MANAGEMENT FRAMEWORK AND IMPLEMENTATION GUIDELINES FOR PLANNERS AND MANAGERS

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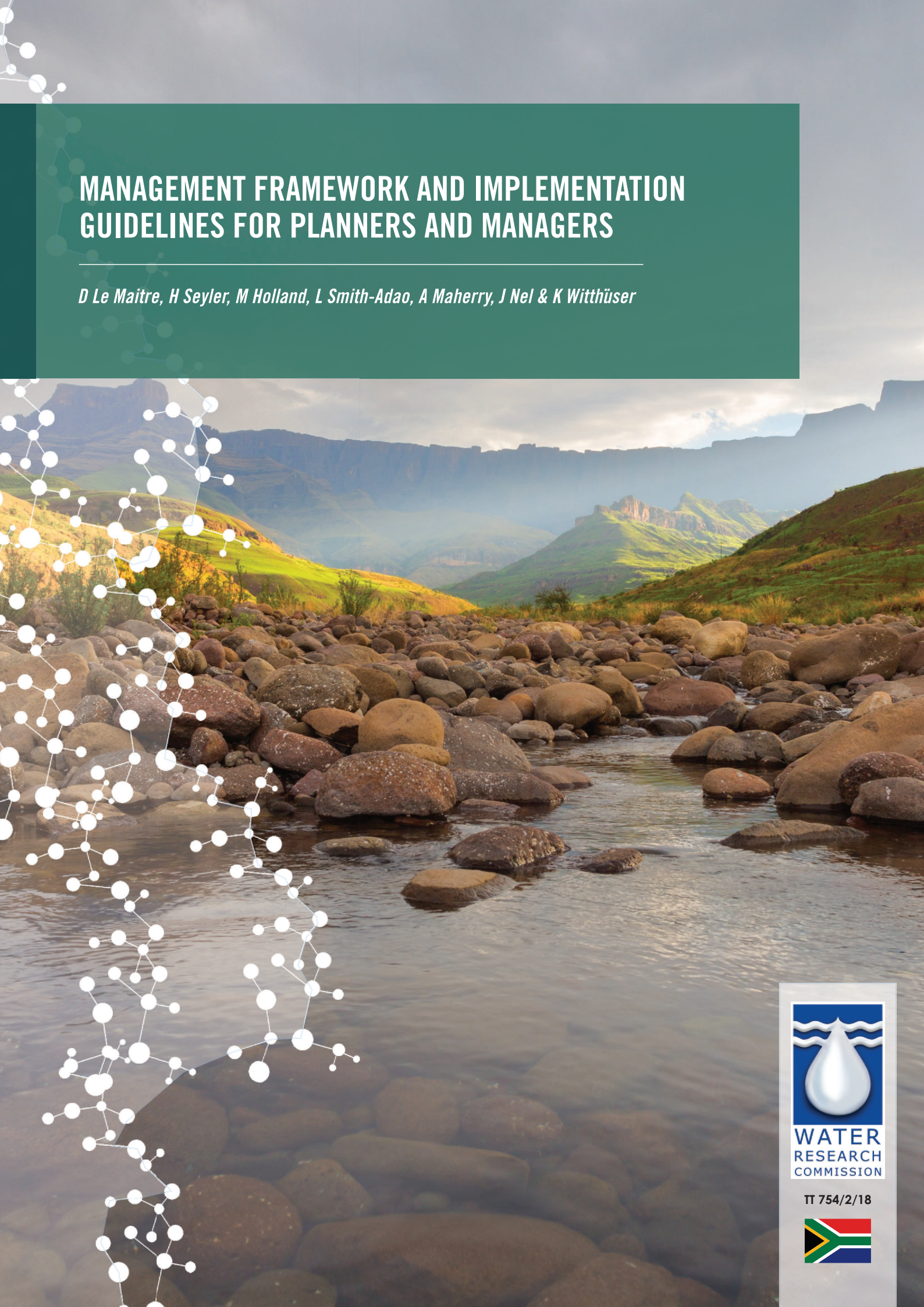

WATER RESEARCH COMMISSION

TT 754/2/18

Strategic Water Source Areas: Management Framework and Implementation Guidelines for Planners and Managers

Report to the

WATER RESEARCH COMMISSION

Prepared by

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EXECUTIVE SUMMARY

Strategic Water Source Areas (SWSAs) are areas of land that either: (a) supply a disproportionate amount of mean annual surface water runoff in relation to their size and are considered nationally important; or (b) have high groundwater recharge or where the groundwater forms a nationally important resource or both; or (c) areas that meet both criteria (a) and (b). They are vital for water and food security in South Africa and also provide the water used in generating most of the electricity. We estimate that the surface water SWSAs produce just over 50% of the mean annual runoff from just 10% of the land area. The groundwater SWSAs capture 15% of the national recharge but they exclude extensive areas with high recharge which are covered by the surface water SWSAs, bringing the total contribution to more than 50% of the recharge.

The water from SWSAs sustains people and industry and makes a substantial contribution to the economy:

- More than 50% of the population and 64% of the economy is sustained by water from SWSAs.
- Irrigated agriculture produces almost all the vegetables and fruit, and a large percentage of the sugar cane in South Africa; it generated a gross income of about R47.8 billion in 2013, and gets about 70% of its water from surface water SWSAs.
- Groundwater SWSAs provide water to 126 towns and rural water supply schemes supporting more than 1.9 million people.
- 394 settlements with least 6.7 million people have groundwater as their sole source.
- Groundwater SWSA-based agriculture generated a gross value added (GVA) of about R2.7 billion and industrial GVA adds substantially more.

This Management Framework and Implementation Guideline Report is intended to facilitate and support well-informed and proactive land management, land-use and development planning in these nationally important and critical areas. The aim or primary principle is to protect the quantity and quality of the water produced by maintaining or improving the condition of the SWSAs. This can be achieved by ensuring that:

- strategic planning (e.g. SWSA maps) informs SDFs, IDPs and zoning schemes;
- any existing activities which adversely affect water quantity and quality are effectively managed and their impacts mitigated;
- applications for any planned activities include an assessment of their impacts on water quantity and quality; and
- authorities evaluating these applications take those impacts into account.

SWSA maps provide the information needed for three broad categories of land and water resource use decisions:

- Reactive decision-making where the authorities react to proposed developments, such as environmental impact assessment (EIA), land-use decisions, water-use licensing, and other development control decisions;
- Strategic planning which takes a long-term view, such as the National Water Resource Strategy, National Planning Commission documents and processes, or Integrated Development Plans (IDPs), Spatial Development Frameworks (SDFs) and zoning schemes;
- Proactive conservation and rehabilitation, such as expansion of protected areas, biodiversity stewardship, clearing of invasive alien plants, and rehabilitation of degraded land and wetlands.

Unlike most changes on the land, changes in water quality and quality can propagate downstream to affect water-users and ecosystems, and those impacts must be taken into account.

The Management Framework and Implementation Guidelines are intended for use by planners and decision-makers in multiple sectors at all levels, from landowners and environmental assessment professionals, to district and local municipal officials, to planners and decision-makers in provincial and national government departments. They identify key management outcomes, which are required to conserve and maintain the quantity and quality of water supplied by these important water source areas. The focus is on three human activities (changing land cover, irrigated agriculture and mining) which are known to have significant impacts on water quantity and quality and also addresses the issue of the impacts of invasive alien plants on water provision. The report also provides advice on which land-uses and activities are not compatible with protecting water availability and maintaining or improving the ecological integrity of the strategic surface water and groundwater source areas that underpin the quality and quantity of water they supply.

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LIST OF ACRONYMS

CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EIA	Environmental Impact Assessment
GRAII	Groundwater Resource Assessment II
GVA	Gross Value Added
IDPs	Integrated Development Plans
MAR	Mean Annual Runoff
NDP	National Development Plan
NGOs	Non-governmental organizations
NPC	National Planning Commission
NRM	Natural Resource Management
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SDF	Strategic Development Framework
SWSA	Strategic Water Source Areas
TMG	Table Mountain Group
WRC	Water Research Commission
WSA	Water Source Areas
WSS	Water Supply System
WWF	World Wildlife Fund

TERMINOLOGY

Aquifer	A geological formation which has structures or textures that hold water or permit appreciable water movement through them (National Water Act 1998). A saturated stratum which contains intergranular interstices, or a fissure/fracture or a system of interconnected fissures/fractures capable of transmitting groundwater rapidly enough to supply a borehole or spring directly.
Baseflow	The volume of water in the stream when at its minimum or base level of flow; this is the level to which the stream flow returns between storms; in climates with seasonal rainfall it is often treated as the dry season flow; it is derived from groundwater flow or discharge (termed the groundwater contribution to baseflow), and from drainage from deep soil and weathered material (i.e. interflow); generally synonymous with the term low flow.
Beneficiaries	The people benefiting from a particular ecosystem service. In the context of Strategic Water Source Areas, beneficiaries are defined broadly as those who benefit from the water supply and quality regulation performed by healthy ecosystems in the associated Strategic Water Source Area.
Groundwater	Water occurring underground: (i) In the unsaturated zone as soil water and interflow (see below), (ii) in the saturated zone as groundwater in aquifers (extractable), and (iii) groundwater in aquitards and aquicludes (not extractable) (Colvin et al., 2007). In common usage and in this document, the term groundwater includes all subsurface water in the zone of saturation with a focus on water contained in aquifers. This is in line with both the wetlands and groundwater literature.
Interflow	Refers to the (rapid) lateral movement of subsurface water from rainfall through the soil layers above the water table to a stream or other point where it reaches the surface; generally synonymous with subsurface stormflow. In the context of this report, interflow is considered as lateral flow in the unsaturated (vadose) zone.
Mean Annual Runoff	Mean annual run-off is the amount of water flowing over the surface of the land (mainly in water courses) over the period of a year; the average (or mean) is calculated over several years (typically at least 10 years).
Protected Areas	The Protected Areas Act recognises two categories: Protected Areas which are areas of land or sea that are formally protected in terms of the Protected Areas Act and managed mainly for biodiversity conservation. This includes most categories of protected government land (e.g. national parks, provincial nature reserves) as well as various forms of contractually protected private land (e.g. stewardships). Conservation areas are portions of the land or seas of land or sea that are not formally protected in terms of the Act but are nevertheless managed at least partly for biodiversity conservation.
Strategic Water Source Areas	A subset of water source areas that are considered of strategic significance for water security. In this report, the term strategic is based on national water resource planning considerations and includes groundwater and surface water source areas (both national and transboundary). Criteria for identifying nationally Strategic Water Source Areas (SWSAs) have been developed as part of this project. Those which are not considered nationally strategic are identified as sub-national WSAs. The term SWSA also was used for the 2013 version of the SWSAs which only included surface water. This study has modified the 2013 definition of strategic and also includes groundwater, which has changed the definition of a strategic water source to include use and dependence on groundwater. We use the following abbreviations: SWSA for any type, SWSA-sw to indicate surface water and SWSA-gw for groundwater.
Water source areas	Natural areas for that provide disproportionate (i.e. relatively large) volumes of surface water and/or groundwater water per unit area, or which meet critical social, economic and environmental water requirements and provide water security.

