and the NDP?
	Which spatial implication can be gathered from the strategy?
	Are there any norms and standards for infrastructure services delivery?
Provincial and/or District IDP	What is the provincial vision statement?
	What is the district's vision statement?
	What challenges and opportunities exist within the municipality?
	List the location and budgets allocated for capital investment projects from sector departments (Energy, Water and Sanitation, Waste, etc.)
Provincial and/or District SDF	Does the provincial SDF have an established spatial hierarchy?
	Is there alignment between the provincial spatial hierarchy and the district spatial hierarchy?
	Are the study areas subject to any provincial or district nodes, growth points or investment corridors?
	Are there any spatial challenges or opportunities that should be addressed at a local level?
	Is there any existing state land with agricultural potential in the municipality?

Documents and information required	Questions to be answered
District Rural Development Plan (agri-park)	Are there any identified farmer production support units, a Rural-Urban Market Centre and/or an agri-hub planned within the municipality?
	Which agricultural value change has been identified in the area?
	Which communities will be most impacted on by the agri-park initiative?
	Is the data available in GIS format?
Land claims and status	Are there any traditional authorities within the district that will impact on the municipality?
	Is the data available in GIS format?
	Are there any land claims with accompanying spatial data that affect the municipality?
Provincial/District Water Sector Plan or Master Plan	Are there any priority areas identified for service delivery?
	Are there any major water and sanitation projects underway?
Catchment Management Strategy	Which strategies, objectives, plans, guidelines and procedures for the protection, use, development, conservation, management and control of water resources within its water management area have been set by the catchment management agency?
	Do the water allocation plans within the strategy have any implications for the municipality?
	What are the expectations of existing and potential water users?
Water Reconciliation Strategy	What is the yield of the currently available water resources within the catchment?
	Are there any targets?
	Which drivers of growth have been identified?
	By which date will a high growth requirement exceed current resources?
	How much additional water is required before a certain date?
	Are there any measures to supply additional water?
Provincial Biodiversity Management Plan	Are there any critical biodiversity areas or environmentally sensitive areas within the study area?
	Which management guidelines are applicable to the SDF?
Provincial list of threatened ecosystems and species	Is a provincial list of threatened ecosystems and species applicable to the study area?
Integrated Waste Management Plan	Are there any areas within the municipality that are negatively impacted by poor waste management practices that affect the health and the environment (specifically with regard to groundwater)?
	Have any new facilities for the disposal and decommissioning of existing waste disposal facilities been identified within the municipality?
Provincial Land Transportation Framework (PLTF)/ District Integrated Transport Plan (DITP)	What is the vision of the PLTF?
	What spatial implications (structuring or non-structuring) does the PLTF have on the municipality?
Provincial Housing Sector Plans	Have any areas within the municipality been identified for housing delivery?
	Are there any housing standards or preferred housing typologies applicable to the local municipality?
The location and extent of existing and future mining operations	Which areas are currently used for mining?
	Which areas will be required in future?
Municipal Growth and Development Plan (GDP)	Is there alignment between the NDP, the provincial GDP, the district GDP and the municipal GDP?
	Which spatial implication can be gathered from the strategy?
Municipal IDP	What are the vision statements of the district and the municipality?
	What challenges and opportunities exist within the district and within the municipality?
	Which sector plans that impact on both land and water resources are available?
	List the location and budgets allocated for capital investment projects from sector departments (Energy, Water and Sanitation, waste, etc.)
Existing municipal SDF (if any)	What is the spatial vision and mission statement?
	Does the SDF have any spatial development principles in place?
	Does the SDF present a spatial hierarchy and how is it aligned with the provincial spatial hierarchy?
	Are there any identified district and municipal nodes, growth points or investment corridors?
	Are there any environmentally sensitive areas to be protected?

Documents and information required	Questions to be answered
	Are there any defined urban areas and settlements?
	Are there any urban edges or urban growth boundary delineations application to the municipality?
	Are there any development projects underway that will have a significant spatial restructuring impact on the municipally?
	Is the data available in GIS format?
Municipal Valuation Roll	Are there different forms of land tenure and what is their spatial distribution?
	What is the nature of land ownership?
	What is the value of land?
Municipal Land Use Scheme	Has data been collected on the following:
	• Existing zoning
	• Existing land use
	• Existing vacant land
	• Land ownership
	• Illegal land uses
	• Amendments to existing schemes
Municipal Local Economic Development (LED) Plan	Are there any strategic investment areas or areas where economic growth should be encouraged or discouraged?
	Do the LED strategies have any spatial implications?
Land claims and status	Are there any land claims with accompanying spatial data that affect the municipality?
	Are there any traditional authorities within the district that will impact on the municipality?
	Is the data available in GIS format?
Agriculture (Rural Development Plan)	Which areas will be used for agriculture in future?
	What is the location of valuable agricultural land that should be protected?
Water Services Development Plan (Chapter 3 of the Water Services Act, Act No. 108 of 1997)	What are the existing levels of services, service backlogs, current demand and capacity levels, and costs and thresholds for expansion?
	What are the development opportunities and constraints?
	List the location and budgets allocated for capital investment projects from sector departments (Energy, Water and Sanitation, Waste, etc.)
	What is the water tariff structure?
	Are there water conservation and demand management strategies?
Municipal Asset Management Plan	What is the location, extent and condition of the water and sanitation networks?
Environmental Management Plan	Is there spatial information on the municipality's geology, soil, topography and slope analysis?
	What areas are of agricultural potential?
	What are the links between core areas and partially functional ecosystems?
	Is there a register of protected areas, provincial protected areas, nature reserves, world heritage sites, protected forest areas and mountain catchment areas?
District Integrated Transport Plan	Does the DITP have a rationalisation plan in place?
	Does the DITP include a public transport plan and where will this take place?
	Will the DITP have a spatial impact on the layout and density of settlements within the municipality?
	Are there any planned investments for corridors, nodes, modal transfer points, non-motorised transport, ingress and egress requirements, car-free areas and parking standards?
	Are there roads to be upgraded?
Stormwater Management Plan	Are there any stormwater quality conditions?
	Are there any post-development standards in place?
	Are there strategies to reduce and treat stormwater?
Municipal Housing Sector Plan	Which settlements within the municipality have been identified for housing upgrade projects?
	Does the municipality have a preferred housing typology or standards for housing delivery in place?

Not all provinces and districts have the same policies or plans in place. However, as indicated in Table 5.9, national legislation mandates provincial, district and local municipalities to prepare and implement certain plans for the planning and management of land, water and environmental resources. The question as to why these provincial or municipal plans are not in place is therefore critical.

Step 5: Provide a comprehensive analysis of relevant policies and plans

Once all policies and plans have been confirmed, a comprehensive review and assessment should follow. By using Table 5.11 as a guide, the policy and plan analysis should aim to indicate how the policy or plan impacts on land, water and environmental resources planning and management within the municipality, as it relates to the policies and plans:

- Vision statement
- Aims and principles
- Implications for water resources planning and management
- Implications for spatial planning
- Development targets and goals

By tabulating the content, a clear assessment is provided of the vision statement, aims and principles, as well as a summary on how the Act impacts on land, water and environmental resources planning and management, and development targets and goals. See Annexure A, Table A2: Water-sensitive policy and plan analysis – template. The template is partially complete as the planner should use his own insights when conducting a water-sensitive policy and plan analysis. Provincial, district and local municipal policies and plans are unique and area-specific. However, the same method of assessment as used for the assessment of national strategies can be used for assessing provincial, district, local municipal and sector plans.

Step 6: Synthesis of key findings

It is not common for SDFs to have a "target analysis" included as part of the review. However, several policies and strategies adopted by national government have set targets that have land, water or environment-related implications, i.e. the NDP has set a target to reduce urban water demand by 15% below baseline levels in urban areas by 2030. The National Protected Areas Expansion Strategy also has a set target of adding 2.7 million hectares to the land-based protected area network. A summary of targets is useful when developing spatial proposals for water-sensitive SDFs or scheme clauses as part of the LUS.

Step 7: Map information to the study area

Step 7 of the analysis requires the planner to gather or generate spatial data, representing the spatial location of all planned projects as identified in the policy analysis related to land, water and environmental resources planning and management within the municipality.

Key spatial information to be mapped as part of the policy analysis includes the following:

- Projects of national importance (National Infrastructure Plan)
- Projects of provincial important (Provincial Growth and Development Plan)
- Growth points and nodal hierarchies
- Location of housing projects
- Water infrastructure plans
- Electrification plans
- Transportation plans and road upgrade plans
- Areas identified for environmental protection, conservation and rehabilitation
- Planned community facilities (community halls, schools, hospitals, libraries, sports and recreation facilities)

Phase 2.2: Water-sensitive spatial analysis

SPLUMA sets out several requirements to which the process of developing an SDF and/or LUS must conform. In essence, SDFs and LUSs should ensure the sustainable development of municipalities' biophysical, built and socio-economic environment. Table 5.12 and Table 5.13 list the content of an SDF and LUS as legislated by SPLUMA, and highlight the type of assessment to give effect to the clause.

The biophysical analysis provides insights into the broader environmental characteristics of the municipality and the state of the natural resource base on which life depends. It should identify and assess all biophysical structuring elements, also referred to as the ecological infrastructure, which is the nature-based equivalent of the built or hard infrastructure that the physical infrastructure needs to function. The biophysical analysis has a vital role to play in addressing the pillars of practice, specifically "cities providing ecosystem services". Identifying wetlands, river, dams, estuaries and areas with high groundwater resources for future protection and – if needed – rehabilitation should be the main focus area of the biophysical analysis. The built environment analysis should examine the extent of land cover change, identify the spatial location of existing land uses and accompanying infrastructure, assess the historical and current settlement development pattern, identify a hierarchy of nodes and corridors, and assess growth patterns. While the socio-economic analysis strongly relates to the built environment's ability to provide services to the municipality's residents, its purpose is to build an understanding of the current level of access to services, a backlog of services, the affordability of services, as well as the future demand for services.

Table 5.12: Content of a municipal spatial development framework

SPLUMA clauses	A municipal spatial development framework must:	Biophysical analysis	Built environment analysis	Socio-economic analysis
S21(a)	…give effect to the development principles and applicable norms and standards set out in Chapter 2;	x	x	x
S21(b)	…include a written and spatial representation of a five-year spatial development plan for the spatial form of the municipality;	x	x	x
S21(c)	…include a longer-term spatial development vision statement for the municipality;	x	x	x
S21(d)	…identify current and future significant structuring and restructuring elements of the spatial form of the municipality, including development corridors, activity spines and economic nodes where public and private investment will be prioritised and facilitated;	x	x	x
S21(e)	…include population growth estimates for the next five years;			x
S21(f)	…include estimates of the demand for housing units across different socio-economic categories and the planned location and density of future housing developments;			x
S21(g)	…include estimates of economic activity and employment trends and locations in the municipal area for the next five years;		x	x
S21(h)	…identify, quantify and provide location requirements of engineering infrastructure and services provision for existing and future development needs for the next five years;		x	x
S21(i)	…identify the designated areas where a national or provincial inclusionary housing policy may be applicable;		x	
S21(j)	…include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of	x		

SPLUMA clauses	A municipal spatial development framework must:	Biophysical analysis	Built environment analysis	Socio-economic analysis
	environmental sensitivities, high potential agricultural land and coastal access strips, where applicable;			
S21(k)	…identify the designation of areas in the municipality where incremental upgrading approaches to development and regulation will be applicable;	x	x	x
S21(l)	…identify the designation of areas in which: iii. more detailed local plans must be developed; and iv. shortened land use development procedures may be applicable and land-use schemes may be so amended;		x	
S21(m)	…provide the spatial expression of the coordination, alignment and integration of sectoral policies of all municipal departments;	x		x
S21(n)	…determine a capital expenditure framework for the municipality's development programmes depicted spatially;			
S21(o)	…determine the purpose desired impact and structure of the land use management scheme to apply in that municipal area; and	x	x	
S21(p)	… include an implementation plan comprising: vi. sectoral requirements, including budgets and resources for implementation; vii. necessary amendments to a land use scheme; viii. specifications of institutional arrangements necessary for implementation; ix. specifications of implementation targets, including dates and monitoring indicators; and x. specifications, where necessary, of any arrangements for partnerships in the implementation process.	x	x	

Table 5.13: Content of a municipal land use scheme

SPLUMA clauses	A land-use scheme adopted in terms of subsection (1) must:	Biophysical analysis	Built environment analysis	Socio-economic analysis
S24(2)(a)	…include appropriate categories of land use zoning and regulations for the entire municipal area, including areas not previously subject to a land use scheme;	x	x	
S24(2)(b)	…take cognisance of any environmental management instrument adopted by the relevant environmental management authority, and comply with environmental legislation;	x		
S24(2)(c)	…include provisions that permit the incremental introduction of land use management and regulation in areas under traditional leadership, rural areas, informal settlements, slums and areas not previously subject to a land use scheme;		x	x
S24(2)(d)	…include provisions to promote the inclusion of affordable housing in residential land development;		x	x
S24(2)(e)	…include land use and development incentives to promote the effective implementation of the spatial development framework and other development policies;	x	x	x
S24(2)(f)	…include land use and development provisions specifically to promote the effective implementation of national and provincial policies; and	x	x	
S24(2)(g)	…give effect to municipal spatial development frameworks and integrated development plans.	x	x	x

Figure 5.2 provides a high-level overview of the various assessments that will be conducted as part of the water-sensitive spatial analysis. Each assessment will be discussed in more detail as the process continues.

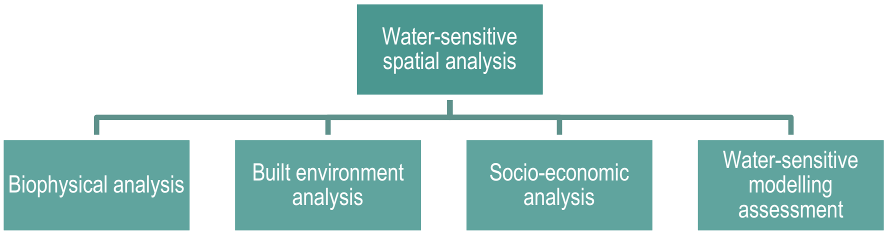


Figure 5.2: Practical process for conducting a water-sensitive spatial analysis

Step 1: GIS and spatial data

Before any analysis can commence, the planner should have access to GIS and should have various datasets at his disposal. A list of spatial datasets or shapefiles recommended for use when conducting a water-sensitive spatial analysis is provided in Annexure B, Table B1: List of spatial datasets and sources. The process of conducting a meaningful water-sensitive spatial analysis depends on the availability and accuracy of spatial data. Institutions such as the ARC, SANBI and Biodiversity GIS (BGIS) have played a fundamental role in developing national spatial datasets to address climate, geology, terrain, soils, vegetation, protected and conservation areas, critical biodiversity areas and ecological support areas. Unfortunately, national datasets are developed at a low resolution and mapped at a scale of 1:250 000 or greater, which is a limiting factor when assessing local municipalities, and even more so when dealing with individual sites. Information is even more limiting when dealing with the quality and quantity of water resources. As a result, the hydrological analysis that should be a core component of the spatial analysis is often limited to a map indicating the spatial location of rivers, dams and wetlands, without taking the quality and quantity of the resources into account.

A review of previous planning documents has also indicated that groundwater resources have been ignored entirely. The reason could be a lack of spatial data, or purely because it is an underground source that is not visible to the naked eye. Fortunately, the WRC and DWS recently released updated spatial information related to the quality and quantity of water resources. Of specific importance to developing a water-sensitive SDF is the spatial information that represents the FEPA, as well as the spatial and non-spatial information provided by the National Integrated Water Information System. These datasets should provide guidance on land use planning and decision making as they provide spatial information on the location of biodiversity features.

Step 2: Land audit

Furthermore, when a planner is appointed to develop an LUS, conducting a wall-to-wall municipal land audit is a mandatory practice, as it determines the spatial location of all existing land uses within the municipality. A land audit sets out a legal base of all properties, including the following main attributes: who the land belongs to, what the land is used for, what the land is, in fact, supposed to be used for, and what land should be protected by law. Although a land audit is not mandatory when developing an SDF, it provides valuable information on development trends and pressures such as the extent of land cover change that has taken place and the direction of development. Land audit data also helps to determine which natural assets are most valuable, which are most at risk due to development pressure, and which could be lost if no action is taken. This guideline recommends that a land audit be carried out before any other spatial analysis is conducted as it provides critical land use information that must inform and guide all future spatial planning and land use management decision-making processes. Annexure C provides a detailed description of how to conduct a wall-to-wall land audit (if spatial data does not exist).

Step 3: Compile a base map

Compile a geodatabase (GDB) in GIS. Populate the GDB with the data identified in Step 1. Make sure that the dataframe is set to the right projections. For calculation purposes, the projection should be in metres. Proposed datasets to be included as part of the base map include municipal boundary, major roads, major towns and cities, land use/built footprint, primary and secondary river network, and quaternary catchment boundaries.

Phase 2.2.1: Biophysical analysis

BIOPHYSICAL ANALYSIS

The objective of a water-sensitive biophysical analysis is to limit the expansion of the built footprint to areas of ecological importance, to protect and expand the ecological infrastructure and to restore ecological functionality, specifically in freshwater ecosystem priority areas.

The aims of a water-sensitive biophysical analysis are to do the following:

- Determine the climate, hydrological and geological characteristics of the municipality.
- Determine areas of ecological significance.
- Determine spatial areas with high-value groundwater resources.

Key questions to inform the biophysical analysis:

1. What are the climate characteristics of the municipality?
2. Which physical structural elements can be found in the municipality?
3. Which underlying geological elements can impact on development?
4. What is the extent of protected areas and areas of ecological significance?
5. Is groundwater resource development and managed aquifer recharge an option?
6. What is the quality of water resources in the study area?

Figure 5.3 illustrates the various assessments to be conducted as part of the biophysical analysis. Each assessment will be discussed in more detail as the process continues.

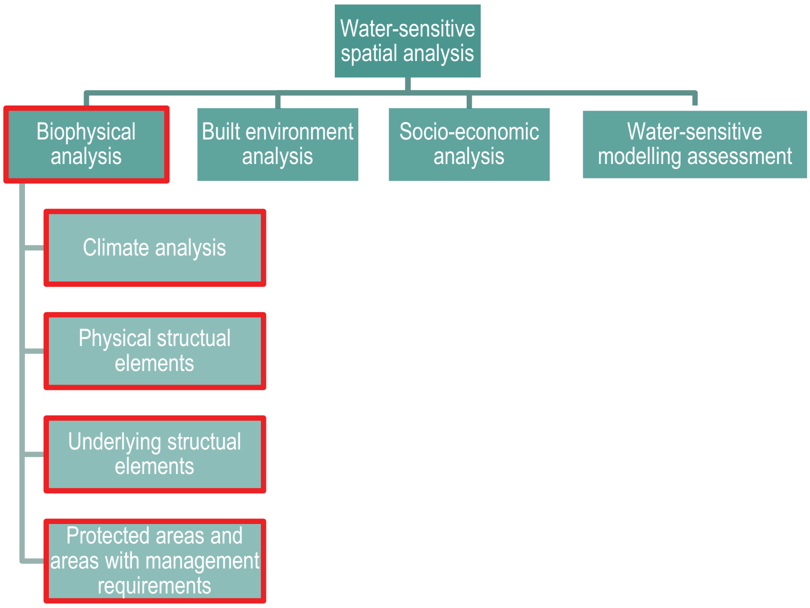


Figure 5.3: Biophysical analysis

Step 4: Conduct a climate analysis

The climate of a region has a major impact on the availability of freshwater resources, on soil productivity and food security, energy and the physical development of a region. The fourth step in conducting a biophysical spatial analysis is to map spatial data representing climate factors. Use the base map (see Step 3), and add the following spatial datasets:

- Mean annual temperature (A37) (See Annexure B)
- Mean annual precipitation (A38)
- Mean annual evaporation (A39)

Step 5: Analyse the climate data

Mean annual temperature (A37)

The ARC provides spatial data on a national scale on South Africa's mean annual temperature. Use the A37 “Max_temp” rasterfile to determine which areas within the municipality experience high and low maximum and minimum annual temperatures.

Why? People living in areas that experience high annual temperatures will naturally have a higher demand for water for drinking, cooling off (swimming pools) and gardening.

Mean annual precipitation (A38)

The DWS provides spatial data on a national scale of South Africa's mean annual precipitation, ranging from 0-100 mm to >1,500 mm of precipitation per annum. Use the A38 "Precipitation.shp” shapefile to determine which areas in the municipality experience high and low mean annual precipitation. First, determine the average annual precipitation for the entire municipality, then create a new column in the attribute table “Macro_RWH_potential” and differentiate between four categories (low, moderate, high and very high) of rainwater harvesting potential.

Why? From a macro perspective, the map should provide some indication of which regions within the municipality are favourable for rainwater harvesting. Settlements located in regions with high to very high rainwater harvesting potential should consider utilising rainwater as an alternative source of water for daily usage. In areas with low rainwater harvesting potential, other alternatives such as grey and black water reuse would be considered more feasible as the risk of rainwater tanks remaining empty is too high.

Mean annual evaporation (A39)

The DWS provides spatial data on a national scale of South Africa's mean annual evaporation rate, ranging from <1,200 mm to >2,000 mm per annum. Use the “evaporationwr90.shp” shapefile to determine which regions in the municipality experience high and low annual S-pan evaporation rates. First, determine the average mean annual S-pan evaporation rate for the entire municipality, then create a new column in the attribute table “Evapo_factors” and differentiate between four categories (low, moderate, high and very high) of mean annual evaporation.

Why? From a macro perspective, the map should provide some indication of which regions in the municipality are not suitable for the damming of surface water and where the managed artificial recharge of aquifers should be considered. Increasing vegetation and tree canopy coverage is proven to reduce the evaporation rate and should be considered as a preventative measure in securing water resources.

Step 6: Compile a synopsis and spatialise key findings of the climate analysis

Compile a synopsis and spatialise key findings of the climate analysis. Distinguish between areas with high temperature, low precipitation and high evaporation rates, and areas with low temperature, high rainfall and low evaporation rates. The combination of these three factors will determine the availability of water resources. A slight change in one of the three factors can have an impact on both water quality and quantity. The analysis should thus address the projected climate change implications of the region.

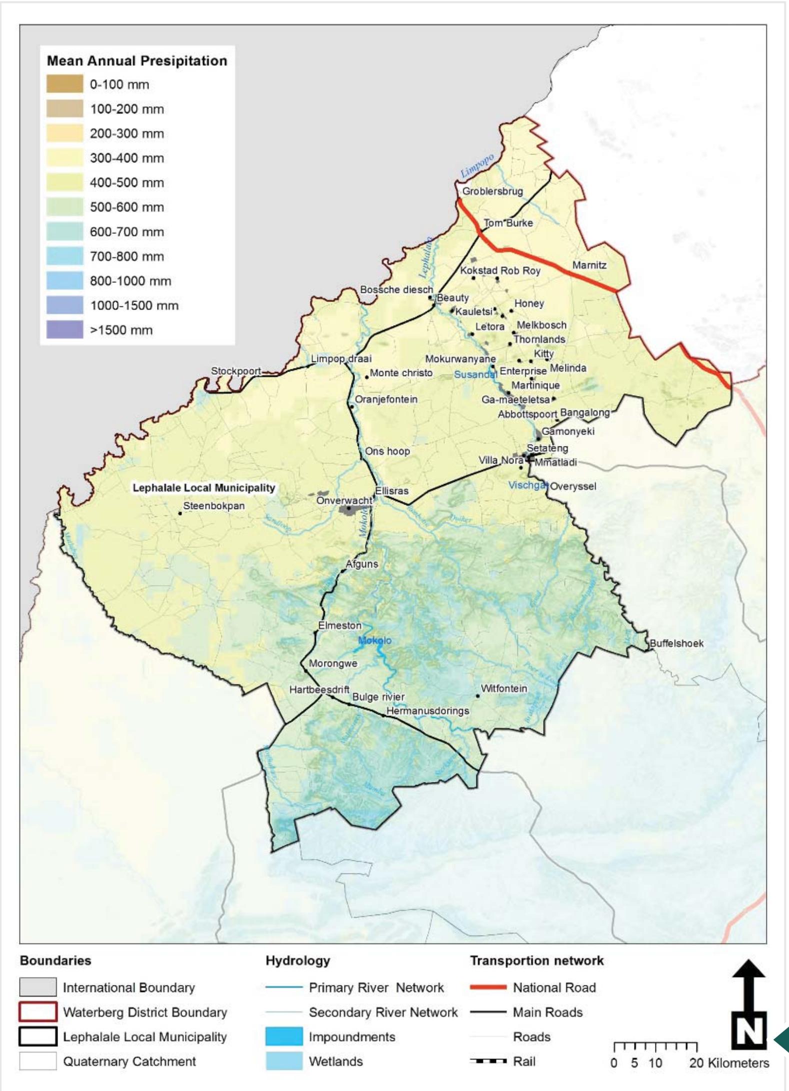
New data created:

- Macro_RWH_potential
- Evapo_factors

Example A explains briefly how to determine areas of macro rainwater harvesting potential.

Example A: How to use GIS and spatial data to determine areas of high and low precipitation

The map on the left represents a typical rainfall map found in most spatial analyses, whereas the map on the right provides a new perspective as to where (spatially) rainwater harvesting potential is high or very low. Both maps use the same data.



Use "precipitation" to map the study area.

Create a new shapefile depicting "Macro_RWH_potential"

Differentiate between areas experiencing
- ✓ "low"
- ✓ "moderate"
- ✓ "high"
- ✓ "very high"

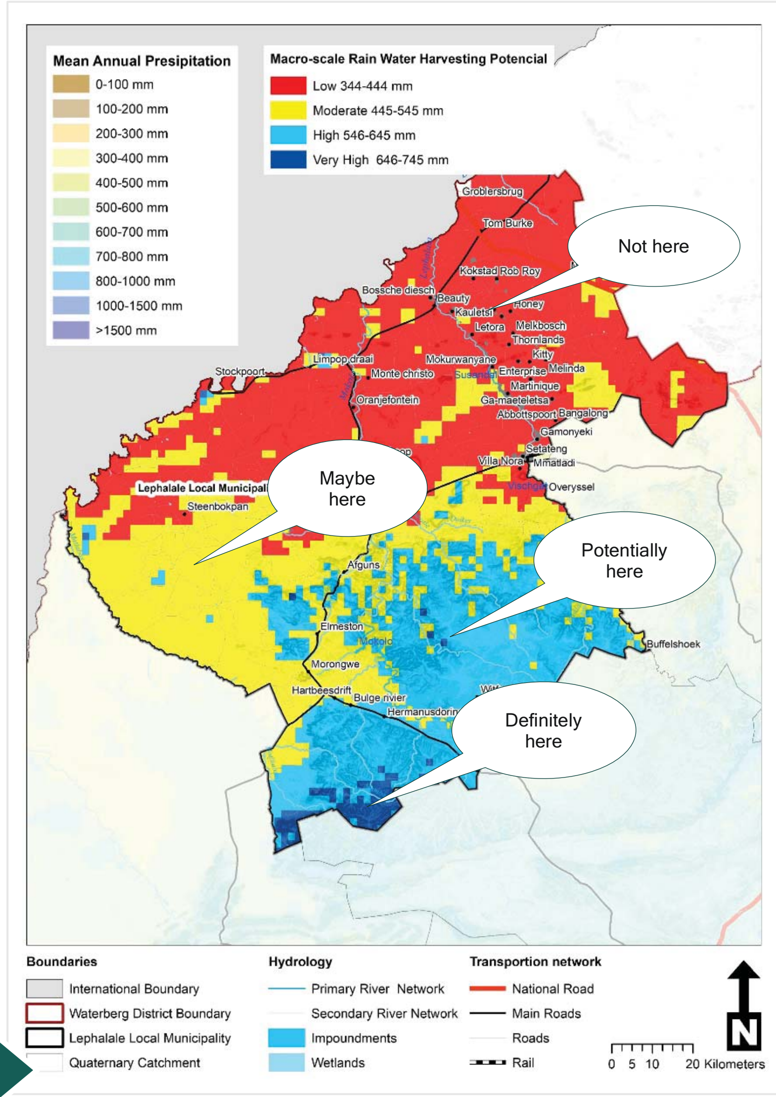
rainwater harvesting potential.

Using the symbology – quantities – graduated colour value fields "map_mm" and method: Equal interval (four classes)

For Lephalale
- ✓ Low = 344-444 mm/a
- ✓ Moderate = 445-545 mm/a
- ✓ High = 546-645 mm/a
- ✓ Very high = 646-745 mm/a

Same data

Different perspective



Step 7: Investigate all physical structuring elements

Physical structuring elements, such as hills and rivers, provide ecological services and development direction within a municipality. Although engineering solutions have evolved to overcome development limitations, altering or destroying physical structuring elements is not considered good practice and should be avoided as far as possible. It is therefore important to determine the spatial location of all physical structuring elements such as rivers, wetlands and high slopes. The seventh step in conducting a biophysical spatial analysis is to investigate all physical structuring elements. Use the base map (see Step 3), and add the following spatial datasets:

- Slope and contours (A29; A30)
- Primary and secondary river networks (A31; A32)
- Wetlands, estuaries and impoundments (A33; A34)
- Mean annual runoff (A40) and gullies (A36)
- Areas prone to water erosion
- Sediment yield and total dissolved solids
- Quaternary sub-catchment sediment yield (100 t/a)

Step 8: Analyse all physical structuring elements

Slope and contours (A29; A30) and gullies (A36)

The ARC provides spatial data on a national scale on South Africa's topography or slope and contours ranging between <2.0% and >20.0%. As the slope gradient increases, development potential decreases. Use the A29 “slope” raster file to determine which regions in the municipality have high and almost undevelopable high slopes. First, convert the raster file to a shapefile, then create a new shapefile by selecting all areas with a slope gradient over 25% and create a new shapefile “Undevelopable_high_slopes”.

Why? Steep slopes increase stormwater runoff rates, making wetlands and rivers at the bottom prone to erosion if natural vegetation is no longer intact. This can also cause the formation of gullies. As slopes become steeper, development becomes limited and infrastructure costs increase.

Primary and secondary rivers (A31; A32)

The DWS provides spatial data on a national scale on South Africa's primary and secondary river networks. Use the A32 “wriall500_primary.shp” and the A32 “wriall500_secondary.shp” shapefiles to determine the spatial location and extent of primary and secondary rivers within the municipality. There is no need to create a new shapefile at this stage, as further analysis of the quality and quantity of the freshwater resources is required.

Why? In many areas, rivers may have dried up over time. This does not mean that they no longer exist. The spatial location of rivers is of utmost importance to the assessment, even if they have temporarily dried up.

Wetlands, estuaries and impoundments (A33; A34)

The DWS provides spatial data on a national scale on South Africa’s wetlands, estuaries and impoundments. Use the A33 “wetlands_estury.shp” and the A34 “dams500_wgs84.shp” shapefiles to determine the spatial location and extent of all wetlands, estuaries and impoundments within the municipality. There is no need to create a new shapefile at this stage, as further analysis on the quantity and quality of the freshwater resources is required.

Why? Wetlands, estuaries and impoundments are essential ecological infrastructures and should always be protected. The spatial location of these ecosystems is often unknown as they too may have dried up temporarily.

Assess the mean annual runoff (A40)

Rivers, wetland, estuaries and impoundments are fed by runoff. The rate, volume and quality of runoff is determined by rainfall, evaporation rate, slope, soil drainage potential, the availability of natural vegetation and land use. Freshwater networks situated in areas with high runoff potential will naturally be fed more frequently and with higher volumes of water than freshwater resources in areas with low annual runoff potential. However, these resources are also more prone to pollution and gully erosion when natural vegetation is removed or altered due to development pressure. Vegetated landscapes act as a natural filter and the soil is strengthened, clearing runoff from populates before it enters freshwater networks, preventing buffer zones from gully erosion. The DWS modelled the MAR potential of the entire country. Use the A40 “rsa_mar_wr2012.shp” shapefile to determine which areas have high annual runoff potential. SANBI provides spatial data on a national scale on South Africa's gully formations and areas prone to water erosion. Use the A36 “Gullie.shp” shapefile to determine where gullies already exist and the “Water_erosion.shp” shapefile to determine which areas are prone to water erosion within the municipality. Create a new shapefile, “Erosion_concern_areas”, which is a combination of existing gullies and areas prone to water erosion due to a lack of natural vegetation and high runoff potential.

Why? From a macro perspective, these areas should be prioritised for the revegetation of land cover if required, the cleaning of alien invasive species and other sustainable land use management practices. Areas with high runoff potential should also be priorities for further investigation of runoff or stormwater harvesting.

Assess the water quality – sediment yield and total dissolved solids

Areas identified as erosion concern areas, “Erosion_concern_areas.shp”, would naturally have higher sediment deposits and higher total dissolved solids (TDS). However, other areas of low erosion concern can also have high sediment and TDS caused by effluent discharge, land use and wind erosion. The DWS provides spatial data on a national scale on sediment yield 1 000 t/a and TDS, which provides some form of representing surface water quality. Use the “sediment_yid_wr90.shp” shapefile to determine the amount of quaternary sub-catchment sediment yield (1 000 t/a) and the “Surfacewater_quality_TDS_concentration.shp” shapefile to determine the TDS quaternary sub-catchment concentration levels within the municipality. Create a new shapefile, “Water_quailty_concern”, to represent catchments with high sediment yield and high TDS concentration.

Why? On a macro scale, these catchments should be prioritised for land use interventions, including the revegetation or implementation of SUDS in sensitive areas, especially in river and wetlands buffer zone areas. This information is often excluded from a spatial analysis as it highlights water quality factors and not spatial factors. However, the spatial location of land uses has a water quality impact and is therefore very important to the biophysical analysis.

Assess the water quantity – cumulative neutralised streamflow

Surface water from rivers and dams is the main source of water for domestic and economic use and should be kept in a good ecological condition. Unfortunately, over-utilisation, land use change and pollution have led to a decline in surface water availability. Gathering spatial and non-spatial information on surface water availability is important for all future development. This information is key to the study, and various sources – in particular, catchment management and water reconciliation strategies – should be assessed. The DWS provides spatial data on a national scale on cumulative neutralised streamflow (no land use included) at key points (million m^3/a) and cumulative present-day streamflow (with land uses as at 2009/10) at key points (million m^3/a). The information is provided as a graphic. However, it has clear spatial references on the map. The planner should identify key points where the present-day streamflow is less than half of the neutralised streamflow.

Why? This assessment will provide a clear indication of which catchments have been highly impacted on by land use activities. Later in the analysis, this information will be linked with the land use data that will help to establish a relationship between land use and water resources availability.

Step 9: Compile a synopsis and spatialise key findings of the physical structuring elements

The planner should identify and map areas with slopes that range between 15 and 25%, all gullies, and all existing rivers, dams, wetlands and estuaries. These physical structuring elements should be avoided by development at all times. Areas with high runoff potential and high sediment yield, and areas prone to water and wind erosion should also be avoided by development. However, these areas should be prioritised for revegetation and other natural interventions. Furthermore, catchments, where the present-day streamflow is less than half of the neutralised streamflow, should be prioritised for further assessment in the built environment analysis. Two new maps, first displaying the areas where development should not take place at all and the other representing areas where water quality has already been affected by development, and will most likely be affected in future, should accompany the synopsis for which a conclusion should be drawn.