1. INTRODUCTION

1.1 The purpose of this document

This Management Framework and Implementation Guideline Report is one of the products of the Strategic Water Source Areas Project (WRC Project K5/2431). The project was a three-year partnership between CSIR, DELTA-H and the Water Research Commission (WRC) with the aim of defining strategic spatial priorities for conserving South Africa's freshwater ecosystems, supporting sustainable use of water resources and advancing our knowledge on the benefit-flows and management of these areas. These strategic spatial priorities are known as Strategic Water Source Areas, or SWSAs. The other outputs from this project are a Knowledge Dissemination Report and an Integrated Report (Le Maitre et al., 2018).

This manual is intended to facilitate well-informed and proactive land management, land-use and development planning, and decision making by relevant authorities, within areas identified as SWSAs, with the aim of protecting water availability and maintaining or improving the state of these important water source areas. The implementation manual is structured as follows:

- Chapter 2 explains what SWSAs are and why they are important,
- Chapter 3 outlines existing legal provisions for the protection of water source areas,
- Chapter 4 sets out a management objective
- Chapter 5 provides a management framework and guidelines for key sectors
- Chapter 6 covers implementation guidelines for selected government bodies; and
- Chapter 7 provides some recommendations that were identified during the preparation of this report.

South Africa is water-stressed and already uses its existing freshwater resources intensively. A focus on the sustainable use and management of water resources is therefore becoming crucial, in particular due to effects of natural drivers such as climate change and hydrological variability, and to current and future pressures from economic and population growth. It is widely accepted that social, ecological and economic systems are interlinked and inter-dependent (Figure 1). Protection and utilisation of natural resources therefore needs to work hand-in hand to achieve sustainable development as expressed in the Sustainable Development Goals.

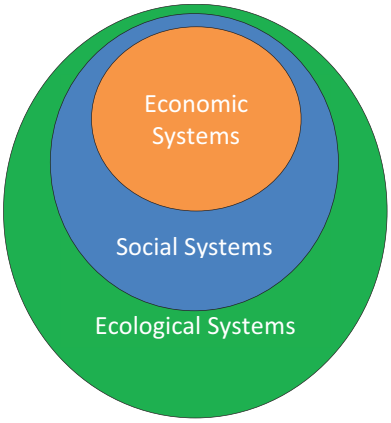

Figure 1: The health of our ecological systems and associated natural capital underpins social and economic development.

The primary principle behind these guidelines is to protect the quality and quantity of the water produced by SWSAs. This can be achieved by ensuring that:

- **SWSAs are used in strategic planning, e.g. SWSA maps should inform SDFs, IDPs EMFs and zoning schemes;**
- **any existing activities which adversely affect water quantity and quality are effectively managed and their impacts mitigated or avoided;**
- **applications for any planned activities must include an assessment of their impacts; and**
- **authorities evaluating these applications must take those impacts into account.**

Unlike changes on the land, changes in water quality and quality can propagate downstream to affect water-users and ecosystems, and those downstream impacts must be taken into account.

The SWSA maps indicate where special attention needs to be given to the potential impacts of three broad categories of land and water resource use decisions (Driver et al., 2011) on water quality and quantity:

- Reactive decision-making where the authorities react to proposed developments, such as environmental impact assessment (EIA), land-use decisions, water-use licensing, and other development control decisions;
- Strategic planning which takes a long-term view, such as the National Water Resource Strategy, National Planning Commission documents and processes, or Integrated Development Plans (IDPs), Spatial Development Frameworks (SDFs) and zoning schemes;
- Proactive conservation and rehabilitation, such as expansion of protected areas, biodiversity stewardship, clearing of invasive alien plants, and rehabilitating of degraded land and wetlands.

1.2 Intended users of this manual

This management framework and implementation guideline document is intended for use by planners and decision-makers in multiple sectors at all levels, from landowners and environmental assessment professionals, to district and local municipal officials, to planners and decision-makers in provincial and national government departments. They identify key management outcomes (refer to **Section 1.3**), which are required to conserve and maintain the quantity and quality of water supplied by these important water source areas.

As large parts of the WSAs are already subject to various forms of land-use and land management, the existing activities would need to be assessed to ensure that the impacts on water quantity and quality are effectively mitigated. This project focuses on the **Forestry sector** (refer to **Section 5.2**), the **Agriculture sector** (refer to **Section 5.3**) and **Mining activities** (refer to **Section 5.4**), as well as the management of **Alien invasive plants** (refer to **Section 5.5**). Guidelines on the implementation of SWSAs are also provided for government agencies (refer to **Section 6**). This document cannot cover every aspect of the protection of the quantity and quality of groundwater and surface water provided by the SWSAs. So relevant literature has been identified and can be consulted and we strongly recommend that the advice of specialists should be sought whenever there is doubt about a decision or course of action.

For further information on SWSAs and their location, refer to Section 2 of this report: What are Strategic Water Source Areas and why are they important?

1.3 Key management outcomes

The report also provides advice on which land-uses and activities are not compatible with protecting water availability and maintaining or improving the ecological integrity of the strategic surface water and groundwater source areas that underpin the quality and quantity of water they supply. The guidelines for the implementation of the National Freshwater Ecosystem Priority Areas (Driver et al., 2011) discuss the responsibilities of the implementers in considerable detail and they are also dealt with briefly in Section 6.1

The protection of rivers and wetlands is a joint responsibility of the Department of Water and Sanitation and the Department of Environmental Affairs, as well as other government entities at national and sub-national levels. The governance of SWSAs spans an even wider range of government entities as it addresses the planning, management and use of the land areas which produce the water that sustains the rivers and wetlands, and the people and the economic activities that depend on that water. Maintaining the natural vegetation and the ecological processes in these areas, including restoration where necessary, is the most cost-effective way of ensuring that water quantity and quality are maintained. However, large portions of the SWSAs are landscapes where human activities generate impacts on water but also sustain the economy so there have to be trade-offs. The current state of South Africa's water resources provides very strong evidence that the country is failing to balance those trade-offs and, particularly, to maintain critical infrastructure that protects water quality (CSIR, 2011; DWA, 2013). The core issue, therefore, is one of finding a balance between the imperatives of protecting water source areas and the water they produce for human well-being, and continuing the human activities that sustain human well-being. The best way to do that is to define how the water source areas should be managed by defining some key management outcomes.

Key management outcomes include:

- maintaining healthy functioning riparian zones and wetlands to regulate water quantity and quality, including protecting them from adjacent land-uses with suitable buffer strips;
- ensuring good agricultural management which leads to soil conservation that supports the water cycle and minimises adverse impacts;
- avoiding activities that reduce stream flow through water abstraction (e.g. irrigated agriculture) or by decreasing stream flows (e.g. forestry plantations) and, where this is not possible, ensuring strict regulation of these activities;
- avoiding activities that reduce infiltration (e.g. soil degradation, construction of areas with hard surfaces; unwise land cultivation practices), and where this is not possible ensuring judicious planning and regulation of these activities;
- ensuring that other activities that adversely affect water quality (e.g. some forms of mining, discharges of pollutants, polluted stormwater, malfunctioning wastewater treatment plants) are effectively managed and that the impacts of proposed new activities are properly assessed and avoided or mitigated, or not permitted where this cannot be achieved;
- clearing invasive alien plants to protect ecosystem structure and function and enhance stream flows; and
- restoring the hydrological functioning of degraded landscapes.

2. WHAT ARE STRATEGIC WATER SOURCE AREAS AND WHY ARE THEY IMPORTANT?

Water Source Areas (WSAs) are internationally known as "water towers", a term that was first used by Meybeck et al. (2001) to describe mountain areas that supply disproportionate runoff compared to adjacent lowland areas (Nel et al., 2013; WWF, 2013). Strategic Water Source Areas are those that are important from the human perspective because they are the only or primary source of the water that sustains society and the associated economic activities, and are considered important enough to be given special attention in water resource planning and protection. This distinction recognises that although some water source areas may provide lots of water, the people and the economic activities they support are only of local importance, or there may be very few or no people at all. An example would be some desert areas with ephemeral rivers fed by rains in their source catchments.

Strategic Water Source Areas (SWSAs) are areas of land that either: (a) supply a disproportionate amount of mean annual surface water runoff in relation to their size and are considered nationally important; or (b) have high groundwater recharge and are locations where the groundwater forms a nationally important resource; or (c) are areas that meet both criteria (a) and (b).

The study that produced this management framework and implementation guidelines focused on water source areas that are considered critical at the national and transboundary level. It is also important to assess water source areas at both the regional (e.g. provincial, water management area) and the local level (e.g. municipal water supply dams or wellfields). We would encourage government bodies operating at these levels to undertake similar studies to identify their strategic water source areas and to ensure that these are given the required levels of protection to safeguard the they water provide for the future.

2.1 An introduction to Water Source Areas

In South Africa, the concept of identifying and protecting SWSAs began in 1959 with the Soil Conservation Board's interdepartmental committee working on conservation strategies for the principal mountain catchments of South Africa, considered to be the main sources of the country's water supply. This work identified 109 important mountain catchments based on mountains or relatively high lying areas together with data on the key rivers, mean annual runoff and its importance, area of State Forest land and ecological condition (Government of South Africa 1961). This work eventually led to the proclamation of Mountain Catchment Areas in terms of the Act (Act 63 of 1970) but only some areas were proclaimed and this has a limited impact on their protection and management. In 2004, the first National Spatial Biodiversity Assessment of South Africa (Driver et al., 2005) analysed mean annual runoff data at a quaternary catchment resolution to identify those quaternary catchments that provided 20% of South Africa's mean annual runoff. This work was refined using data on rainfall and runoff at a 1 minute x 1 minute resolution to identify "high water yield areas". The SWSAs were found to represent just 8% of the land area in South Africa, Lesotho and Swaziland, but produced 50% of its mean annual surface run-off (Nel et al., 2013). The findings of the 2013 study have now been updated and refined to identify those strategic surface water sources areas that are of national and transboundary importance and to add the areas considered nationally important as sources of groundwater based on the volumes available or their importance for water supplies to settlements and agriculture (Le Maitre et al., 2018).

Surface-water source areas

The incorporation of the national water planning perspective resulted in the inclusion of three new SWSAs for surface water: Upper Vaal, Upper Usutu and Waterberg. Two high mean annual runoff areas identified by Nel et al. (2013), namely the Pondoland and Zululand Coast, were considered to be of sub-national importance. The final set of 22 surface-water SWSAs supply 50% of the region's mean annual runoff (see Appendix 1A for details) (Figure 2), of which 80%, 12% and 8% are contributed respectively by South Africa, Lesotho and Swaziland.

Surface-water SWSAs are found in areas with high rainfall and produce most of the runoff (Figure 3; see Appendix 1A for details). They are found mainly along the eastern side of the country, particularly along the Drakensberg escarpment from the Eastern Cape though to Limpopo. They are the source of most of the major river systems, notably the Orange, Tugela and Mzimvubu rivers. This Orange River is the only perennial river extending into the Northern Cape other than the Vaal River and depends on Lesotho for most of its water. The high concentration of rivers which have their source areas along the Drakensberg escarpment is also clear. The Vaal River catchment falls mainly into an area with relatively low rainfall as it is in the rain shadow of the Drakensberg escarpment and so has only limited contributions from SWSAs. The relatively low runoff is the main reason why the water in the Vaal River System has had to be supplemented with water from the Tugela River and Lesotho. The upper Olifants River also has relatively low rainfall and runoff and is one of the most severely affected by human activities but its middle reaches are fed by the Mpumalanga Drakensberg SWSA. The Limpopo River Basin includes some important groundwater SWSAs and has some contributions from the Waterberg and Soutpansberg SWSAs.

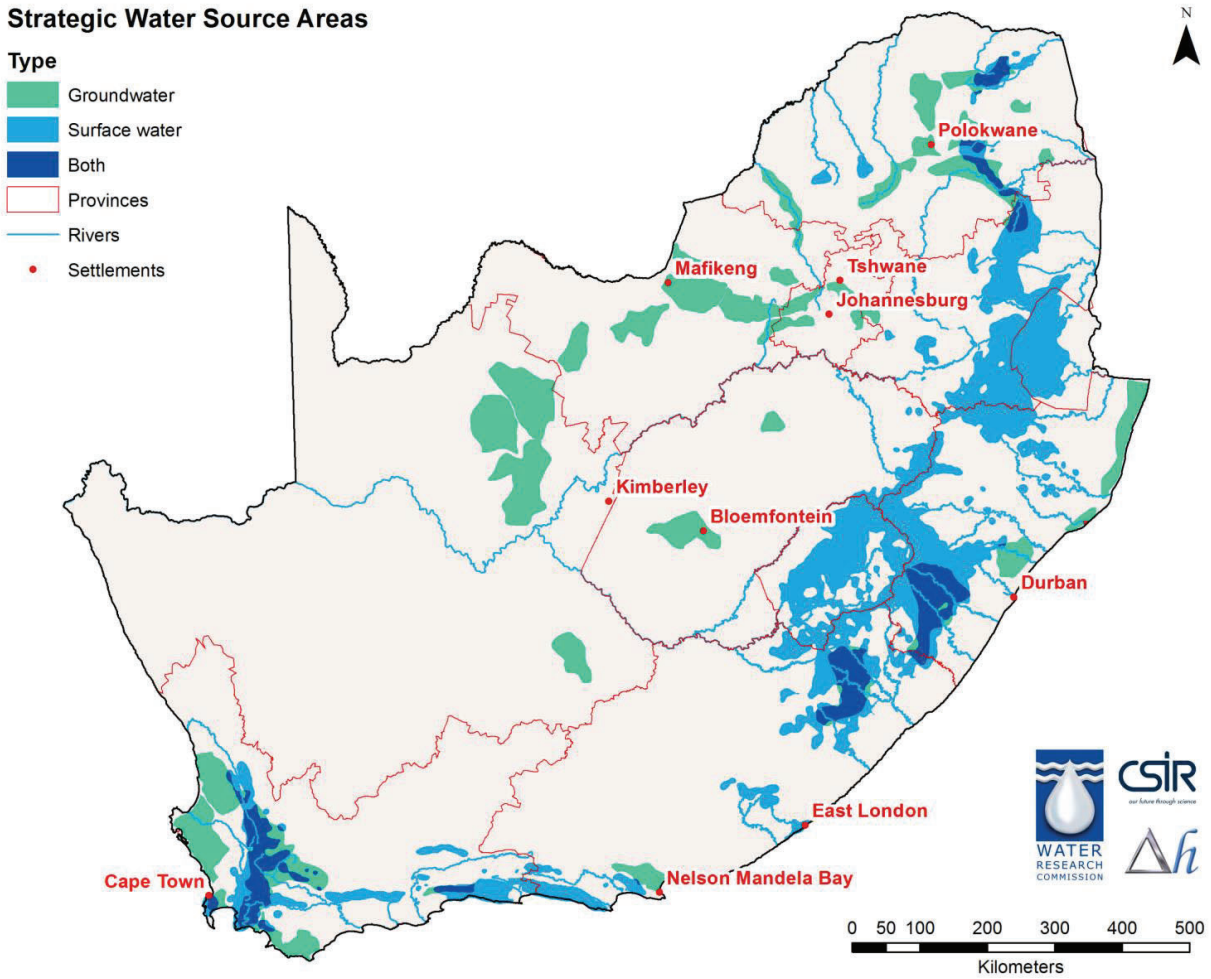

Figure 2: The national and transboundary Strategic Water Source Areas of South Africa Lesotho and Swaziland showing the surface water and groundwater areas and their overlaps. Note that no groundwater SWSAs were identified in Swaziland or Lesotho due to a lack of suitable data on water demand.

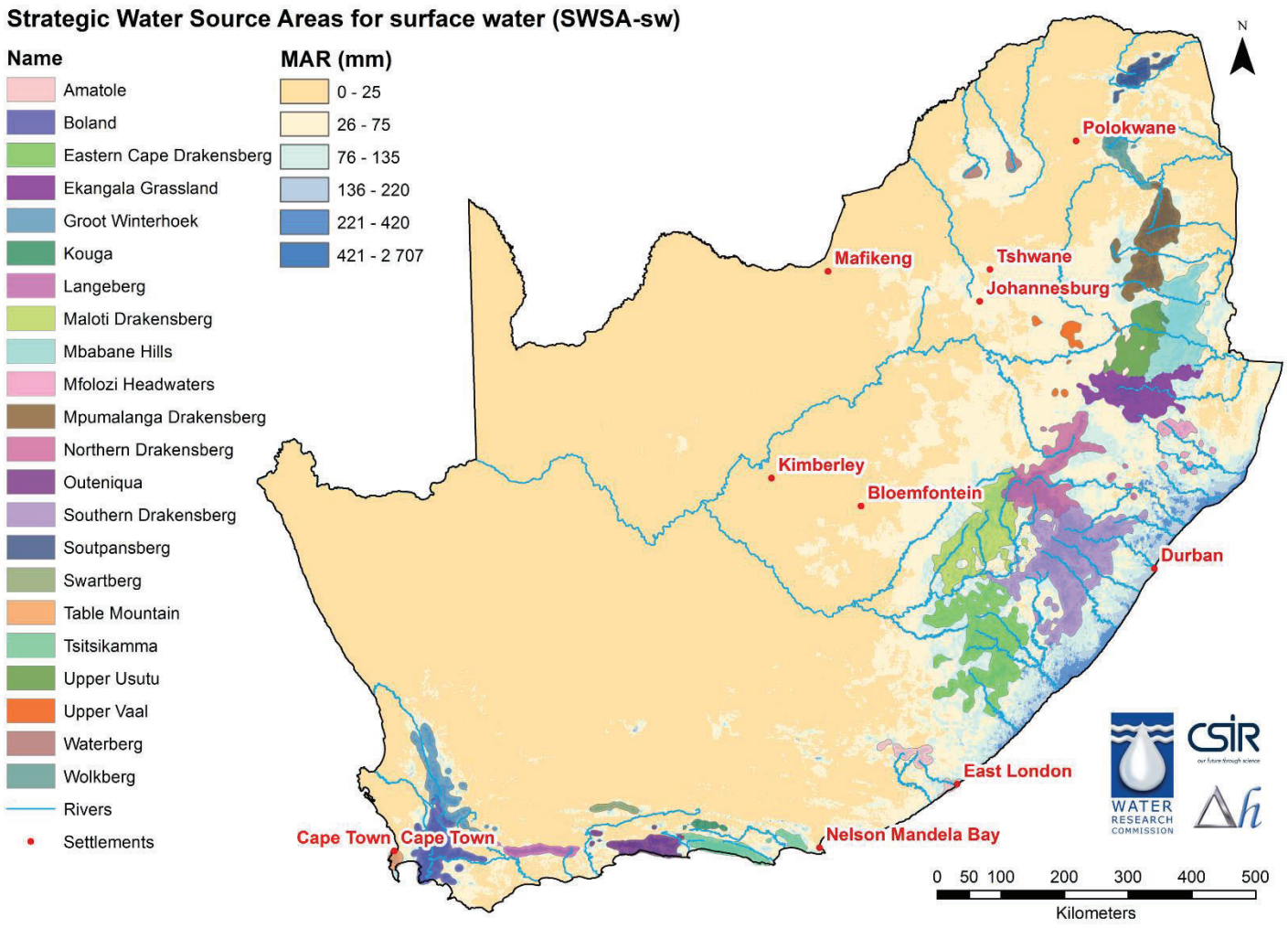

Figure 3: The surface water Strategic Water Source Areas of South Africa Lesotho and Swaziland showing the mean annual runoff overlaid with the areas (polygons) identified as being of national strategic importance. Areas on the east coast which exceed 135 mm/a of mean annual runoff are of sub-national importance.

Groundwater source areas

Groundwater SWSAs are areas which combine areas with high groundwater availability as well as where this groundwater forms a *nationally* important resource (Le Maitre et al., 2018). Five criteria and associated thresholds were used to identify the groundwater SWSAs in South Africa, Lesotho and Swaziland (Table 1).

Table 1: Criteria and thresholds used in groundwater source area delineation (Le Maitre et al., 2018)

Criteria	Description	Threshold	Motivation
1	Recharge as mm/a (GRAII, (DWAF, 2006))	>65mm/a	Corresponds to >50% of the national recharge volume
2	Ratio of recharge per 1km^2 grid cell compared to the average recharge of the secondary catchment	>1.5	Threshold set iteratively and subjectively
3	Registered groundwater use (WARMS) as l/s per km^2 (Kernel function)	>0.3 l/s/km^2	Threshold set iteratively and subjectively
4	Towns/village clusters with groundwater as sole supply, for *current* domestic water supply, mapped as points with a 10 km radius.	None (i.e. all areas included)	All areas are relevant, no threshold to be met
5	Groundwater resource unit used for current or future supply to an area of national economic importance, and groundwater control areas	None (i.e. all areas included)	National interest

Any areas meeting criteria 1 or 2, and 3, 4 or 5 were delineated as a groundwater SWSA. Furthermore, any area meeting criterion 5 was delineated as a groundwater SWSA. Fifty-seven groundwater WSAs were identified in South Africa (Figure 4; for details see Appendix 1B). Thirty-seven of these areas were considered to be of national importance or significance (i.e. SWSAs for groundwater), 10 of which incorporate groundwater control areas. Twenty groundwater source areas were considered to be of sub-national importance (e.g. Beaufort West, Loxton, Carnarvon, Sishen/Kathu, Soutpansberg) although they met the necessary criteria.

Areas meeting criterion 1 largely coincide with surface water source areas, as high rainfall generally translates into high recharge and, in turn, high baseflow. High rainfall also translates into high runoff, and surface waters are sustained during the dry season by high baseflow in the same areas (Vegter, 1990; Woodford, Rosewarne & Girman, 2006; Winter et al., 1999).

More than half of these areas met criteria 1 or 2 and so have relatively high groundwater recharge and could be considered areas with high groundwater potential. Together they account for 92% of the recharge from groundwater SWSAs and 15% of the national recharge. Among these, there are extensive overlaps with surface water SWSAs in nine areas. These overlaps are largely due to the high rainfall and recharge in the mountain areas and emphasize the importance of taking the water cycle into account in assessing SWSAs.