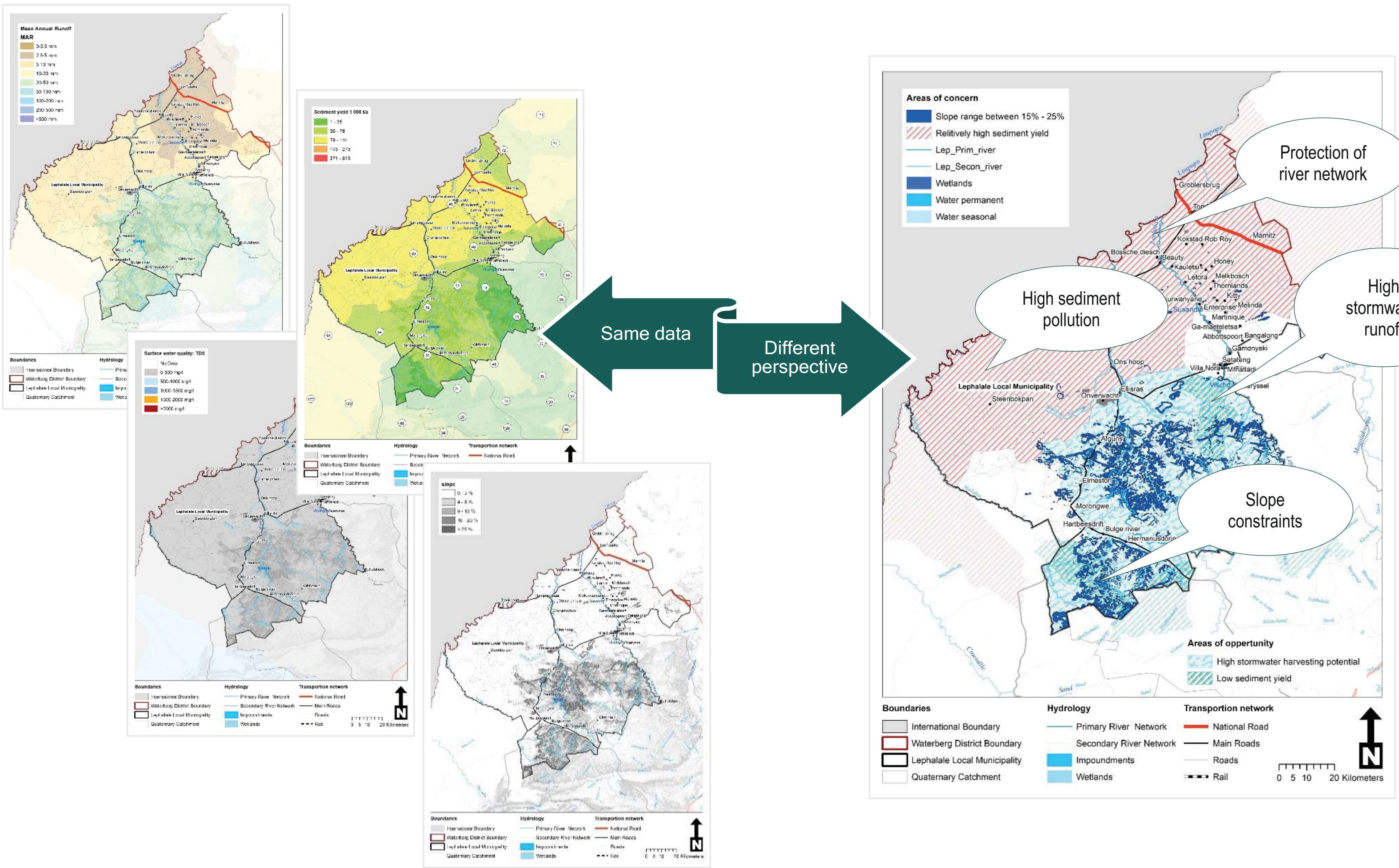
New data created:

- Undevelopable_high_slopes
- Erosion_concern_areas
- Water_quailty_concern

Example B briefly explains how to determine areas with physical constraints.

Example B: How to use GIS and spatial data to determine areas with physical constraints

The maps on the left define areas with high slopes, rivers and wetlands, and areas with high sedimentation and high runoff potential. Individually, these datasets do not present too much information for spatial proposals or land use management. When combined, as presented on the right, a macro-scale perspective on physical constraints and opportunities becomes evident.



Step 10: Investigate underlying structural elements

The geology of a region determines both the quality and quantity of groundwater resources as rock types have different physical (permeability) and chemical compositions. Underlying structural elements can also hinder development and vice versa. It is therefore critical to map all underlying structural elements that are not necessarily visible to the naked eye, but that hold underlying development and water resources-related implications. Use the base map (see Step 3), and add the following spatial datasets:

- Geology and swelling clays (A47; A48)
- Soil drainage (A49)
- Utilisable groundwater exploration potential (A41)
- Groundwater recharge potential (A42)
- Depth to groundwater (A50)
- Groundwater quality (A43)

Step 11: Analyse the data related to the underlying structural elements

Geology and swelling clays (A47; A48)

The ARC provides spatial data on a national scale on South Africa's geology. Use the A47 "rsa_geol.shp" shapefile to determine which underlying geological formations are found in the municipality. The geology shapefile represents areas with dolomitic characteristics. The ARC also provides spatial data on a national scale on South Africa's swelling clay potential. Use the A48 "swelling_clay.shp" shapefile to determine areas with high swelling clay potential. Create a new shapefile, "under_geo_concern", which represents all underlying geological formations to be avoided by development as far as possible.

Why? Dolomitic areas and areas with high swelling clay potential are geological formations of high concern for physical development. Dolomitic areas are also favourable for groundwater recharge and should be avoided by development at all costs.

Soil drainage (A49)

The ARC provides spatial data on a national scale on South Africa's soil drainage and water-holding capacity. Use the A49 "Soil drainage" shapefile to determine which areas have high water-holding capacity and which areas have low water-holding capacity. Create a new shapefile representing areas with high water-holding capacity, "high_water_holding_capacity", within the municipality.

Why? The water-holding capacity is determined by soil texture and organic matter. Soils with poor drainage commonly support wetlands. These areas should be identified as potential areas to support constructed wetlands used to treat stormwater runoff.

Utilisable groundwater exploration potential (A41)

Groundwater resources are generally not addressed in spatial plans, as this is a resource that is not visible to the naked eye. However, spatial planning revolves around the planning and management of land use. It has an impact on both the quality and quantity of groundwater resources. For this reason, the spatial location of groundwater resources with development potential should be integrated into spatial plans and land use schemes as far as possible. The DWS provides spatial data on a national scale on South Africa's UGEP, which represents the total volume of available and renewable groundwater and allows for factors such as physical constraints on extraction, potability and maximum allowable drawdown. Use the A41 "GRIDS_ugep.shp" shapefile to determine the UGEP of the municipality. Create a new "High_UGEP" shapefile, which typically represents areas where the UGEP is <25 000 $m^3/km^2/a$.

Why? Rural settlements are highly dependent on groundwater resources. Knowing the spatial location of areas with a high UGEP should be a determining factor for all future developments. Development on or close to these areas should be avoided as far as possible. Sustainable land use management is key in areas with high UGEP and areas with good groundwater quality

Groundwater recharge potential and depth to groundwater (A42; A50)

The DWS provides spatial data on a national scale on South Africa's groundwater recharge potential. Use the A42 "GRIDS_recharge" raster file to determine which areas have high mean recharge potential (mm/a). Create a new shapefile, "high_Recharge_potential", that represents aquifers with naturally high permeability. The DWS also provides spatial data on a national scale on South Africa's depth to groundwater. The average cost of drilling for groundwater can be calculated at R2 000 per metre. Use the "Grids_wl_1x1km" shapefile and reclassify the depth into cost categories.

Why? If groundwater levels have dropped in an aquifer with high permeability due to over-utilisation, the aquifer can be recharged through artificial borehole injection. If the conditions are suitable, treated wastewater can be used to recharge aquifers as they are a perennial municipal source.

Assess the groundwater quality (A43)

Groundwater pollution is a major problem in South Africa as the impact of land activities on groundwater resources is poorly understood and the contamination of groundwater sources can go undetected for a long time. The DWS provides spatial data on a national scale on South Africa's groundwater quality. High levels of pollution are determined by the amount of salinity found in water, measured as electrical conductivity and expressed in units of mS/m. Use the A43 "SA_qual_dd.shp" shapefile to determine which areas have high levels of electrical conductivity. The target water quality is between 0 and 70 mS/m. If the electrical conductivity is over 150 mS/m, water will have a salty taste. Create two new shapefiles, "Good_Quality_GW", which represents areas where the electrical conductivity is below 70 mS/m, and "Groundwater_Quality_Concern". The DWS also provides spatial data on a national scale on South Africa's groundwater quality, indicating levels of nitrate, fluoride and iron. Use the A44 "Nitrate_dd.shp", the A45 "Fluo_dd.shp" and the A46 "iron_dd.shp" shapefiles to determine which boreholes extract water with chemical concerns. Combined with land use information, a relationship between land use and water quality can be established by highlighting areas with high levels of nitrate, fluoride and iron. This information gives a good indication of the groundwater quality.

Why? In areas where groundwater is of a high-quality concern, residents should be informed. Extracting water from boreholes in those areas may lead to health risks.

Step 12: Compile a synopsis and spatialise the underlying structural elements

Compile a synopsis and spatialise the key findings of the underlying structural elements by mapping areas under geological concern. This includes dolomitic areas, areas with high swelling clay potential and areas with impeded soil drainage. The synopsis should also include a map representing areas with high groundwater development potential. This includes areas with high UGEP (generally more than <25 000 $m^3/km^2/a$) and areas with high mean recharge potential. The average depth or cost of drilling for groundwater should also be summarised and depicted spatially.

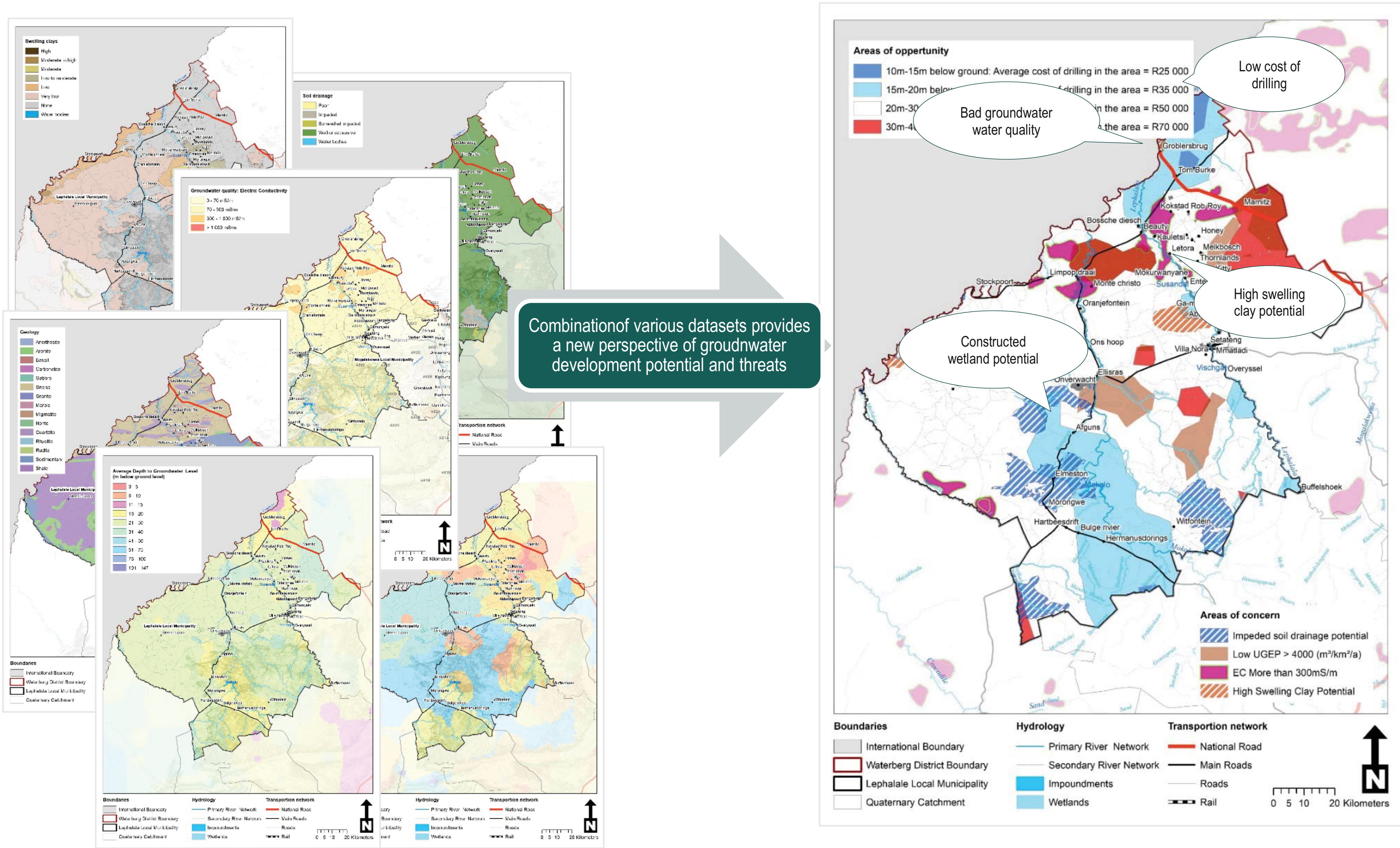
New data created:

- under_geo_concern
- high_water_holding_capacity
- High_UGEP
- high_Recharge_potential
- Good_Quality_GW
- Groundwater_Quality_Concern

Example C explains briefly how to determine areas with groundwater resource development potential or threat.

Example C: How to use GIS and spatial data to determine areas of groundwater resource development potential and constraints

A combination of various spatial datasets can help planners to identify areas with groundwater development potential. This includes areas with high UGEP (generally <25 000 m³/km²/a) and areas with high mean recharge potential, as well as the average depth or cost of drilling for groundwater.



Step 13: Investigate areas with management requirements

Protected areas enjoy legal protection, and ecological infrastructure located within protected areas would generally be in a good ecological condition as the site-specific management falls within the management responsibility assigned to provincial conservation authorities or institutions. However, the National Biodiversity Framework identified the need to expand these areas to achieve national biodiversity targets. The expansion should be informed by systematic biodiversity assessment, which identifies areas of ecological significance (critical biodiversity areas and ecological support areas), which should be kept in a good ecological condition. Use the base map (see Step 3), and add the following spatial datasets:

- Protected and conservation areas (A51)
- Critical biodiversity areas and ecological support areas (A52; A53)
- River FEPAs (A54)
- Wetland FEPAs and wetland clusters (A55; A56)
- Fish support areas (A57)
- Upstream management areas (A58)
- Phase 2 FEPA (A59)
- Free-flowing rivers (A60)

Step 14: Analyse areas with management requirements

Protected and conservation areas (A51)

The DEA provides spatial data on a national scale on South Africa's formal protected areas. This includes national parks, provincial nature reserves, world heritage sites and protected environments. These areas are secured by a legal declaration under the National Environmental Management Act: Protected Areas (Act No. 57 of 2003). The DEA also provides spatial data on a national scale on South Africa's conservation areas. This can include private nature reserves and/or conservation-orientated game or stock farms. In most instances, these land parcels are privately owned. Although not legally protected, ecological infrastructure in these areas will be in a good ecological condition as the purpose of conservation areas is to protect the environment and specific species. Use the A51 "Protected_areas.shp" shapefile to determine which areas in the municipality enjoy legal protection from development through the efforts of conservation.

Why? Protected areas are physical structuring elements and are generally seen as "no-go" areas for development. The protection, conservation and management of these areas are subject to a management plan in terms of section 28 of Act No. 57 of 2003. This management plan must contain at least a zoning of the areas, indicating what activities may take place in different sections of the areas. If available, these zoning should be mapped accordingly.

Critical biodiversity areas and ecological support areas (A52; A35)

On the provincial level, the National Biodiversity Framework requires provinces to develop provincial spatial biodiversity plans, which identify provincial critical biodiversity areas (CBAs) and ecological support areas (ESA). However, CBAs and ESAs call for a finer-scale biodiversity plan, which is the bioregional plan. The purpose of a bioregional plan is to inform land use planning, environmental authorisations and natural resource management and decision making for a range of sectors whose policies and decisions impact on biodiversity outside protected areas. Once CBAs and ESAs have been published, the spatial information can be obtained from SANBI. Use the A52 "CBA_shp" shapefile to identify the spatial location of CBAs within a municipality. Use the A53 "ESA_shp" shapefile to identify the spatial location of ESAs within the municipality. Depending on the plan itself, categories and descriptions of ESAs may differ. Depending on the bioregional plan, categories and descriptions of CBAs and ESAs may also differ. Typical terrestrial CBAs include irreplaceable sites, critical linkages in biodiversity corridors, areas identified in existing plans and other important sites. Aquatic CBAs include FEPA rivers and FEPA wetlands.

Typical terrestrial ESAs include important habitats, biodiversity corridors that promote ecological connectivity and protected buffer areas. Aquatic ESAs include FEPA sub-catchments, FEPA river buffers, FEPA wetland buffers and other wetlands, and dolomitic recharge areas.

Why? Like protected areas, CBAs and ESAs provide essential ecosystem services on which humans and other species depend. These areas should be protected from development where physically possible. If there is no existing spatial data on CBAs or ESAs, the spatial analysis will need to identify areas that require a similar protection status and management processes. Fortunately, the DWS provides spatial data on a national scale on South Africa's FEPAs. This spatial information must be used in the event of no spatial data on CBAs and ESAs being published yet. It must also be used to cross-check published CBAs and ESAs to ensure that these FEPAs are included.

River FEPAs (A54)

The DWS provides spatial data on a national scale on South Africa's river FEPAs. These are rivers in a good ecological condition (A or B ecological category rivers). Use the A54 "river_conditions.shp" shapefile to illustrate which rivers in the municipality are in a good ecological condition. Use the "riverfepa.shp" shapefile to identify river FEPAs and associated sub-quaternary catchments.

Why? Catchments with rivers in a good ecological condition should be kept in a good ecological condition and therefore require special land use management.

Wetland FEPAs and wetland clusters (A55; A56)

The DWS provides spatial data on a national scale on South Africa's wetland FEPAs and wetland clusters. Use the A55 "wetlands_estury.shp" shapefile to identify the actual functional zones of mapped wetlands or estuaries as indicated with the turquoise outline. Due to their ecological importance, all wetlands and estuaries, regardless of their ecological condition, are classified as FEPAs. There is no need to create a new shapefile as further analysis will be conducted. The DWS also provides spatial data on a national scale on South Africa's wetland clusters. These clusters represent groups of wetlands embedded in a relatively natural landscape. Use the A56 "Wetland_Cluster.shp" shapefile to determine the spatial location and extent of wetland clusters within the municipality. There is no need to create a new shapefile as further analysis will be conducted.

Why? These clusters allow for important ecological processes, such as the migration of frogs and insects between wetlands.

Fish support areas (A57)

The DWS provides spatial data on a national scale on South Africa's fish support areas, sanctuaries and associated sub-quaternary catchments. Use the A57 "Fishsque.shp" shapefile to determine which sub-quaternary catchments have critically endangered and other threatened fish species. Fish sanctuaries in a good ecological condition were identified as FEPAs and catchments of lower conditions are classified as fish support areas. There is no need to create a new shapefile as further analysis will be conducted.

South Africa's upstream management areas (A58)

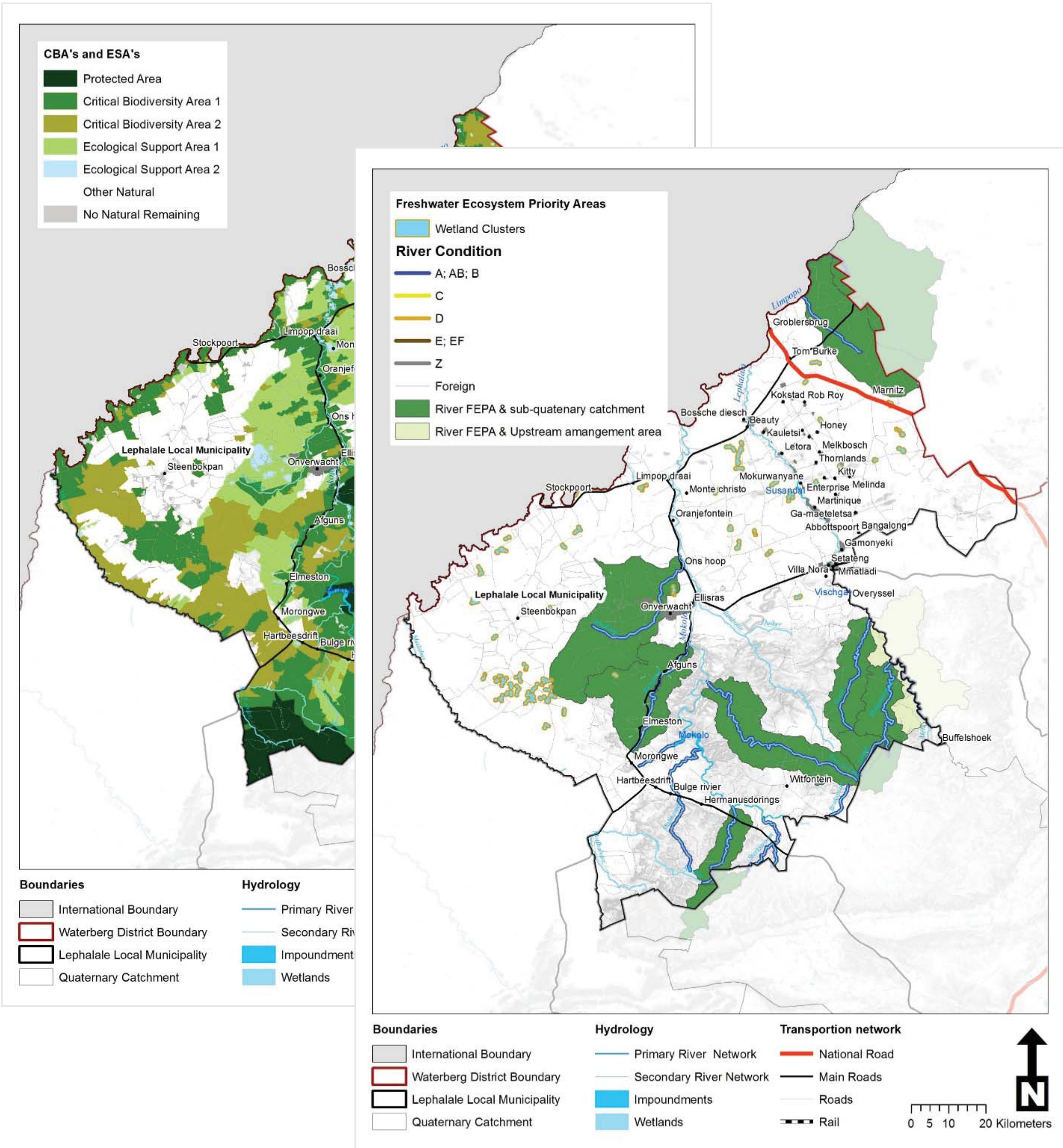
The DWS provides spatial data on a national scale on South Africa's upstream management areas, which represent areas where land use must be managed to prevent the degradation of downstream river FEPAs and fish support areas. Use the "Upstream_management_areas.shp" shapefile to determine which catchments have special management requirements.

Phase 2 FEPAs and free-flowing rivers (A59; A60)

The DWS provides spatial data on a national scale on South Africa's Phase 2 FEPAs, which represent catchment where river conditions should not be degraded any further. Use the A59 "Phase_2fepa.shp" shapefile to determine which catchments require special land use management to prevent the further degradation of river FEPAs. The DWS also provides spatial data on a national scale on South Africa's free-flowing rivers, which are undisturbed from their source to the confluence with a larger river or sea. Use the "Free_flowing_riv.shp" shapefile, which still exists within the municipality.

Step 15: Compile a synopsis of areas with management requirements

Compile a synopsis that summarises and spatialise the key findings of existing protected areas, conservation areas and areas with special land use management guidelines. These include CBAs, ESAs and FEPAs. These spatial entities should also be seen as physical structural elements to be avoided by development. Calculate the full extent of the areas identified in Step 9 and Step 12, and calculate the percentage of municipal land that should "ideally" not be regarded as developable land. These areas should be prioritised for the expansion of protected areas or for biodiversity stewardship contracts.



Phase 2.2.2: Built environment analysis

BUILT ENVIRONMENT ANALYSIS

The objective of a water-sensitive built environment analysis is to determine the historical trends and current extent of physical development to build an understanding of the land use water quality and quantify the impact.

The aims of a water-sensitive built environment analysis are to do the following:

- Determine the extent of land cover change.
- Determine historic growth trends (direction and density).
- Identify spatial structuring elements.

Key questions to inform the built environment analysis:

1. What are the climate characteristics of the municipality?
2. Which physical structural elements can be found in the municipality?
3. Which underlying geological elements can impact on development?
4. What is the extent of protected areas and areas of ecological significance?
5. Is groundwater resource development and managed aquifer recharge an option?
6. What is the quality of the water resources in the study area?

Figure 5.4 illustrates the various assessments to be conducted as part of the built environment analysis. Each assessment will be discussed in more detail as the process continues.

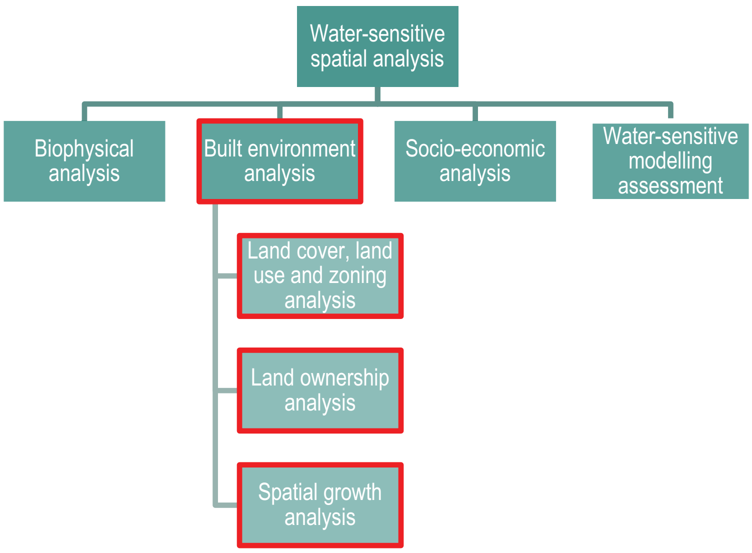


Figure 5.4: Water-sensitive built environment analysis

Step 16: Investigate land cover and land use

Land use has an impact on both the quality and quantity of the water resource and should be assessed accordingly as part of the water-sensitive built environment analysis. Like the CBAs and ESAs, natural and near-natural landscapes provide ecosystem services that are vital to the local hydrological cycle as they regulate the flow, encourage infiltration and purify water.

The objective of the following mapping exercise is to determine which areas within the municipality are still in a natural or near-natural condition and how much of the municipality's surface area has been transformed to accommodate desired anthropogenic land uses. Land cover data does not provide detailed data on land use activities in built-up areas (rural and urban). In the past, rural settlements were excluded from municipal planning, therefore spatial data is extremely limited in these areas.

The land audit process, as required in Step 2, is therefore very important for this analysis to establish a relationship between land use and water resource planning. National land cover data, combined with the land audit, forms the foundation of the following mapping exercise. If the municipality does not have up-to-date land audit spatial information, a wall-to-wall land audit will need to be conducted (see Annexure C). This section assumes that the land audit has already been completed and that the data is available for analysis. Use the base map (see Step 3), and add the following spatial datasets:

- Land cover data (A35)
- Land audit data (as determined in Annexure E)

Step 17: Analyse land cover and land use

Land cover (A35)

The DEA and BGIS host national land cover data. Use A35 "Landcov.raster", the latest land cover data rasterfile, to determine the extent of the remaining natural vegetation. Create a new "Natural_vegetation.shp" shapefile that represents at least the following:

- Bare non-vegetated areas
- Eroded areas
- Thicket or dense bush
- Grasslands
- Woodlands or open bush and low shrublands

In an ideal world, the naturally vegetated areas will cover the full extent of areas identified in Step 15. Use the A35 "Landcov.raster" rasterfile to determine the extent of agricultural and mining areas. Create a new shapefile, "Agricultural_land_use.shp", which represents land used for the following:

- Plantations
- Cultivated orchards
- Cultivated subsistence farming
- Cultivated commercial pivots
- Cultivated commercial fields

Create a new shapefile, "Mining_land_use.shp", which represents land use for mining, and includes areas used for the following:

- Mining
- Mining buildings
- Mine water areas that are permanent or seasonal
- Bare mines
- Semi-bare mines

Why? Both agriculture and mining practices form part of the food, energy, water nexus. However, irrigated agriculture is the largest water user in the country at ±60%, and contributes to a high level of contamination. Mining has a relatively small water resource demand at ±3%, yet the aftermath of mining activities has a detrimental impact on both land and water resources.

Land audit data

The national land cover (A35) rasterfile does not provide sufficient information to determine individual land uses within built-up areas. Therefore a municipal land audit (Step 2) (Annexure C) must be conducted to determine what land use is exercised where. Zoning, land ownership and date of the establishment should also be gathered. To date, formal zoning with legal status will predominantly be limited to formal urban areas. It is necessary to explain the process of conducting a land audit.

Vacant and open-space erven: Use the spatial data generated by the land audit (Annexure C) to map and assess all existing “vacant.shp” and “open_space.shp” land parcels in both urban and rural settlements. Identify and map the existing zoning (if any) assigned to the properties.

Why? Vacant land within the existing built-up area should be prioritised for higher density, infill development and/or prioritised for government housing schemes. If feasible, vacant erven located near already open spaces should be utilised for green infrastructure, to harvest and treat stormwater runoff, rainwater, greywater and, in some areas, blackwater.

Business and industrial purposes: Use the spatial data generated by the land audit (Annexure C) to map and assess all existing erven and informal land parcels used for “business.shp” (shops, offices, restaurants and taverns) and “industria_purposes.shp”. Identify and map the existing zoning (if any) assigned to the properties. Special attention should be paid to the zonings assigned to industrial land uses as these noxious industries may have a higher pollution rating than other industrial land uses.

Why? Business and industrial land uses generally contribute to the municipality’s economic growth. The economic potential of an area is essential for the overall financial sustainability of a municipality. In most towns, cities and settlements, these land uses would be found in either natural or artificially created economic and industrial zones. Beautification of business and industrial zones through WSUD and other green design elements encourages the investment potential and sense of place. Water demand by these land uses is also relatively high, and water-efficient appliances, practices and initiatives should be the main priority for all business and industrial land uses. Wastewater discharge from industrial land uses generally has a higher pollutant rating and should be treated on-site before being discharged into the system. Furthermore, the contamination rate of stormwater from industrial zones is much higher, as noxious chemicals and particles interact with each other. Implementing WSUD should be prioritised in these areas.

Educational, institutional and health care: Use the spatial data generated by the land audit (Annexure C) to map and assess all existing erven and informal land parcels used for “educational.shp”, “institutional.shp” and “health_care.shp” purposes. Identify and map the existing zoning (if any) assigned to the properties.

Why? Educational, institutional and health care facilities generally fall under government or municipal management and control. These facilities require relatively large erven as buildings are designed to accommodate large groups of people for several hours. The size of the building is favourable for water harvesting and storage. Stormwater from parking areas should also be harvested and used to water sportsfields and to clean premises. The same goes for community facilities with large gardens. Harvested water can be used to flush toilets.

Government, municipal and services-related infrastructure: Use the spatial data generated by the land audit (Annexure C) to map and assess all existing erven and informal land parcels used for “government.shp”, “municipal.shp” and “services_related_infrastructure.shp” purposes. Identify and map the existing zoning (if any) assigned to the properties. This includes post offices, police stations, museums, camping sites, cemeteries, dumping sites, roads, fire stations, composting installations, water purification works, water treatment works and electrical substations and reservoirs.

Most land uses have accompanying buildings designed to accommodate people and/or economic activities that require water resources for domestic or economic purposes. This is provided by a combination of physical infrastructure typically referred to as public services infrastructure. This can be visible or it can be underground. The spatial location of underground water and sanitation distribution networks and stormwater channels should also be identified in order to cover the full extent of the infrastructure network. The municipal asset register should provide valuable spatial data on both visible and underground physical infrastructure. Additional information should be gathered on the management structure, operations and maintenance, and the hydrological integrity of this system. This information can be obtained from the municipal WSDP or the National Integrated Water Information System. The location of cemeteries relative to groundwater resources is very important, as cemeteries have a high contamination rate.

Residential use: Use the spatial data generated by the land audit (Annexure C) to map and assess all existing erven and informal land parcels used for "residential.shp" purposes. Identify and map the existing zoning (if any) assigned to the properties.

Why? Zonings help to identify density and level of intensity of residential land uses. In most municipalities, the bulk of land uses will be residential. Formal or urban domestic water demand accounts for ±24% of the national water demand. South Africa's gross average consumption is estimated at 229 litres per person per day, which is much higher than the intended 50-60 litres per person per day. Domestic water use refers to water used for showering, bathing, toilet flushing, laundry, cooking, gardening and, in some instances, for filling the swimming pool.

Step 18: Determine land ownership information

Annexure C states that land ownership information should also be captured during the land audit process. Land ownership information should differentiate between state-owned, parastatal and privately owned land. Map and determine the extent of municipality-owned land vs. privately owned land, etc. Map and determine the ownership of vacant municipality-owned land.

Why? Ownership could potentially contribute to water-sensitive planning in the sense that, once a municipality has developed a water-sensitive policy, all spheres of government need to adhere to this policy, launching the transformation process. The private sector often needs to be incentivised in some way to give effect to government policies.

Step 19: Determine settlement structure and growth direction

The transformation and occupation of land have both a qualitative and quantitative impact on natural resources. Land-cover change is widely recognised as the major driver of habitat and biodiversity loss in the world. These changes not only fragment the landscape but alter biogeochemical cycles, climate, ecosystem processes and ecosystem resilience, thereby changing the nature of ecosystem services' provision and human dependencies. One of the ecological processes that being severely impacted on by the change in land cover is the hydrological cycle, as water depends on natural landscapes to be replenished.

Step 20: Compile a synopsis and spatialise key findings of the built environment analysis

Compile a synopsis that summarises and spatialise the key findings of the land audit data. The synopsis should indicate the extent of natural landscapes and land cover change, the extent of formal and informal land uses within the municipality, land ownership analysis and growth direction.

Example D provides examples of land use, zoning, land ownership and spatial growth.