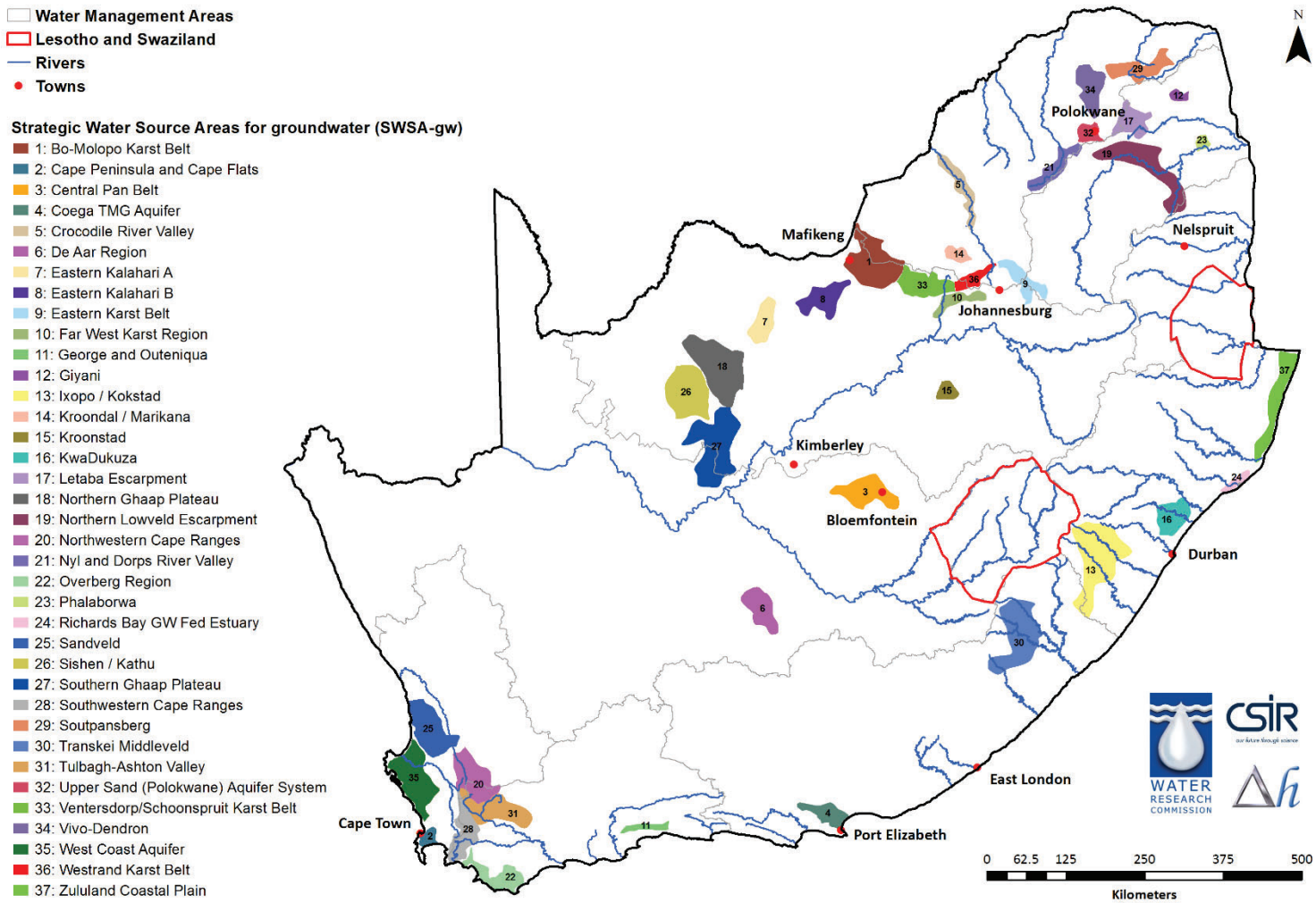

Figure 4: Groundwater SWSAs. No groundwater SWSAs were identified in Lesotho or Swaziland because of a lack of suitable data on groundwater use and dependence.

2.2 Water Source Areas and the Water-Cycle

The water-cycle describes the ways in which water is exchanged between the atmosphere and the earth's surface and sub-surface. Water that evaporates from the earth's surface, whether from open water such as rivers, lakes and the oceans, or vegetated areas and soil and rocks, condenses again to form clouds. The clouds then release their water as precipitation – which can be in the form of dew, captured mist or fog droplets, rainfall or snow, back to the earth *(*Figure 5). Water that infiltrates into the soil percolates through it and either flows out to rivers and wetlands (as interflow, or from perched groundwater systems) or continues downwards to the water table where it replenishes or recharges the aquifers. Groundwater flows under the surface from recharge areas (which may extend across an entire aquifer in the case of unconfined aquifers like the one shown in Figure 5) till it reaches a discharge point, which may be discharged to surface water – a route known as the aquifer pathway. Groundwater plays an important role in sustaining our perennial (always flowing) rivers through groundwater discharges into rivers ("groundwater contribution to baseflow"). As the travel time for groundwater is significantly slower than surface water, groundwater's discharge to surface water can be significant in maintaining surface water during drought when rainfall related runoff is limited.

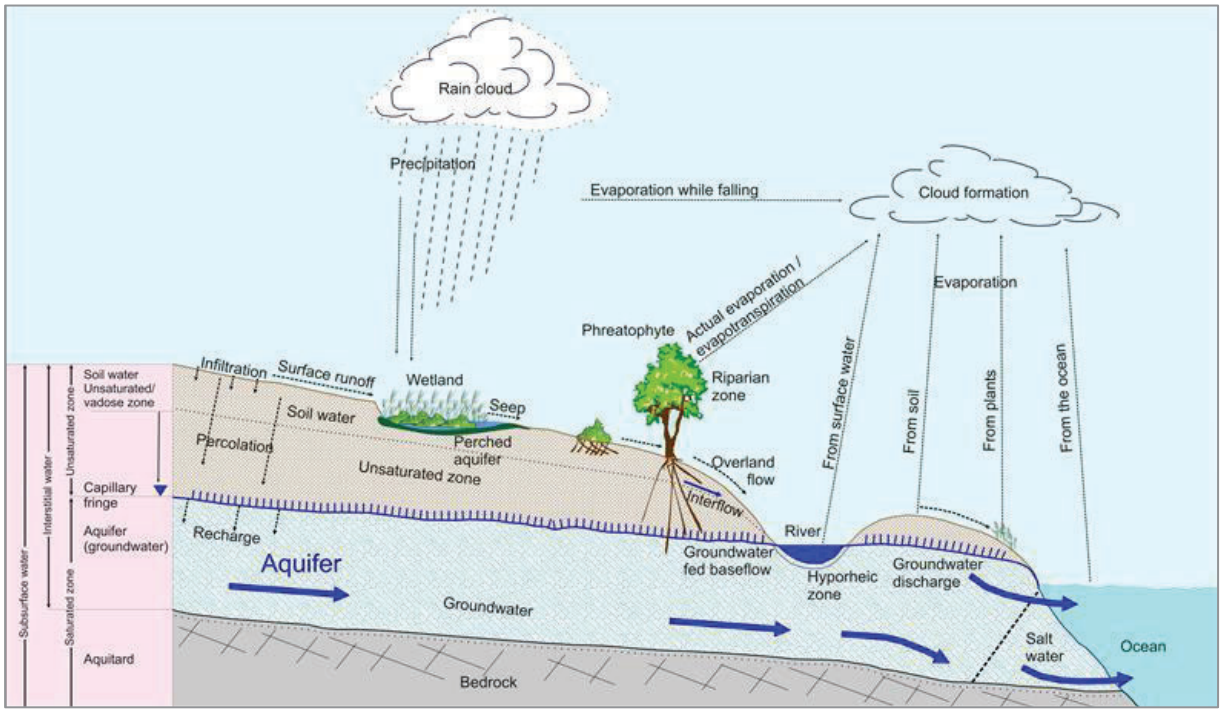

Figure 5: The water cycle illustrating surface water – groundwater connections and flows with the example of an unconfined aquifer underlain by impermeable bedrock (Credited to CSIR 2004 in ***http://www.limpopo.riverawarenesskit.org***)

What is done on the land, even well away from any obvious body of water, can have effects elsewhere and potentially hundreds of kilometres away. The Orange River is a good example. Water that is transferred from dams in Lesotho to Gauteng, is not available to towns and farming communities downstream on the Orange River. Similarly, sediment or chemicals released into a river at one point can affect all the people downstream.

An important message from this brief description is that liquid water flows – it connects upstream with downstream – so that what is done with, or to, water in one place can have effects elsewhere.

Water is the basis for all life so water is important to us in many, many ways, influencing people's activities and aspirations (Palmer et al., 2002). The needs for water range from essential water required by all living organisms to maintain their vital functions, to providing environments which shape our well-being and inspire us as human beings. We need water to drink and for irrigation, for growing food and fibre, for our industries and vehicles. Sustained supplies of high quality water depend on how we use and manage the land areas that capture that water, store it in the soils and aquifers and release it slowly into the rivers. Natural ecosystems are also adapted to different climates and soils. The native species along the rivers are adapted to withstand the effects of floods, minimize the mobilization of sediment and mitigate the damage done by floods but they need water flows of the right quantities and at the right times to maintain those functions. Sustained flows of water in our rivers are vital for filling the dams that supply our towns and cities and so are the sustained flows from groundwater sources. Freshwater flows are also needed to sustain estuaries and for the breeding some marine species, so river water that flows into the sea is not wasted.

2.3 Water Source Areas and their value to South Africa

The fact that water is a key limiting resource for South Africa has been demonstrated by the recent drought which resulted in water shortages in many places, negatively affecting our social and economic development, and leading to service protests. There is ample evidence that pressures arising from social and economic needs have resulted in widespread water stress and significant impacts on water quantity and quality (DWA, 2013; CSIR, 2011). In many regions of the country water demand outstrips supply, and water quality has declined due to increased pollution from industry, urban expansion, mining, power generation, agriculture, forestry, unrestrained littering and inadequate sewage treatment. This is aggravated by the fact that more than half of our river, wetland and estuary ecosystem types in South Africa are threatened (Nel et al., 2011). Such widespread degradation of freshwater ecosystems inevitably compromises ecosystem service delivery and results in more costly management interventions and the loss of resilience when circumstances change. This current situation is even more alarming when future pressures on water resources are considered – the demand for water is predicted to escalate exponentially (DWA, 2013) and many parts of the country are expected to become drier due to of climate change, threatening our water supplies (Schulze, 2005; DEA, 2011).

Water source areas are critical because they produce large volumes of water that sustain people both locally and far away and, in the case of groundwater, are often the only sustainable and reliable water source. The updated surface water SWSAs produce 50% of the mean annual runoff from 9.7% of the land area including transboundary areas. If the SWSAs falling within Lesotho and Swaziland are excluded they provide 44.4% of the mean annual runoff from 7.76% of the land area; this emphasises how important Lesotho, in particular, is in providing water to South Africa. The Southern Drakensberg yields the most runoff (8.9% of the national and transboundary runoff) followed by the Eastern Cape Drakensberg (5.7%) and the Boland (5.01%). The groundwater SWSAs provide 16.5% of the national recharge but that does not include most of the areas with >65 mm/a of recharge which overlap with the surface water SWSAs. An analysis of the groundwater contribution to baseflow (the flow between rainfall events) from the SWSAs shows that it accounts for >40% of the mean annual runoff from more than half the surface water SWSAs. In other words, sustained water production from surface water SWSAs is heavily dependent on groundwater discharges.