Example D: Examples of land use, zoning, land ownership and spatial growth

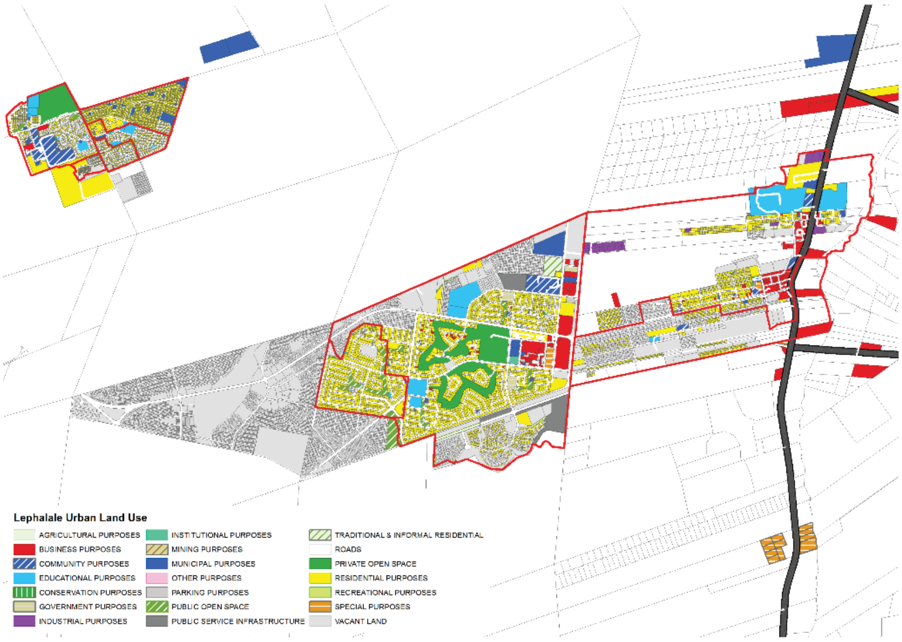


Figure 5.5: Lephalale urban land use

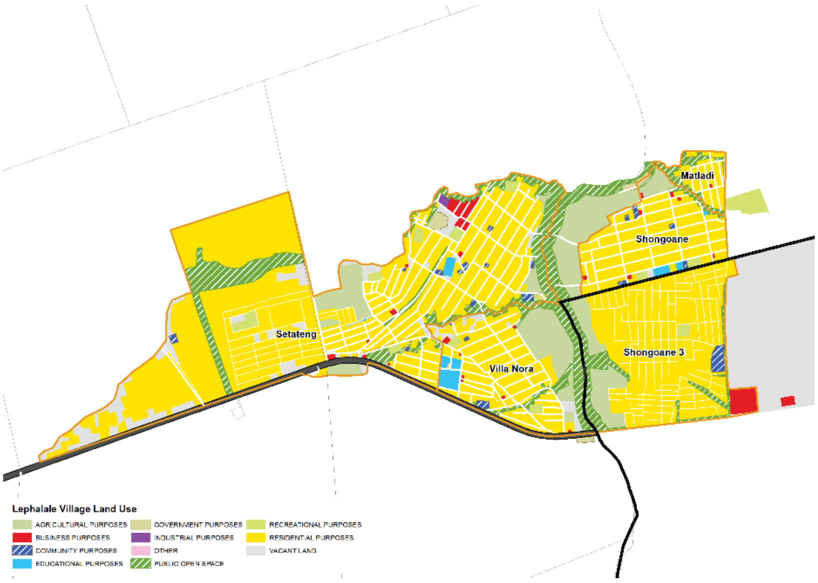


Figure 5.6: Lephalale village land use

Figure 5.7: Land ownership map

Figure 5.8: Spatial growth

Phase 2.2.3: Socio-economic analysis

SOCIO-ECONOMIC ANALYSIS

The objective of a water-sensitive socio-economic analysis is to determine the current and future socio-economic demand for water and identify opportunities for change.

The aims of a water-sensitive socio-economic analysis are to do the following:

- Determine household access to services.
- Determine household income and affordability levels.

Key questions to inform the built environment analysis:

1. What are the general characteristics of households in the municipality (income, tenure, size)
2. What is the current household level of access to services?
3. Which settlements experience high levels of backlog to services?
4. How is the water service provider?
5. Are the services reliable? Which challenges related to service delivery are faced by the municipality (water losses, illegal connections, high water use)?
6. What is the tariff structure for services in the municipality?

Figure 5.9 illustrates the various assessments to be conducted as part of the socio-economic analysis. Each assessment will be discussed in more detail as the process continues.

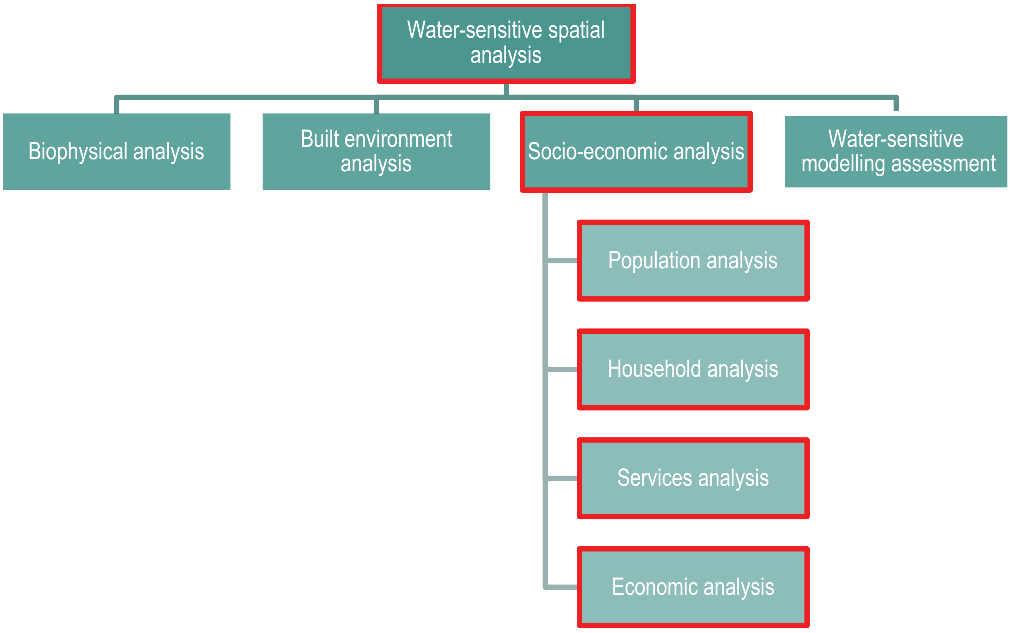


Figure 5.9: Socio-economic analysis

Step 21: Analyse socio-economic data

The socio-economic analysis relates strongly to the ability of the biophysical and built environment to provide services to the municipalities' residents and economic sectors. The socio-economic analysis is mostly informed by statistical data published by Statistics South Africa. The significance of the statistical data often gets "lost" in SDFs as most of the data has no spatial allocation assigned to it.

In addressing water sensitivity as part of the analysis, one should aim to identify areas where new technologies can be socially embedded, both physically and institutionally. The analysis should also determine the level of services to be provided for future development and set realistic objectives and targets that address financial sustainability. Although not a direct spatial element, water tariffs represents the economic value of water resources and the attitude towards water within the municipality. New governance approaches towards tariff policies should also be informed by the analysis. The socio-economic analysis makes use of statistical data, which is then mapped on the lowest spatial scale possible.

Census data for 1996, 2001 and 2011 is available at a sub-place level and is downloadable in Excel format on “main_place” or “sub_place” level, while more recent 2016 census data is only available on a municipal level. The following statistics should be downloaded from Statistics South Africa’s website or from Quantec:

- Number of people per sub-place
- Number of households per sub-place
- Households’ access to water source per sub-place
- Households’ access to piped water per sub-place
- Households’ access to toilet facilities

Once the Excel data has been downloaded and edited according to the requirements of the writer, the Excel spreadsheets can be linked to the “main_place” cadastre by using the “join” function in GIS. By selecting the “mainplace_code” as the field to be joined and the Excel spreadsheet containing the household level of access to services statistics as the table to be joined to the cadastre, the “mainplace_code” in the Excel spreadsheet can be selected as the field to join in the two datasets. Once joined, the data can be mapped and illustrated as pie charts, which provide a good indication of where the largest services backlog is currently experienced.

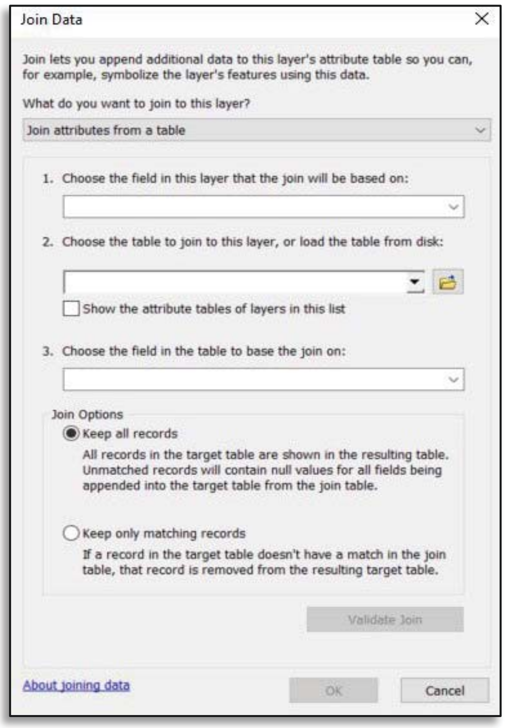


Figure 5.10: Join data

Step 22: Analyse population demographics

Population distribution and demographics

Map and assess statistical information (Stats SA, 2011b) as “population_density” per sub-place. Highlight which sub-places are most populated and have the highest population densities. If possible, report on change over time. Review and reflect on statistical information (Stats SA, 2011a; Stats SA, 2016a) on the municipality’s population according to age, sex and racial composition. If possible, indicate change over time.

Step 23: Analyse household statistics

Household statistics

Map and assess (where possible) statistical information on the number of households by sub-place, as well as the household density by sub-place. Highlight in which sub-places most households reside and which households have the highest densities. Report on the average household size. If possible, report, on change over time.

Review, reflect and map (where possible) statistical information regarding the type of households on sub-place level and indicate how it has changed over time. Additional information on the ownership and tenure status of the property should also be addressed. The assessment should also determine the existing housing backlog. The housing backlog figure can often be obtained from the IDP or the housing sector plan, if available.

Step 24: Analyse households' access to services

Households' access to potable water services

The socio-economic analysis should determine the current household level of access to services, as well as the backlog (spatially). Census data published by Statistics South Africa is freely available for public use and can be mapped on a relatively detailed spatial scale. One of the preferred ways of doing this is to map the statistics as pie charts, either on main place or sub-place level. By adding annual household income information, household affordability of services can also be determined and mapped accordingly. The latest 2016 statistical data is unfortunately only available on the municipal level and not on a mappable scale as in the case of the previous 2011 census. Other sources may include the municipal IDP and relevant sector plans, such as the WSDP. Map and assess the existing household levels of access to potable water services on a sub-place level, as well as the reliability of service provision. Information on the reliability of services can be sourced from the NWRS. Identify the source, as well as the service provider.

Water source: The source of water data reports on the household's main source of water for household use.

The categories include the following:

1: Regional/local water scheme (operated by a municipality or other water services provider; households usually have asses to a conventional water distribution infrastructure)

2: Borehole (groundwater resources would typically be a main water resource for households receiving their main source of water through boreholes; the quality of groundwater should, however, be taken into account as some sources may be unfit for human consumption)

3: Spring

4: Rainwater tank (households that receive their main source of water from rainwater tanks generally depend on natural rainfall to fill the tanks; even though the utilisation of rainwater for household purposes is one of the water-sensitive practices, its practicality is questionable in many climate regions of South Africa)

5: Dam, pool or stagnant water

6: River or stream (in many areas of the country, springs, rivers, streams, dam, pools and stagnant water are still tapped into for household use; keeping the ecological infrastructure in a good condition is critical for these households, as the water quality and quantity can be and has been severely impacted on by land use)

7: Water vendor

8: Water tanker

9: Other

Access to piped water: Access to piped water reports on the way in which households mainly get piped water for household use.

The categories include the following:

1: Piped (tap) water inside dwelling or institution

2: Piped (tap) water inside the yard

3: Piped (tap) water on a community stand: distance less than 200 m from the dwelling or institution

4: Piped (tap) water on community stand: the distance between 200 and 500 m from the dwelling or institution

5: Piped (tap) water on community stand: the distance between 500 and 1,000 m from the dwelling or institution

6: Piped (tap) water on community stand: distance greater than 1,000 m from the dwelling or institution

7: No access to piped (tap) water.

Table 5.14 provides a description of the minimum national standards for water services as per section 9(1) of Act No. 108 of 1997.

Table 5.14: National standards for water services

Level of service	Description of the level of service
None or inadequate	No access to water services
Basic level of domestic water supply (RDP)	A basic (or RDP) household water supply is defined by the Strategic Framework for Water Services (DWAF, 2003) as either 25 ℓ per person per day, or 6,000 ℓ per household per month, supplied according to the following criteria: • A minimum flow rate of not less than 10 ℓ per minute • Within 200 m of a household (however, according to DWS (2015), Cabinet approved that the basic water supply be amended from within 200 m to within the yard, although this has yet to be promulgated) • Interruption of less than 48 hours at any one time and a cumulative interruption time of less than 15 days a year; and at a potable standard (SANS 241)
Medium or higher levels of domestic water supply	Government's intention is to ensure that all households receive between 50 and 60 ℓ of potable water per person per day via an individual connection either in the house or in the yard.
Interim water supply solution	The DWS prioritised all communities living in settlements that have more than 50 households within these areas as receiving at least a minimum interim water supply by 30 June 2015. The minimum standard of an interim or intermediate water supply is: • 10 ℓ per person per day within 500 m of a household and fit for human consumption (SANS 241) • no consumer should be without a water supply for more than seven full days in any year and for more than three consecutive days

With the above description in mind, the census data can be used to spatially determine in which main places the access to at least an RDP level of service is inadequate. Compare the findings to the municipalities' targeted levels of services and determine the existing backlog. It is important to highlight which households receive water through a borehole, as well as from a rainwater tank. In addition, report on any policy or regulations related to this access.

Households' access to sanitation services

Access to toilet facilities reports on the main type of toilet facility used by the household. The categories include the following:

1: Flush toilet (connected to a sewerage system)

2: Flush toilet (with a septic tank)

3: Chemical toilet

4: Pit toilet with ventilation

5: Pit toilet without ventilation

6: Bucket toilet

7: Other

8: None

9: Unspecified

The provision of sanitation is a key development intervention. Without it, ill health dominates a life without dignity. Achieving real gain in sanitation coverage in South Africa has been slow, as many households still lack access to a basic level of sanitation. Despite the slow pace of services delivery, the government and communities tend to choose highly technical sanitation solutions, which, in the long term, are unaffordable and/or unsustainable, particularly the implementation of water-intensive sanitation technologies in water-scarce regions of the country. Table 5.15 provides a description of the minimum national standards for water services in accordance with section 9(1) of Act No. 108 of 1997.

Table 5.15: National standards for sanitation services

Level of services	Description of the level of service
Basic level of domestic sanitation	A ventilated improved pit latrine (VIP), which is a dry toilet facility
	The preferred temporary sanitation solution is a chemical toilet
	A bucket toilet is unacceptable
Higher level of domestic sanitation	Any of the following: full waterborne sanitation, septic tank, soakaways and urine diversion toilets

Backlog to sanitation services is currently determined as access to anything but a bucket toilet. With the above description in mind, the census data can be used to spatially determine in which main places the access to at least an RDP level of sanitation services is inadequate. Map and assess the existing household levels of access to sanitation services on sub-place level. Compare the findings to the municipalities' targeted levels of service and determine the existing backlog. In addition, a report on any policy or regulation related to this access.

Step 25: Analyse economic trends

Economic sector

Determine which economic sector is the strongest, as well as the economic growth rate per industry. Employment by industry, growth per sector and employment potential of the sector should also be determined. Determine the employment by industry ratio, employment by industry, growth per sector and employment potential of the sector.

Step 26: Compile a synopsis of the socio-economic analysis

The synopsis should summarise the backlog to services on a sub-place level, as well as the distribution of people and households. Determine the employment by industry ratio, employment by industry, growth per sector and employment potential of the sector, as well as the household level of income, the percentage of households that qualify for government grants, and the households' affordability of the level of services provided (water and sanitation).

Phase 2.2.4: Water-sensitive modelling assessment

Figure 5.12 illustrates the various assessments to be conducted as part of the water-sensitive modelling assessment. Each assessment will be discussed in more detail as the process continues.

Environmental assessment

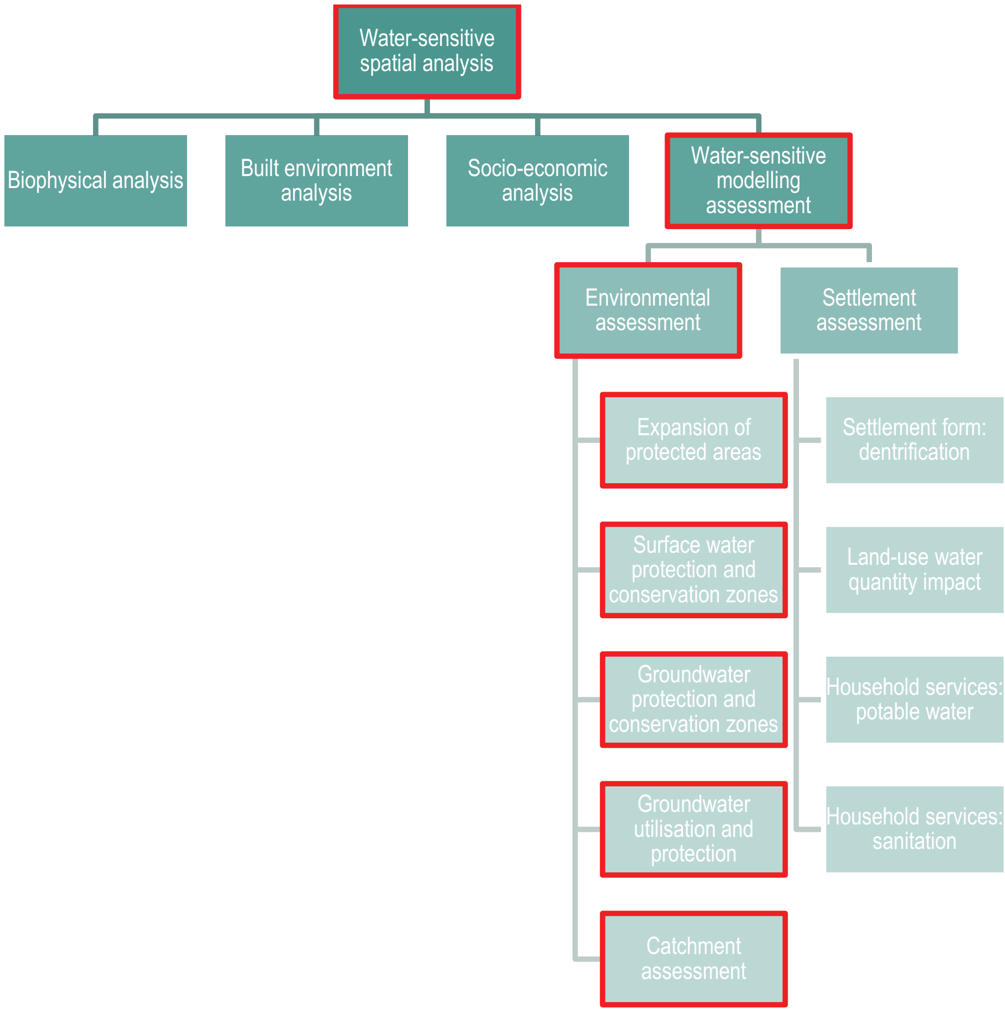


Figure 5.11: Water-sensitive modelling assessment: environmental assessment

Step 27: Determine areas of environmental conflict

The purpose of this analysis is to determine where in the municipality development should be restricted at all times, areas where land use is already in conflict, and areas where guidance on future development direction is required. The aim of the modelling exercise is to determine where in the municipality development should always be restricted, which protected areas are already affected by physical development and require immediate intervention, and which protected areas will face future threats and require guidance on future development direction. Map the following data:

- Spatial data representing all formally protected areas as determined in Step 15
- Use the combination of land use and land cover data mapped in Step 17 and determine which protected areas are currently threatened and affected by development. The term development should not be limited to settlement development, but should also include mining, forestry and agricultural development.
- Map the spatial growth direction as per Step 19
- Map ownership information as per Step 18

Step 28: Assess environmental conflict areas

Use the "select by location" tool in GIS and identify areas where development has already disrupted protected areas.

Create a new shapefile, “immediate_intervention.shp”, to represent areas of immediate intervention. Determine which protected areas are most likely to face future development threats. Use the spatial growth information as mapped in Step 19 and determine where the development footprint is moving towards existing protected areas. Extract the data and create a new shapefile, “areas_of_future_concern.shp”, to represent the areas of future concern. Use the property ownership information from Step 18 to determine which stakeholder should be consulted.

Step 29: Compile a synopsis and spatialise areas of environmental conflict

Compile a synopsis summarising and spatialising the key findings of the assessment of the environmental conflict areas. Land use management guidelines and spatial intervention are necessary for both immediate intervention and areas of future concern. The authority responsible for protected areas **must** be informed about areas identified for immediate intervention, as it is their responsibility to take legal action against any unlawful land use within declared protected areas. Furthermore, stakeholders identified as custodians or owners of land identified as areas of future concern must be consulted. Therefore, development should not interfere with protected areas, and development pressure towards protected areas should be avoided where possible.

Step 30: Determine areas for possible expansion of protected areas

The National Protected Areas Expansion Strategy (NPAES) aims to increase the amount of land under legal protection in order to achieve the country’s national biodiversity target. Existing CBAs and ESAs should be used to determine which areas are most suitable for the expansion of existing protected areas. However, not all CBAs and ESAs will be eligible for legal protection, as some may already have been invaded by development. Other areas may be of high agricultural potential or face future development threats. The challenge is to refine the CBA and ESA networks to create focus areas. Focus areas should include existing CBAs and ESAs to be declared protected areas or areas legally protected by the municipal land use scheme. Unfortunately, some CBAs and ESAs will be compromised for development as settlements will continue to grow. Nonetheless, the compromised portions of land must be accommodated elsewhere.

Use the map created in 0 as a base map and map the following:

- CBAs and ESAs as identified in 0
- The spatial growth direction as per 0
- Ownership information as per 0
- FEPAs as per 0

Step 31: Determine where to expand protected areas

First, the planner needs to determine which CBAs and ESAs have already been affected by development by using the “select by location tool” to extract CBAs and ESAs affected by development. Use the “select by location” tool and extract CBAs and ESAs affected by development. Create a new shapefile, “Modified_CBA_ESA.shp”.

Next, the planner needs to determine which CBAs and ESAs will most likely face development threats in the near future. Use the spatial growth information mapped in Step 19 to determine these areas. In addition, the spatial location of future national, provincial and local municipal planned projects and areas of high agricultural potential should be included as a potential future threat. Use the “select by location” tool and extract CBAs and ESAs likely to be affected by development in the near future.

Extract the data and create a new shapefile, “CBA_ESA_areas_of_concern”. Of the remaining CBAs and ESAs, determine which are within close proximity of existing protected areas by using “select by location – within a (5 km) distance of protected areas”. Use the FEPA spatial data as mapped in Step 15 (if not included as part of an existing CBA or ESA) as an additional parameter when determining areas to form part of the NPAES. Once identified, select all CBAs and ESAs that form part of the connected network (corridors).

Extract the data and create a new shapefile, “PA_CBA_ESA_potential_expansion_network.shp”. Land ownership information, as mapped in Step 18, should be added as a layer to determine which expansion strategy to be used:

- Declaration of protected areas
- Land acquisition
- Contractual agreements
- Biodiversity stewardship programmes

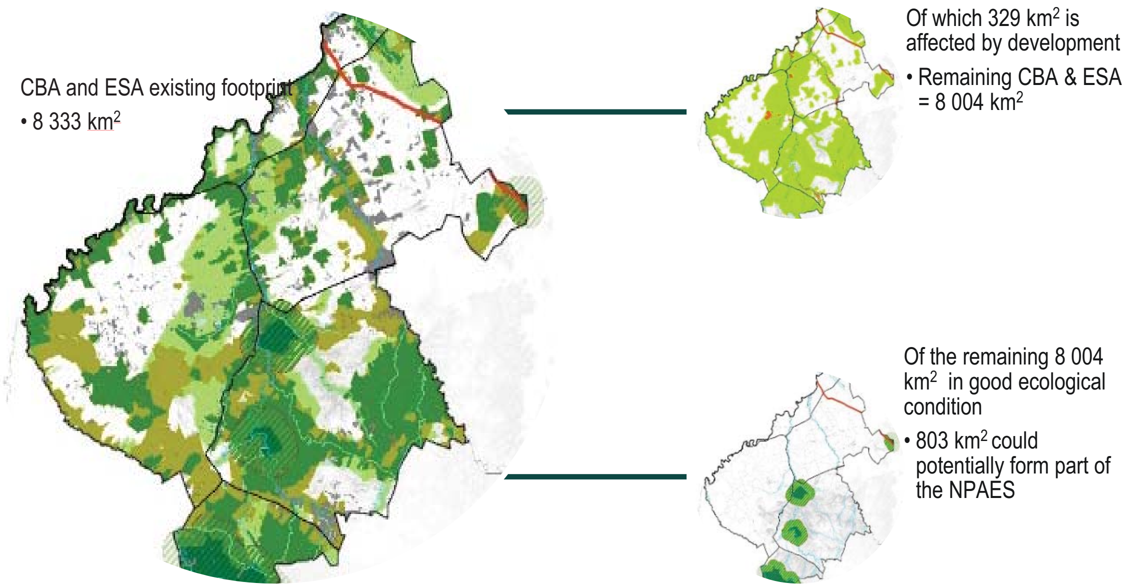
Once the ownership of affected areas has been confirmed, spatial prioritisation should be aligned to the availability of funds.

Step 32: Compile a synopsis of protected areas with potential for expansion

Compile a synopsis that summarises and spatialise the key findings of the expansion of protected areas assessment. Land use management guidelines and spatial intervention are required for modified CBAs and ESAs, CBAs and ESAs that are areas of concern, and protected areas, CBAs and ESAs that form part of the potential expansion network. The SDF should identify areas where the possible rehabilitation of CBAs and ESAs can take place. Growth should be directed away from CBAs and ESAs, as well as CBAs and ESAs in a good ecological condition, overlapping FEPAs and land within close proximity to existing protected areas, CBAs and ESAs.

Example E calculated the surface area that could potentially form part of the NPAES.

Example E: The surface area that could potentially form part of the National Protected Areas Expansion Strategy



Step 33: Assess the surface water protection and conservation zone

While Step 31 aimed to identify land of ecological importance and significance within close proximity to existing protected areas, the remaining CBAs, ESAs and FEPAs must still be managed and conserved as far as possible. Since the publication of the FEPA spatial data, many bioregional plans have included FEPAs as part of CBAs and ESAs with assigned land management guidelines. However, a water-sensitive spatial analysis must purposefully focus on FEPAs to promote water sensitivity within the spatial planning and land use management framework. Use the map created in Step 31 as a base map and add the following spatial data:

- All surface water resources as identified in Step 8
- All FEPAs as identified in Step 15
- Sediment load as identified in Step 11

Step 34: Determine the surface water protection and conservation zone

The planner should determine which FEPAs are excluded from legal protection and which FEPAs could potentially form part of the expansion strategy. Once mapped, use the "select by location" tool to identify all freshwater resources already under legal protection, and all surface water resources expected to form part of the expansion strategy as identified in Step 30. Since these freshwater resources are either already protected or feasible for future legal protection, shift focus to the remaining freshwater resource areas in need of protection and rehabilitation. First, export all remaining FEPAs (not within protected areas or within areas identified for potential expansion) and create a new shapefile. According to the FEPA land use guidelines, several buffer zones should be added to FEPAs before determining the land use impact on FEPAs. Use the "buffer" tool in GIS to create 100 m, 200 m, 500 m, 1,000 m and 2,000 m buffer zones for the remaining FEPAs. Determine which FEPAs and their buffer zones are already affected by development by using the land use and land cover data mapped in 0 as a spatial overlay.

Use the “select by location” tool and extract FEPAs that have been completely destroyed by development.

Create a new shapefile, “Verification_FEPA”. These areas should be prioritised for site inspection or verification to determine whether they can be rehabilitated or not. Use the “select by location” tool and select FEPA buffer zones.

Create a new shapefile, “priority_FEPA_rehabilitation”. Further analysis should be done of the type of land use in 0, the sediment load in 0 and the remaining vegetation within the buffer zones.

Determine which FEPAs and their buffer zones will most likely face development threats in the near future. Use the spatial growth information mapped in Step 19 and all future developments to determine these areas. Use the “select by location” tool.

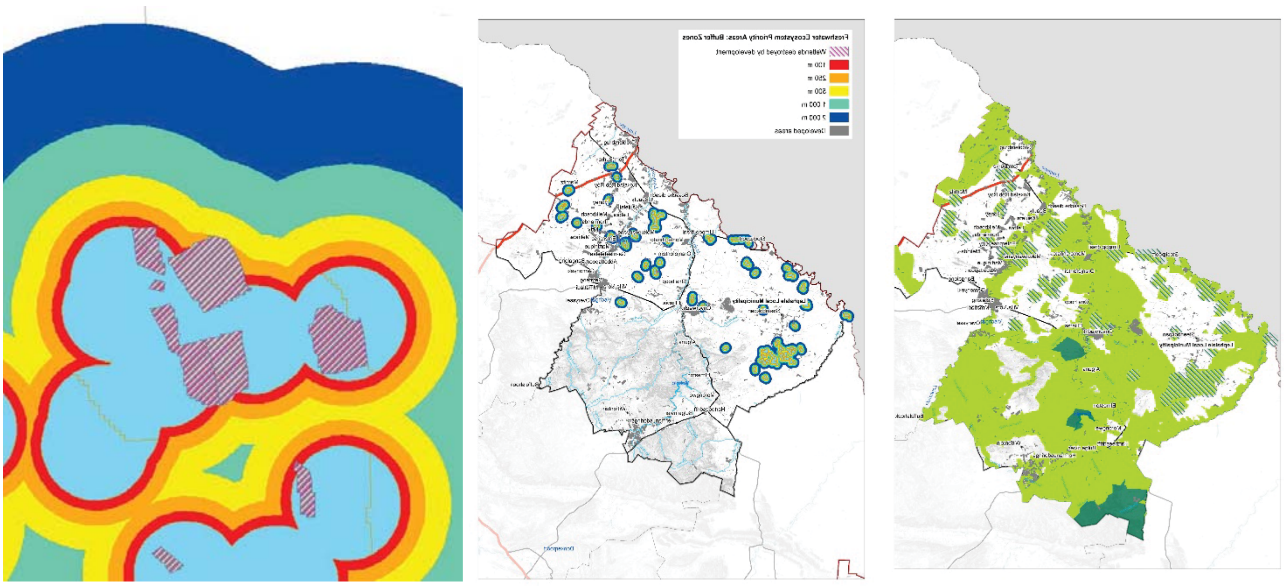
Create a new shapefile, “FEPA_future_concern”. Use the “select by location” tool and extract FEPAs and their buffer zones not affected by development at all.

Create a new shapefile, “Intact_FEPA”. Further analysis on the sediment loads in 0 and the remaining vegetation within the buffer zones should be assessed.

Step 35: Compile a synopsis of freshwater protection areas

Compile a synopsis that summarises and spatialises the key findings of the “Surface water protection and conservation zones” assessment. Land use management guidelines and spatial intervention are required for “Verification_FEPA”, “priority_FEPA_rehabilitation”, “FEPA_future_concern” and “Intact_FEPA”. The WRC’s “Implementation manual for freshwater ecosystem priority areas” (WRC, 2011) provides land use management guidelines for freshwater ecosystem. These guidelines must be included in the municipal land use scheme clauses. Intact FEPAs should remain unthreatened, while areas of future concern should be addressed by means of a growth management strategy. FEPAs affected by development should be prioritised for investigation and rehabilitated if possible.

Example F: Example of surface water protection zones



Step 36: Assess groundwater protection and conservation zones

Groundwater is considered to be an under-utilised freshwater resource. However, concerns about pollution due to land cover change have increased in recent years. Some areas in the municipality may have underlying geological formations (dolomite) with high groundwater recharge potential. These areas should be protected from development as land cover change and land uses will most likely affect the groundwater quality and quantity.

Map all areas identified:

- "under_geo_concern" (Step 12)
- "high_Recharge_potential" (Step 12)
- Land use and land cover data (Step 17)

Step 37: Determine groundwater protection and conservation zones

The planner should first determine which groundwater areas are currently affected by development. Use the "select by location" tool to determine what high groundwater recharge potential is affected by land use activities.

Create a new shapefile, "land_use_groundwater_interaction_areas". Import water quality data from "Groundwater_Quality_Concern" and "Good_Quality_GW", and determine the quality impact of land use on the recharge zone. In areas where "land_use_groundwater_interaction_areas" aligns with "Good_Quality_GW", the impact of land use on groundwater is minimal.

Create a new shapefile, "low_ land_use_groundwater_impact_zone", representing areas of low land use groundwater impact. In areas where "land_use_groundwater_interaction_areas" aligns with "Groundwater_Quality_Concern", the impact of land use on groundwater is high.

Create a new shapefile, "High_land_use_groundwater_impact_zone", representing areas of high land use groundwater impact.

It is essential that land use in these landscapes does not interrupt or degrade the recharge of these aquifers any further. The spatial data "Nitrate_dd.shp", "Fluo_dd.shp" and "iron_dd.shp" should be used to determine the chemical composition of groundwater resources to trace the root cause of the impact of the groundwater quality.

Areas with a "low_ land_use_groundwater_impact_zone" should limit development, as these areas still provide high levels of groundwater recharge. A "groundwater_conservation_zone" should be assigned to this area to prevent future developments from destroying the source.

Step 38: Compile a synopsis of groundwater protection and conservation zones

Compile a synopsis that summarises and spatialises the key findings related to areas where land use is affecting groundwater quality, areas that should be identified for rehabilitation or alternative intervention strategies, areas where land use has a low water quality impact and where it should remain low, and areas with high valued groundwater resources where development should be limited. Areas with a "high_land_use_groundwater_impact_zone" should be prioritised for rehabilitation. Careful groundwater management actions should maintain the rehabilitated state of the groundwater resources. The remaining landscapes "under_geo_concern" and "high_Recharge_potential", where development has not yet altered the surface areas, should be protected from future development by means of a "Groundwater_recharge_protection_zone". Land use management guidelines and spatial intervention is required for "low_land_use_groundwater_impact_zone", "High_land_use_groundwater_impact_zone" and "Groundwater_recharge_protection_zone". Consult with hydrological experts on these zonings, as the relationship between land use and groundwater is complex and often misunderstood.

Step 39: Catchment assessment

According to Allan (2004), streams in agricultural catchments usually remain in good condition until the extent of agriculture in the catchment exceeds 30-50%. Similarly, for every 10% of altered catchment land use, a correlative 6% loss in freshwater diversity can be noted. The "Atlas for freshwater ecosystem priority areas in South Africa" (Nel et al., 2011) designed several land use management guidelines to be implemented on a catchment scale.

Map the following spatial data:

- River FEPAs and associated sub-catchments
- Upstream management areas

Step 40: Determine which catchments are of high concern

The planner should use the "Guidelines for land use practices and activities that impact on water quantity in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011), "Guidelines for land use practices and activities that impact on water quality in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011) and "Guidelines for land use practices and activities that impact on habitat and biota in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011).

Create a "Rivers_FEPA_and_assosiated_sub-catchments_overlay_zone". Use the land uses and land cover, and the catchment boundaries to calculate what percentage between 0 and 30% and between 30 and 50% of the catchment is used for agricultural purposes, and calculate the percentage of additional land use found in the catchment. For every 10% of land taken up by other land uses, a corrective 6% loss in freshwater should be calculated. Identify the catchments of high concern.

Create a "Catchment_concern_buffer_zone" that will restrict any new development within these catchments.

New development applications must be subject to a vigorous development application process before the application can be approved. Additional measures to improve water quality in these catchments must form part of land use management and spatial planning interventions.

Step 41: Compile a synopsis of catchment areas of concern

Compile a synopsis that summarises and spatialises the key findings of the catchment assessment. The area identified with FEPA management needs should be managed as per the "Guidelines for land use practices and activities" (WRC, 2011). Catchments where the land cover has changed more than 30-50% will most likely suffer from bad water quality. New development applications must be subject to a vigorous development application process before the application can be approved. Additional measures to improve water quality in these catchments must form part of land use management and spatial planning interventions. Land use management guidelines and spatial interventions are required for the "Rivers_FEPA_and_associated_sub-catchments_overlay_zone" and the "Catchment_concern_buffer_zone" to protect catchments and water resources against degradation and biodiversity loss.