The water from SWSAs sustains people and industry and makes a substantial contribution to the economy. To support this, South Africa has invested in some very large and complex water supply schemes (WSSs)

which transfer large volumes of surface water between catchments to meet demand and to ensure a high security of water supply (Figure 6). The most complex WSS supplies the city region of Gauteng, including the cities of Johannesburg and Pretoria, namely the Vaal WSS and interlinked Crocodile West WSS. The total population in this city region in 2011 was 13.2 million people (25% of the population) and its total Gross Value Added (GVA, a measure of sub-national monetary flows) was R587 billion. About 65.0% of the water supplied to this city region is derived from the Maloti Drakensberg, Northern Drakensberg, Upper Vaal, Enkangala and Upper Usutu SWSAs. This includes a large transfer from the Vaal WSS to the Crocodile West WSS which amounts to 68.9% of the water supplied by the latter WSS (Figure 6).

The Cape Town city region had a population of 4.2 million people in 2011 and a GVA of R195 billion (10.7% of the national GVA). It gets more than 98% of its water from the Western Cape WSS which includes three surface SWSAs and the rest from groundwater SWSAs. Almost all of the 98% comes from the Boland SWSA, with Voëlvlei Dam getting some of its water from the Grootwinterhoek SWSA, and small quantities are produced by the Table Mountain SWSA. These SWSAs also sustain extensive areas of irrigated agriculture which produce most of South Africa's wine and much of the deciduous fruit.

The eThekwini city region (Durban and surrounds) had a population of 4.4 million in 2011 and a GVA of R174 billion. The eThekwini and Pietermaritzburg WSS – which includes the uMkhomazi, uMngeni and Mooi River systems – gets 97.8% of its water from the Southern Drakensberg SWSA.

The Nelson Mandela city region had a population of 1.1 million in 2011 and a GVA of R42 billion, and gets its water from the Algoa WSS which gets 91.3% of its water from SWSAs. This includes about 16.1% from transfers from the Gariep Dam which gets its water primarily from SWSAs in Lesotho and South Africa (Figure 6).

Irrigated agriculture produces almost all the vegetables and fruit, and a large percentage of the sugar cane in South Africa. The agricultural sector sustains about 8.5 million people and generated a gross income of R47.8 billion in 2013 from horticultural crops (which are all irrigated). This value includes some secondary processing by large companies which also own farms (e.g. McCain's frozen vegetables). In 2013/14 the total area under irrigation was about 1.76 million ha and the estimated water requirement was about 8 128 m^3/a, with about 70% of that water coming from surface water SWSAs.

The groundwater SWSAs provide water to 126 towns and rural water supply schemes, many of which include several villages, which support more than 1.9 million people. If all the 394 sole source settlements are included, then at least 6.7 million people are largely supported by groundwater. These figures do not include private abstractions and people living on the thousands of farms that depend on groundwater. Important regional centres that are highly dependent on groundwater include Mafikeng with 75% of its water from groundwater, Lichtenburg >50%, Thabazimbi 34%, Giyani 26% and Polokwane >11%. Both Tshwane and Johannesburg get a small proportion of their water from groundwater as does the Cape Town Metropol. Agricultural groundwater use in the SWSAs comes to about 753 mill m^3/a and these areas also supply about 25 million m^3/a to industry. These activities generated a GVA of about R2.7 billion (44.7% of the groundwater-generated GVA) with most of that being generated in the SWSAs in the Western Cape and the Karst areas.

In summary, more than 60% of the population and 64% of the economy is sustained by water from surface water SWSAs which also provide about 70% of the water used in irrigated agriculture. Groundwater SWSAs support 126 towns which house more than 1.9 million people, and support 31% of agricultural and 43% of industrial groundwater use.

Electricity is essential for South Africa but power generation consumes large quantities of water. Power generation by Eskom uses water both in the processes of mining and preparing the coal, and for cooling systems at the power stations. The air-cooled stations use much less water than the water-cooled stations. All the power stations are achieving high levels of efficiency in water-use per kWh, but in 2011 they still used about 327 million m^3 of water just for power generation (http://financialresults.co.za/2011/eskom_ar2011/fact_sheets_12.php).

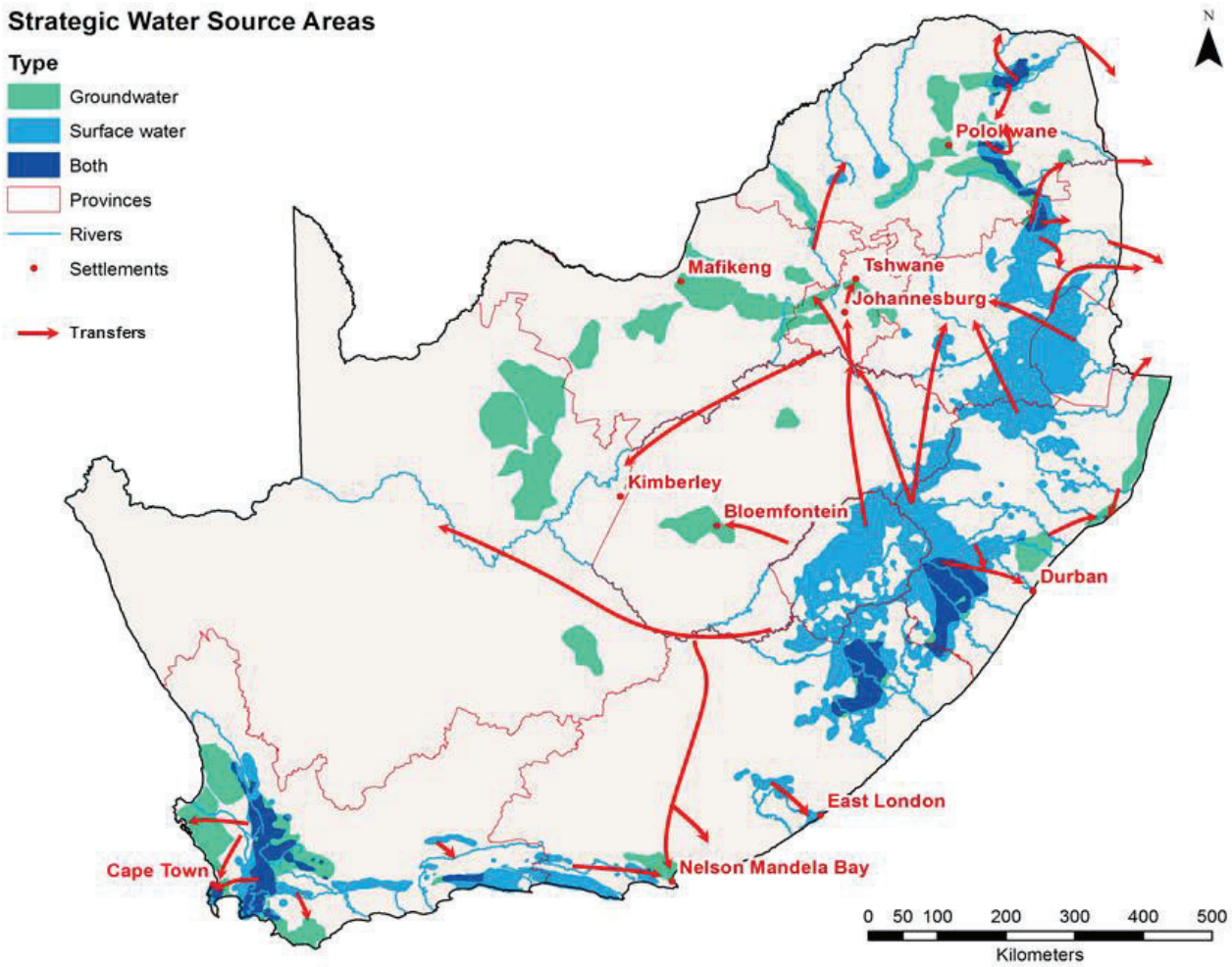

Figure 6: Strategic Water Source Areas highlighting the major water transfers and major flow modifications (➔) enabled by the major water supply schemes

3. LEGAL PROVISIONS FOR THE PROTECTION OF STRATEGIC WATER SOURCE AREAS

The current water situation in South Africa provides a strong motivation for protecting WSAs to ensure that they continue to supply a sustained yield of high quality water. Although surface-water WSAs were included in the National Water Resources Strategy (DWA, 2013), there is no specific policy, legislation or regulation that specifically protects these areas or their groundwater counterparts. This section discusses some of the legal provisions that could be applied in the management and implementation of Strategic Water Source Areas for both groundwater and surface water (Table 1).

Section 24 of the Constitution of the Republic of South Africa (Constitution, Act 108 of 1996) affords everyone the right to an environment that is not harmful to health or well-being. It also places an obligation on the State to protect the environment, for the benefit of present and future generations through legislative and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development. It specifically identifies the provision of sufficient water (and food) as basic right (Section 27) and the water providing environment needs to be protected to give effect to that right.

Various laws have been passed since the adoption of the Constitution to give effect to Section 24. The most important law for the purposes of this document is the National Water Act (Act No 36 of 1998), which is the main law dealing with water resource protection and management in South Africa. The National Water Act does not contain provisions for the protection of water source areas, but it is currently under review and there is thus an opportunity for the inclusion of appropriate provisions. The current provisions include the Resource Directed Measures and anti-pollution measures for protecting the integrity of water sources (Table 1) and the Act could be amended to include special provisions for Water Source Areas. The implementation manual for the National Freshwater Priority Areas (Driver et al., 2011) gives examples of the kinds of protection and restoration measures that could be taken. Other environmental laws, such as the National Environmental Management Act (Act No 107 of 1998) contain provisions for the protection of specified geographical areas, but not specifically because of their value as water source areas.

A number of international conventions which address sustainable development have been ratified by South Africa. These include Agenda 21 where Section 8 calls on countries to adopt national strategies for sustainable development to address issues such as water quality and quantity, climate change, waste management, soil loss and pollution, food production and strategic biodiversity management, while attending to development priorities associated with addressing poverty and basic human needs. Others include the Framework Convention on Climate Change, Convention to Combat Desertification and the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar convention). All of these address the protection of land and the resources it provides, including water.

There are several legal measures which are available for protecting water and water sources producing that water, such as SWSAs, in various ways (Table 2).

Table 2: Legal provisions that are available for protecting water and the SWSAs producing that water.

Legislation	Applicability to SWSAs
National Water Act (Act No. 36 of 1998)	The overarching objective of the National Water Act is to ensure that South Africa's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account, amongst other facts, meeting the basic human needs of present and future generations, promoting the efficient, sustainable and beneficial use of water in the public interest, facilitating social and economic development, providing for growing demand of water use, protecting aquatic and associated ecosystems and their biological diversity, and reducing and preventing pollution and degradation of water resources. One of the Act's main mechanisms for the protection of water resources is the establishment of a "reserve" for major water resource in South Africa. The reserve is a minimum quantity and quality standard necessary to satisfy basic human needs and to sustain the functioning of aquatic ecosystems which deliver that water. Resource quality objectives must be determined for every significant water resource with the level of protections provided by these objectives being set according to the agreed or desired state of that water resource. The reserve and the resource quality objectives may not be exceeded. It also contains provisions and measures for pollution prevention, controlled activities, water-use licensing and the regulation of stream flow reduction activities. However, the Act does not specifically provide protection for the surface water and groundwater source areas (WSAs) as defined in this document. Section 21 of this Act identifies certain land uses, infrastructural developments, water supply/demand and waste disposal as 'water uses'. Water uses may only be conducted with a water use licence, in accordance with an existing water use or in terms of a general authorisation. Small-scale water use (so-called *de minimus* water use) is exempted from this requirement. The water uses defined in Section 21 of the NWA include taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource), altering the bed, banks, course or characteristics of a watercourse, removing water found underground for certain purposes, and recreation. Section 38 of this Act empowers the Minister to declare certain activities as controlled activities, which no person is allowed to undertake without receiving authorisation to do so in terms of the NWA.
National Environmental Management Act (Act No. 107 of 1998)	The National Environmental Management Act (NEMA) is the framework environmental law applicable in South Africa. It sets out a number of environmental management principles in Section 2 to give guidance to developers, private land owners, members of public and authorities on how to interpret and apply environmental laws. Given the centrality of sustainable development in Section 24 of the Constitution, one of the key national environmental management principles is that *"sustainable development requires the consideration of all relevant factors including the following: (i) that the disturbance of ecosystems and loss of biological diversity are avoided, or, where they cannot be altogether avoided, are minimised and remedied; (ii) that pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;… (vi) that the development, use and exploitation of renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;… and (viii) that negative impacts on the environment and*

Legislation	Applicability to SWSAs
	on peoples' environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied". The national environmental management system is central to NEMA. It creates an environmental impact assessment system for South Africa, in accordance with which certain listed activities that have environmental impacts may not commence without environmental authorisation. An environmental authorisation application and decision-making related to such applications must be informed by comprehensive environmental impact assessment reports. Section 24(2A) of the NEMA empowers the Minister of Environmental Affairs to prohibit or restrict the granting of environmental authorisation for listed or specified activities within identified geographical areas (possibly WSAs), where it is necessary to ensure the protection of the environment, the conservation of resources or sustainable development. This mechanism can be used to prohibit or restrict inappropriate development in water source areas.
Environmental Impact Assessment Regulations and Listing Notices (GN R982, R983, R984 and R985 of 2014)	The Listing Notices identify the activities for which environmental authorisation is required, the Environmental Impact Assessment Regulations prescribe the process to be followed in the environmental authorisation application procedure and the minimum information requirements for applicable documents, such as environmental impact assessment reports.
National Environmental Management: Protected Areas Act (Act No. 57 of 2003)	The National Environmental Management: Protected Areas Act provides for the declaration and management of protected areas in South Africa. Significantly, it prohibits commercial prospecting, mining, exploration and production in national parks, special nature reserves and nature reserves. These include world heritage sites, specially protected forest areas, forest nature reserves and wilderness areas. The written permission of the cabinet members responsible for environmental affairs and mineral resources are required for prospecting, mining, exploration or production in protected environments. Approximately 11% of the surface-water SWSAs (about 18.2 million ha) are under some level of formal protection in terms of the Act. However, this protection is spread very uneven across the country, with most of the protected areas being in the mountain ranges of the Western Cape, KwaZulu-Natal Drakensberg and Mpumalanga Drakensberg (see Appendix 3 for details).
Mountain Catchment Areas Act (Act No. 63 of 1970)	The main objective of this Act is to provide for the conservation, use, management and control of land situated in mountain catchment areas, and to provide for matters incidental thereto. An owner or occupier of land which is situated within any mountain catchment area, is responsible for the following: the conservation, use, management and control of such catchment land; the prevention of soil erosion, the protection and the treatment of the natural vegetation and the destruction of vegetation which is, in the opinion of the Minister, intruding vegetation; and any other matter which he considers necessary or expedient for the achievement of the objects of this Act in respect of such land. This Act was, apparently, only applied in the former Cape Province so areas protected in this Act are found only in the Western Cape.
Spatial Planning and Land Use Management Act (Act No. 16 of 2013)	One of the objectives of the Spatial Planning and Land Use Management Act (Act No. 16 of 2013) is to provide for a uniform, effective and comprehensive system of spatial planning and land use management. Although the thrust of the Act is on equity and achieving social and economic inclusion, it recognizes that this requires development to be sustainable and aligned with everyone's right to have their environment protected. It also requires all levels of government to work together

Legislation	Applicability to SWSAs
	to realise these outcomes. The national and provincial spheres of government and each municipality are required to prepare spatial development frameworks that, *inter alia*, represent the spatial development vision of the responsible sphere of government and competent authority. Municipalities must develop land use schemes for their respective geographic jurisdictions. Land use schemes prescribe the purposes for which each portion of land may be used.
Local Government: Municipal Systems Act (Act No. 32 of 2000; RSA, 2000)	The Local Government: Municipal Systems Act (Act No. 32 of 2000; RSA, 2000) requires that municipalities develop Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs). The IDP is a comprehensive five-year plan for a municipal area that gives an overall framework for development, land use and environmental protection. The SDF is a compulsory core component of an IDP that must guide and inform land development and management by providing future spatial plans for a municipal area. The SDF should be the spatial depiction of the IDP, and should be the tool that integrates spatial development plans from a range of sectors.
AGRICULTURE	
Conservation of Agricultural Resources Act (Act No. 43 of 1983) and associated regulations	This Act provides for, *inter alia*, restrictions on the cultivation of land, the protection of soils and water courses, the combating and prevention of erosion, and the prevention of the weakening or destruction of water sources on agricultural land. One of the provisions of the Act is that no land user shall utilize wetland vegetation (i.e. vegetation found in watercourses or pans) in a manner that will cause its deterioration or damage by, for example, cultivation, overgrazing and diverting water run-off. This provision is important for ensuring that uncultivated buffers are maintained along water courses and around water bodies to reduce sedimentation and for reducing agro-chemical pollution. However, these provisions generally have not been applied so there is a lot of cultivated land in areas subject to periodic flooding and which has resulted in significant sediment mobilization.
Subdivision of Agricultural Land Act (Act No. 70 of 1970)	The Subdivision of Agricultural Land Act prohibits the subdivision and sale of or development on agricultural and without the consent of the cabinet member responsible for agriculture. The Act can therefore also be used to prohibit inappropriate development on land classified as “agricultural” in terms of the Act.
FORESTRY	
National Forest Act (Act No. 84 of 1998)	The National Forests Act provides for the management of timber plantations on state land as well as the management of indigenous forest and woodland ecosystems and individual indigenous trees. It sets out measures to prevent and remedy deforestation in natural forests.
MINING	
Mineral and Petroleum Resources Development Act (Act No. 28 of 2002)	The Mineral and Petroleum Resources Development Act governs prospecting, mining, exploration and production in South Africa. In terms of the Act, rights, permits or permission are required for prospecting, mining, exploration or production. The Act sets out the requirements for the issuing of rights, permits or permission. One of the requirements is obtaining environmental authorisation for a proposed operation in terms of the National Environmental Management Act (Act No 107 of 1998). Prospecting, mining, exploration and production operations must be managed in accordance with the principles of the National Environmental Management Act, as well as approved environmental management programmes and the conditions of environmental authorisations. In terms of Section 49 of the Act, the cabinet member responsible for mineral resources may restrict or prohibit the granting of prospecting or mining, exploration

Legislation	Applicability to SWSAs
	or production rights in respect of specified geographical areas if such restriction or prohibition is necessary to promote the sustainable development of South Africa's mineral or petroleum resources. That provision can be utilised to restrict or prohibit the granting of rights or permits in water source areas.
Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources (Government Notice No. R. 704, 1999)	These regulations are aimed at ensuring the protection of water resources through restrictions on locality, material, and the design, construction, maintenance and operation of separate clean and dirty water systems. The Department of Water & Sanitation has also published a draft Mine Water Management Policy Position (this policy was published for comment; the revised policy has not been published yet)
ALIEN INVASIVE SPECIES	
Conservation of Agricultural Resources Act (Act No. 43 of 1983) and associated regulations	This Act includes invasive plant species control which are categorized as follows: Category 1 may not be grown and must be eradicated and controlled; Category 2 may only be grown in an area demarcated for commercial cultivation purposes and for which a permit has been issued, and must be controlled; and Category 3 plants may no longer be planted and existing plants may remain as long as their spread is prevented, except within the flood line of watercourses and wetlands from where they must be removed.
Invasive species regulations (Regulation 598 of 1 August 2014) under the NEM: Biodiversity Act (Act, No. 10 of 2004)	One of the purposes of the Act is to provide for the management and conservation of biological diversity within South Africa, and of the components of such biological diversity. One of the mechanisms used to achieve this objective is the management of alien and invasive species. In terms of the Act, the member of cabinet responsible for environmental affairs is obligated to publish a list of alien and invasive species. The list must also set out restricted and prohibited activities in relation to the species identified in the list. In addition, all owners of land have a duty to take steps to control and eradicate alien and invasive species on their property. Invasions by introduced (alien) woody plant species, notably trees, are known to reduce stream flows by about as much as commercial plantations (Le Maitre et al., 2016), and also have adverse effects on water quality (Jovanovic et al., 2009; Chamier et al., 2012). The invasive species regulations (Regulation 598 of 1 August 2014) under the NEM: Biodiversity Act require that land owners control all Category 1a and 1b invasive species on their land because, among others, of their adverse impacts on water resources (see **Section 5.5**) for more information). South Africa has in recent years seen the development of many control programmes aimed at conserving and rehabilitating ecosystems and their biodiversity. These programmes often involve different governmental departments and organisations and contribute to education, community empowerment, capacity building and employment (NSOER, 2010). The management of invasive alien plants is spearheaded by the Working for Water (WfW) programme that is administered through the Department of Environmental Affairs.

There are policies and guidelines that deal specifically with agricultural and mine water management and specifically with groundwater management which are noted in the respective sections. There are also numerous provisions in Acts and regulations relating to mining, agriculture and various levels and kinds of planning which do have some bearing, but they were not designed with WSAs in mind. Table 3 summarises general activities that may impact water resources and are applicable to these sectors and for which a permit, licence or authorization is required.

The Centre for Environmental Rights is currently investigating the most effective ways to protect WSAs under the current legislation and have identified two main options:

- Under NEMA Section 24(2A) which allows the minister to prohibit or restrict the granting of environmental authorizations for listed activities in certain geographical areas. The list of activities would include those known to adversely affect water quality and/or quality.

- Adding a chapter on Water Source Area protection to the new Water & Sanitation Act that is currently being drafted, which would make provision for the restriction or prohibition of activities in certain geographical areas which could adversely affect water quality and quantity.

Table 3: Activities requiring a permit, licence authorisation or consent for use.