Settlement assessment

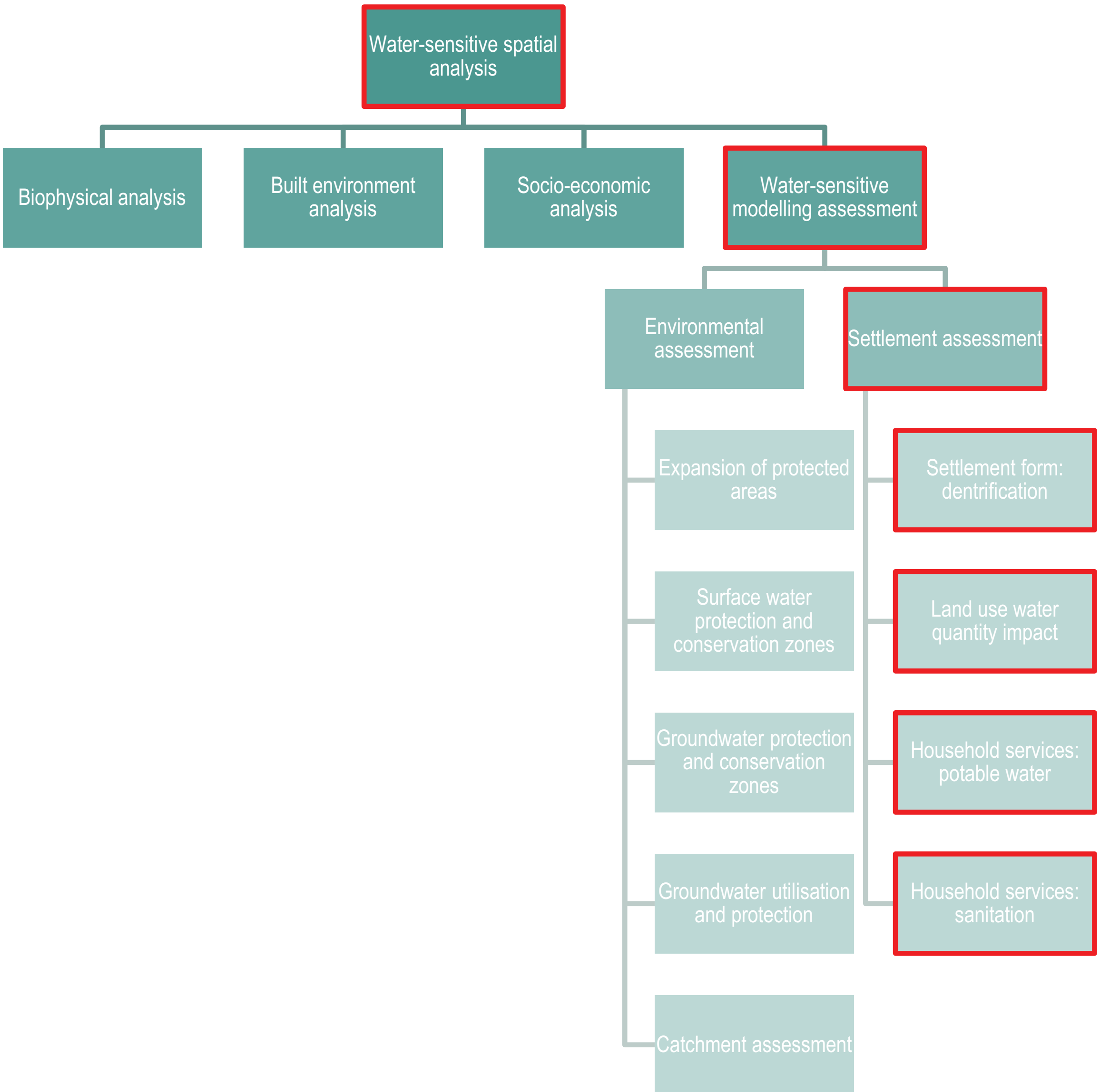


Figure 5.12: Water-sensitive modelling assessment: settlement assessment

Step 42: Urban blue-green corridor assessment

Natural and near-natural landscapes within the existing settlement boundaries should be connected to one another as far as possible to create an integrated blue-green corridor. The blue-green corridor development zone represents a consolidated network of ecological infrastructure. The following data should be mapped to determine areas to form part of the blue-green corridor:

- “Undevelopable_high_slopes”
- “Natural_vegetation.shp”
- “CBAs and ESAs areas of concern”
- “Protected areas, CBAs and ESAs potential expansion network”
- “Freshwater areas of concern”
- “Intact freshwater resources”
- “Groundwater_recharge_protection_zone”
- “Land_ownership”

Step 43: Urban blue-green corridor delineation

The planner should determine which land parcels are within close proximity of an existing ecological infrastructure network that could potentially form part of the blue-green corridor. Use the spatial data mapped as “Undevelopable_high_slopes”, “Natural_vegetation.shp”, “CBAs and ESAs areas of concern”; “PA, CBAs and ESAs potential expansion network”, “freshwater_areas_of_concern”, “intact_freshwater_resources” and “Groundwater_recharge_protection_zone” to determine areas to form part of the blue-green corridor.

- Identify all existing vacant land eligible to be included in the blue-green corridor network (Step 14). Determine the ownership of the property by using the spatial information provided in Step 16.
- Identify other land parcels (not vacant) obstructing the blue-green corridors’ connectivity. Determine the ownership of the property by using the spatial information provided in Step 16.
- Create a new shapefile, “Blue-green corridor development zone”, representing a consolidated network of ecological infrastructures.
- Use the spatial data “high_water_holding_capacity” as an overlay to determine which areas within the blue-green corridor development zone can be used to develop constructed wetlands. Constructed wetlands can treat polluted stormwater runoff, can prove to be an alternative source of water, and can be used as a decentralised wastewater treatment system.
- Vacant land should be prioritised. However, occupied land should also be identified. Determine which areas can support SUDS. These areas have high water-holding capacity for developing constructed wetlands.

Step 44: Compile a synopsis of blue-green corridor developments

Compile a synopsis that summarises and spatialises the key findings of the blue-green corridor assessment. Land use management guidelines and spatial intervention are required for the blue-green corridor development zone, as this zone should have multipurpose functionality.

Step 45: Assess the settlement’s form and function

Most town and cities in South Africa have some form of development boundary assigned to their built-up footprint by the SDF. This is referred to as the development boundary or urban edge. This is one planning tool that can help protect the natural landscapes outside the existing development footprint from development. Another planning tool is to enforce higher density development. Higher-density developments associated with high-rise buildings instead of outwardly expanding buildings require less land to accommodate the development footprint. Higher-density developments also have a reduced water loss rating. The purpose of this analysis is, therefore, to determine the existing development density and availability of vacant land within it. The assessment requires the planner to delineate a strict urban edge that promotes infill development and higher density development.

The following data should be mapped:

- Land use data
- Sub-place data
- Existing urban edge (if available)

Step 46: Visual assessment of the settlement’s form and function

The purpose of this analysis is to determine the existing development density and the availability of vacant land within it. The assessment requires the planner to delineate a strict urban edge that promotes infill development and higher density development. Looking at the existing land use data, the planner should determine the various settlement patterns, including the following:

- Disperse patterns that are low density with single land uses
- A fragmented pattern that is made up of patches of single-use built-up areas with large unused areas in between
- A compact pattern that is denser with a mix of land use

This can also be informed by the household density information calculated.

Once the development pattern has been identified, the planner should do the following:

- Create a new shapefile representing the development edge, which is traced as close as possible to the existing built-up footprint.

Step 47: Calculate the potential for higher density development

Use existing land use and zoning information mapped in Step 14 to determine the development density assigned to buildings. Once the development pattern and density have been confirmed, the spatial analysis needs to identify areas to accommodate infill development and a new development boundary to restrict spatial expansion.

- Use the spatial data provided in Step 14, “Vacant land”, as well as Step 16, “Vacant municipal-owned land”, but exclude the newly developed “Blue-green corridor development zone” (Step 39), and determine the extent of available vacant land within the newly delineated “Development Edge”. Calculate the size of all vacant land.
- Use the zoning data to identify the development density assigned to vacant land within the development edge. Based on the assigned density, determine the number of houses that can be accommodated on the vacant land based on South Africa’s housing typology. Table 5.16 illustrates how the different housing typologies cater for various densities, as well as the average plot size. As the densities increase, the plot size decreases. In addition to the land requirements for future residential development, land for other purposes or uses also needs to be determined.

Table 5.16: Thresholds proposed for different housing typologies in South Africa

Housing typology	Net density	Plot size
Single	10-20 dwelling units per hectare	400-800 m²
Semi-detached	20-30 dwelling units per hectare	300-500 m²
Row housing	30-60 dwelling units per hectare	150-300 m²
Walk-ups	80-100 dwelling units per hectare	
Flats	More than 100 dwelling units per hectare	

In addition to the land requirements for future residential development, land for other purposes or uses also needs to be determined. This includes land for community facilities and economic development (business and industrial). There is a direct link between the density of residential development and the provision of community facilities. Higher densities also imply that larger facilities are required as long as the maximum size for the facility type is not exceeded (CSIR, 2012, p. 17). The Council for Scientific and Industrial Research (CSIR) published guidelines for the provision of social facilities in South African settlements, which take into account the number of households within a certain density.

Compare the densities assigned to the existing vacant land and reassess where higher densities can be implemented. Calculate the number of households that can be accommodated by the existing vacant land within the existing development edge by higher densities. Quantify this amount in terms of years and determine the time period that it will take to fully develop all vacant stands.

Step 48: Compile a synopsis of density potential

Compile a synopsis that summarises and spatialises the key findings on how to limit development by increasing the development density assessment. Land use management guidelines and spatial interventions must promote infill development where possible as it may contribute to reduced water loss, as well as a reduced environmental impact on surrounding landscapes.

Identify areas of well-located vacant, municipality-owned land and prioritise those land parcels for higher density development. Key to the SDF is to guide the future shape of the city. Infill and density development include several attributes for water-sensitive spatial planning and land use management. One, in particular, is reduced water loss.

Example G: Reduce water loss through densification

Literature points to the fact that higher density development holds several sustainable factors. One of these is that the probability of physical water losses will be less in compact urban structures.

$$UARL = (18\, x\, LM + 0.80\ \times Nc + Lp) \times P$$

where:

UARL = unavoidable annual real losses (ℓ/day)

Lm = Length of mains (km)

Nc = Number of service connections (mains to meter)

Lp = Length of unmetered underground pipe from street to customer meter (km)

P = Average operating pressure at average zone point (meters)

The case study: Ekurhuleni density water loss model

A modelling exercise was undertaken to determine the impact of density development on water loss. Due to the fact that not all of the above information was available, alternative information was sourced and some assumptions had to be made. The following information is required to populate the equation:

1. Length of metered main
2. Number of service connections
3. Length of unmetered underground pipe from street to customer meter (km)
4. Density = Determine the net residential density on the lowest level of detail

The two main data sources that were used include the Ekurhuleni asset register and cadastral spatial information:

1. Length of metered main (Lm) = The municipal asset register provided sufficient information on the length of the main pipelines.
2. Number of services connection (Nc) = The municipal erf cadastre (spatial) was used to make the assumption that at least every property has a connection.
3. Length of unmetered underground pipe from street to customer meter (km) = The Lm pipe diameter was used to reclassify the network into mains and unmetered underground pipe networks. Pipes smaller than 50 mm in diameter were the underground pipeline.
4. Density = Erf cadastre, as well as the number and type of customers (water users) per property, was used to determine the net density (number of households per hectare) on the sub-places level.

Table 5.17 and Figure 5.14 prove that, in high-density developments, the litres of water lost per day equate to 4 ℓ per person per day. In areas where development density is low, the average litres of water calculated as UARL is three times more, at 12 ℓ of water per person per day.

Table 5.17: UARL by settlement density

Density	UARL (ℓ per day)	Number of customers serviced	Litre per customer per day
High	104 405	23 918	4
Medium	88 486	13 471	7
Low	332 200	26 634	12

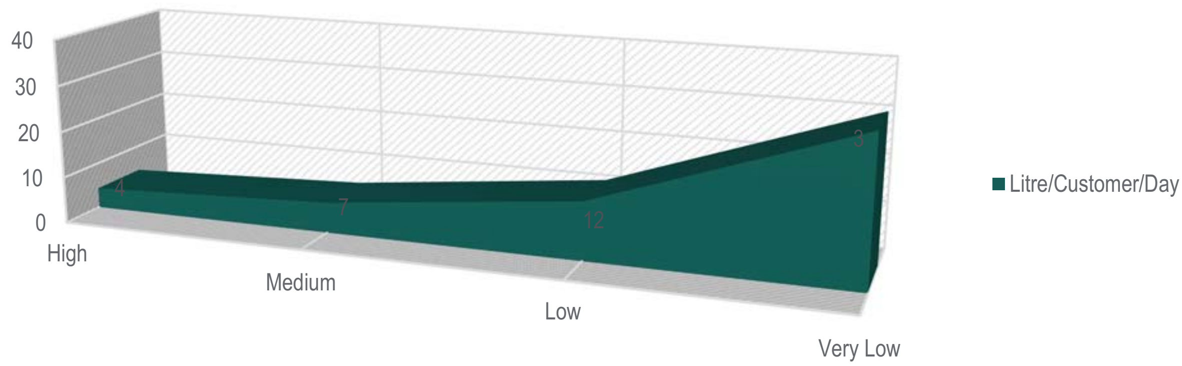


Figure 5.13: UARL by settlement density

From the above analysis, a strong argument can be made for higher density development as the volume of UARL is almost three times less per person in higher density development areas than in sprawling low-density settlements; the latter is a common characteristic of most settlements in South Africa.

Step 49: Determine the impact of land use water quantity

The quantitative impact of land use on water resources refers to the physical consumption of water. This can be determined spatially by merging two datasets. The purpose of this modelling exercises is to determine the impact of land use water quantity by linking land use and water billing information. This exercise will help the planner to identify which land uses consume the highest volumes of water (water-intensive land uses), and to determine spatially where the municipality water consumption is highest by creating high water-use zones. Datasets to be merged and mapped accordingly include the following:

- Land use data (Step 14)
- Municipal billing system

If possible, the billing information should be in digital format. Unfortunately, the consumption data is limited to billed consumption, which is often only applicable in urban areas.

Step 50: Land use water quantity model

Once the data has been received, identify common information in both the billing data and the land use data that will allow for the two data sets to be linked. This refers to information representing the physical location of the property billed and the extent of the water consumed by the property.

Use the "join and relate" tool in GIS to link the billing information to its rightful spatial location. Use the "reclassify" tool to make sense of the volume of water consumed by land use.

In an ARC sense, the volume of water consumed by land use can be extruded, which provides a spatial representation of the volume of water consumed by land use type.

Table 5.18: Extract: Mogalakwena Local Municipality Venus Billing System Data

Unit	Account	YYYMM	ReadDate	MeterReading	ReadType	MeterRef	MeterType
1000000000000100000000000	1031054	200505	20050505	1731.000	3	380147	MW08
1000000000000100000000000	1031054	200409	20040906	1692.000	3	380147	MW08
1000000000000100000000000	1031054	200410	20041012	1700.000	3	380147	MW08
1000000000000100000000000	1031054	200411	20041104	1703.000	3	380147	MW08

Table 5.19: Extract: Lephalale Local Municipality Sebata Billing System Data

Erf number	Account	Physical meter no	Calcparm	Reading	Date	Average monthly consumption
0000/0255/00003962/00000/000	109686		W	1571	2016/07/04	1320.08
0001/0001/00000001/00000/000	2	3197	W	89	2016/07/10	83
0001/0001/00000002/00000/000	4	3205	W	74	2016/06/30	81.85
0001/0001/00000003/00000/000	114489	985535	W	4224	2016/07/10	39.05

The planner should now determine or identify the following:

- The land uses that consume the highest volumes of water
- Land uses with irregular usage volumes ("flag" these properties for further investigation)

This irregular high usage can be a result of illegal land use activities, e.g. car washing or a laundromat on a residential-zoned property. It can also be due to high volumes of water leakages or incorrect billing information.

Use the property ownership data (Step 16) to determine which municipality-owned buildings contribute to high water consumption, and where the municipality the consumption is the highest, and create a new shapefile representing "high_water_useage_zones".

Step 51: Compile a synopsis of high water use by land use

The land use water consumption that is modelled should be used to build an understanding of the future water demand of a town or settlement that should be used to influence land use approvals or rejections. Municipality-owned buildings or land uses with high water consumption patterns must be flagged for immediate intervention if it is the municipality's objective to become more water sensitive. Targeted water conservation and demand management strategies should be implemented through development controls or incentives.

Example H: Land use water consumption model

Water consumption can be mapped spatially, as explained in Step 49 to Step 51. In the figures below, each property is depicted in relation to the amount of water used on average per month. Land uses are introduced, as well as consumption. These images are displayed in three dimensions in order to better depict the multiple variables.

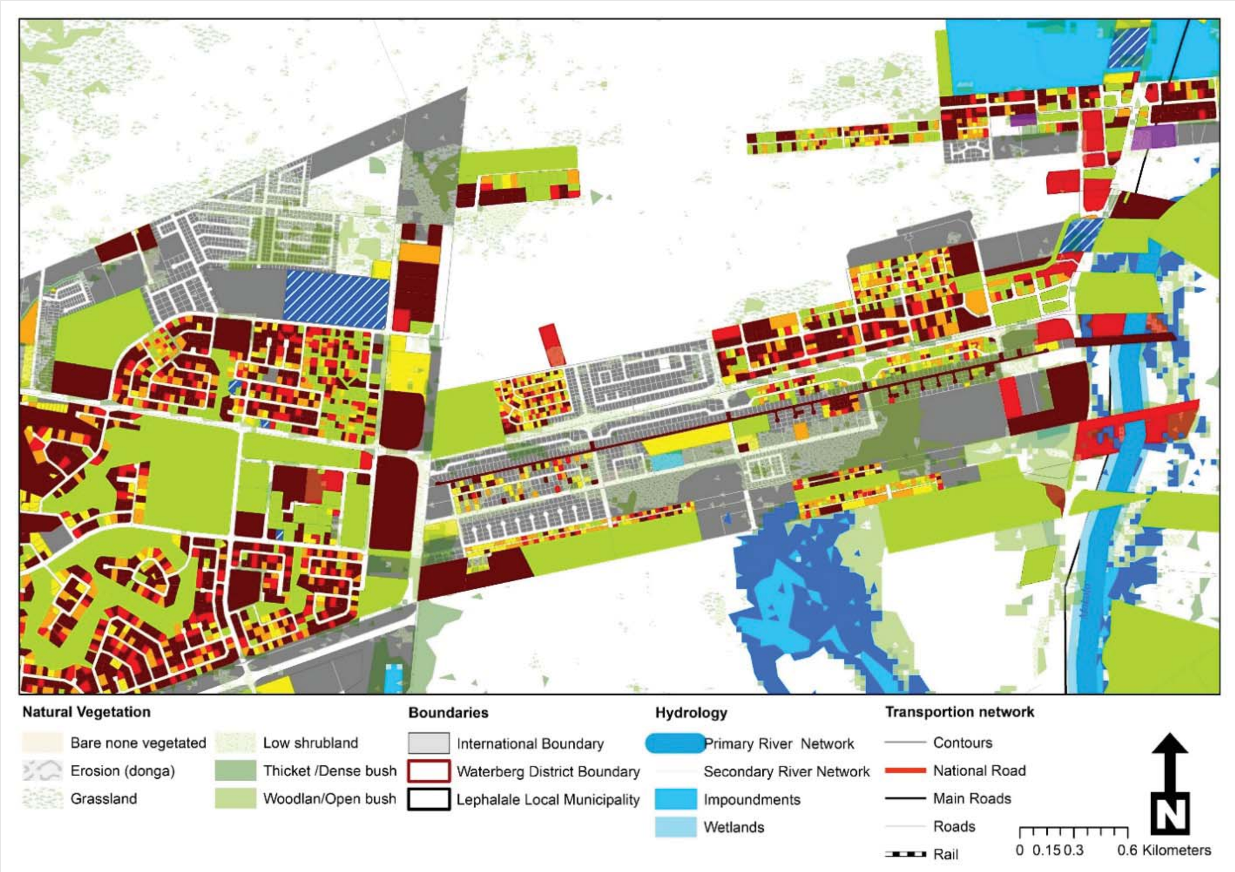


Figure 5.14: Land use water consumption model

Threat rating	Symbol	Average monthly water consumption	Description
Very low	VL	0-50	Very low water consumption
Low	L	51-100	Relatively low water consumption
Moderate	M	101-200	Average water consumption
High	H	201-300	High water consumption. Water use should be investigated.
Very high	VH	1	Very high and irregular water use. Immediate intervention should be applied.

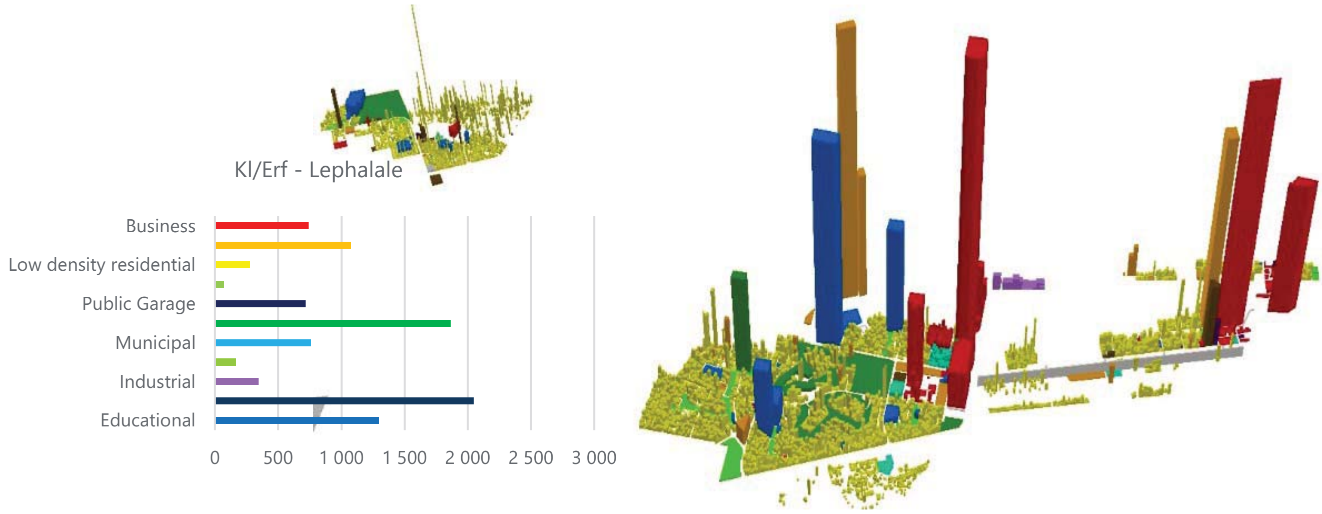


Figure 5.15: Volume of water consumed by land use

Step 52: Household services' affordability assessment

This modelling exercise will assist planners in determining which sub-places' existing water and sanitation services are provided at an unaffordable and unsustainable level. The concept of water and sanitation levels of service relates to the options that consumers can be provided, taking into account the convenience of providing the services, the amount of water that they will consume, and the associated wastewater that will be generated. The assessment conducted in Step 21 already addressed the household level of access to basic services. This assessment will aim to determine the affordability of services. Providing a higher level of water services, where households most probably use more water than the official Department's planning allocation of 60 ℓ/c/d, could restrict rapid improvements in water service levels beyond RDP standards. This has a direct impact on the service delivery targets that are used in the scenario planning process. Table 5.20 explains the relationship between a household's annual income and its level of services.

Table 5.20: Household income and affordability in relation to municipal services

Household income classification	Annual household income	Description
Severe poverty	Households earning less than R19,600 per annum	These households will generally be unable to pay for the cost of municipal services. These households should have access to at least a basic level of domestic water supply (RDP).
Low income	Households earning between R19,601 and R76,400 per annum	These households should be in a position to contribute at least a portion of the cost of municipal services, even though they may be unable to pay the full cost.
High-income	Households earning more than R76,400 per annum	Households in this group should be expected to pay full cost recovery rates for the services that they receive.

The following statistical information should be merged and mapped accordingly:

- Annual household income distribution
- Access to piped water
- Access to sanitation

Step 53: Determine household water services' affordability

Census 2011 information can be used to classify households as high-income, low-income or within severe poverty. Using the "Access_To_piped_Water" and "Access_to_sanition" statistics as a filter, household affordability to services can be determined and mapped accordingly.

Select and merge "annual household income distribution" with "access to piped water" to determine the household's affordability to services. Reclassify the household income levels as households that fall into the severe poverty classification (earning less than R19,600 per annum), low-income (households earning between R19,601 and R76,400 per annum) and high-income (households earning more than R76,400 per annum). The information should be mapped on sub-place level.

Select and merge "annual household income distribution" with "access to sanitation" to determine the household's affordability of services. Reclassify the household income levels as households that fall in the severe poverty classification (earning less than R19,600 per annum), low-income (households earning between R19,601 and R76,400 per annum) and high-income (households earning more than R76,400 per annum). The information should be mapped on sub-place level.

Step 54: Compile a synopsis of household water services' affordability

This exercise will help to spatially determine which settlements enjoy a higher level of services for which they are unable to pay, as well as settlements that could potentially make a financial contribution to municipal services; however, their level of access to services is below the norm.

Identify sub-places where the majority of households classified in the poverty category have access to piped water. These households would typically not be able to pay for water services, yet they have access to the highest level of services. Since these households already have access to piped water, water conservation strategies must be a priority within these settlement areas.

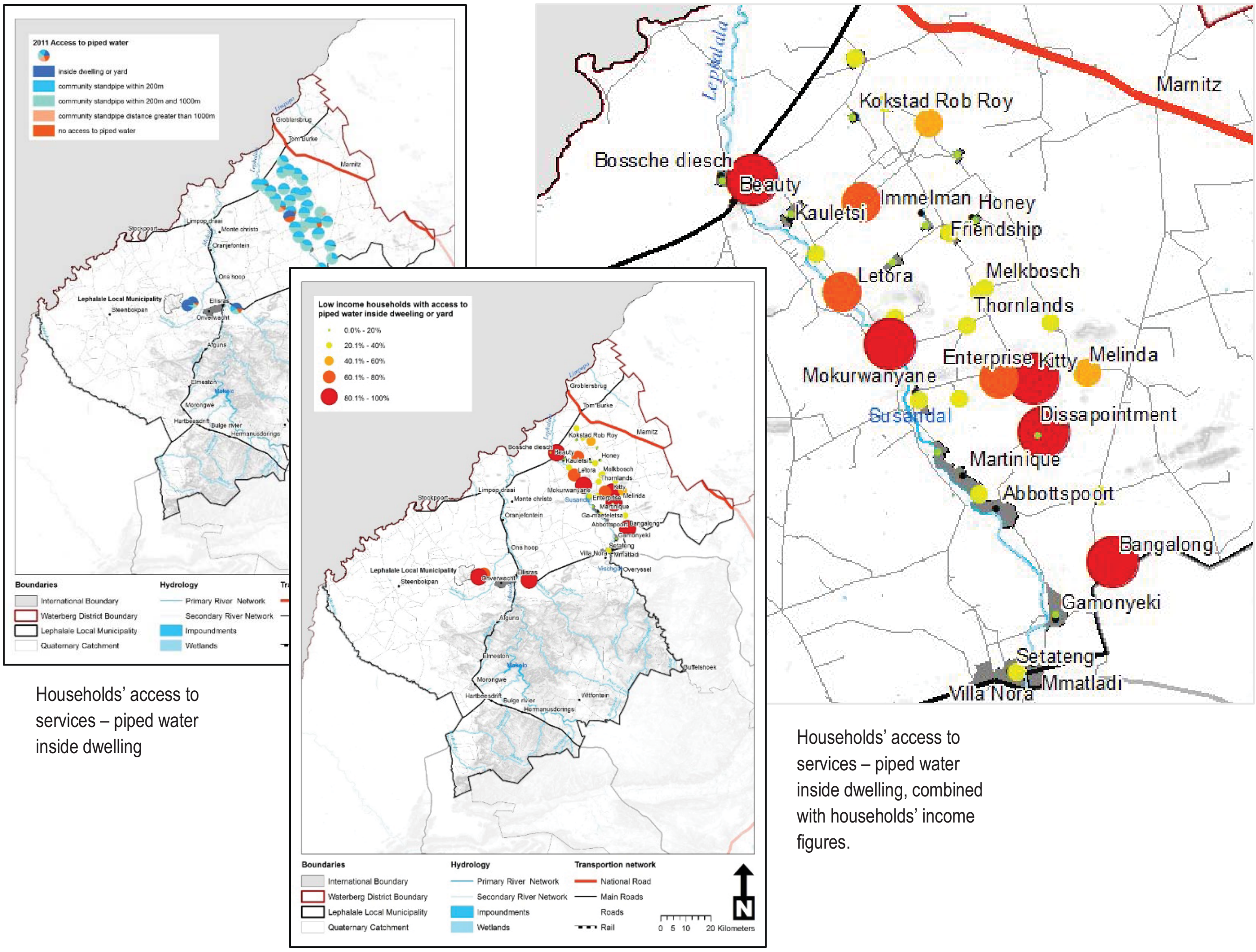
Identify sub-places where the majority of households classified in the severe poverty category still have no access to piped water and identify alternative sources of water such as rainwater harvesting. Groundwater sources (if available), rather than surface water resources, should be utilised for domestic purposes.

Since many of the sub-places will already have a higher level of services in place, water conservation strategies must be prioritised within these settlement areas. Settlements with no access to piped water should be prioritised for the development of alternative sources, such as rainwater harvesting. Groundwater sources (if available), rather than surface water resources, should be utilised for domestic purposes.

Example I: Analysis of households' access to services' affordability

Determine the household's affordability to services by sub-place

Households earning more than R76,400 per annum are classified as high-income for the purpose of this analysis. Households in this group should be expected to pay full cost recovery rates for the services they receive. By comparing the level of access to household services with annual household income, it was found that 32.43% of households earning less than R19,201 per annum have access to water services that are above their affordability levels and probably use more water than the official Department's planned allocation of 60 ℓ/c/d.



Households' access to services – piped water inside dwelling

Households' access to services – piped water inside dwelling, combined with households' income figures.

Household income classification	Annual household income	Description
Severe poverty	Households earning less than R19,600 per annum	These households will generally be unable to pay for the cost of municipal services. These households should have access to at least a basic level of domestic water supply (RDP).
Low income	Households earning between R19,601 and R76,400 per annum	These households should be in a position to contribute at least a portion of the cost of municipal services, even though they may be unable to pay the full cost.
High income	Households earning more than R76,400 per annum	Households in this group should be expected to pay full cost recovery rates for the services that they receive.

Step 55: Alternative sources of water: rainwater harvesting potential

Water services authorities should broaden the scope and classification of what is a good or appropriate level of service to be provided to communities, specifically to those communities that are unable to pay for services, sparsely populated communities, and those located far from existing fixed infrastructure, with limited economic or growth potential, making water services delivery through pipelines impractical and too expensive. The utilisation of alternative water resources is one of the key pillars of practice of water-sensitive cities. As mentioned previously, the harvesting of rainwater for household purposes is a water-sensitive alternative to substitute conventional water supply. Stormwater harvesting should also be considered as an alternative to non-potable water.

Step 56: Calculate the rainwater harvesting potential

Rainwater harvesting potential model

Calculating the rainwater harvesting potential of an individual site is relatively simple. The equation for determining the volume of usable rainwater on an individual site level is as follows:

$$V = R \times A \times C \times FE$$

where:

V = Volume of usable rainwater (ℓ)

R = Average rainfall over a period (mm)

A = Area contributing to runoff (m^2)

C = Runoff coefficient (0-1)

FE = Filter efficiency (0-1)

However, calculating the optimal rainwater harvesting potential (volume of useable rainwater) for multiple stands requires some thinking.

First, daily rainfall data for the entire year should be obtained from the South African Weather Service (at a cost).

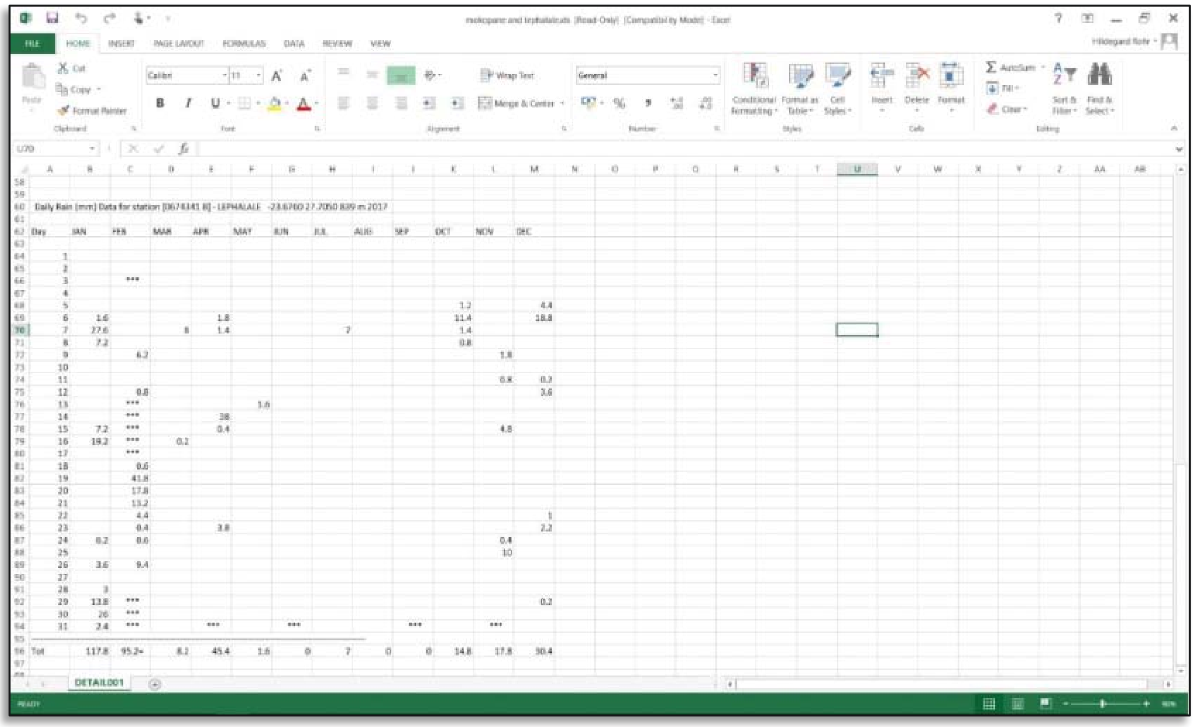


Figure 5.16: South African Weather Service: daily rainfall data

Secondly, the land use data/cadastre, as captured during the land audit process, should provide spatial information on the land use, zoning and erf size. However, it does not provide the m^2 of the area contribution to runoff (A), also referred to as the roof size. To determine A, the calculation assumes that the full coverage, as assigned by the land use scheme, has been built.

The Lephalale Local Municipalities Land Use scheme would thus define coverage as:

"Coverage" means the total area of a land unit that may be covered by buildings, expressed as a percentage of the nett erf area of the land unit and includes:

(a) walls and buildings;
(b) solid roofs;
(c) stairs, steps, landings, except entrance landings and steps, galleries, passages and similar features, whether internal or external; and
(d) canopies, verandahs, porches, balconies, terraces and similar features provided that the following portions of buildings must be disregarded in the calculation of coverage, namely:
  (i) stoeps, entrance steps and landings;
  (ii) cornices, chimney breasts, pergolas, flower boxes, water pipes, drainpipes and minor decorative features not projecting more than 500 mm from the wall of the building;
  (iii) eaves not projecting more than 1 m from the wall of the building; and
  (iv) a basement provided that the basement ceiling does not project above the ground level."