Activity	**Type of Permit/ Licence/Consent Required**	**Relevant Legislation**	**Issuing Authority**
Construction of a development triggering any listed activity in terms of the EIA Regulations (2014)	Environmental Authorisation	NEMA, EIA Regulations and associated listing notices promulgated in Government Notices 982, 983, 984 and 985 (8 December 2014)	Department of Environmental Affairs
Prospecting, Exploration, Mining and Production	Mining permit	Mineral and Petroleum Resources Development Act, 2002	Department of Mineral Resources
Establishment and management of a plantation in State forest	Licence	National Forest Act, 1998	Department of Agriculture, Forestry and Fisheries
Cultivate land and grow crops; graze or herd animals in a State Forest	Licence	National Forest Act, 1998	Department of Agriculture, Forestry and Fisheries
Cultivate 'virgin land' (land which has at no time during the preceding 10 years been cultivated)	Permit	Conservation of Agricultural Resources Act, 1983	Department of Agriculture, Forestry and Fisheries
Change in land use from Agriculture to development	Letter of exemption	Subdivision of Agricultural Land Act, 1970	Department of Agriculture, Forestry and Fisheries
Stream flow reduction activities (afforestation), including registration of all afforestation (tree planting) for commercial purposes and communal forestry for commercial gain, that took place prior to 1972;	Licence	National Water Act, 1998	Department of Water and Sanitation
Development of water resources: • Local authorities and other bulk suppliers (water boards); • Controlled Activities, such as recharging an aquifer	Licence	National Water Act, 1998	Department of Water and Sanitation
Water uses in terms of Section 21 of the National Water Act. This includes the following activities:	Licence	National Water Act, 1998	Department of Water and Sanitation

Activity	Type of Permit/ Licence/Consent Required	Relevant Legislation	Issuing Authority
• 21(a) taking water from a water resource; • 21(b) storing water; • 21(c) impeding or diverting the flow of water in a watercourse; • 21(d) see above			
Discharges of water containing waste in terms of Section 21 of the National Water Act. This includes the following activities: • Section 21(e) – engaging in a controlled activity defined as such in Section 37(1), with specific reference to irrigation of any land with waste or water containing waste generated through any industrial activity or by a water work. • Section 21(f) – discharging waste or water containing waste into a water resource through a pipe, canal or other conduit. • Section 21(g) – disposing of waste in a manner which may detrimentally impact on a water resource. • Section 21(h) – disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process. • Section 21(j) – removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people. The above wastewater uses include a number of non-point sources of discharge: • Disposal of effluent to land or to a facility (such as a tailings dam, irrigated effluent or evaporation ponds treatments); • Disposal of effluent to land or to a facility (such as a landfill, waste rock dumps, fly ash	Licence	National Water Act, 1998	Department of Water and Sanitation

Activity	Type of Permit/ Licence/Consent Required	Relevant Legislation	Issuing Authority
disposal or solid waste disposal); • Land use activities such as confined animal facilities or dirty water systems.			
Use of treated wastewater (dust suppression, domestic water supplies)	Letter of Approval	National Water Act, 1998	Department of Water and Sanitation
Storage of general waste and hazardous waste in excess of 100 cubic metres and 80 cubic metres respectively, for a period exceeding 90 days.	Comply with the National Norms and Standards for the Storage of Waste (published on 29 November 2013 under GN 926)	National Environmental Management: Waste Act 59 of 2008, List of Waste Management Activities that have or are likely to have a detrimental effect on the environment, Category C (GN 921, 2013)	Department of Environmental Affairs
Retain Alien Invasive Plant Species Categories 2 or 3 in demarcated areas. Permits are also required for biological control reserves (where alien invasive plants can be maintained for breeding of biocontrol organisms)	Permit	National Environmental Management: Biodiversity Act, 2004, Alien and Invasive Species List, 2014 (GG No. 37886)	Department of Environmental Affairs
Commencement of construction activities.	Notify one week before commencement	NEMA, EIA Regulations and associated listing notices (2014)	Department of Environmental Affairs
Erecting a new building or improving or adding to an existing building (including diesel fuel storage tanks)	Approval of building plans	Municipal by-laws	Local Municipality
Storage and handling of hazardous substances above approved thresholds	Licence, Environmental Authorisation	Occupational Health and Safety Act,1993 NEMA Environmental Impact Assessment Regulations and associated listing notices (2014)	Department of Health and Department of Environmental Affairs
Storage of flammable liquids above approved thresholds	Licence	Municipal by-laws	Local Municipality
Construction and use of borrow pits and quarries	Mining permit (<5 hectares) or a Mining licence (>5 hectares)	NEMA and Mineral and Petroleum Resources Development Act (No 49 of 2008) Regulation 52	Department of Mineral Resources

4. OVERALL MANAGEMENT OBJECTIVE FOR SWSAS

The Strategic Water Source Areas are vital for water and food security in South Africa and also provide the water used to sustain the economy. Given this context, the overall objective of these management and implementation guidelines is to facilitate and support well-informed and proactive land management, land-use and development planning in these nationally important and critical areas. The primary principle behind this objective is to protect the quantity and quality of the water they produce by maintaining or improving their condition. This can be achieved by ensuring that:

- strategic planning (e.g. SWSA maps) should inform SDFs, IDPs and zoning schemes;
- any existing activities which adversely affect water quantity and quality are effectively managed and their impacts mitigated;
- applications for any planned activities include an assessment of their impacts; and
- authorities evaluating these applications take those impacts into account.

The SWSAs form the foundational ecological infrastructure on which a great deal of built infrastructure for water services depends (Nel et al., 2013; WWF, 2013). Deterioration of water quality and quantity in these WSAs can have a disproportionately large adverse impact on the functioning of downstream ecosystems and the overall sustainability of growth and development in the regions they support (Viviroli, 2004, Viviroli et al., 2007).

However, large proportions of the SWSAs are working landscapes (Cadman et al., 2010) – places where people live and work and there are urban settlements, mine and quarries, plantations, croplands and rangelands as well as protected natural areas. The challenges are, therefore, to maintain at least the present condition and ecological functioning of these landscapes, to restore where necessary, and to limit or avoid further adverse impacts on the sustained production of high quality water. Where areas of these landscapes have been degraded though unwise land management practices or use, or activities have direct impacts on the quality and quality of water, those practices and activities must be changed to mitigate the impacts and these areas must be restored. Some of these changes are already happening with increasing attention being given to environmental management by industries such as mining and forestry (FIEC, 2002[1]), and by the increasing uptake of the principles of sustainable farming and conservation agriculture in South Africa (Blignaut et al., 2014; Knot et al., 2015;[2]). Much of this is due to consumer pressure, particularly to meet the requirements of the markets and consumers in the countries South Africa exports to, but there are local initiatives as well.

These initiatives need to be supported by the relevant government bodies, non-government and private sectors, and build on the objectives and principles of wise and sustainable natural resource use (DAFF, 2012). Unfortunately, the freshwater ecosystems which are vital for the transport of this water, regulating flow and quality, including assimilating pollutants, have been adversely affected (Nel et al., 2011). More than half of the river, wetland and estuary ecosystem types are considered threatened, i.e. in a poor ecological state as a result of changes in flow regimes, water pollution or ecosystem modification. Only one third of the

[1] http://www.chamberofmines.org.za/work/environment/environmental-resources
[2] http://www.daff.gov.za/daffweb3/Programme/LandCare/guidelines

length of our main rivers is still in a good condition and much of the degradation is due to the impacts of activities in the adjacent areas. This situation has to be addressed and tools are available in the form of an atlas showing the ecological state of the systems and guidelines for the implementation of the findings of these studies (Driver et al., 2011).

5. MANAGEMENT FRAMEWORK FOR THE STRATEGIC WATER SOURCE AREAS

This section focuses on the evaluation of applications for activities and the need for them to include a thorough assessment of their impacts both at the site and downstream, and for authorities evaluating these applications to take these impacts into account.

5.1 Impacts of land-use changes and land management on water quantity and quality

A wide range of activities can alter water flows and water quality in both groundwater and surface water. Some can result in pollution of the groundwater and surface water and these impacts on water quality can be grouped into three main classes:

- those involving the addition of chemical compounds and elements;
- those involving increases in suspended and transported sediments; and
- those involving living organisms (water-borne diseases, parasites and pathogens).

The addition of chemical compounds and elements, in particular, consists of:

- those which are key nutrients that enhance the growth of organisms (e.g. nitrogen, phosphorus); and
- others which have varying effects on the health of organisms and people using the water (e.g. are toxic, alter hormone production) (Genthe et al., 2013).

The following sections provide information on the current land-use and land management practices in selected sectors which may impact the quantity and quality of the surface and groundwater resources produced by SWSAs and how these uses and practices should be managed to prevent/mitigate any impacts.

5.2 Management framework for the Forestry Sector

The establishment of plantations requires clearing of vegetation which can result in surface runoff carrying sediment loads and nutrients, especially following rain. In the case of extensive forest plantations, clearing of vegetation will also be required to establish the extensive network of roads and tracks. The maintenance of the riparian vegetation between the harvesting area and the surrounding waterways can reduce the environmental impacts of operational activities by maintaining the stream bank stability and reducing the run off of sediments and debris (logs and branches) into the waterways. Areas that can result in sediment discharge into waterways include roads, landings, and logging earthworks so extra care must be taken in designing and managing these areas.

Sustainable forest management practices must ensure the conservation of natural resources, especially soil, water, ecosystems and habitats. Forestry activities must be suitably managed and monitored to prevent and mitigate impacts on SWSAs and maintain the water quality, water quantity and wetland habitat during the establishment of a forestry plantation, operation activities and harvesting of the timber.

Many of the plantation trees species have become invaders, together with a range of other species, and these invasions have resulted in significant reductions in the mean annual runoff (Le Maitre et al., 2015, 2016). The higher evapotranspiration demands of several alien plantation species may also impact shallow groundwater tables (Le Maitre et al., 1999; Kienzle and Schulze, 1992). These impacts can be minimized by adhering to the guidelines for buffers along water courses and around wetlands (DWAF, 2005; Macfarlane et al., 2015).

Furthermore, once the seedlings are planted, selective herbicides and pesticides may be used to control weeds and insect pests around the newly planted seedlings. The chemicals contained in the herbicides and pesticides have the potential to contaminate the soil, groundwater, or surrounding waterways which can have environmental impacts at the local level.

Section 3 of this report provides a brief introduction to the legal provisions aimed at protecting water, and the catchment areas that produce that water, and gives a summary of the necessary permits/licences and authorisations.

The following table provides a management framework for the key impacts resulting from land-use practices or activities in the forestry sector and the corresponding legal framework for the implementation of these management actions.