The coverage used in the case study is as follows:

Table 5.21: Coverage as per zoning

Zoning	Coverage percentage
Residential 1 and 2	60% (for stands smaller than 350 m^2, maximum coverage of 50%)
Residential 3 and 4	80%
Business 1, 2, 3 and 4	95% for business use and 70% for residential use
Industrial 1 and 2	95%
Industrial 3	75%
Commercial	90%
Educational	70%
Instutitional	60%
Government, municipal, public open spaces, private open space, transport, protected areas, mining, special	As approved by the municipality.

The next step is to export the land use cadastre as an Excel file to be edited. Once opened in Excel, the assumed area contributing to runoff, which in this case is calculated as the percentage coverage assigned to the zoning of each formally registers erf parcel by the land use schemes, can be calculated. The following equation was used to determine the assumed area's contribution to a runoff as it is not the actual roof or building size.

$$AA = ES \times Cov$$

AA = Assumed area contributing to runoff (m^2)
ES = Erf size (m^2)
Cov = Percentage coverage as assigned by the land use scheme

Once calculated, the pivot table function in Excel should be used to filter out all vacant erven. Next, the sum of total AA by land use should be calculated and multiplied by average rainfall (mm), the runoff coefficient and the filter efficiency (0-1). The runoff coefficient is the realistic proportion of rainfall-runoff that enters the specified storage facility. For this specific calculation, a runoff coefficient was assumed to be 0.85.

Table 5.22: Runoff coefficient

Roof classification	Runoff coefficient (C)
Pitched roof, tiled	0.85
Flat roof tiled	0.6
Flat roof, gravel	0.4
Extensive green roof	0.3
Intensive green roof	0.2

The filter efficiency refers to the proportion of water after filtration available for use. Generally, manufacturers recommend a conservative 0.9. Since daily rainfall data was available, the optimal daily rainfall potential could also be calculated.

$$V = ADR \times AA \times C \times FE$$

where:

V = Volume of usable rainwater (ℓ)
ADR = Average daily rainfall (mm)
AA = Assumed area contributing to runoff (m^2)
C = Runoff coefficient (0-1)
FE = Filter efficiency (0-1)

The above calculations and steps can be used to determine the rainwater harvesting potential of a settlement. The more detailed the data, such as the building footprints, the more accurate the outcome will be.

Step 57: Compile a synopsis of rainwater harvesting potential

The rainwater harvesting potential of a settlement should be calculated as it is one technique for optimising the use of available rainfall in any given location. With minimal treatment, rainwater could be used to supplement the potable water supply for secondary water uses such as toilet flushing and garden irrigation. However, South Africa still lacks a regulatory framework for the different categories of rainwater use, i.e drinking water for potable use (humans and livestock), irrigation and gardening, commercial use and industry. The following modelling exercise is Excel-based and is to be informed by land use and detailed rainfall information.

Step 58: Land use water quality impact assessment

The change in land cover to accommodate land uses has both a qualitative and quantitative impact on stormwater runoff. This modelling assessment will help the planner evaluate the level of threat posed by land use and land use activities on stormwater runoff. This can be determined spatially by joining a generic threats table to the existing land use data. The following data should be used and mapped accordingly:

- Land use data
- Use the generic threats table published by Macfarlane et al. (2014), which consists of 82 detailed land uses, grouped into nine main sectors, to determine the land use water quality impact within built-up areas.

Step 59: Land use water quality impact model

Steps to conduct the analysis are as follows:

- Reclassify the 82 land uses to match the existing land use classification. Add a new field to the land use cadastre to link the numeric threats ratings.
- Linking the generic threats table to the cadastral information can be done by various methods. The preferred method is to use the land use description as captured in the land audit process to update or reclassify the land use activity column in the generic threats table.
- Once updated, a new field should be added to the land use cadastre, which will be used to capture the numeric threat value. Add a field to the land use cadastre's attribute table and label it according to the threat. Using the "select by attribute" and the field calculator function, a threat rating can be assigned to each land use.
- Use the threat ratings to spatialise the impact of land use on stormwater quality. Use a colour gradient to indicate the severity or threat posed by the land use and the spatial location of the threat.
- Identify areas with high threat ratings and create a new shapefile representing "High_runoff_threat_rating_Zone".
- Add the spatial data "Blue-green corridor development zone" (Step 38) as an overlay to the areas of "High_runoff_threat_rating_Zone" and identify spatial areas to form part of the SUDS treatment train, which will help treat polluted stormwater before it enters the natural environment.

Step 60: Compile a synopsis of land use water quality assessment

Compile a synopsis that summarises and spatialises the key findings of the land use water quality impact assessment. Land uses within the "high_runoff_threat_rating_zone" should intervene by reducing the volume of water generated on the property by means of rainwater harvesting, increased permeability and increased vegetation cover. This will not only improve the quality of the runoff but also reduce the volume of runoff. Cities and settlements have a responsibility to restore ecological functions through the layout, design and use of infrastructure. One of the key approaches in achieving this is to increase the permeability of built-up areas. Once again, growth management and density strategies can be used to achieve this. Land use management guidelines and spatial intervention must assign targeted water quality, as well as reduce the quantity improvement measures to this zone. The South African Guidelines for Sustainable Urban Drainage Systems (Armitage et al., 2013). should be used to develop these targeted interventions, reduce coverage, increase natural vegetation and reduce the volume of runoff.

Example J: Land use water quality impact assessment

The above steps allow a planner to determine the impact of the land use water quality. By combining the generic threat rating to land use information, the following can be identified:

- Areas where land use is causing a high level of stormwater pollution.
- The development of targeted interventions that can directly reduce the impact on the quality of water by curbing pollution through the utilisation of impermeable surfaces for SUDS interventions to treat stormwater pollution.

Table 5.23: Threat rating

Threat rating	Symbol	Threat score	Description
Very low	VL	0.2	The level of threat (based on the likelihood, magnitude and frequency of potential impacts) posed by the land use/activity to water resources is very low for the threat type assessed. In the case of water quality impacts, special limit values are unlikely to be exceeded in diffuse surface runoff.
Low	L	0.4	The level of threat posed by the land use/activity to water resources is low for the threat type assessed. In the case of water quality impacts, general limit values are unlikely to be exceeded in diffuse surface runoff.
Moderate	M	0.6	The level of threat posed by the land use/activity to water resources is moderate for the threat type assessed. If not managed, pollutant loads in diffuse surface runoff may range up to five times the general limit value.
High	H	0.8	The level of threat posed by the land use/activity to water resources is high for the threat type assessed. If not managed, pollutant loads in diffuse surface runoff may range up to ten times the general limit value.
Very high	VH	1	The level of threat posed by the land use/activity to water resources is very high for the threat type assessed. If not managed, pollutant loads in diffuse surface runoff may exceed ten times the general limit value.

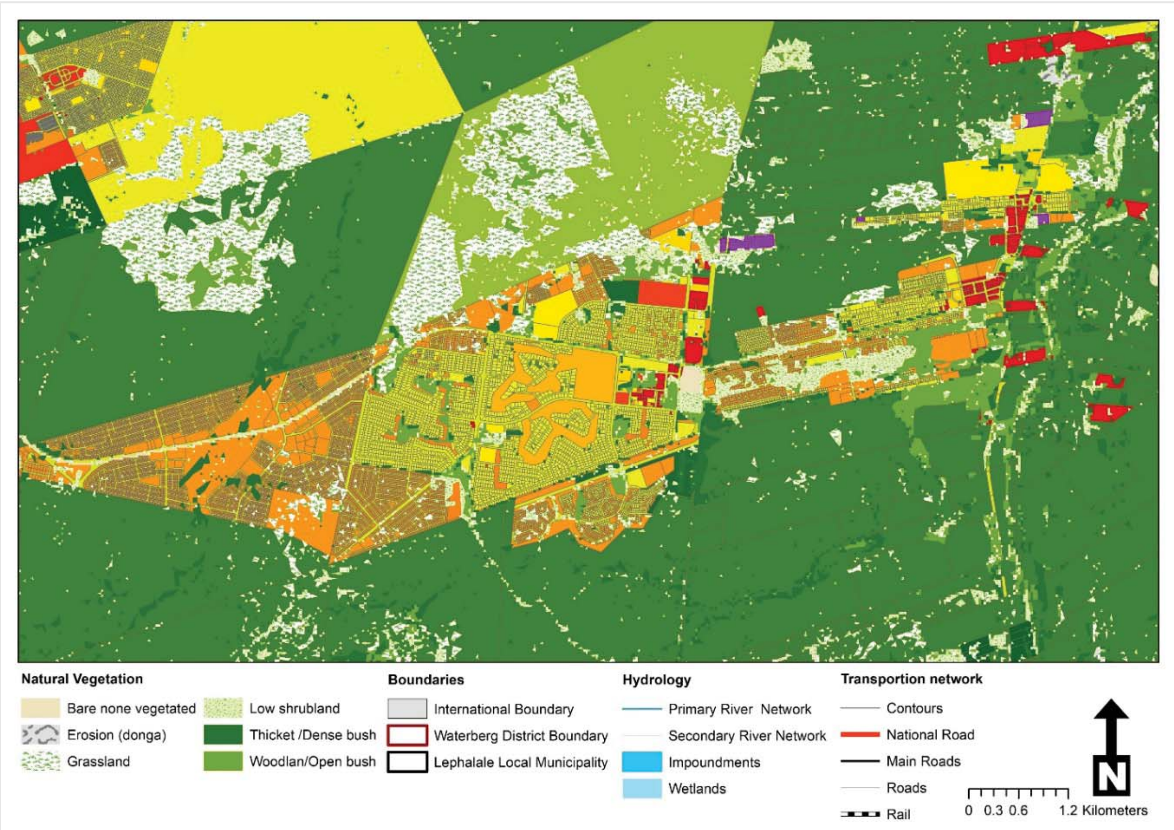


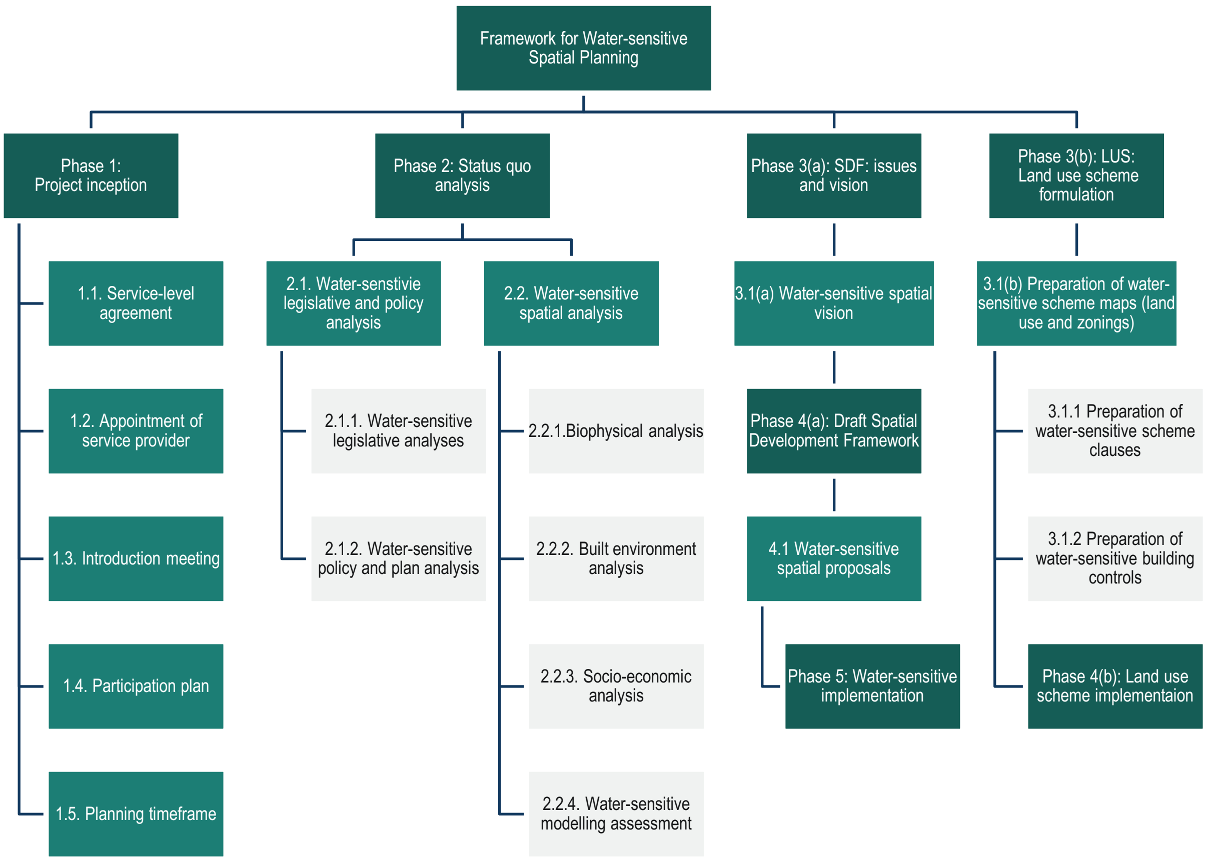
Figure 5.17: Land use water quality assessment

Phase 2.3: Produce status quo report

After the status quo analysis is complete, the service provider should produce a status quo report. The report should focus on water-sensitive specifics, including, but not limited to the following:

1. Protected areas (threatened or unthreatened by development)
2. Areas to be included in the NPAES (priority areas include unthreatened CBAs, ESAs and FEPAs)
3. CBAs, ESAs and FEPAs (unthreatened, modified and of future concern)
4. Potential groundwater development areas (quality and quantity)
5. Groundwater resources affected by development (borehole concerns)
6. Network of potential blue-green corridor development (to give effect to SUDS)
7. Development density and areas to prioritise for infill development (reduce water losses)
8. Household affordability to levels of services (sustainable/unsustainable)
9. Settlements where alternative sources of water should be prioritised
10. The rainwater harvesting potential of a settlement area
11. Land use water quantity impact (intervention zones – alternative technologies should be prioritised)
12. Land use water quality impact (intervention zone – SUDS should be prioritised)

The next phase of water-sensitive spatial planning is to use the information generated by the status quo analysis to inform the actual water-sensitive SDF (Phase 3(a)) and water-sensitive LUS (Phase 3(b)).



Phase 3: Section A – Developing water-sensitive SDFs

Phase 3(a): SDF: issues and vision

The Spatial Planning and Land Use Management Act, Act No. 16 of 2013, requires a spatial vision to inform the compilation of an SDF. A municipal SDF must include a written and spatial representation of a five-year spatial development plan for the spatial form of the municipality (Section 21(b)). A municipal SDF must include a longer-term spatial development vision statement for the municipal area, which indicates the desired spatial growth and development pattern for the next 10 to 20 years (Section 21(c)).

The key objective (with regard to water sensitivity) as far as the spatial vision of the SDF is concerned, is to ensure that water sensitivity is in some way or form entrenched in the spatial vision of the SDF. Most often, it is not. At best, some aspects related to "sustainability" can be found in vision statements. This next section will focus on ensuring that water sensitivity is also addressed in the "vision" component of an SDF. The following two key informants inform the SDF's spatial vision:

- The municipal vision (typically developed through the IDP process)
- Principles found in SPLUMA

The municipal vision

An important component of the IDP process (which is reviewed every year) is the municipality's vision and mission statement. The vision is a statement of the ideal situation the municipality would like to achieve in the long term once it has addressed the problems and issues prevalent in the municipality.[5] The following are examples of vision statements (at various scales) that impact on Lephalale Local Municipality:

Table 5.24: Vision statements impacting on Lephalale Local Municipality

Geographic scale	Vision
Province	The Limpopo SDF envisions a provincial spatial structure where the **natural environment** and v**aluable agricultural land** in the **rural areas** are protected for **future generations**, with a strong, diverse and growing economy focused around a range of **nodal areas** that offers its residents **high-quality living environments** and good job opportunities in a sustainable manner.
District municipality	The Waterberg District Municipality sees itself as the **energy hub** and **eco-tourism destination** of Southern Africa.
Local municipality	The vision of Lephalale Local Municipality is to build a **vibrant city** and to be **the energy hub** of Africa. It is committed to: • R**ural development, the provision of quality,** sustainable **and affordable services**, financial viability and good governance, local economic development and job creation. • Capacitating disadvantaged groups • **Protect**ing **the environment** and improving community wellbeing • Creating a conducive environment for business to invest and prosper • Enhancing revenue and financial management • Rational planning to bridge first and second economies and **provide adequate land for development** • Providing **quality and well-maintained infrastructural services** in all municipal areas • Responsible, accountable, effective and efficient corporate governance • Improving functionality, performance and professionalism

[5] http://www.etu.org.za/toolbox/docs/localgov/webidp.html

Given that a vision is supposed to describe an ideal situation once issues in the municipality have been addressed, the above vision statements do little to highlight or address issues around water security. Items that are bolded could possibly be linked to issues of sustainability, although it is a tenuous link at best.

Principles of SPLUMA

The following is a short summary of the development principles contained in SPLUMA:

- **Spatial justice.** In the broadest sense, spatial (in)justice refers to an intentional and focused emphasis on the spatial or geographical aspects of justice and injustice. As a starting point, this involves the fair and equitable distribution in space of socially valued resources and the opportunities to use them. Locational discrimination, created through the biases imposed on certain populations because of their geographical location, is fundamental in the production of spatial injustice and the creation of lasting spatial structures of privilege and advantage. The three most familiar forces shaping locational and spatial discrimination are class, race and gender, but their effects should not be reduced only to segregation.
- **Spatial sustainability.** The first dimension of the sustainability principle is to ensure that we plan within the means of the municipality (whether financial, administrative or institutional). Secondly, protection should be given to land that is environmentally sensitive or has agricultural potential. A final dimension of spatial sustainability is to promote land development in locations that are sustainable and limit urban sprawl.
- **Efficiency.** Municipalities worldwide are exploiting a host of creative solutions to reduce energy consumption, water use, waste and emissions, while also making it easier for people to get around. The efficient city uses the available resources at their optimum to create a city that has low congestion, yet high mobility for work and leisure. It has high efficiency in using energy and space, and also ensures that the greatest social, economic and environmental benefits are realised from its financial investments. Planning an efficient city means taking a forward-thinking and cooperative approach to ensure that efficiency contributes to a range of city objectives, including accessibility, reductions in greenhouse gas emissions, health, environmental quality, climate resilience and social equity, and will improve the quality and value of the plan, as well as political commitment to its implementation.
- **Spatial resilience.** The notion of spatial resilience in cities and towns has gained considerable attention and interest over recent years, not only in relation to environmental management but also in terms of urban planning. The notion of urban resilience is not just confined to academic discourses – it is increasingly prevalent in urban policy documents. Specific attention should be paid to the issue of climate change and how planning processes in the city consider or deal with the risks that it presents.
- **Good administration.** This principle refers to improved integrated planning and the improvement of administrative processes to facilitate effective spatial planning and land use management between the three spheres of government. One of the “easier ways” of ensuring this principle in planning is to align planning instruments. The dimensions of planning, and land use management and forward planning are often divorced from one another. One dimension plans the future shape of our cities. The other is a mechanism through which land uses are managed and regulated.

Linking the vision with the SDF

How does the vision statement described above inform the SDF? The best way to ensure this is to take key elements from the vision statement and develop spatial objectives around these statements. The following is an example of this process:

The vision of the Lephalale Local Municipality includes a statement that reads: “Protect the environment and improve community wellbeing”. Using this key theme, the following spatial development objective and sub-objectives can be developed:

Protect and enhance environmental assets and natural resources within Lephalale Local Municipality

- The key informant regarding environmental assets and natural resources within this region is the recently completed Waterberg Bioregional Plan. The plan spatially identifies CBAs and ESAs and recommends that these manifest in the SDF and LUS of the municipality.
- The CBAs should be maintained in a natural state with limited or no biodiversity loss. Degraded areas should be rehabilitated to a natural or near-natural state and managed for no further degradation.
- Within ESAs, ecosystem functionality and connectivity should be maintained, allowing for limited loss of biodiversity pattern. Additional or new impacts on ecological processes should be avoided.
- Valuable agricultural resources should be protected. The sprawl of villages towards land currently used for agriculture should be limited. Once identified by DWAF, agricultural land of national and provincial importance should be integrated into the SDF and LUS.
- Agripark proposals should be integrated into the SDF.

Phase 3(a) 1. Water-sensitive spatial vision

It is critical that any spatial vision informing SDFs in South Africa address issues of water scarcity. As illustrated earlier in this document (and as experienced in vivid detail by residents of the Western Cape), the availability of water for future generations and land uses is by no means a certainty. The Water Research Commission puts forward the following “narrative” that should be included in any spatial vision for any municipality in South Africa (Armitage et al., 2014, p. 27):

> *“… mitigating water scarcity, improving water quality, thereby protecting ecosystems, through the development of water-sensitive urban areas (for all) that are sustainable, resilient and adaptable to change, while simultaneously being a place where people want to live.”*

The above “narrative” aligns with the principles of SPLUMA in the following way:

Table 5.25: Alignment between the water-sensitive vision and the principles of SPLUMA

Water-sensitive vision	SPLUMA principles
“mitigating water scarcity”, “protecting ecosystems”, “water-sensitive urban areas”	**Spatial sustainability.** The concept of sustainability embraces the idea that resources are finite, and that we need to conserve in order to service the needs of future generations. In addition, protecting ecosystems can directly contribute to ensuring the quality of water.
	Efficiency. Water-sensitive urban areas focus on the reduction of water consumption through a number of initiatives.
“resilient and adaptable to change”	**Spatial resilience.**

Example K: Towards a water-sensitive vision statement for Lephalale Local Municipality

The current vision statement for Lephalale Local Municipality should be amended in the manner set out below to include aspects of water sensitivity.

Vision: To build a **vibrant city** and be **the energy hub** of Africa, we are committed to the following:

- **Rural development, the provision of quality, sustainable and affordable services**, financial viability and good governance, local economic development and job creation.
- Capacitating disadvantaged groups
- Creating a conducive environment for business to invest and prosper
- Enhancing revenue and financial management
- Rational planning to bridge first and second economies and **provide adequate land for development**
- Providing **quality and well-maintained infrastructural services** in all municipal areas
- Responsible, accountable, effective and efficient corporate governance
- Improving functionality, performance and professionalism.
- Planning sustainably, including mitigating water scarcity, improving water quality, thereby protecting ecosystems, through the development of water-sensitive urban areas (for all) that are sustainable, resilient and adaptable to change, while simultaneously being a place where people want to live.

Phase 4(a): Draft SDF

The purpose of the spatial analysis (built environment, biophysical and socio-economic analyses) is to inform the municipality's spatial development proposals. This section explores only spatial proposals that are aligned with water-sensitive planning.

Spatial proposal: Institute a growth management strategy for the municipality

This is typically achieved by the introduction of an urban development boundary or urban edge. Growth management is a set of techniques used by government to ensure that, as the population of a city grows, there are services available to meet their needs. Services can include the protection of natural areas and provision of parks and open spaces, sufficient and affordable housing, adequate land for business and industry, and the delivery of utilities (water, wastewater, roads and transit). Compact city growth can lead to a substantial saving on the length of infrastructure required (and therefore associated costs and – more importantly – water losses).

- **Improve water quality:** Growth management through an SDF can reduce sprawl and rapid land cover change, which in turn reduces the rate and volume of stormwater runoff. This reduces stormwater pollution and increased groundwater recharge. Water quality, as well as the surrounding ecosystems, is likely to improve as more water is made available to infiltrate into surrounding areas, instead of feeding the built infrastructure.
- **Mitigate water scarcity:** Growth management can limit the extent or can direct where development can take place. A compact settlement form can be achieved through spatial growth management tools, as shown in section 2.4.1 (specifically the case study dealing with water losses vs. density). Ultimately, a compact spatial structure reduces the need for long, extensive infrastructure pipelines being required to provide water services such as potable water and wastewater systems to communities. South Africa has very high water losses of non-revenue water (NRW) percentage due to ageing infrastructure, and financial and skills constraints. A compact settlement reduces the servicing of widely spread public infrastructure such as water and wastewater pipelines, as well as roads and transit infrastructure. By reducing the servicing distances, the capital and operating cost will drop. Most importantly, the volume of potable water losses will decrease, as there are fewer areas to present leakages, etc. As such, less water will need to be treated and pumped to settlements. This will also reduce energy needs (which also uses water to produce the "nexus"). This could potentially reduce water losses by half, while also increasing future resources by half.

Spatial proposal: Density management

The spatial development framework should specify minimum densities within certain spatial structuring elements (e.g. nodes). Main nodes or mixed-use nodes should, in general, have a higher density than other areas of the municipality. This should not only be limited to urban areas. Traditional villages, for example, can also be made more compact through the allocation of smaller stands.

- **Improve water quality:** Similar to the growth management tool, increased densities also lessen the extent of the development footprint, which, in turn, reduces land cover change and the degradation of soil resources. Higher densities preserve land resources for agriculture, green lands and water resources as less land is required for development. Densely populated settlements have higher capital per square metre and present an opportunity to introduce sustainable urban drainage systems that are designed to improve the quality of water resources.
- **Mitigate water scarcity:** Higher densities or a compact settlement pattern is land-intensive, with medium-high densities and mixed-use land policies forming a continuous footprint where growth is adjacent to consolidated areas. Densely populated settlements induce a more cost-effective use of infrastructure as the cost of installation and maintenance per square metre is lower since there are more taxpayers in the area to pay for them. This could ultimately present an opportunity for municipalities to introduce development incentives for private developers when taking the “green” approach to developments, such as mixed-use developments, e.g. business and residential units, where one building could introduce water savings infrastructures such as water harvesting or greywater re-use systems.

Spatial proposal: Design and layout of future development

The growth of cities and towns is often the result of private sector development applications that are approved by the local town planner. In recent times, this has led to haphazard development in a leapfrog manner that is not coherently planned, resulting in a plethora of gated communities without adequate attention or access to green spaces (not only for residents but also for use as green or blue corridors).

- **Improve water quality:** The design and layout of settlements or neighbourhoods are most likely a result of growth and density management policies. The key to a water-sensitive city is that water is used and treated as close as possible to its source point. In order to accomplish this, the layout and design of neighbourhoods must incorporate existing water systems and provide sufficient space for green infrastructure such as constructed wetlands and retention ponds, which could be utilised for non-potable water and for enhancing water quality.
- **Mitigate water scarcity:** On a larger municipal scale, local water systems should be protected and rehabilitated to create blue-green corridors or integrated open space systems that are designed to create localised water catchments. These water resources could be utilised for local uses and re-used, which reduce the demand for municipal treated water. Decentralised water treatment terrains are proven to be more sustainable than the conventional, centralised sewage treatment works, as less water is pumped to and treated at one central point. Centralised WWTW often experiences high volumes and high pressure to treat wastewater. The quality of treated water is often below the defined water resource quality objective and, in the long run, less clean water is available for use.

Spatial proposal: Future services

SPLUMA clearly states that the SDF should quantify the need for future infrastructure. A water-sensitive SDF would not only quantify infrastructure but also focus on the actual resource. Therefore, the SDF should quantify the amount of water that would be required in future.

- **Improve water quality:** Linked to the above point, if entire suburbs are planned with sufficient connected green spaces, future services can be provided using a SUDS approach (specifically stormwater), which can contribute to improved water quality.
- **Mitigate water scarcity:** A clear picture of future land uses will assist planners and infrastructure specialists with scenarios that can be used to plan for water efficiency. Firstly, areas with spare capacity and existing infrastructure can be targeted for infill development. This will mitigate the need for new infrastructure, thereby reducing water losses. Secondly, if the growth of a specific heavy water use activity is predicted, part of the approval process can include mandating that the new land use recovers or re-uses some of the water consumed.

Spatial proposal: Spatial targeting of nodes

This principle assumes that not all areas within the municipality should receive the same level of service. This does not mean that all consumers have the right of access to the service. The socio-economic analysis should indicate affordability levels, which should, in turn, inform the level of service for each node. The municipality should only ever consider providing a higher level of service in a node to achieve a specific aim (e.g. densification and compacting of a node).

- **Improve water quality:** A higher level of service, such as waterborne sanitation, contributes to the amount of wastewater that needs to be treated at a wastewater treatment plant. Currently, this places strain on already overburdened wastewater treatment plants, which results in polluted water that is returned to the natural environment.
- **Mitigate water scarcity:** A higher level of service consumes more water. Providing levels of service in line with affordability levels can reduce the amount of water used by communities.

Spatial proposal: Protecting FEPAs and groundwater resource areas

The SDF includes a spatial development pattern. Part of the legislative requirements includes protecting environmentally sensitive areas. These areas should be expanded to include FEPAs, as well as groundwater resource areas.

- **Improve water quality:** As indicated earlier, all land uses have a pollution threat rating. The SDF should determine the spatial allocation of land uses and mitigate the pollution potential by keeping land uses with a high pollution rating away from FEPAs and groundwater resource areas.
- **Mitigate water scarcity:** The FEPAs and groundwater resource areas in good condition could lead to increased water resources.

Phase 5(a): Water-sensitive SDF implementation

The primary reason for public participation in South Africa is that it is mandated by law to give citizens an opportunity to exercise their rights. Public participation is an important aspect of decision making and has more advantages than disadvantages.

Phase 5(a)1: Public meetings

Public participation is entrenched, in particular in sections 17, 59, 70, 72, 115 and 118, of the Constitution of the Republic (Republic of South Africa, 1996), which gives the right for public involvement in legislative processes. It is regarded as “an important element of building democracy” (Matshe, 2009, p. 14) and is almost inseparable from a democratic system because it forms part of enhancing the constitutional democracy of a nation. Both the Municipal Systems Act, Act No. 32 of 2000 (Republic of South Africa, 2000) and SPLUMA advocate public participation.

Sections 4 and 5 of the Municipal Systems Act gives citizens the right to participate in a municipality's decision-making processes. Section 7(e)(iv) of SPLUMA, on the other hand, requires that, upon the preparation and amendment of spatial plans, policies, LUSs and procedures for development applications, transparent processes of public participation should be included that afford all parties the opportunity to provide inputs on matters affecting them.

Legislation has made it mandatory for municipalities to create opportunities for public consultation and involvement in municipal affairs. Ward committees have been established as mechanisms to consult and involve communities (Maphazi et al., 2013). Public participation should aim to "ensure that development responds to people's needs and problems, ensure that municipalities come up with appropriate and sustainable solutions to problems of communities in a municipality, use local experience and knowledge to entrench a sense of ownership in local communities by making use of local experience, knowledge, resources and initiatives, and promote transparency and the accountability of local government by opening a space for all concerned to negotiate different interests" (Njenga, 2009, p. 18). However, public participation can become a costly and timeous exercise and, in some instances, could result in making "the worst policy decision, if heavily influenced by opposing interest groups" (Irvin and Stansbury, 2004, p. 58). Philip et al. (2011, p. 22) differentiate between the level of stakeholder involvement and associated modalities of communication since different objectives in the stakeholder process will require different working modes.

These include the following:

- Sharing information (one-way communication):
  - One-way communication between the project team (developing the SDF) and the stakeholders (affected by the SDF) could take place by means of fact sheets or presentations that are generally geared towards changing behaviour.
- Consultation (two-way communication):
  - This would typically take place between the project team and the primary stakeholders to gather factual and non-factual information and get feedback from different professional perspectives.
- Collaboration (bilateral or multilateral partnerships):
  - Stakeholder involvement could also be used to assign certain tasks to primary or secondary members.
- Empowerment (multi-stakeholder decision making):
  - This is considered to be the highest level of involvement and refers to sharing power by sharing decision making. This requires all parties involved to meet each other as equals and have the desire, skill and legal mandate to share that power.

Stakeholder engagement can also be formal and/or informal in nature. It should, however, not be confused with a few public workshops or an isolated once-off awareness-raising campaign (Philip et al., 2011, p. 7).

Methods of public participation can include the following:

- Public hearings:
  - The method of public hearing is used by government departments under legislation that mandates that public hearings should be conducted before any major policies or infrastructure projects may begin.
- Imbizo:
  - An *imbizo* refers to a special meeting that is "usually convened by someone in authority such as a traditional leader" (DPSA, 2014, p. 25). It has been the most popular method of public participation used by politicians to communicate with the public regarding governmental affairs (DPSA, 2014). The *imbizo* has become entrenched in the South African political scene and is regarded as a valid technique of public participation (DPSA, 2014).

- Ward committees and community development workers:
  - Ward committees serve as forums to facilitate public participation within municipalities. One of the major strategic functions of ward committees is "interacting with external role players on behalf of or for the benefit of their local communities" (Maphazi et al., 2013, p. 62). These committees provide a structure for public participation and work very closely with community development workers (CDWs) to convey vital information between government and the public (DPSA, 2014).

"The key *dictum* remains that public participation is essential to make democratic societies work" (Maphazi et al., 2013, p. 65) and "is fundamental to democracy as it counters public mistrust of the system" (Matshe, 2009, p. 34).

Phase 5(a)2: Traditional authority engagement

Many traditional authorities, which include a number of villages (especially in the rural space), have never been exposed to any form of spatial planning. Many spatial proposals that include the protection of water resources will be required within these areas. Education, training and capacity building are therefore essential to implement these proposals.

Phase 5(a)3: Report summary

This stage incorporates the comments received from the interested and affected party into the draft SDF.

Phase 5(a)4: Final report

The final SDF is submitted to the Executive Council of the municipality. The Council must adopt the SDF, thereby effectively committing the municipality to the SDF. This stage is very important. Councils need to understand the implication of the SDF in order to effectively budget for the implementation of these proposals. For example, a differentiated level of service may require political intervention and, as such, needs to be understood by the councillors.

Phase 3: Section B – Developing water-sensitive LUSs

Phase 3(b): Land use scheme formulation

Phase 3(b)1: Preparation of water-sensitive zonings

Two aspects related to zonings apply to "water-sensitive zonings":

- Zoning can allow or restrict development
- Zoning in older schemes was mostly restricted to urban areas; with the new legislation, all land within municipal jurisdiction must be zoned

In Lephalale Local Municipality, the following zonings apply to land outside built-up areas:

Table 5.26: Typical zonings outside urban areas

Zoning	Primary uses allowed	Secondary uses allowed
Agriculture	Agricultural purposes, agricultural land, agricultural buildings	Workers' dwellings, hunters' accommodation, veterinary clinics, resort dwellings, guest lodges, second dwelling units
Protected areas	All declared national, provincial and private nature reserves, all other protected areas (including biospheres), conservancies, conservation purposes, cultural heritage sites and protected areas	Airstrips, camping sites, employee housing events, forestry, freestanding base telecommunication stations, guesthouses, helicopter landing pads, outdoor markets, places of assembly, places of sport and recreation, private roads, rooftop base telecommunication stations, tourist accommodation, tourist facilities
Mining	Mining activities: extraction and beneficiation	Cemeteries, crematoriums, dwelling units, electrical purposes, offices, private open spaces, public garages, public open spaces and railway purposes

From the water-sensitive analysis, it is clear that (from a water-sensitivity perspective) additional areas may require some form of protection. These areas may not necessarily be "declared protected areas" and, as such, may, in fact, be included under agricultural zoning with no regard to water sensitivity. Another complexity is that the Subdivision of Agricultural Land Act, Act No. 70 of 1960, considers most land outside urban areas as "agricultural land". Another way of introducing some level of protection in water-sensitive areas is to develop a "management overlay", specifically developed to deal with issues of water sensitivity.

In terms of the Lephalale LUS, such an overlay:

- gives expression, in a planning context, to the local needs and values of the communities concerned; and
- promotes particular types of development, urban form, landscape character, environmental features or heritage values.

The following management overlay zones should be considered:

Environmental conflict areas: protected areas

- **Protected areas: Immediate intervention zone (Section 3.1.1.3)**

  The "protected areas: immediate intervention zone" is a management overlay zone used to address areas that are supposed to be protected by law. However, due to unregulated and illegal land use activities, the protected area status is under threat. The overlay zone is a reactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

  1. Inform the authority responsible for the management and conservation of the protected area that illegal land use activities are being exercised within the protected area.
  2. Verify the spatial data by means of a site inspection.
  3. Confirm the extent and cause of illegal land invasion and identify stakeholders who are willing to interact for communication purposes.

4. Develop a protected areas intervention and rehabilitation plan. This plan should address the rehabilitation of land processes and address the relocation of settlements or other land use.
5. This management overlay zone should be amended (five-year iteration) or removed once the land under discussion has been rehabilitated to its natural state.

- **Protected areas: Areas of future concern (Section 3.1.1.6)**

  The “protected areas: areas of future concern” is a management overlay zone or buffer zone assigned to land parcels close to existing protected areas that experience high development pressure from other land uses. This overlay zone should be used as a preventative or proactive forward planning tool towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Inform the authority responsible for the management and conservation of the protected areas, as well as the stakeholder/s (community members) associated with the land use activities that are encroaching protected areas.
2. Verify the spatial data by means of a site inspection.
3. Engage with the stakeholder/s or community members and communicate and discuss the threats posed to the protected area by the settlement’s natural growth direction.
4. Engage with the stakeholder/s or community members on the settlement’s natural growth direction and communicate the threat posed to the protected area.
5. In consultation with the affected parties, develop a growth management strategy that assigns a new growth direction (away from protected areas) and a strict development boundary to the settlement area and land use in question. The densification of the existing settlement footprint should be promoted, if possible.
6. This management overlay zone should be amended (five-year iteration) or removed if and when the land under discussion is no longer under threat.

Expansion of protected areas management overlay zone

- **Modified CBAs and ESAs (Section 3.1.2.3)**

  Areas identified in the analysis as modified CBAs and ESAs would not necessarily receive an overlay zone, as the spatial data indicates that the ecological significance of the CBAs and ESAs under discussion has already been destroyed by development. However, the aim is to confirm whether the management status is still applicable to the CBA and ESA in question. This is both a reactive and a preventative measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Verify the spatial data by means of a site inspection.
2. Engage with the environmental specialist responsible for generating the original spatial datasets and confirm the status of the CBA and ESA in question.
3. If these CBAs and ESAs have been modified to a point beyond rehabilitation, it is recommended that the management status should be removed for the land parcels.
4. Removing the management status from CBAs and ESAs will provide a more realistic understanding of the full extent of remaining CBAs and ESAs. This will also facilitate the prioritisation of capital spending, and the protection and conservation of other CBAs and ESAs in good ecological condition.

- **CBAs and ESAs of concern (Section 3.1.2.5)**

  The "CBAs and ESAs of concern zone" is a management overlay zone or buffer zone assigned to land parcels close to existing CBAs or ESAs, which experience high development pressure from other land uses. This overlay zone should be used as a preventative or proactive forward planning tool towards water-sensitive spatial planning and land use management.

  Steps to follow:

  1. Verify the spatial data by means of a site inspection.
  2. Engage with stakeholder/s (community members) associated with the land use activities that encroach on CBAs and ESAs.
  3. Engage with the stakeholder/s or community members and communicate and discuss the threats posed to the remaining CBAs and ESAs by the settlement's natural growth direction.
  4. In consultation with the affected parties, develop a growth management strategy that assigns a new growth direction (away from protected areas) and a strict development boundary to the settlement area and land use in question. The densification of the existing settlement footprint should be promoted, if possible.
  5. If CBAs and ESAs are located within the new development boundary, a land use zoning such as "public open space" can be assigned to the land in question to protect the area from other land uses.
  6. This management overlay zone should be amended (five-year iteration) or removed if and when the land under discussion is no longer of concern.

- **Protected areas, CBAs and ESAs potential expansion network (Section 3.1.2.7)**

  The "NPAES zone" is a management overlay zone assigned to CBAs and ESAs in a good ecological condition and in close proximity to existing protected areas.

  Steps to follow:

  1. The area of land identified to form part of the NPAES zone requires further assessment in terms of the 2008 National Protected Areas Expansion Strategy. The assessment is based on "importance" and "urgency."
  2. Assessment should be conducted by the authority responsible for protected areas.
  3. Once these areas have been confirmed, the "NPAES zone" should remain in place until these areas have been legally declared protected areas.
  4. The management zone can also be amended to accommodate "biodiversity stewardship agreements."
  5. All remaining CBAs and ESAs must be managed as prescribed by the bioregional plan guidelines for the land use management of CBAs and ESAs.
     - Critical Biodiversity Area 1
     - Critical Biodiversity Area 2
     - Ecological Support Area 1
     - Ecological Support Area 2

Surface water protection and conservation management overlay zone

- **Verification of freshwater resources areas (Section 3.1.3.5)**

  Areas identified during the analysis as "verification of freshwater resources areas", more specifically the verification of FEPAs, would not necessarily receive a management zone, as the spatial data indicates that the ecological significances of the specific freshwater resources areas under discussion have already been destroyed by development.

However, the aim is to confirm the status of the freshwater resources areas and their buffer zones. This is both a reactive and preventative measure towards water-sensitive spatial planning and land use management.

Steps to follow:

1. Verify the spatial data by means of a site inspection.
2. Engage with the environmental specialist responsible for generating the original spatial datasets and confirm the status of the FEPAs in question.
3. If FEPAs and their buffer zones have been modified to a point beyond rehabilitation, it is recommended that the FEPA's management status should be removed from the land parcels.
4. Removing the management status from FEPAs will provide a more realistic understanding of the full extent of the remaining FEPAs in the municipality. This will also facilitate the prioritisation of capital spending, and the protection and conservation of the remaining FEPAs in good ecological condition.

- **Priority freshwater rehabilitation areas (Section 3.1.3.6)**

The "FEPA rehabilitation zone" is a management overlay zone or buffer zone assigned to land parcels with a FEPA management status, which are affected by other land uses, but which can still be rehabilitated to their natural state. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management.

Steps to follow:

1. Verify the spatial data by means of a site inspection.
2. Engage with stakeholder/s (community members) associated with the land use activities affecting FEPAs and their buffer zones.
3. Engage with the stakeholder/s or community members and communicate and discuss the threats posed to the FEPAs and their buffer zones by the land use.
4. In consultation with the affected parties and environmental specialist, develop a rehabilitation strategy for the FEPAs. Other affiliations such as Working for Water; Working for Wetlands and the Adopt-a-River Programme should also be consulted.
5. This management overlay zone should be amended (five-year iteration) or removed if and when FEPAs under discussion are rehabilitated and no longer of concern. A new management overlay zone should then be assigned for the FEPAs (see the section below).

- **Freshwater areas of concern (Section 3.1.3.7)**

The "FEPA concern zone" is a management overlay zone or buffer zone assigned to land parcels close to existing FEPAs that experience high development pressure from other land uses. This overlay zone should be used as a preventative or proactive forward planning measure towards water-sensitive spatial planning and land use management.

Steps to follow:

1. Verify the spatial data by means of a site inspection.
2. Engage with stakeholder/s (community members) associated with the land use activities encroaching on FEPAs.
3. Engage with the stakeholder/s or community members and communicate and discuss the threats posed to the remaining FEPAs by the settlement's natural growth direction.
4. In consultation with the affected parties, develop a growth management strategy that assigns a new growth direction (away from FEPAs) and a strict development boundary to the settlement area and land use in question. The densification of the existing settlement footprint should be promoted, if possible.

5. If FEPAs are located within the new development boundary, a protective zoning such as "public open space" can be assigned to the land in question to protect the area from other land uses. Where possible, the FEPA should be integrated into a broader or larger blue-green corridor network.
6. This management overlay zone should be amended (five-year iteration) or removed if and when the land under discussion is no longer of concern.

- **Intact freshwater resources (Section 3.1.3.8)**

  Areas of land identified as intact freshwater resources or FEPAs should receive a management overlay zone providing legal enforcement of the land use management guidelines for FEPAs being developed according to the "Implementation manual for freshwater ecosystem priority areas" (WRC, 2011). This is a preventative zoning measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Verify the FEPAs with an environmental specialist.
2. Differentiate between wetland and river FEPAs and use the land use management guidelines to formulate a fit-for-purpose overlay zone:
   River FEPAs and upstream management areas
   - "Guidelines for land use practices and activities that impact on water quantity in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)
   - "Guidelines for land use practices and activities that impact on water quality in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)
   - "Guidelines for land use practices and activities that impact on habitat and biota in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)

   Wetland FEPAs
   - "Guidelines for land use practices and activities that impact on water quantity in sub-quaternary catchments associated with wetland FEPAs" (WRC, 2011)
   - "Guidelines for land use practices and activities that impact on water quality in sub-quaternary catchments associated with wetland FEPAs" (WRC, 2011)
   - "Guidelines for land use practices and activities that impact on habitat and biota in sub-quaternary catchments associated with wetland FEPAs" (WRC, 2011)

Groundwater protection and conservation management overlay zone

- **Low land use groundwater impact zone (Section 3.1.4.4)**

  The "low land use groundwater impact zone" is assigned to land parcels with high groundwater recharge potential, modified by artificial land uses to some extent, but with a low impact on water quality. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Consult a groundwater specialist to confirm the quality of the underlying water resources.
2. Once it is confirmed that the groundwater is still of good quality, community members and property owners must be consulted on their land use impact on the underlying resource.
3. The management overlay zone should regulate the intensity, as well as the permeability of land use within the zone. The groundwater quality impact should remain as low as possible.

4. Specialised investigations on managed aquifer recharge potential should be priorities in the zone.
5. This management overlay zone should be amended (five-year iteration) or removed if and when the land under discussion is no longer of concern.

- **High land use groundwater impact zone (Section 3.1.4.5)**

  The "high land use groundwater impact zone" or "groundwater quality improvement zone" is assigned to land parcels with high groundwater recharge potential, modified by artificial land uses to some extent and with a high impact on water quality. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Consult a groundwater specialist to confirm the quality, as well as the root cause of pollution of the underlying water resources.
2. Once the quality has been confirmed and the root cause identified, community members and property owners must be consulted on their land use impact on the underlying resource.
3. The management overlay zone should regulate the intensity, as well as the permeability of land uses within the zone. The focus should be placed on stormwater treatment and revegetating impermeable surfaces. The groundwater's quality impact must be lowered to protect the resource. All future developments within the "groundwater quality improvement zone" must accommodate SUDS and WSUD to prevent further pollution.
4. Specialised investigation on managed aquifer recharge potential should be priorities in the zone.
5. This management overlay zone should be amended (five-year iteration) or removed if and when the land under discussion is no longer of concern.

- **Groundwater recharge protection zone (Section 3.1.4.8)**

  The "groundwater recharge protection zone" is a management overlay zone that is assigned to areas of land with high groundwater recharge potential in a natural state. This overlay zone is a proactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Consult a groundwater specialist to confirm the groundwater recharge potential of the areas.
2. Once the quality has been confirmed, areas of high importance should be delimited. A specialised investigation on managed aquifer recharge potential should be priorities in the zone.
3. Assign the "groundwater recharge protection zone" to the areas of high importance and notify potentially affected parties about the protected status of the area. The zone should remain in a natural state for as long as possible.
4. This management overlay zone can be amended (five-year iteration), but should not be removed for as long as possible.

Groundwater utilisation and protection management overlay zone

- **Borehole protection zone (Section 3.1.5.6)**

  The "borehole protection zone" is a management overlay zone that is assigned to the land surrounding existing and future boreholes to prevent the contamination of borehole water. This overlay zone is a preventative (existing boreholes), as well as a proactive measure (future boreholes) towards water-sensitive spatial planning and land use management.

  Steps to follow:

1. Verify the spatial data by means of a site inspection. Confirm the location of the borehole and assess any existing land uses within a radius of 20 m.

2. Engage with stakeholder/s (community members) who rely on the borehole for water services and communicate threats and health risks associated with borehole contamination.
3. In consultation with the affected parties and groundwater specialist, develop a borehole management strategy for each borehole. The strategy must delineate both an inner and outer borehole protection zone.
4. The "borehole protection zone" should not allow any development within its inner or outer zones.
5. If and when the borehole is no longer in use, the management overlay zone can be amended (five-year iteration) or removed after consulting a groundwater specialist.

Catchment concern management overlay zone

- **River FEPAs and associated sub-catchments overlay zone (Section 3.1.6.3)**

  The "river FEPAs and associated sub-catchments overlay zone" is a management overlay zone that is assigned to catchments with specific management requirements, as identified in the "Implementation manual for freshwater ecosystem priority areas" (WRC, 2011). This overlay zone is both a preventative and proactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

  1. Create an overlay management zone that is informed by the:
     - "Guidelines for land use practices and activities that impact on water quantity in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)
     - "Guidelines for land use practices and activities that impact on water quality in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)
     - "Guidelines for land use practices and activities that impact on habitat and biota in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011)
  2. Consult the catchment management agency (if any) for any additional management guidelines.
  3. Workshop the overlay management zone with key stakeholders.
  4. The management overlay zone should be amended (five-year iteration) if and when new management guidelines are published by the responsible authority.

- **Catchment concern zone (Section 3.1.6.5)**

  The "catchment concern buffer zone" is a management overlay zone that is assigned to catchments where 30% or more of the surface area is used for agriculture or other land uses. Water resources identified within these catchments have a higher pollution rating and should be managed accordingly. This overlay zone is a preventative measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

  1. Site verification is not a requirement as the overlay zone covers the entire catchment area.
  2. Consult the catchment management agency (if any) for land use management guidelines that can improve water quality within the catchment.
  3. All new development applications within the "catchment concern zone" must go through a vigorous assessment process to determine the future water quality impact that the development may possibly have.
  4. The overlay management zone must protect water quality for further degradation and provide guidance on improving water quality through land use management.

Urban blue-green corridor management overlay zone

- **Blue-green corridor development zone (Section 3.1.7.6)**

  The "blue-green corridor development zone" is a management overlay zone that is assigned to land identified to form part of a connected system of ecological infrastructure. This overlay zone is both a preventative and a proactive measure towards water-sensitive spatial planning and land use management.

  Steps to follow:

  1. Verify the spatial data by means of a site inspection.
  2. Engage with stakeholder/s (community members and property owners) associated with the land in question.
  3. Confirm whether the land identified during the analysis is available to form part of the blue-green corridor and design the corridor overlay zone accordingly.
  4. The overlay zone should be accommodated by a blue-green corridor development and management plan. Ideally, the plan should delineate internal zones to accommodate SUDS implementation.
  5. This management overlay zone should be amended (five-year iteration) to accommodate new features.

Settlement intervention

Limit development by increasing development

- **High-density development zone (Section 3.2.1.11)**

  The "high-density development zone" is a management overlay zone that is assigned to areas or parcels of land within the existing built-up area, mostly targeted at vacant land, to promote and accommodate higher density developments. This overlay zone is a proactive measure towards water-sensitive spatial planning and land use management. By increasing the development density, natural landscapes on the outskirts of the development boundary are protected from development. Water infrastructure networks in higher density development zones have a lower physical water loss rating. The overlay zone and development control can also be assigned to new development areas, therefore making it water sensitive before actual development takes place.

  Steps to follow:

  1. Higher-density development zones can be assigned to any area within the existing development boundary.
  2. This management overlay zone should be amended (five-year iteration) to accommodate new areas appropriate for higher-density development.

Land use water quantity intervention and management zone

- **High water usage intervention zones (Section 3.2.2.8)**

  The "high water usage intervention zones" is a management overlay zone that is assigned to areas or parcels of land with irregularly high water usage. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management. The overlay zone and development control can also be assigned to new development areas, therefore making it water sensitive before actual development takes place.

  Steps to follow:

  1. Conduct a water audit for all buildings in the zone.
  2. Refer to clauses relating to building control.

Household services: Potable water

- **Water conservation and demand management zone (Section 3.2.3.4)**

  The "water conservation and demand management zone" is a management overlay zone assigned to settlements where high levels of services are provided to households that cannot afford the level of services. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management. The overlay zone and development control can also be assigned to new development areas, therefore making it water sensitive before actual development takes place.

  Steps to follow:

  1. Conduct a water audit of all water uses in the zone.
  2. Identify areas where water reuse can take place.
  3. Implement a targeted water conservation and demand management strategy.

- **Off-grid development zone: potable water (sections 3.2.3.4, 3.2.3.5 and 3.2.5.8)**

  The "off-grid development zone: potable water" should apply to settlements with high levels of existing backlogs to services and where households cannot afford to pay for services. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management. The overlay zone and development control can also be assigned to new development areas, therefore making it water sensitive before actual development takes place.

  Steps to follow:

  1. Conduct a services audit and determine the full extent of the existing backlog.
  2. Identify alternative sources, such as rainwater harvesting, stormwater harvesting, groundwater utilisation and – where possible – water reuse.
  3. Workshop the services plan with municipal authorities and community members and aim for community buy-in.

Household services: sanitation

- **Off-grid development zone: sanitation (Section 3.2.4.5)**

  The "off-grid development zone: sanitation" should apply to settlements with high levels of existing backlog to services and where households cannot afford to pay for services. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management. The overlay zone and development control can also be assigned to new development areas, therefore making it water sensitive before actual development takes place.

  Steps to follow:

  1. Conduct a services audit and determine the full extent of the existing backlog.
  2. Identify alternative technologies that are suitable for sanitation services. Dry sanitation technologies should be prioritised in these settlements.
  3. Investigate opportunities to produce biogas, which can be used for energy for cooking.
  4. Workshop the services plan with municipal authorities and community member and aim for community buy-in.

Land use water quality intervention zone

- **High runoff threat rating zone (Section 3.2.6.6)**

  The "high runoff threat rating zone" is a management overlay zone that is assigned to areas or parcels of land with high pollution ratings, which cause high levels of polluted runoff.

The aim of this zoning is to increase the permeability of an area or land parcel to reduce the runoff volume and to treat polluted stormwater before it enters the natural hydrological system. This overlay zone is a reactive measure towards water-sensitive spatial planning and land use management. The overlay zone and development control can also be assigned to new development areas, therefore making it water-sensitive before actual development takes place.

Steps to follow:

1. Conduct a stormwater impact analysis of specific areas or land uses with a high pollution rating.
2. Determine the existing coverage control measures and develop new coverage control measures for new developments.
3. Conduct a stormwater modelling exercise to determine in which direction polluted stormwater will travel.
4. Use the SUDS guideline document to implement a treatment train that is connected to the blue-green development corridor.
5. This management overlay zone should be amended (five-year iteration) to accommodate new features and greater areas of intervention.

Phase 3(b)2: Preparation of water-sensitive development controls

Coverage

The coverage element of building control determines the percentage of a property that can be developed (e.g. 60% for residential buildings). The building footprint relates to the runoff in the sense that the larger the footprint, the larger the runoff volume generated. Water sensitivity calls for using rainwater instead of allowing this to dissipate as runoff. The coverage building control can be leveraged in new buildings to achieve this. The developer of a new building can be incentivised by making a portion of the property coverage conditional to rainwater catchment and harvesting. The table below illustrates this principle in the case of Residential 3 (group housing, retirement villages, etc.) zoned properties in Lephalale.

Table 5.27: Proposed coverage development control (Lephalale Local Municipality)

<table>
<tr><th>Existing development control</th><th colspan="3">Proposed development control</th></tr>
<tr><td rowspan="2">Some 80% of the extent of the property may be developed.</td><td>Allowable coverage with no rainwater harvesting</td><td colspan="2">Allowable coverage with rainwater harvesting</td></tr>
<tr><td>70%</td><td>82%</td><td>The site development plan submitted with the application should include rainwater harvesting techniques to store and re-use 30% of runoff.</td></tr>
</table>

Permeability

In the two case studies of the Lephalale and Mogalakwena local municipalities, very little is said regarding paving. The only mention of it is in the Lephalale Scheme, where paving must be indicated in a site development plan. Introducing a permeable paving requirement (as compulsory building control) can contribute to water sensitivity in the following manner:

- Rainwater is returned underground, i.e. the groundwater is replenished as opposed to freshwater being routed to streams, rivers and the sea.
- Rainwater may be harvested straight away if the paving and substructure are designed in such a way that the absorbed water is collected underground. From here, it may be pumped for use in the surrounding landscape or otherwise.

It is proposed that a permeability development control should be introduced, which would be applicable to all zonings, where a percentage of all paving on a property should be permeable.

Clauses relating to building control

Municipalities are authorised to act as a Building Regulator, which should enforce the National Building Regulations set out in Schedule 4, Part A and B, of the Constitution of the Republic of South Africa (Republic of South Africa, 1996). South African energy-efficient building regulations are captured in SANS 204: "Energy efficiency in buildings" (not compulsory) and SANS 10400: "XA: Energy usage in buildings" (compulsory). These regulations were added to the National Building Regulations for Energy Usage in Buildings in 2011.

At the time of writing, no national standard for water efficiency in buildings could be found. The LUS could be used to bridge this gap until such time as water efficiency is similarly dealt with. This would imply that a specific chapter (or clause) be added to the LUS, specifically dealing with water efficiency in buildings.

These clauses could address the following:

- **Water-efficient domestic plumbing:** Typical commercial flush toilets can be retrofitted with ultra-low-flow or high-efficiency single flush or dual-flush toilets. Urinals can be replaced with dry or urine diversion urinals. Typical faucets and showerheads can be retrofitted with low-flow or aerator heads. These possible strategies are easy and cost-effective and can save between 20 and 50% of water. Water-intensive appliances such as washing machines should, in time, be replaced with water-efficient appliances.

- **Domestic and commercial irrigation:** There are two areas on which to focus when it comes to system improvements. These are control upgrades and distribution system enhancements. Control upgrades include the utilisation of weather-based smart controllers, the implementation of master flow control meters, and the implementation of soil moisture sensors and/or rain gauges for localised data points. Distribution system enhancements include the retrofitting of sprayers with high-efficiency nozzles, ensuring properly sized rotors and spray heads, utilising sub-surface drip irrigation where economically feasible, and high-efficiency pumps. Drip irrigation systems involve installing thin pipes directly to the base of plants, with drippers on the end of the pipes. These drippers slowly supply water to the plant directly where it is needed, so less water is used. The amount of water used for irrigation can be reduced by 50% or more by using such a system. Reducing lawn size and encouraging water-wise gardening can have a significant impact on water uses. Consider limiting the size of lawns when a site development plan is submitted.

- **Private and public swimming pools:** Swimming pool water use is influenced by a variety of factors, including the size of the pool, evaporation rates due to climate, the frequency of backwashing, leaks and splash-outs, water temperature, as well as the pH and chemical content of the pool. The use of insulation, such as a solid pool cover, can eliminate almost all evaporation. Consider limiting the size of swimming pools when a site development plan is submitted.

- **Water harvesting tank:** A decentralised rainwater harvesting system can be installed on almost all roofs and other elevated, impervious surfaces, such as covered parking bays. Rainwater harvesting is most effective on corrugated iron, pitched roof typically associated with modern buildings. Rainwater harvesting utilises stormwater for non-potable uses such as gardening and toilet flushing and thus contributes to water conservation. Stormwater storage facilities can also be connected to other SUDS options such as infiltration trenches or soakaways, which increase the recharge volume. This approach can become a centralised water harvesting system, which can redistribute the harvested water to communities for irrigation or other non-potable uses. Rainwater harvesting can also become the main source of water supply where centralised alternatives are not available. However, rainwater harvesting is constrained by local rainfall characteristics, and on-site and off-site space availability, as well as the size of the storage tank.

Phase 3(b)3: Consultation

The consultation component of the LUS is meant to provide all interested and affected parties with sufficient opportunity to make inputs to the content and process of compiling an LUS. The legal requirement for this phase can often be found in the Municipal Spatial Planning By-law. In the case of Lephalale Local Municipality, the by-law stipulates the following:

- Publication of the draft LUS in the provincial gazette and two local newspapers, inviting any person or body to provide written comments within a period of 60 days.
- The municipality may also arrange specific consultations with professional bodies, community structures and public meetings.

This part of developing an LUS is often seen more like a “rubber-stamping” process, instead of a phase that is aimed at getting the approval and input of others. The following should be considered as good practice as far as it relates to the development of water-sensitive LUSs:

- **Technical input is important.** Throughout this document, the emphasis has been placed on the fact that land uses consume water or can affect the quality of water. The practice of compiling an LUS, however, is normally left to town planners, who are not water experts. It is therefore important that the LUS should be circulated to water specialists for their input at least in its draft version (or even earlier if possible).

  - *Municipal infrastructure specialist:* Engineers are seldom involved in developing land use schemes, yet they are often tasked with remedying the result of bad land use decisions. The LUS decision to allow increased densities in a specific area can have serious implications on the availability of water as a resource, as well as on the bulk and reticulation infrastructure.
  - *Water resource management specialists:* The management of our country’s water resources is a task assigned to DWS. Although research has indicated that the Department performs some level of planning at a catchment level related to future growth, it provides very little input to municipalities in the development of either SDFs or LUSs. Consider, for example, agriculture. In terms of Section 3(g) of the Agricultural Land Act, Act No. 70 of 1960, the Minister of Agriculture must provide written consent before any public notice of an LUS can be given. Note that the emphasis here is not to create a massive administrative burden on both the municipality and DWS, but rather to ensure alignment and cooperation.

- **Participation vs. capacitation:** It should be kept in mind that an LUS is a technical document. Yet, especially in traditional authority areas, the scheme expects the public to “do the right thing”. In addition, municipalities in which traditional authorities are located will have to rely on traditional authorities to apply the LUS in these areas (the municipalities simply do not have enough manpower to manage all land uses in every single village). The consultation phase of an LUS should, therefore, be used to train people in the principles of land use management and, importantly to this project, how land use management could contribute to water resource management. Examples of this type of consultation could include the following:

  - The actual demarcation of wetlands, mountain catchment areas and freshwater ecosystem priority areas is not something that can be seen on the ground. This stage of the project can produce community maps with enough information to allow community leaders to identify landmarks in conjunction with the delineation of sensitive areas or areas with specific management characteristics. These maps should then be used to ensure that land is allocated in these areas.
  - Training about the negative effects certain land uses (e.g. overgrazing) could have on natural areas, riparian areas or wetlands.

- The importance of buffer areas negating pollution around groundwater extraction points (e.g. boreholes).
- Many of the interventions should take on the form of basic land use management and water management rules of thumb that can assist traditional leaders in managing land and water effectively.

Phase 4(a): Land use scheme implementation

Once the consultation phase has been finalised and the Council has adopted the LUS, it needs to be promulgated by placing a notice in the Government Gazette. This will inform all stakeholders and the public that the new scheme is now in operation. Another important component of the scheme includes the following:

- *Monitoring:* Some of the interventions discussed in this document are proposed to influence consumer behaviour regarding water scarcity, for example, the recommendation compelling new houses in areas of high water usage to implement rainwater harvesting. Water consumption should, therefore, be monitored on a regular basis to make sure that the recommendation is indeed having the right effect. New areas could also manifest as using too much water, in which case the scheme can be amended to also consider new geographic areas. Similarly, the recommendations regarding land use management in traditional authority areas should be closely monitored to ensure that traditional leaders are indeed implementing the scheme. In areas where they are clearly not, additional capacity building and training may be required.
- *Updating the scheme:* The scheme can be updated whenever the municipality requires it, but at least every five years. This is a departure from previous thinking, which held that once in place, schemes are hardly ever updated. The scheme should be updated to reflect municipal, as well as stakeholder policy, especially as far as water is concerned. Water scarcity is a relatively “new” concern in South Africa, and in the next couple of years, one can expect many innovations that could be enforced using the LUS.

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ANNEXURE A – WATER-SENSITIVE LEGISLATIVE POLICY ANALYSIS TEMPLATE

Table A1: Water-sensitive legislative analysis – template

Short title	Year	Vision	Aim and principles	Water and environmental resource implication	Spatial planning and land use management implications
The Constitution	1996				
Municipal Systems Act No. 32	2000				
Water Services Act No. 108	1997				
National Water Act No. 36	1998				
National Environmental Management Act No. 62	1998				
Municipal Systems Act No. 32	2000				
National Environment Management: Protected Areas Act No. 57	2003				
National Environmental Management: Biodiversity Act No. 10	2004				
Spatial planning and Land Use Management Act No. 16	2013				

Table A2: Water-sensitive policy and plan analysis – template

Short title	Year	Vision	Aim and principles	Water and environmental resource implication	Spatial planning and land use management implications
The Constitution	1996				
Municipal Systems Act No. 32	2000				
Water Services Act No. 108	1997				
National Water Act No. 36	1998				
National Environmental Management Act No. 62	1998				
Municipal Systems Act No. 32	2000				
National Environment Management: Protected Areas Act No. 57	2003				
National Environmental Management: Biodiversity Act No. 10	2004				
Spatial Planning and Land Use Management Act No. 16	2013				

ANNEXURE B – LIST OF SPATIAL DATA AND SOURCES

Table B1: List of spatial datasets and sources

Shapefile name		Code	Polygon/ line/ point	URL	WRC	ARC	Municipal Demarcation Board	SANBI	Chief Surveyor-General	Local government	DWS	PlanetGIS	DEA	Stats SA	Department of Basic Education	mapIT	Department of Mineral Resources	ESRI
Base map and data	Provincial Boundaries	A01	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm			x		(x)	x		x						x
	District Boundaries	A02	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm			x		(x)	x		x						x
	Local Municipal Boundaries	A03	Polygon	http://www.demarcation.org.za/site/2017-2018-technical-municipal-boundary-alignment/#			x		(x)	x		x						x
	Towns point data	A04	Point	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x
	Ward Boundaries	A05	Polygon	http://www.demarcation.org.za/site/2016-3/, http://csg.dla.gov.za/spatial.htm			x		(x)	x		x		x				
	Main Place Boundary	A06	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm			x		(x)	x		x		x				
	Subplace boundary	A07	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm			x		(x)	x		x		x				
	General Plans Boundaries	A08	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						
	Allotment or Township Boundaries	A09	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						
	Water Management Boundaries	A10	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x						x							x
	Primary Catchment Boundaries	A11	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x						x							x
	Secondary Catchment Boundaries	A12	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x						x							x
	Tertiary Catchment Boundaries	A13	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x						x							x
	Quaternary Catchment Boundaries	A14	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x						x							x
Cadastral data	Farm Portions Cad	A15	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x
	Parent Farms	A16	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x
	Holdings Cad	A17	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x
	Erf Cadastre	A18	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x
	Public Places CAD	A19	Polygon	https://planetgis.co.za/browse.php?id=11 , http://csg.dla.gov.za/spatial.htm					(x)	x		x						x

Shapefile name		Code	Polygon/ line/ point	URL	WRC	ARC	Municipal Demarcation Board	SANBI	Chief Surveyor-General	Local government	DWS	PlanetGIS	DEA	Stats SA	Department of Basic Education	mapIT	Department of Mineral Resources	ESRI
Infrastructure Data	Road Networks	A20	Line	https://mapit.co.za/, http://csg.dla.gov.za/spatial.htm					(x)	x						(x)		x
	Water treatment works	A21	Point		x					x	x							
	Wastewater treatment works	A22	Point		x					x	x							
	Water reticulation network	A23	Line		x					x	x							
	Wastewater reticulation network	A24	Line		x					x	x							
	Boreholes	A25	Point	http://www.dwa.gov.za/iwqs/gis_data/	x					x	x							
	Pump stations	A26	Point	http://www.dwa.gov.za/iwqs/gis_data/	x					x	x							
	Inlet and output points	A27	Point	http://www.dwa.gov.za/iwqs/gis_data/	x					x	x							
	Electricity Infrastructure Network	A28	Line							x	x							
Natural environment	Topography (slope)	A29	Raster	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx		(x)		x										
	Contours	A30	Line	https://planetgis.co.za/browse.php?id=11								x						
	Primary river network	A31	Line	http://bgis.sanbi.org/Search?SearchTerm=rivers	x	x		x			x							
	Secondary River Network	A32	Line	http://bgis.sanbi.org/Search?SearchTerm=rivers	x			x			x							
	Wetlands and estuaries	A33	Polygon	http://bgis.sanbi.org/Search?SearchTerm=wetlands	x			x			x							x
	Impoundments	A34	Polygon	http://bgis.sanbi.org/Search?SearchTerm=inland+water	x			x			x							x
	Land Cover data	A35	Raster	http://bgis.sanbi.org/SpatialDataset		(x)		x		x		x	x					
	Gullies	A36	Polygon			(x)		x			x							
	Mean annual Temperature	A37	Raster	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx		(x)		x			x							
	Mean Annual Precipitation	A38	Raster	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx		(x)		x			x							
	Mean Annual Evaporation Rate	A39	Polygon	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx		(x)		x			x							
	Mean Annual Runoff	A40	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
	Utilisable Groundwater Exploration Potential	A41	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							

Shapefile name		Code	Polygon/ line/ point	URL	WRC	ARC	Municipal Demarcation Board	SANBI	Chief Surveyor-General	Local government	DWS	PlanetGIS	DEA	Stats SA	Department of Basic Education	mapIT	Department of Mineral Resources	ESRI
	High Groundwater Recharge Potential	A42	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
	Groundwater quality	A43	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
	Boreholes with Nitrate (n)	A44	Point	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
	Boreholes with Fluoride (f)	A45	Point	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
	Boreholes with Iron (Fe)	A46	Point	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
Underlying structural elements	Geology	A47	Polygon	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx	x	(x)		x										
	Swelling clay	A48	Polygon	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx	x	(x)		x										
	Soil drainage	A49	Polygon	http://www.arc.agric.za/arc-iscw/Pages/Earth-Observation.aspx	x	(x)		x			x							
	Depth to groundwater	A50	Polygon	http://waterresourceswr2012.co.za/resource-centre/	x			x			x							
Protected and management areas	Formal protected areas	A51	Polygon	https://egis.environment.gov.za/data_egis/user	x			x		x			x					
	Critical Biodiversity Areas (CBA)	A52	Polygon	http://bgis.sanbi.org/SpatialDataset				x		x								
	Ecological Support Areas (ESA)	A53	Polygon	http://bgis.sanbi.org/SpatialDataset				x		x								
	river FEPAs	A54	Line	http://bgis.sanbi.org/SpatialDataset	x			x			x							
	wetlands FEPAs	A55	Polygon	http://bgis.sanbi.org/SpatialDataset	x			x			x							
	Wetlands Cluster	A56	Polygon		x			x			x							
	Fish sanctuaries and associated sub-quaternary catchments	A57	Polygon		x			x			x							
	Upstream Management Areas	A58			x			x			x							
	Phase 2 FEPAs	A59	Line		x			x			x							
	free flowing rivers	A60	Line		x			x			x							
	High Agricultural potential land	A61	Polygon					x			x							
	Mining	A62	Raster										x				(x)	
	Total Dissolvent Solids																	

Shapefile name		Code	Polygon/ line/ point	URL	WRC	ARC	Municipal Demarcation Board	SANBI	Chief Surveyor-General	Local government	DWS	PlanetGIS	DEA	Stats SA	Department of Basic Education	mapIT	Department of Mineral Resources	ESRI
New generated data	vacant	A63	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	open space erven	A64	Point, xlsx, PDF	(Dwelling Frame)					(x)	x				(x)				
	business	A65	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	industrial purposes	A66	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	educational	A67	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	institutional	A68	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	health care	A69	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	government	A70	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	municipal	A71	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	services related infrastructure	A72	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	residential	A73	Point, xlsx, PDF	(Dwelling Frame)						x				(x)				
	Schools	A74	xlsx	https://www.education.gov.za/Programmes/EMIS/EMISDownloads.aspx						x				(x)	x			

(x) means the data is not free.

ANNEXURE C – HOW TO CONDUCT A LAND AUDIT

The first step in conducting a water-sensitive spatial analysis is therefore to determine the extent of land cover change and to asses existing land use.

Step 1: Assemble and review all existing and relevant data to the study area

Land uses are the building blocks at the disposal of an urban planner. These building blocks are used to inform the SDF in determining the future shape of settlements within the municipality and in municipal land use to regulate the legality of land use. The first step in conducting a water-sensitive spatial analysis is to gather and assemble all existing land use data. If the municipality has an up-to-date GIS land use database, the planner should ensure that it covers the entire extent of the municipality, including all land uses in rural or traditional villages. If the GIS land use data is incomplete or non-existing, a land use audit will be the next step. In addition to the land use data, all spatial data that was used to inform the existing provincial, district and local municipality SDFs should be gathered as it will be used to inform future spatial development proposals.

Step 2: Conduct a desktop land use audit for all formal registered erven

The purpose of a wall-to-wall land audit is to determine the extent of land uses for the entire municipality (not just previously known urban areas), the actual use of land and the legal zoning and ownership of the land. The methodology for conducting a wall-to-wall desktop land audit is summarised briefly in five sub-steps:

1. Compile a geo-database

The first step is to create a geo-database, populated with all relevant data that is required to create a single wall-to-wall land use cadastre. The base data for the land use audit should include provincial, district and local municipality boundary, municipal ward boundaries, main place boundaries and sub-place boundaries. The database should then be populated with various sets of cadastral information, which includes farm portions CAD, parent farms, holdings CAD, general plan boundary; erf cadastre CAD, public places CAD, streets CAD, general plan boundary and allotment or township boundaries sourced from the Surveyor-General. These datasets should be layered in the following order, starting with the farm portions CAD, holdings CAD, erf cadastre, public places and streets datasets. Ideally, the datasets should piece together a complete “cadastre puzzle.” Use Annexure D to identify the relevant spatial dataset to inform the base map. However, in most cases, datasets will overlap, creating duplicate layers on the same spatial entity. Therefore, the next step is to delete all spatial duplicates.

2. Clean the data

The next step is to identify and delete all overlapping cadastral entities by using the “select by location” and “erase” tool in ArcGIS. The following order of identification was followed: Surveyor-General erf was selected by location relevant to the street CAD, then public places, followed by the holdings CAD.

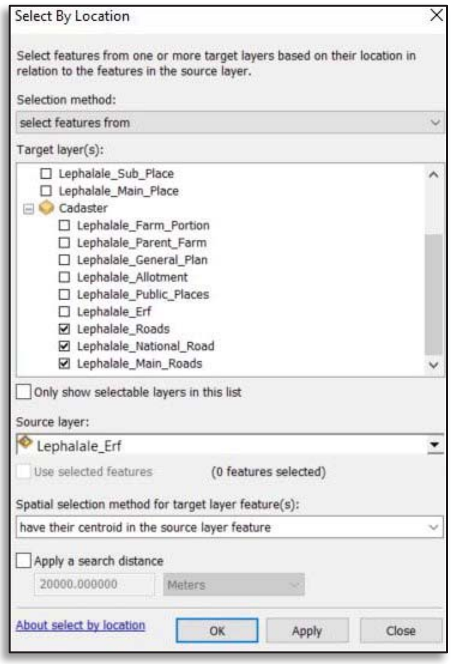


Figure C1: Select by location

Each overlap had to be identified and deleted by using the erase tool. Once all overlapping data has been deleted, the remaining CAD was merged, creating a new shapefile. This new shapefile now includes all surveyed but not overlapping spatial information of municipal erven, farm portions, holdings, public places and streets.

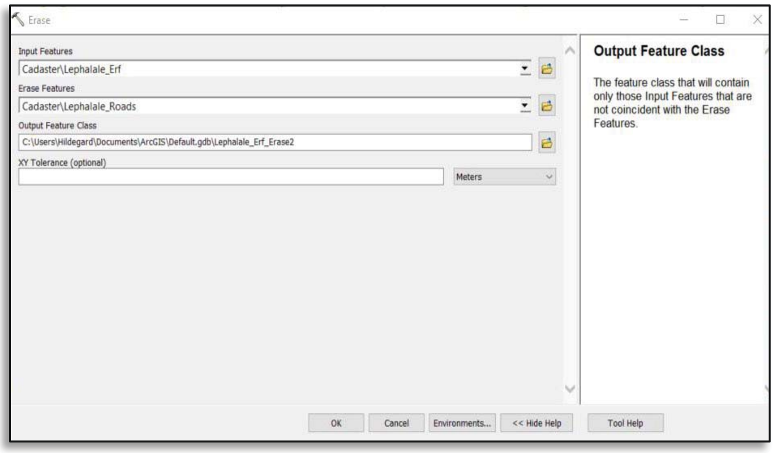


Figure C2: Erase tool

3. Identify spatial gaps

Gaps in the data could occur, possibly related to incomplete or outdated spatial information. Erf number, compilation plan indexes and township names can be used to source the missing spatial information from the Chief Surveyor-General site's search engine. In some instances, title deed records existed, but there was no matching cadastral entity. In this case, specifically, the Surveyor-General's diagram should be obtained and spatial information captured by keying in the coordinates from the small-scale diagram or general plan into auto-CAD. Once completed, the cadastre should be fully updated spatially, but may still lack land use and ownership information.

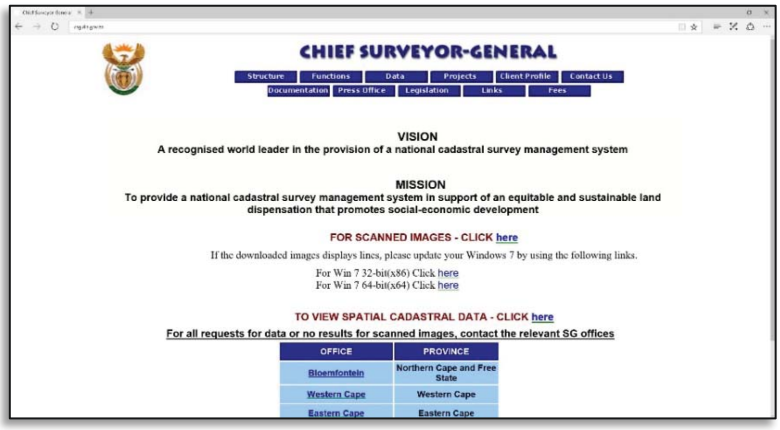


Figure C3: Chief Surveyor-General web site

4. Obtain land use information for all formal areas

The next step is to obtain land use information for all formal areas. Possible sources may include the municipal valuation roll, municipal billing data, municipal asset register, land use information from former land audits or land use scheme, Stats SA Dwelling Frame 2012/15, spatial data from national and provincial departments such as Health, Education and SAPS, and Eskom's SPOT Building Count data. However, land use descriptions in these sources may differ from one another, e.g. the municipal valuation roll typically refers to a guest house as a business, whereas in other sources, the land use would be referenced as residential. The municipal valuation roll should be used as a starting point in obtaining land use information. The join and relate tool in ArcGIS should be used to link the LPI/SG code provided in both the cadastral shapefile and the municipal valuation roll with one another.

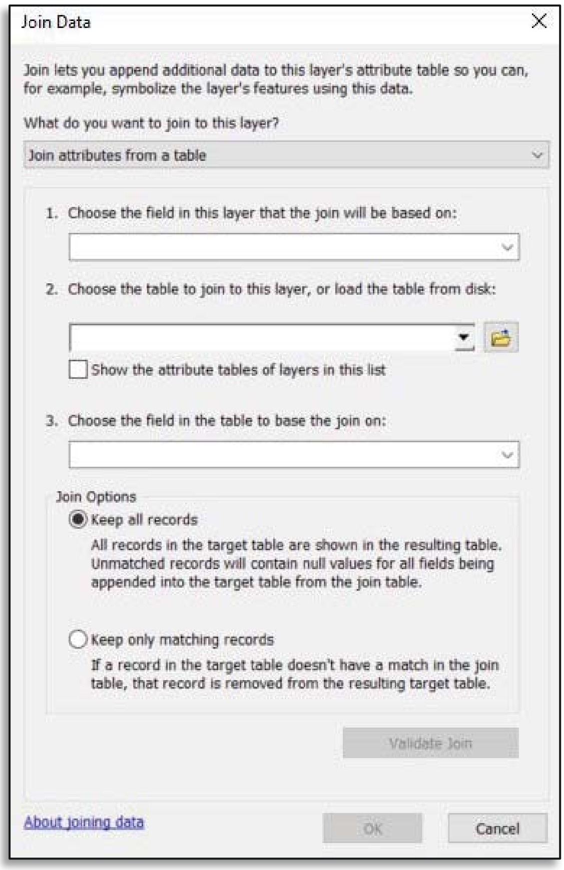


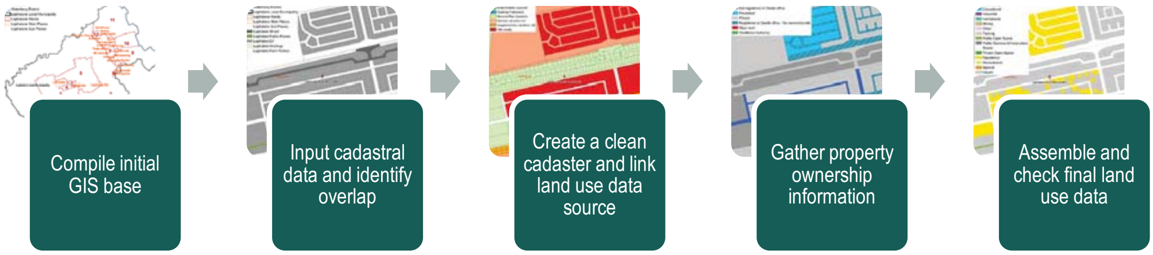
Figure C4: Join data

Where records do not link, these “non-matching” records indicate where possible new township establishments, consolidation and subdivisions took place. Once again, the missing information should be searched for on the Chief Surveyor-General’s website and updated accordingly.

5. Obtain and update ownership information

As the municipal valuation roll is already linked to the new CAD, most of the erven should already have ownership information assigned to them. However, if a registered property still has missing ownership information, the ownership information should be obtained from the Deed’s office. The “buyers name” field in the deeds database is the registered owner of the property and should be used to update the ownership information. The ownership description should be reclassified according to the following categories: private, state-owned enterprise, local municipality, district municipality, provincial government, state land, ecclesiastical and traditional authority. At this stage, all formally registered erven (typically located within urban areas) should have up-to-date land use and ownership information as attributes.

Summary on how to conduct a land audit for informal settlements:



When compiling a wall-to-wall land use audit, rural land uses also need to be captured.

Step 3: Conduct a desktop land use audit for all informal land uses

Prior to SPLUMA, the LUS and SDF did not exactly cater to the broader rural environment found within a municipality. Therefore, spatial information of land uses outside existing urban settlements will most likely not exist in the correct format. Sub-sets 6 to 10 explain the process of conducting a desktop land use audit for all informal land uses.

6. Assemble data for land use capturing

The methodology for compiling a rural land use audit started off with importing aerial photography or base-map imagery from ArcGIS imagery (Bing, Google Earth and SA 50 cm colour imagery) into GIS as this will be used as a backdrop to capture spatial entities. The 2011 Stats SA settlement boundaries (the latest dataset available at the time of writing) should then be imported into the base map as an overlay to establish settlement boundaries.

7. Import linear data

The next step is to incorporate linear data such as rivers and streams from the 1:50 000 topographical datasets and roads data which is available from National Geospatial Information (NGI) but can also be purchased from commercial data vendors such as TomTom. The "buffer" tool in GIS was used to buffer the street centre lines by 3.4 m to both sides.

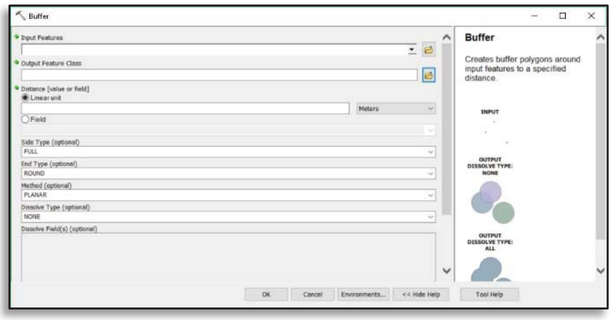


Figure C5: Buffer tool

8. Create block boundaries

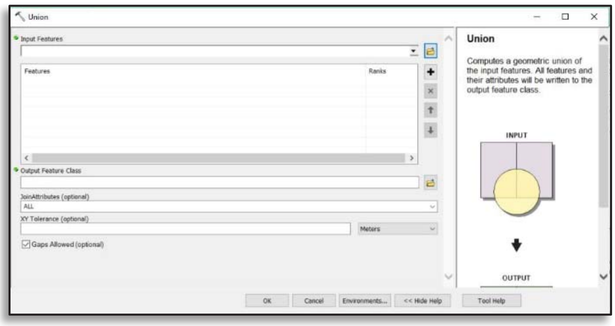


Figure C6: Union tool

The next step was to overlap the village boundary with linear data to create a set of street block polygons. A single shapefile layer was created by using the "union" function to merge the sub-place layer and the street centrelines.

9. Capture rural land uses

The next step is to capture rural land uses. Various sources can be used to capture rural land use, including Stats SA's Dwelling Frame 2016, the national, provincial and municipal departments' data such as Health, Education and SAPS, and Eskom's SPOT Building Count, municipal asset registers, and commercial data vendors such as GeoTerraImage. Stats SA's Dwelling Frame 2016 was used for this land audit, as it was at the time of writing the most up-to-date source available. It also provides information on the data from which the land use was captured.

In other words, this dataset could provide an indication of spatial growth patterns. The "class_name" column in the attribute table can be used to determine rural land use. By starting an editor session in ArcGIS, similar land uses were lumped together to create smaller and more defined land use blocks. The "cut" function in ArcGIS was used to create separate blocks based on the spatial plan boundary using the "multipart to single part" tool.

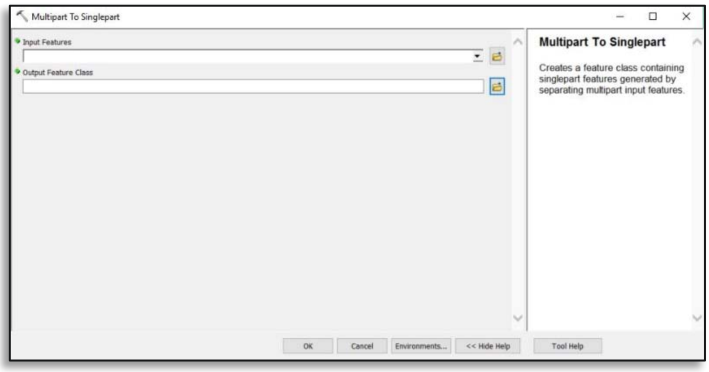
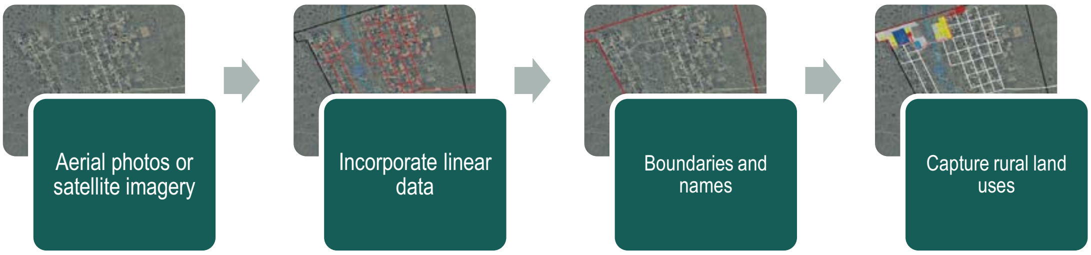


Figure C7: Multipart to single part

10.Cross-check data

The final step is to cross-check areas with no land use data. Some areas may appear to be vacant on aerial photography, yet it could be used for some form of agriculture or more importantly grazing. Formal and informal land use information, ownership information, as well as zoning information, should now be available for the entire municipal area.

Summary on how to conduct a rural land audit in informal settlements:



ANNEXURE D – WATER-SENSITIVE LEGISLATIVE POLICY ANALYSIS TEMPLATE

2.1.1	**Climate analysis**	**Note:** 2.1.1.1	The climate of a region has a major impact on the availability of freshwater resources, on soil productivity and food security, energy and physical development driven by anthropogenic needs.
		2.1.1.2	The ARC* provides national-scale spatial data of South Africa's temperature. Use the "Max_temp" rasterfile to determine which areas within the municipality experience high and low **maximum and minimum annual temperatures.** People living in areas experiencing high annual temperatures will naturally have a higher demand for water – for drinking, for cooling (swimming pools) and for gardening.
		2.1.1.3	The WRC* provides spatial data on a national scale of South Africa's mean annual precipitation ranging between 0-100 mm and >1500 mm of precipitation per annum. Use the "roadmaps" shapefile to determine which areas within the municipality experience high and low mean annual precipitation. First, determine the average annual precipitation for the entire municipality, then create a new column in the attribute table "Macro_RWH_potential" and differentiate between four categories (low, moderate, high and very high) of rainwater harvesting potential. From a macro-level perspective, the map should provide some indication on which regions within the municipality are favourable for rainwater harvesting. Settlements located in regions with high to very high rainwater harvesting potential should consider utilising rainwater as an alternative source of water for daily usage. In areas with low rainwater harvesting potential, other alternatives such as grey and black water reuse would be considered more feasible as the risk of rainwater tanks remaining empty is too high.
		2.1.1.4	The WRC* provides spatial data on a national scale of South Africa's mean annual evaporation rate ranging between < 1200 mm and > 2000 mm per annum. Use the "evaporationwr90.shp" shapefile to determine which regions within the municipality experience high and low annual S-pan evaporation rates. First, determine the average mean annual S-pan evaporation rate for the entire municipality, then create a new column in the attribute table "Evapo_factors" and differentiate between four categories (low, moderate, high and very high) rates of mean annual evaporation. From a macro-level perspective, the map should provide some indication on which regions within the municipality are not suitable for the damming of surface water and where managed artificial recharge of aquifers should be considered. Increasing vegetation and tree canopy coverage is proven to reduce the evaporation rate and should be considered as a preventative measure in securing water resources.
		2.1.1.5	Climate change spatial data. Under wetter scenarios, a significant increase in runoff would result in increased flooding, human health risks, ecosystem disturbance and aesthetic impacts. Drier climate scenarios would result in reduced surface water availability, but would not exclude the risk of extreme flooding events.
		2.1.1.6	Compile a synopsis and spatialise key findings of the climate analysis. Distinguish between areas with column and high evaporation rates and areas with low temperatures, high rainfall and low evaporation rates. The combination of the three factors determines the availability of water resources. A slight change in one of the three factors can have both water quality and quantify the impact. The analysis should, therefore, address the projected climate change implications of the region.
2.1.2	**Physical structuring elements**	**Note** 2.1.2.1	Physical structuring elements such as hills and rivers provide ecological services and development direction within a municipality. Although engineering solutions have evolved to overcome development limitations, altering or destroying physical structural elements is not considered good practice and should be avoided as far as possible.
		2.1.2.2	The ARC* provides spatial data on a national scale on South Africa's topography or slopes ranging between < 2.0% and > 20.0%. If the slope gradient increases, development potential decrease. Use the "slope" rasterfile to determine which regions within the municipality have high and almost undevelopable high slopes. First, convert the rasterfile to a shapefile, then create a new shapefile by selecting all areas with a slope gradient of over 25% "Undevelopable_high_slopes". Steep slopes also increase stormwater runoff rates, making wetlands and rivers at the bottom prone to erosion if natural vegetation is no longer intact. This can also cause the formation of gullies. As slopes become steeper, development becomes limited and infrastructure costs increase.

		2.1.2.3	The WRC* provides spatial data on a national scale on South Africa's primary and secondary river networks. Use the "wriall500_primary.shp" and the "wriall500_secondary.shp" shapefiles to determine the spatial location and extent of primary and secondary rivers within the municipality. There is no need to create a new shapefile at this stage as further analysis on the quality and quality of the freshwater resources is required.
		2.1.2.4	The WRC* provides spatial data on a national scale on South Africa's wetlands, estuaries and impoundments. Use the "wetlands_estury.shp" and the "dams500_wgs84.shp" shapefiles to determine the spatial location and extent of all wetlands and estuaries within the municipality. There is no need to create a new shapefile at this stage as further analysis on the quality and quality of freshwater resources is required.
		Note 2.1.2.5	Rivers, wetlands, estuaries and impoundments are fed by runoff. The rate, volume and quality of runoff is determined by rainfall, evaporation rate, slope, soil drainage potential, the availability of natural vegetation and land use. Freshwater networks situated in areas with high runoff potential will naturally be fed more frequently and with higher volumes of water than freshwater resources in areas with low annual runoff potential. However, these resources are also more prone to pollution and gully erosion if and when natural vegetation is removed or altered due to development pressure. Vegetated landscapes act as a natural filter and soil being strengthened, clearing runoff from populates before it enters freshwater networks and preventing buffers zones from gully erosion.
		2.1.2.6	The WRC* modelled the mean annual runoff potential of the entire country. Use the "rsa_mar_wr2012.shp" shapefile to determine which areas have high annual runoff potential. The WRC* also provides spatial data on a national scale on South Africa's gully formations and areas prone to water erosion. Use the "Gullies.shp" shapefile to determine where gullies already exist and the "Water_erosion.shp" shapefile to determine which areas are prone to water erosion within the municipality. Create a new shapefile "Erosion concern areas", which is a combination of existing gullies and areas prone to water erosion due to a lack of natural vegetation and high runoff potential. From a macro-level perspective, these areas should be prioritised for the revegetation of land cover if required, clearing of alien invasive species and other sustainable land use management practices. The mean annual runoff potential should correspond to the spatial assessment of Section 2.1.1.6. Furthermore, the assessment should also reflect on Section 1.1.1.5. as the impact of climate change will lead to changes in runoff across the country.
		Note 2.1.2.7	Areas identified in Section 2.1.2.6 would naturally have higher sediment deposits and higher TDS. However, other areas not identified as "erosion concern areas" can also have high sediment and TDS as it can also be caused by effluent discharge, land use and wind erosion. The WRC* provides spatial data on a national scale on sediment yield 1 000 t/a and surface water quality (TDS). Use the "sediment_yid_wr90.shp" shapefile to determine the amount of quaternary sub-catchment sediment yield (100 t/a) and the "Surfacewater_quality_TDS_concentration.shp" to determine the TDS quaternary sub-catchment concentration levels within the municipality. Create a new shapefile "Water_quailty_concern" representing catchments with high sediment yield and high TDS concentration. On a macro scale, these catchments should be prioritised for land use interventions, especially in buffer zones. This information is often excluded from spatial analysis as it highlights water quality factors and not spatial factors. However, the spatial location of land uses has a water quality impact and is therefore very important to the status quo analysis.
		2.1.2.8	Surface water from rivers and dams are the main source of water for domestic and economic use and should be kept in good ecological condition. Unfortunately, overutilisation, land use change and pollution have led to a decline in surface water availability. Gathering spatial or non-spatial information on surface water quantity and availability is important for all future development. This information is key to the study and various sources should be consulted to gather as much spatial data as possible. The WRC* provides spatial data on a national scale on the "cumulative neutralised streamflow (no land use included) at key point (million m^3/a)" and "cumulative present-day streamflow (with land uses as at 2009/10) at key points (million m^3/a)". Identify key points where the present-day streamflow is less than half of the neutralised streamflow. This will provide a clear indication of which catchments are highly impacted on by land use activities. The information is provided as a graphic. However, it has clear spatial references on the map. Later in the analysis, this information will be linked with the land use data, which will help to establish a relationship between land use and water resources availability.

		2.1.2.9	Compile a synopsis that summarises and spatialises the key findings of the physical structuring elements and highlight areas with slopes that range between 15 and 25% and gullies, all existing rivers, dams, wetlands and estuaries, areas with high runoff potential, as well as areas with high **and low sediment yield** and areas prone to water and wind erosion.
2.1.3	**Underlying structural elements**	**Note** 2.1.3.1	Underlying structural elements mean the mapping and assessment of geological formations and features, not necessarily visible to the naked eye, but holding underlying development, as well as water resource-related implications. This includes geology, soil classes, swelling clays, soil drainage or water-holding capacity, and areas prone to wind and water erosion and groundwater resources. The geology of a region determines both the quality and quantity of groundwater resources within a region as rock types have different physical (permeability) and chemical compositions.
		2.1.3.2	The ARC* provides spatial data on a national scale on South Africa's geology. Use the "rsa_geol.shp" shapefile to determine which underlying geological formations are found in the municipality. Dolomitic areas are the geological formation that is of high concern for physical development and for groundwater resources. The ARC* also provides spatial data on a national scale on South Africa's swelling clay potential. Use the "swelling clay" shapefile to determine areas with high swelling clay potential. Create a new shapefile, "under_geo_concern", representing all underlying geological formations that must be avoided by development as far as possible.
		2.1.3.3	The ARC* provides spatial data on a national scale on South Africa's soil drainage and water holding capacity. Use the "Soil drainage" shapefile to determine which areas have high water-holding and low water-holding capacity. The water-holding capacity is determined by soil textures and organic matter. Soils with poor drainage commonly support wetlands. These areas should, therefore, be identified as potential areas to support constructed wetlands used to treat stormwater runoff. Create a new shapefile representing areas with "high_water_holding_capacity" within the municipality.
		Note 2.1.3.4	Groundwater resources are generally not addressed in spatial plans as they are a resource that is not visible to the naked eye. However, spatial planning revolved around the planning of land use, which has both quality and quantity impacts on groundwater resources. For this reason, the development potential of the spatial location of groundwater resources should be integrated into spatial plans as far as possible. Map and assess all groundwater resources, including the location of aquifers**,** the UGEP and the mean recharge potential. In addition to the UGEP, depth to groundwater extractions should also be mapped accordingly.
		2.1.3.5	The WRC* provides spatial data on a national scale on South Afrcia's UGEP, which represents the total volume of available and renewable groundwater that allows for factors such as physical constraints on extraction, potability and a maximum allowable drawdown. Use the "GRIDS_ugep.shp" shapefile to determine the UGEP of the municipality. Create a new "High_UGEP" shapefile, which typically represents areas where the UGEP is <25 000 ($m^3/km^2/a$). Rural settlements are highly depended on groundwater resources. Knowing the spatial location of areas with high and low UGEP should be a determining factor for all future developments. Development or or close to these areas should be avoided as far as possible. Sustainable land use management is key in areas with high UGEP and areas with good groundwater quality
		2.1.3.6	The WRC* provides spatial data on a national scale on South Africa's groundwater recharge potential. Use the "GRIDS_recharge" rasterfile to determine which areas have high mean recharge potential (mm/a). Create a new "high_Recharge_potential" shapefile representing aquifers with naturally high permeability. If groundwater levels have dropped in aquifers with high permeability due to overutilisation, the aquifer can be recharged through artificial borehole injection. A perennial source of municipal water is treated wastewater. If the conditions are suitable, treated wastewater can be used to recharge aquifers.
		2.1.3.7	The WRC* provides spatial data on a national scale on South Africa's depth to groundwater. The average cost of drilling for groundwater can be calculated at R2 000 per meter. Use the "Grids_wl_1x1km" shapefile and reclassify the depth into cost categories. This information must be taken into account when a municipality considers where future development should take place.

		Note: 2.1.3.8	Groundwater pollution is a major problem in South Africa as the impact of land activities on groundwater resources is poorly understood and contamination of groundwater sources can go undetected for a long time. The WRC* provides spatial data on a national scale on South Africa's groundwater quality. High levels of pollution are indicated as salinity in water measured as electrical conductivity expressed in units of mS/m. Use the "SA_qual_dd.shp" shapefile to determine which areas have high levels of electrical conductivity. The target water quality is between 0-70 mS/m. If the electrical conductivity is over 150 mS/m, water will have a salty taste. Create two new shapefiles, "Good_Quality_GW", representing areas where the the electival conductivity is below 70 mS/m and "Groundwater_Quality_Concern". The latter should inform residents extracting water from boreholes in areas where groundwater quality is of concern as it may lead to health risks.
		2.1.3.9	The WRC* provides spatial data on a national scale on South Africa's groundwater quality, indicating levels of nitrates, fluoride and iron. Use the "Nitrate_dd.shp", "Fluo_dd.shp" and "iron_dd.shp" shapefiles to determine which boreholes extract water with chemical concerns. Combined with land use information, a relationship between land use and water quality can be established by highlighting areas with high levels of nitrate, fluoride and iron. This information provides a good indication of the groundwater quality.
		2.1.3.10	Compile a synopsis that summarises and spatialises the key findings of the physical structuring elements and highlight dolomitic areas, areas with high swelling clay potential and areas with impeded soil drainage. Groundwater development potential areas include areas with high UGEP (generally < 25 000 ($m^3/km^2/a$)) and areas with high mean recharge potential, as well as the average depth or cost of drilling for groundwater. Groundwater quality should highlight areas of concern, which includes areas where electrical conductivity, nitrate, fluoride and iron are high. Areas where groundwater is of good quality, where electrical conductivity, nitrate, fluoride and iron are low should be kept low.
2.1.4	**Protected areas and areas with management requirements**	**Note** 2.1.4.1	Protected areas enjoy legal protection and ecological infrastructure located within these areas would generally be in a good ecological condition as the site-specific management of these areas would fall within the management responsibility assigned to national and provincial conservation authorities. However, the National Biodiversity Framework identified the need to expand these areas to achieve the national biodiversity targets. Expanding these areas should be informed by a systematic biodiversity assessment. These assessments highlight CBAs and ESAs found within the municipality. These spatially identified areas have specific land use management guidelines assigned to each category. However, these guidelines do not have the force of law.
		2.1.4.2	The DEA* provides spatial data on a national scale on South Africa's formal protected areas, which include national parks, provincial nature reserves, world heritage sites and protected environments. These areas are secured by legal declaration under the National Environmental Management: Protected Areas (Act No. 57 of 2003). Use the "Protected_areas.shp" to determine which areas within the municipality enjoy legal protection from development. These areas are also physical structuring elements and are generally seen as "no-go" areas for development. The protection, conservation and management of these areas is subject to a management plan in terms of Section 28 of Act No. 57 of 2003. This management plan must contain at least a zoning of the areas indicating what activities may take place in different sections of the areas. If available, these zoning should be mapped accordingly.
		2.1.4.3	The DEA* also provides spatial data on a national scale on South Africa's conservation areas, which can include private nature reserves and/or conservation-orientated game or stock farms. In most instances, these land parcels are privately owned. Although not legally protected, ecological infrastructure in these areas will also be in a good ecological condition as the purpose of conservation areas is to protect the environment and specific species. Use the "Protected_areas.shp" to determine which areas within the municipality enjoy the efforts of conservation.
		Note 2.1.4.4	On provincial level, the National Biodiversity Framework requires provinces to develop a Spatial Biodiversity Plan, which identifies provincial CBAs and ESAs. However, CBAs and ESAs call for a finer-scale biodiversity plan, which is the Bioregional Plan. The purpose of a bioregional plan is to inform land-use planning, environmental authorisation and natural resource management and decision-making for a range of sectors whose policies and decisions impact on biodiversity outside protected areas.

		2.1.4.5	Once CBAs and ESAs have been published, the spatial information can be obtained from SANBI*. Use the shapefile representing "CBAs" identified within the municipality. Depending on the plan itself, categories and descriptions of CBAs may differ. Typical terrestrial CBAs include irreplaceable sites, critical linkages in biodiversity corridors, areas identified in existing plans and other important sites. Aquatic CBAs include river FEPAs and wetland FEPAs.
		2.1.4.6	Use the shapefile that represents "ESAs" identified within the municipality. Depending on the plan itself, categories and descriptions of ESAs may differ. Typical terrestrial ESAs include important habitats, biodiversity corridors (promoting ecological connectivity) and protected area buffers. Aquatic ESAs include FEPA sub-catchments, FEPA river buffers, FEPA wetland buffers and other wetlands, and dolomitic recharge areas.
		Note 2.1.4.7	If there is no existing spatial data on ESAs, the spatial analysis will need to identify areas that require a similar protection status and management process. Fortunately, the WRC provides spatial data on a national scale on South Africa's FEPAs. This spatial information must be used in the event that no CBAs or ESAs have been published. It must also be used to cross-check published CBAs and ESAs to ensure that these FEPAs are included.
		2.1.4.8	The WRC* provides spatial data on a national scale on South Africa's river FEPAs. These are rivers in a good ecological condition (A or B ecological category). Use the "river_conditions.shp" shapefile to illustrate which rivers within the municipality are in a good ecological condition. Catchments with rivers in a good ecological condition should be kept in a good ecological condition and therefore require special land use management. Use the "riverFEPA.shp" to identify river FEPAs and associated sub-quaternary catchments.
		2.1.4.9	The shapefile used in Section 2.1.2.4 is derived from the FEPA database. The "wetlands_estury.shp" shapefile represents the only (no buffer) actual mapped wetland or estuarine functional zone, as indicated by the turquoise outline. Due to their ecological importance, all wetlands and estuaries, regardless of their ecological condition, are classified as FEPAs. There is no need to create a new shapefile as further analysis will be conducted.
		2.1.4.10	The WRC* provides spatial data on a national scale on South Africa's wetland clusters. These clusters represent groups of wetlands embedded in a relatively natural landscape. These clusters allow for important ecological processes, such as the migration of frogs and insects between wetlands. Use the "Wetland_Cluster.shp" shapefile to determine the spatial location and extent of wetland clusters within the municipality. There is no need to create a new shapefile as further analysis will be conducted.
		2.1.4.11	The WRC* provides spatial data on a national scale on South Africa's fish sanctuaries and associated sub-quaternary catchment wetland clusters. Use the "fishSanc.shp" to determine which sub-quaternary catchments have critically endangered fish species and other threatened fish species. Fish sanctuaries in a good ecological condition were identified as FEPAs, and catchments in lower conditions are classified as fish support areas. There is no need to create a new shapefile as further analysis will be conducted.
		2.1.4.12	The WRC* provides spatial data on a national scale on South Africa's upstream management areas, which represent areas where land use must be managed to prevent the degradation of downstream river FEPAs and fish support areas. Use the "Upstream_management_areas.shp" shapefile to determine which catchments have special management requirements.
		2.1.4.13	The WRC* provides spatial data on a national scale on South Africa's Phase 2 FEPAs, which represent catchment where river conditions should not be degraded any further. Use the "Phase_2fepa.shp" shapefile to determine which catchments require special land use management to prevent the further degradation of river FEPAs.
		2.1.4.14	The WRC* provides spatial data on a national scale on South Africa's free-flowing rivers that are undisturbed from their source to the confluence with a larger river or sea. Use the "Free_flowing_riv.shp" to indicate such rivers that still exist within the municipality.
		2.1.4.15	Compile a synopsis that summarises and spatialises the key findings of existing protected areas, conservation areas and areas with special land use management guidelines, which includes CBAs, ESAs and FEPAs**.** These spatial entities should also be seen as physical structuring elements to be avoided by development. Calculate the full extent of the areas identified in Section 2.1.4 and calculate the percentage of municipal land which should "ideally" not be regarded as developable land. These areas should be prioritised for the expansion of protected areas and to identify areas suitable for biodiversity stewardship contracts.

2.2.1	**Land cover analysis**	**Note:** 2.2.1.1	Similar to the CBAs and ESAs, natural and near-natural landscapes provide ecosystem services that are vital to the local hydrological cycle as they regulate flow, encourages infiltration and purify water. The objective of the following mapping exercise is to determine which areas within the municipality are still in natural of near-natural conditions and how much of the municipalities' surface areas have been transformed to accommodate desired anthropogenic land uses. National land cover data, combined with municipal land audit data, forms the foundation of the following mapping exercise. If the municipality does not have up-to-date land audit spatial information, a wall-to-wall land audit will need to be conducted.
		2.2.1.2	The DEA* as well as BGIG* host national land cover data. Use the latest land cover data "landcover2013_14" rasterfile to determine the extent of the remaining natural vegetation. Create a new "Natural_vegetation.shp" that represents at least the following bare, non-vegetated areas: eroded areas, thicket or dense bush, grasslands, woodlands or open bush and low shrublands. In an ideal world, the natural vegetated areas will cover the full extent of areas identified in Section 2.1.4.
		2.2.1.3	Use the same "landcover2013_14" rasterfile to determine the extent of agricultural and mining areas. Create a new shapefile, "Agricultural_land_use.shp", which represents land used for plantations, cultivated orchards, cultivated subsistence farming, cultivated commercial pivots and cultivated commercial fields. Create to new shapefile, "Mining_land_use.shp", which represents land use for mining, which includes areas used for mining, mining buildings, as well as areas with mine water that is permanent or of a seasonal nature, as well as bare mines and semi-bare mines. Both agriculture and mining practices form part of the food, energy, water nexus. However, irrigated agriculture is the largest water user in the country at ±60% and also contributes to a high level of contamination. Mining has a relatively small water resource demand at ±3%, yet the aftermath of mining activities has a detrimental impact on both land and water resources.
		2.2.1.4	Compile a synopsis which summarises and spatialises the key findings of the land cover analysis.
2.2.2	**Land audit: land use and zoning analysis**	**Note:** 2.2.3.1	The national land cover rasterfile does not provide sufficient information to determine individual land uses within the built-up areas. Therefore, a municipal land audit must be conducted to determine what land use is exercised where. Zonings, land ownership information and date of establishment should also be gathered. To date, formal zonings with a legal status will predominantly be limited to formal urban areas. The process of conducting a land audit should be explained.
		2.2.3.2	Use the spatial data generated by the land audit* to map and assess all existing "vacant" and "open space erven" land parcels in both urban and rural settlements. Identify and map the existing zonings (if any) assigned to the properties. Vacant land within the existing built-up areas should be prioritised for higher density, infill development and/or for government housing schemes. If feasible, vacant erven located near already open spaces should be utilised for decentralised infrastructure and green infrastructure to harvest and treat stormwater runoff, rainwater, greywater and, in some areas, black water as well.
		2.2.3.3	Use the spatial data generated by the land audit* to map and assess all existing erven and informal land parcels used for "business" (shops, offices, restaurants and taverns) and "industrial purposes". Identify and map the existing zonings (if any) assigned to the properties. Special attention should be given to the zonings assigned to industrial land uses as these noxious industries have may have a higher pollution rating than other industrial land uses. These land uses generally contribute to the municipalities' economic growth. The economic potential of an area is essential for the overall financial sustainability of a municipality. In most towns, cities and settlements, these land uses would be found in either natural or artificially created economic and industrial zones. The beautification of business and industrial zones through WSUD and other green design elements encourages the investment potential and sense of place. Water demand by these land uses is also relatively high, and water efficient appliances, practices and initiatives should be the main priority for all business and industrial land uses. Wastewater discharge from industrial land uses generally has a higher pollutant rating and should be treated on-site before being discharged into the system. Furthermore, the contamination rate of stormwater from industrial zones is much higher as noxious chemicals and particles interact with each other. WSUD should be prioritised in these areas.
		2.2.3.4	Use the spatial data generated by the land audit* to map and assess all existing erven and informal land parcels used for "educational", "institutional" and "health care" purposes. Identify and map the existing zoning (if any) assigned to the properties. These land uses generally fall under government or municipal management and control. These facilities require relatively large erven as buildings are designed to accommodate

			large groups of people for several hours. The size of the building is favourable for water harvesting and storage. Stormwater from parking areas should also be harvested and used to water sports field and to clean premises. The same goes for community facilities with large gardens. Harvested water can also be used to flush toilets.
		2.2.3.5	Use the spatial data generated by the land audit* to map and assess all existing erven and informal land parcels used for "government", "municipal" and "services-related infrastructure" purposes. Identify and map the existing zonings (if any) assigned to the properties. This includes post offices, police stations, museums, camping sites, cemeteries, dumping sites, roads, fire stations, composting installations, water purification works, water treatment works, and electrical substations and reservoirs. Most land uses have accompanying buildings designed to accommodate people and/or economic activities that require water resources for domestic or economic purposes. This is provided by a combination of physical infrastructure, typically referred to as public services infrastructure, which can either be visible or below ground. The spatial location of underground water and sanitation distribution networks and stormwater channels should also be identified in order to cover the full extent of the infrastructure network. The municipal asset register should provide valuable spatial data on both visible and underground physical infrastructure. Additional information on the management structure, operations and management, and the hydrological integrity of this system should also be gathered. This information can be obtainable from the municipal WSDP or the National Integrated Water Information System (NIWIS). The location of cemeteries relative to groundwater resources is very important as cemeteries have a high contamination rate.
		2.2.3.6	Use the spatial data generated by the land audit* to map and assess all existing erven and informal land parcels used for "residential" purposes. Identify and map the existing zonings (if any) assigned to the properties. Zonings help to identify the density and level of intensity of residential land uses. In most municipalities, the bulk of land uses will be residential. Formal or urban domestic water demand accounts for ±24% of the national water demand. RSA's gross average consumption is estimated at 229 litres per person per day which is much higher than the intended 50 to 60 litres per person per day. Domestic water use refers to water used for showering, bathing, toilet flushing, laundry, cooking, gardening and, in some instances, filling the swimming pool.
		2.2.3.7	Compile a synopsis that summarises and spatialises the key findings of the land audit data.
2.2.4	**Land ownership analysis**	**Note:** 2.2.4.1	Section 2.2.3.1 mentioned that the land ownership information should also be captured during the land audit process. Land ownership information should differentiate between state-owned, parastatal and privately owned land.
		2.2.4.2	Map and determine the extent of municipality-owned land vs privately owned land, etc.
		2.2.4.3	Map and determine the ownership of vacant municipality-owned land, etc.
		2.2.4.4	Compile a synopsis that summarises and spatialises the key findings of the land ownership analysis.
2.2.5	**Spatial growth analysis**	**Note:** 2.2.5.1	The aim of this analysis is to conceptualise historic growth patterns (density) and natural growth direction (where areas expanded).
		2.2.5.2	Use historic and current land cover data (2000–2014) to determine the rate and extent of land cover change that took place over the last ten years. The latest statistics from Stats SA's Dwelling Frame and Eskom's SPOT Building Count spatial information provides detailed information on when (date) buildings were erected.
		2.2.5.3	Use colour various to indicate dates of development. Infill development is a positive development trend, while development on the outskirts of the existing development boundary is referred to as sprawl.
		2.2.5.4	Compile a synopsis that summarises and spatialises the key findings of the spatial growth analysis.
2.3.1		**Note** 2.3.1.1	The socio-economic analysis is informed by statistical data published by Stats SA. Census data for 1996, 2001 and 2011 is available on sub-place level, while more recent 2016 census data is only available on municipal level.

	Population demographic analysis	2.3.1.2	Map and assess statistical information (Stats SA 2011/2016) on the "number of people" per sub-place, as well as "population density" per sub-place. Highlight which sub-places are most populated and have the highest population densities. If possible, report on change over time.
		2.3.1.3	Review and reflect on statistical information (Stats SA 2011/2016) on the municipalities' populations in terms of age, sex, and racial composition. If possible, indicate change over time. This information is required to build an understanding on who the municipality must plan for.
2.3.2	**Household analysis**	2.3.2.1	Map and assess (where possible) statistical information on the "number of households" by sub-place, as well as the "household density" by sub-place. Highlight in which sub-places most households reside and which households have the highest densities. Report on the average household size. If possible, report on change over time. Report on the average household size.
		2.3.2.2	Review, reflect and map (where possible) statistical information regarding the type of households on sub-place level and indicate how it has changed over time. Additional information on the ownership and tenure status of the property should also be addressed. The assessment should also determine the existing housing backlog. The housing backlog figure can often be obtained from the IDP or the housing sector plan, if available.
		2.3.2.3	Additional information on ownership and tenure status should also be addressed. The assessment should determine the existing housing backlog. The housing backlog figure can often be obtained from the IDP or the housing sector plan, if available.
		2.3.2.4	The household analysis should determine the existing housing backlog. The housing backlog figure can often be obtained from the IDP or the housing sector plan, if available.
2.3.3	**Access to services analysis**	2.3.3.1	Map and assess the existing household "levels of access to potable water services" on sub-place level, as well as the "reliability of service" provision. Information on the reliability of services can be sourced from the NWRS.
		2.3.3.2	Identify the source, as well as the services provider.
		2.3.3.3	Compare the findings to the municipalities' targeted levels of services and determine the existing backlog. In addition, report on any policy or regulation related thereto.
		2.3.3.4	Map and assess the existing household levels of access to sanitation services on sub-place level. Compare the findings to the municipalities' targeted levels of services and determine the existing backlog. In addition, report on any policy or regulation related thereto. It is important to highlight which households receive water through a borehole, as well as by rainwater tank.
		2.3.3.5	Map and assess the existing household levels of access to sanitation services on sub-place level. Compare the findings to the municipalities' targeted levels of services and determine the existing backlog. In addition, report on any policy or regulation related thereto.
		2.3.3.6	Highlight sub-place areas where the majority of household predominantly use VIP latrines not connected to a sewerage network.
		2.3.3.7	Map and assess the existing households' levels of access to energy (energy for lighting and energy for cooking) on sub-place level. Compare the findings to the municipalities' targeted levels of services and determine the existing backlog. In addition, report on any policy or regulation related thereto. It is important to highlight which households are not connected to the grid and do not have access to electricity for cooking.
		2.3.3.8	Highlight sub-place areas where the majority of households are not connected to the grid and do not have access to electricity for cooking.
2.3.4	**Economic analysis**	2.3.4.1	Determine which economic sector is the strongest, as well as the economic growth rate per industry. Employment by industry and growth per sector and employment potential of the sector should also be determined.
		2.3.4.2	Determine the employment by industry ratio, employment by industry, growth per sector and employment potential of the sector, as well as the household's level of income and the percentage of households the qualify for government grants, and the household affordability of the level of services provided (water and sanitation).

Spatial analysis and modelling exercise to inform water-sensitive spatial development proposals and land use management

Environmental considerations

3.1.1	**Environmental conflict areas**	**Note: 3.1.1.1**	The purpose of this analysis is to determine where in the municipality development should be restricted at all times, areas where land use is already in conflict, and where guidance on future development direction is required.
		3.1.1.2	Use the spatial data mapped in sections 2.1.4.2 and 2.1.4.3, which represents all areas protected by law.
		3.1.1.3	Use the combination of land use and land cover data mapped in sections 2.2.1.2, 2.2.1.3 and 2.2.3.2 to 2.2.3.6 and determine which protected areas are currently threatened and affected by development. The term “development” should not be limited to settlement development, but should also include mining, forestry, agricultural development.
		3.1.1.4	Use the “select by location” tool in GIS and identify areas where development disrupted protected areas. Create a new shapefile representing areas of “immediate intervention”.
		3.1.1.5	Determine which protected areas are most likely to face future development threats. The spatial growth information mapped in Section 2.2.5 should be used to determine these areas.
		3.1.1.6	Extract the data and create a new shapefile representing the “areas of future concern”. Use the property ownership information in Section 2.2.4 to determine which stakeholders should be consulted.
		3.1.1.7	Compile a synopsis that summarises and spatialises the key findings of the environmental conflict areas assessment. Land use management guidelines and spatial intervention are necessary for both immediate intervention and areas of future concern.
		3.1.1.8	The authority responsible for protected areas must be informed about areas identified for immediate intervention as it is their responsibility to take legal action against any unlawful land use within declared protected areas. Furthermore, stakeholders identified in Section 3.1.1.6 applicable to the areas of future concern must be consulted.
3.1.2	**Expansion of protected areas**	**Note:** 3.1.2.1	National and provincial governments’ Protected Areas Expansion Strategy aims to increase the amount of land under legal protection in order to achieve national biodiversity target. Existing CBAs and ESAs should be used to determine which areas are most suitable for the expansion of existing protected areas. However, not all CBAs and ESAs will be eligible for legal protection as some areas may already have been invaded by development. Other areas may be of high agricultural potential, or face future development threats. The challenge is to refine the CBA and ESA networks to create focus areas. Focus areas should include existing CBAs and ESAs to be declared as protected areas or legally protected by the municipal land use schemes. Unfortunately, some CBAs and ESAs will be compromised for development as settlements will continue to grow. Nonetheless, the compromised portions of land must be accommodated elsewhere.
		3.1.2.2	Determine which areas of CBAs and ESAs are already affected by development by using the land use and land cover data mapped in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6 as a spatial overlay.
		3.1.2.3	Use the “select by location” tool and extract CBAs and ESAs affected by development and create a new shapefile representing “modified CBAs and ESAs”.
		3.1.2.4	Determine which CBAs and ESAs will most likely to face development threats in the near future. Use the spatial growth information mapped in Section 2.2.5 to determining these areas. Spatial location of future national, provincial and local municipal planned projects should be used in determining these areas. In addition, areas of high agricultural potential should also be selected.
		3.1.2.5	Use the “select by location” tool and extract CBAs and ESAs likely to be affected by development in the near future. Extract the data and create a new shapefile representing CBA and ESA areas of concern.

		3.1.2.6	Of the remaining CBAs and ESAs, determine which are within close proximity of existing protected areas by using "select by location – within a __ distance of protected areas". Use the FEPA spatial data (sections 2.1.4.8 -to 2.1.4.10 if not included as part of an existing CBA or ESA) as an additional parameter when determining areas to form part of the Protected Areas Expansion Strategy. Once identified, select all CBAs and ESAs that form part of the connected network (corridors).
		3.1.2.7	Once identified, select all CBAs and ESAs that form part of the connected network (corridors). Extract the data and create a new shapefile representing protected areas, CBA and ESA potential expansion network.
		3.1.2.8	Land ownership information should be added as a layer in order to determine which expansion strategy should be used (declaration of protected areas, land acquisition, contractual agreements or biodiversity stewardship programmes).
		3.1.2.9	Once the ownership of the areas selected in terms of Section 3.1.2.7 has been confirmed, spatial prioritisation should be aligned to the availability of funds.
		3.1.2.10	Compile a synopsis that summarises and spatialises the key findings of the expansion of protected areas assessment. Land use management guidelines and spatial intervention is required for "modified CBAs and ESAs", "CBA and ESA areas of concern" and "protected area, CBA and ESA potential expansion network".
3.1.3	**Surface water protection and conservation zones**	**Note:** 3.1.3.1	While Section 3.1.2 aimed to identify land of ecological importance and significance within a close proximity of existing protected areas, the remaining CBAs, ESAs and FEPAs must still be managed and conserved as far as possible. Since the publication of the FEPA spatial data, many bioregional plans have included FEPAs as part of CBAs and ESAs with assigned land management guidelines. However, a water-sensitive spatial analysis must purposefully place the focus on FEPAs to promote water sensitivity within the spatial planning and land use management framework.
		3.1.3.2	Map all surface water resources (rivers, wetlands, estuaries) as identified in sections 2.1.2.3 and 2.1.2.4 and highlight their FEPA status (if any) as identified in sections 2.1.4.8 - 2.1.4.10. Once mapped, use the "select by location" tool to identify all freshwater resources already under legal protection, and all surface water resources expected to form part of the expansion strategy as identified in Section 3.1.2.7, protected area, CBA and ESA potential expansion network. Since these freshwater resources are either already protected or feasible for future legal protection, the focus should shift to the remaining freshwater resource areas in need of protection and rehabilitation.
		3.1.3.3	According to the FEPA's land use guidelines, several buffer zones should be added to FEPAs before determining the land use impact on them. Use the "Buffer" tool in GIS to create 100 m, 200 m, 500 m, 1,000 m and 2,000 m buffer zones for the remaining FEPAs.
		3.1.3.4	Determine which FEPA and their buffer zones are already affected by development by using the land use and land cover data mapped in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6 as a spatial overlay.
		3.1.3.5	Use the "select by location tool" and extract FEPAs that have been completely destroyed by development. Create a new shapefile representing "verification of freshwater resources areas". These areas should be prioritised for site inspection or verification to determine whether or not these sites can be rehabilitated.
		3.1.3.6	Use the "select by location tool" and select FEPA buffer zones. Create a new shapefile representing "priority freshwater rehabilitation areas". Further analysis on the type of land use (sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6). Sediment load (section 2.1.2.7) and the remaining vegetation (Section 2.2.1.2) within the buffer zones should be assessed as well.
		3.1.3.7	Determine which FEPAs and their buffer zones will most likely face development threats in the near future. Use the spatial growth information mapped in Section 2.2.5 and all future developments to determine these areas. Use the "select by location tool" and create a new shapefile representing "freshwater areas of concern".
		3.1.3.8	Use the "select by location tool" and extract FEPAs and their buffer zones not affected by development at all. Create a new shapefile representing "intact freshwater resources". Further analysis on the sediment load (Section 2.1.2.7) and the remaining vegetation (Section 2.2.1.2) within the buffer zones should also be assessed.

		3.1.3.9	Compile a synopsis that summarises and spatialises the key findings of the surface water protection and conservation zone assessment. Land use management guidelines and spatial intervention are required for “priority freshwater rehabilitation areas”, “freshwater areas of concern” and “intact freshwater resources”. The “Implementation manual for freshwater ecosystem priority areas” (WRC, 2011) provides land use management guidelines for freshwater ecosystem. These guidelines must be included in the municipal land use scheme clauses.
3.1.4	**Groundwater protection and conservation zones**	**Note:** 3.1.4.1	Groundwater is considered an underutilised freshwater resource. However, concerns of pollution due to land cover change have increased in recent years. Some areas in the municipality may have underlying geological formations (dolomite) with high groundwater recharge potential. These areas should be protected from development as land cover change and land uses will most likely affect the groundwater quality and quantity.
		3.1.4	Map all areas identified in Section 2.1.3.2 “under_geo_concern” and Section 2.1.3.6 “high_Recharge_potential” and the land use and land cover data mapped in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6 and determine which areas are currently affected by development.
		3.1.4.3	Use the “select by location” tool to determine areas with high groundwater recharge potential affected by land use activities. Create a new shapefile representing “land_use_groundwater_interaction_areas” and import water quality data from Section 2.1.3.8, "Groundwater_Quality_Concern”, and Section 2.1.3.9, “Good_Quality_GW”, and determine the quality impact of land use on the recharge zone.
		3.1.4.4	In areas where “land_use_groundwater_interaction_areas” aligns with data from Section 2.1.3.9, "Good_Quality_GW", the impact of land use on groundwater is minimal. Create a new shapefile representing areas of “low_ land_use_groundwater_impact_zone”.
		3.1.4.5	In areas where “land_use_groundwater_interaction_areas” align with data from Section 2.1.3.8, “Groundwater_Quality_Concern”, the impact of land use on groundwater is high. Create a new shapefile representing areas of “High_land_use_groundwater_impact_zone”. It is essential that land use in these landscapes does not interrupt or degrade the recharge of these aquifers any further. The spatial data in Section 2.1.3.9, “Nitrate_dd.shp”, “Fluo_dd.shp” and “iron_dd.shp”, should be used to determine the chemical composition of groundwater resources to trace the root cause of the groundwater quality impact.
		3.1.4.6	Areas with a “low_ land_use_groundwater_impact_zone” should limit development as these areas still provide high levels of groundwater recharge. A “groundwater_conservation_zone” should be assigned to this area to prevent future developments that will destroy the source.
		3.1.4	Areas with a “high_land_use_groundwater_impact_zone” should be prioritised for rehabilitation. Careful groundwater management actions should maintain the rehabilitated state of the groundwater resources.
		3.1.4.8	The remaining landscapes “under_geo_concern” and “high_Recharge_potential” where development has not yet altered the surface areas should be protected from future development by means of a “Groundwater_recharge_protection_zone”.
			Compile a synopsis that summarises and spatialises the key findings of the groundwater protection and conservation zones assessment. Land use management guidelines and spatial intervention are required for “low_ land_use_groundwater_impact_zone”, “High_land_use_groundwater_impact_zone” and “Groundwater_recharge_protection_zone”. Developments in these zonings should be done in consultation with hydrological experts as the relationship between land use and groundwater is complex and often misunderstood.
3.1.5	**Groundwater utilisation and protection**	**Note:** 3.1.5.1	While opportunities for surface water development has become increasingly limited, groundwater will need to be utilised in order to meet the country’s growing water requirements.
		3.1.5.2	Map all areas identified in Section 2.1.3.5, “High_UGEP” and identify which land uses and settlements in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6 that are located either on or close to areas with high volumes of UGEP.
		3.1.5.3	Once the settlements have been identified, use the data provided in sections 2.3.3.1 to 2.3.3.6 to determine the need for water services. The municipality should prioritie the utilisation of groundwater resources for these settlements in close proximity to high UGEP areas.

		3.1.5.4	Use the data from Section 2.1.3.8, "Groundwater_Quality_Concern", and Section 2.1.3.9, "Good_Quality_GW", as an overlay to the selected areas in Section 3.1.5.4 to determine the level of treatment required for groundwater.
		3.1.5.5	Future protection of these areas is also required. Use the borehole data from Section 2.2.3.5 and use the "Buffer" tool to create two protective zonings, "Borehole_Inner_protective_Zone" and "Borehole_Outer_Protection_Zone", with specific land use controls.
		3.1.5.6	Compile a synopsis that summarises and spatialises the key findings of the groundwater utilisation and protection assessment. Land use management guidelines and spatial intervention are required for "Borehole_Inner_protective_Zone" and "Borehole_Outer_Protection_Zone" to protect groundwater from pollution. Settlements and community members who will receive future water services from areas of high UGEP must be educated on where their water comes from and how to use it sustainably.
3.1.6	**Catchment assessment**	**Note** 3.1.6.1	The "Atlas for freshwater ecosystem priority areas" (Nel et al., 2011) designed several land use management guidelines to be implemented on catchment scale.
		3.1.6.2	Map the spatial data from Section 2.1.4.8, "River FEPAs and associated sub-catchments", and Section 2.1.4.12, "Upstream Management Areas" and use the "Guidelines for land use practices and activities that impact on water quantity in sub-quaternary catchments associated with river FEPAs and upstream management areas", "Guidelines for land use practices and activities that impact on water quality in sub-quaternary catchments associated with river FEPAs and upstream management areas" and "Guidelines for land use practices and activities that impact on habitat and biota in sub-quaternary catchments associated with river FEPAs and upstream management areas" (WRC, 2011) to create a "Rivers_FEPA_and_assosiated_sub-catchments_overlay_zone".
		Note: 3.1.6.3	According to Allan (2004), stream in agricultural catchments usually remains in good condition until the extent of agriculture in the catchment exceeds 30-50%. Similarly, for every 10% of altered catchment land use, a correlative 6% of loss in freshwater diversity can be noted.
		3.1.6.4	Use the land uses and land cover information provided in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6 and the catchment boundaries to calculate which percentage between 0-30% and 30-50% of the catchment is used for agricultural purposes and calculate the percentage of additional land use found in the catchment. For every 10% of land taken up by other land uses, a corrective 6% loss in freshwater should be calculated.
		3.1.6.5	Identify the catchment of high concern and create a "Catchment_concern_buffer_zone" that will restrict any new development within these catchments. New development applications must be subject to a vigorous development application process before the application can be approved. Additional measures to improve water quality in these catchments must form part of land use management and spatial planning interventions.
		3.1.6.7	Compile a synopsis that summarises and spatialises the key findings of the catchment assessment. Land use management guidelines and spatial intervention are required for the "Rivers_FEPA_and_assosiated_sub-catchments_overlay_zone" and the "Catchment_concern_buffer_zone" to protect catchments and water resources from degradation and biodiversity loss.
3.1.7	**Urban blue-green corridor**	3.1.7.1	Natural and near-natural landscapes within the existing settlement boundaries should be connected to one another as far as possible to create an integrated blue-green corridor.
		3.1.7.2	Use the spatial data mapped in Section 2.1.2.2, "Undevelopable_high_slopes", Section 2.2.1.2, "Natural_vegetation.shp", Section 3.2.1.10, "CBAs and ESAs areas of concern" and "PA, CBAs and ESAs potential expansion network", Section 3.1.3.9, "freshwater areas of concern" and "intact freshwater resources" and Section 3.1.4.8, "Groundwater_recharge_protection_zone", to determine areas to form part of the blue-green corridor.
		3.1.7.3	Identify land parcels within close proximity to an existing ecological infrastructure network that could potentially form part of the blue-green corridor. In areas where connectivity is obstructed, identify the land use by using the spatial information provided in sections 2.2.1.3 and 2.2.3.2 to 2.2.3.6.

		3.1.7.4	Identify all existing vacant land eligible to be included in the blue-green corridor network. Determine the ownership of the property by using the spatial information provided in Section 2.2.4.
		3.1.7.5	Identify other land parcels (not vacant) obstructing the blue-green corridors connectivity. Determine the ownership of the property by using the spatial information provided in Section 2.2.4.
		3.1.7.6	Create a new shapefile "Blue-green corridor development zone" that represents a consolidated network of ecological infrastructure.
		3.1.7.7	Use the spatial data from Section 2.1.3.3, "high_water_holding_capacity" as an overlay to determine which areas within the "Blue-green corridor development zone" can be used for developing constructed wetlands. Constructed wetland can be used to treat polluted stormwater runoff, can provide an alternative source of water, and can be used as a decentralised wastewater treatment system.
		3.1.7.8	Compile a synopsis that summarises and spatialises the key findings of the "blue-green corridor" assessment. Land use management guidelines and spatial intervention are required for "Blue-green corridor development zone" as this zone should have multi-purpose functionality.

Settlement assessment

3.2.1	**Limit development by increasing densities**	Note 3.2.1.1	Most town and cities in South Africa have some form of development boundary assigned to its built-up footprint by the SDF. This is referred to as the development boundary or urban edge. This is one planning tool that can help protect the natural landscapes outside the existing development footprint from development. Another planning tool is development densities. Higher-density development that goes "sideways" requires less land to accommodate the development footprint. Higher densities also have reduced water loss ratings. For this reason, water-sensitive analysis should determine where and how higher density development can be accommodated within the existing development footprint.
		3.2.1.2	The typical South African settlement is characterised by low-density, sprawling development. Use the spatial data provided in sections 2.2.3.1 to 2.2.3.6 to determine the spatial pattern. It should be classified as either a dispersed pattern, which is low density with single land uses, or a fragmented pattern, which is made up of patches of single-use built-up areas with large unused areas in between, or a compact pattern, which is denser with a mix of land uses. This can also be informed by the household density information calculated and mapped in section 2.3.2.1.
			If the settlement has no existing development boundary or urban edge, create a new shapefile representing the "Development Edge", which is traced as close as possible to the existing built-up footprint.
		3.2.1.3	Use the existing zoning information mapped in sections 2.2.3.1 to 2.2.3.6 to determine the density assigned to buildings. Once the development pattern and density are confirmed, the spatial analysis needs to identify areas to accommodate infill development and a new development boundary to restrict spatial expansion.
		3.2.1.4	Use the spatial data provided in Section 2.2.3.2, "Vacant land", as well as Section 2.2.4.3, "Vacant Municipal owned land", but exclude the new development, "Blue-green corridor development zone" and determine the extent of available vacant land and the "Development Edge". Calculate the size of all vacant land.
		3.2.1.5	Determine the zoning and density assigned to vacant erven identified in Section 3.2.1.4. The density for a single dwelling has a net density of 10 to 20 dwelling units per hectare, which requires an erf size of between 400 and 800 m^2.
		3.2.1.6	A semi-detached dwelling has a net density of 20 to 30 dwelling units per hectare, which requires an erf size of between 300 and 500 m^2.
		3.2.1.7	Row housing has a net density of 30 to 60 dwelling units per hectare, which requires an erf size of between 150 and 300 m^2.
		3.2.1.8	Walk-ups have a net density of 60 to 80 dwelling units per hectare, where the erf size is not applicable.

		3.2.1.9	Flats have a net density of 80 to 100 dwelling units per hectare, where the erf size is not applicable.
		3.2.1.10	Compare the densities assigned to the existing vacant land and and reassess were higher densities can be implemented. Calculate the number of households that can be accommodated by the existing vacant land within the existing development edge by higher density. Quantify this amount in term of years and determine the time period that it will take to fully develop all vacant stands.
		3.2.1.11	Compile a synopsis that summarises and spatialises the key findings of the limit development by increasing development assessment. Land use management guidelines and spatial intervention are required to promote infill development where possible, as it may contribute to reduced water loss, as well as a reduced environmental impact on the surrounding landscapes.
3.2.2	**Land use water quantity impact**	**Note** 3.2.2.1	The quantitative impact of land use on water resources refers to the physical consumption of water. This can be determined spatially by means of two datasets.
		3.2.2.2	Obtain water billing information from the municipality. If possible, this information should be in a digital format. Unfortunately, the consumption data is limited to billed consumption, which is often only applicable to urban areas.
		3.2.2.3	Once the data has been received, identify common information in both the billing data and the land use data that will allow for the two data sets to be linked. This refers to information representing the physical location of the property billed and the extent of the water consumed by the property.
		3.2.2.4	Use the "join and relate" tool to link the billing information to its rightful spatial location.
		3.2.2.5	Use the "reclassify" tool to make sense of the volume of water consumed by the land use. In an ARC sense, the volume of water consumed by land use can be extruded, which provides a spatial representation of the volume of water consumed by land use type.
		3.2.2.6	Determine which land uses consume the highest volumes of water. Identify land uses with irregular usage volumes and "flag" the properties for further investigation. This irregular high usage can be a result of illegal land use activities, e.g. car washing or laundromats on a residentially zoned property. It can also be due to high volumes of water leakages or incorrect billing information.
		3.2.2.7	Use the property ownership data to determine which municipality-owned buildings contribute to high water consumption. These buildings and land uses must be flagged for immediate interventions if it is the municipality's objective to become more water sensitive.
		3.2.2.8	Determine spatially where in the municipality consumption is the highest. Create a new shapefile representing "high_water_useage_zones". Targeted water conservation and demand management strategies should be implemented through development controls or incentives in this zone. Water harvesting, and water efficiency and water reuse technologies, should also be promoted in these zones.
		3.2.2.10	The land use water consumption that is modelled should be used to build and understand the future water demand of a town or settlement, which should be used to influence land use approvals or rejections.
3.2.3	**Household services: potable water**	**Note** 3.2.3.1	The concept of service levels relate to the options that consumers can be provided with a service with regard to the convenience of the services; hence, it influences the amount of water they will consume and the associated wastewater they will generate. Household income should be taken into consideration when service level targets are determined.
		3.2.3	The spatial and statistical information in sections 2.3.3.1 to 2.3.3.8 provides information on existing household levels of services. Whether or not the service is sustainable is debatable. However, water resources planning should be informed by the household's ability to pay or not to pay for services. It is therefore necessary to determine in which sub-places households have been serviced with a higher "unaffordable level of services".
		3.2.3.2	Select the "annual household income distribution", together with "access to piped water" to determine the households' affordability to services.
		3.2.3.3	Reclassify the households' income levels to households that fall in the categories of severe poverty (households earning less than R19,600 per annum), low income households (households earning between R19,601 and R76,400 per annum) and high income (households earning more than R76,400 per annum). The information should be mapped on a sub-place level.

		3.2.3.4	Identify sub-places where the majority of households classified in the poverty category have access to piped water. These households would typically not be able to pay for water services, yet they have access to the highest level of services. Since these households already have access to piped water, water conservation strategies must be a priority in these settlement areas.
		3.2.3.5	Identify sub-places where the majority of households classified in the severe poverty category still have no access to piped water and identify alternative sources of water such as rainwater harvesting. Groundwater sources (if available) rather than surface water resources should be utilised for domestic purposes.
3.2.4	**Household services: sanitation services**	**Note** 3.2.4	The concept of service levels relates to the options with which consumers can be provided with a service with regard to the convenience of the services; hence, it will influence the amount of water that they will consume and the associated wastewater they will generate. Providing potable water for sanitation purposes (toilet flushing) is a wasteful usage. Achieving real gain in sanitation coverage in South Africa has been slow, as many households still lack access to a basic level of service.
		3.2.4.2	Information provided in Section 2.3.3.4 determined spatially which settlements still lack access to sanitation services.
		3.2.4.3	VIP latrines, which is a dry sanitation solution, should not be seen as a lower level of services, but rather as a sustainable level of service. In addition, the waste (biogas) left in the VIP latrine can be used to provide energy for cooking.
		3.2.4.5	Use the data provided in Section 2.3.3.6, "household predominantly use VIPs not connected to a sewerage network", and Section 2.3.3.8, **"**households are not connected to the grid and do not have access to electricity for cooking", to determine where both dry sanitation and biogas generation can be considered as a viable service solution.
3.2.5	**Alternative source of water: rainwater harvesting potential**	**Note:** 3.2.5.1	Rainwater harvesting for domestic purposes is a water-sensitive alternative to substituting the conventional water supply. However, the feasibility of this approach must first be determined.
		3.2.5.2	The equation for determining the volume of usable rainwater harvesting at individual site level is as follow: V = R x A x C x FE.
		3.2.5.3	V = Volume of useable rainwater (ℓ)
		3.2.5.4	R = Average rainfall over period (mm): Obtain daily rainfall data for the entire year from the South African Weather Service.
		3.2.5.5	A = Area contributing to runoff (m^2): Determine the catchment area (roof size). Building footprint information would be ideal. However, this spatial data is limited in South Africa. For this reason, the analysis should assume that the full coverage, as assigned by the LUS, is used to accommodate the building. Calculate the percentage of allowed coverage in GIS and then export the shapefile to be edited in Excel.
		3.2.5.6	C = Run-off coefficient (0-1): Due to limited information on roof type, a conservative 0.85 was selected to represent the runoff coefficient.
		3.2.5.7	FE = Filter efficiency (0-1): Manufacturers recommend a filter efficiency of 0.9.
		3.2.5.8	The above calculation will help determine the volume of water that can be harvested on a daily basis. This information should be cross-referenced with the climate analysis data provided in Section 2.1.1.
		3.2.5.9	In addition, spatial information representing households on sub-place level that rely on water harvesting as a main source of potable water, as provided in Section 2.3.3.1**,** must be consulted to find out whether the source of water is sufficient for domestic use.
3.2.6	**Land use water quality impact**	**Note** 3.2.6.1	Evaluating the level of threat posed by land use and land use activities on stormwater runoff can be determined spatially by adding a generic threats table to the existing land use data.
		3.2.6.2	Use the generic threats table published by MacFarlane et el. (2014), which consists of 82 detailed land uses, grouped into nine main sectors to determine the land use water quality impact within the built-up areas.
		3.2.6	Reclassify the 82 land uses to match the existing land use classification as mapped in Section 2.2.2. Add a new field to the land use cadastre to link the numeric threats ratings.

		3.2.6.4	Use the threats ratings to spatialise the impact of land use on stormwater quality. Use a colour gradient to indicate the severity of threat posed by the land use and the spatial location of the threat.
		3.2.6.5	Identify areas with high threat ratings and create a new shapefile to represent “High_runoff_threat_rating_Zone”. Land uses within this zone should intervene by reducing the volume of water generated on the property by means of rainwater harvesting, increased permeability and increased vegetation cover. This will not only improve the quality of runoff, but also reduce the volume of runoff.
		3.2.6.6	Add the spatial data provided in Section 3.1.7.7, “Blue-green corridor development zone” as an overlay to the areas of “High_runoff_threat_rating_Zone” and identify spatial areas to form part of the SUDS treatment train, which will help to treat polluted stormwater before it enters the natural environment.
		3.2.6.7	Targeted water quality, as well as reducing the quantity of runoff and implementing improvement measures must be assigned to this zone.
		3.2.6.8.	Compile a synopsis that summarises and spatialises the key findings of the land use water quality impact assessment. Land use management guidelines and spatial interventions must assign targeted water quality, and reduce the quantity improvement measures to this zone. The South African Guidelines for Sustainable Urban Drainage Systems should be used to develop these targeted interventions - reducing coverage, increasing natural vegetation and reducing the volume of runoff.