Table 4: Key management guidelines for the forestry sector

Key Impact resulting from land-use practice or activity	Key Management Guidelines	Legal framework and existing guidelines
Sedimentation from poorly designed and maintained road networks	• Adherence to environmental guidelines and road construction standards	• Forestry Industry Environmental Committee, 2002: Environmental Guidelines for Commercial Forestry Plantations in South Africa
Sedimentation due to harvesting and planting related activities	• Ensure implementation of wetland and riparian buffer strips (20 metres from the outer edge of the temporary zone of a wetland or from the outer edge of a riparian zone)	• Forestry Industry Environmental Committee, 2002: Environmental Guidelines for Commercial Forestry Plantations in South Africa

Key Impact resulting from land-use practice or activity	Key Management Guidelines	Legal framework and existing guidelines
Stream flow reduction and lowering of water tables	• Ensure that rivers, watercourses and other water bodies are clear of felled trees, vegetation cuttings and debris. Debris resulting from clearing and pruning must be disposed of at a licenced waste disposal facility. • Regulate the planting of exotic timber species in upper catchments • Ensure that required permits are obtained by the commercial timber enterprises and that the water abstraction estimates take groundwater impacts into account	• Forestry Industry Environmental Committee, 2002: Environmental Guidelines for Commercial Forestry Plantations in South Africa • Mountain Catchment Areas [Act 63 of 1970] • National Water Act [Act No. 36 of 1998]
Invasion by plantation species of areas adjacent to the plantations	• Ensure that the management of alien invasive plant species complies with *Act 10 of 2004*, and Working for Water requirements • Disposal of (seed bearing) invasive alien plant material must be done in a sustainable manner to prevent further spread	• Alien and Invasive Species Regulations under the National Environmental Management Biodiversity Act (Act 10 of 2004) • Working for Water Operation Standards[3] and species-specific treatment recommendations[4] • the Forestry Stewardship Council standards are currently being updated and will become much stricter about the cultivation of invasive plant species
Herbicides used for weed management and pesticides	• Only authorised fertilisers must be applied and application must be controlled in order to prevent contamination of the soil, groundwater, or surrounding waterways. Only a registered pest control operator must apply herbicides on a commercial basis. • All herbicide treatments applied to invasive alien plants must	• Fertilisers, Farm, Feeds, Agricultural Remedies and Stock Remedies Act, 1947 (Act 36 of 1947). • 2014 National Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN 331)

[3] https://www.environment.gov.za/sites/default/files/legislations/project_operation_standards.pdf. Note: an updated version of the Operational Standards for Alien Invasive Plant Species.xls is available from https://sites.google.com/site/wfwplanning/implementation via a Dropbox account

[4] Working for Water species and herbicide list v4 (xls) Compiled by D. Sharp adapted from T. Bold and updated 2012 https://sites.google.com/site/wfwplanning/implementation
Sharp, D., 2011 Terrestrial herbicides and growth forms (V3) https://sites.google.com/site/wfwplanning/implementation

Key Impact resulting from land-use practice or activity	Key Management Guidelines	Legal framework and existing guidelines
	comply with the South African National Standards for handling, storage and disposal of Pesticides (SANS 10206:2010, Edition 2.2). Only herbicide registered for a particular plant species are to be used. Where no herbicide has been registered, use the least hazardous herbicide registered[5] for a similar plant species (i.e. another species of tree or shrub).	

5.3 Management framework for the Agricultural Sector

The main impacts on water quality associated with dryland agriculture are through soil loss associated with poor tillage practices (Love et al., 2006; Le Roux et al., 2007). A number of crop species in dryland agriculture have been evaluated as potential stream-flow reduction activities (e.g. sugar cane) but none have yet been shown to significantly reduce the mean annual runoff from planted lands.

Sustainable agricultural activities must prevent impacts on the water environment and water quality through the release of nutrients (soil management and fertiliser application) and other chemicals (pesticides) as well as soil being eroded and washed off farmland.

Irrigated agriculture accounts for about 60% of all the available water supplies in South Africa (Van Rooyen & Versfeld, 2010; CSIR, 2011; DWA, 2013) but it also produces food crops which are essential for food security and significant earners of foreign exchange (Wenhold et al., 2007; Blignaut et al., 2015; Stuart-Hill & Schulze, 2015; Swilling et al., 2016). Irrigated agriculture is typically much more intensive than dryland agriculture and involves agro-chemicals for controlling weeds and pests as well as fertilisation (Scanlon et al., 2007; Twomlow et al., 2008; Van Rooyen & Versfeld, 2010; Ashton & Dabrowski, 2011; CSIR, 2011; Dabrowski et al., 2013; Dabrowski, 2015). Long-term crops like vineyards and orchards typically require less intensive inputs than short-term crops like vegetables but some deciduous fruits (e.g. apples) may require intensive pest control. Pollution of neighbouring water bodies and water courses by overspray and through subsurface water return flows are the main ways in which irrigated agriculture affects water quality in rivers and in groundwater. Elevated nitrate concentrations are a well-known phenomenon, for example in groundwater near and in agricultural areas. Increased nutrient levels in rivers and other water bodies can

[5] For hazard ratings for common commercial herbicides see: National Department of Agriculture (NDA) 2011: http://www.nda.agric.za/doaDev/sideMenu/ActNo36_1947/AR/marketed_%20herbicides_%20active%20ingredients.pdf and Fertilizers, Farm Feeds, Agricultural Remedies Act (36 of 1947): REGULATIONS RELATING TO AGRICULTURAL REMEDIES GN. R. 935 (22 September 2006) – GOVERNMENT GAZETTE No. 29225: http://www.gov.za/sites/www.gov.za/files/gcis_documents/Agricultural%20Remedies%20Regulations.%20Policy.pdf

lead to algal blooms which can become toxic if cyanobacteria are involved (CSIR, 2011; Oberholster & Botha, 2011).

Groundwater and surface water extraction for irrigation can reduce the flow in the rivers downstream so that the volumes are no longer sufficient to provide the dilution capacity needed to meet the limits specified for acceptable water quality for different purposes.

Soil conservation practices can often be combined with water harvesting to increase crop productivity, reduce drought risk and increase food security (Rockström et al., 2009).

Only about 13% of South Africa is suitable for cultivated agriculture and a large proportion of the rest is natural rangelands which are used for livestock farming involving cattle, sheep and goats. In addition there is a growing game farming industry. Unfortunately, there is a long history of overgrazing of these areas dating back to the 1900s, especially in the dryer parts of South Africa, with the result that these lands have become degraded (Hoffman and Ashwell, 2001; Hoffman and Todd, 2000). The confinement and translocation of large populations of rural black people to the former homeland areas also resulted in intense pressure on the land and vegetation and soil degradation. Overgrazing reduces vegetation cover and productivity which reduces the organic matter entering the soil. This in turn results in the soil forming crusts which reduce infiltration and moisture storage in the soil and increase surface runoff. The reduced soil moisture results in reduced plant growth. The livestock also trample the soil and form paths which channel the increased surface runoff. The result is increased soil erosion resulting in sediment movement downslope and, eventually into rivers where it is transported into dams and fills them up. Once-perennial rivers can become ephemeral or intermittent as water tables decline and baseflow decreases (FISRWG, 1998).

The savannas and grasslands of South Africa require regular, intense fires to maintain a balance between woody plants and grasses which makes them suitable for livestock grazing. However, overgrazing reduces grass production and thus fuel loads, favouring woody plants. Increased CO_2 concentrations appear to be favouring woody plants and resulting in substantial increases in woody plant cover in much of South Africa – a phenomenon known as bush encroachment (Hoffman, 2014; O'Connor et al., 2014). The increase in cover of woody plants results in them competing with the grasses and, thus, reducing grass production which, in turn, feeds back to facilitate woody plant densification (thickening). Where there is enough grass, a resting period can generate enough fuel for an intense fire which will thin out the woody plants. The only alternative is to clear the woody plants, but not completely because woody plants play key roles in vegetation dynamics (Smit, 2004).

Section 3 of this report provides a brief introduction to the legal provisions aimed at protecting water and the catchment areas that produce that water and gives a summary of required permits/licences and authorisations.

The following table provides management guidelines for the key impacts resulting from land-use practice or activity in the agriculture sector and corresponding legal framework for the implementation of these management actions.

Table 5: Key management guidelines for the agricultural sector

Key Impact Resulting from Land-Use Practice or Activity	Key Management Guidelines	Legal Framework and Existing References
Excessive fertiliser application leading to nitrogen and/or phosphate contamination of groundwater and, thus, of groundwater discharges to waterbodies (i.e. return flows); wastewater from farm processing of products (e.g. dairies, wineries; fruit juice production) and feedlots	• Ensure that any fertiliser, farm feed, agricultural remedy, stock remedy, sterilising plant used and any pest control operator is registered and controlled. • Ensure compliance with the wastewater limit values applicable to discharge of wastewater into a water resource. • Ensure that effective buffers are maintained between these activities and water courses, wetlands and other water bodies	• Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947) • Discharge limits and conditions set out in the National Water Act, Government Gazette No. 20526, 8 October 1999
Agro-chemical pollution of water-bodies and groundwater and adjacent lands, including overspray because of unwise or careless application and contaminated runoff or irrigation return flows	• Only non-polluting and formally approved biological control methods should be used for the Biological Control of Weeds and Pests. • Chemicals should be mixed in suitable areas and away from open water to avoid the risk of contaminating ground or surface water. • Contaminated soils must be analysed in terms of the Norms and Standards for remediation of contaminated soil. • Ensure that effective buffers are maintained between the treated areas and water courses, wetlands or other water bodies	• 2014 National Norms and Standards for the Remediation of Contaminated Land and Soil Quality (GN 331).
Erosion and sediment loss into water bodies and courses as a result of unwise land cultivation practices such as not ploughing along the contour, not placing berms or terracing to minimise and capture water runoff	• No land-user should drain or cultivate any wetland or area within the flood zone of any watercourse (including its buffer), except in terms of a written permit in terms of the National Water Act.	• Implementation Manual for Freshwater Ecosystem Priority Areas, Water Research Commission. WRC Report No. 1801/1/11, ISBN 978-1-4312-0147-1.
Destabilisation of the banks of water courses because of the failure to maintain effective, uncultivated buffer strips along the banks of water courses.	• Maintain riparian vegetation along water course to act as a physical and biological filter for sediments and nutrients from runoff and stabilisation of banks and soils to reduce erosion. • Removal of indigenous plant species from the banks of water courses or its buffer should be strictly controlled to reduce the impact on the hydrological regime. Sustainable harvesting of plants, if deemed to	• National Water Act [Act No. 36 of 1998] • Implementation Manual for Freshwater Ecosystem Priority Areas, Water Research Commission. WRC Report No. 1801/1/11, ISBN 978-1-4312-0147-1.

Key Impact Resulting from Land-Use Practice or Activity	Key Management Guidelines	Legal Framework and Existing References
	have a negligible impact on species diversity and watercourse functioning, may be acceptable. •	
Overgrazing leading to reduced vegetation cover, trampling and hardening or crusting of soil surfaces, or destabilization of the soil and resulting in erosion	• Reduce grazing pressure on rangelands by keeping to sustainable stocking rates and ensure that pressure is reduced during droughts • Fence off vulnerable areas such as river banks and wetlands to keep livestock out • Provincial departments dealing with agriculture have experts who can advise on veld management and restoration. • Get expert advice on veld restoration from recognised experts • Follow the advice in books such as: • Tainton, N.M. (1999) Veld management in southern Africa. Natal University Press, Pietermaritzburg. • Esler, K.J., Milton, S.J. and Dean, W.R.J. (2010) Karoo Veld – Ecology and Management. Briza Press, Pretoria. • Coetzee, K., 2005. Caring for natural rangelands. University of KwaZulu-Natal Press, Scottsville. • Esler, K.J. (Ed). Fynbos Management. Briza Publications, Pretoria.	• In terms of CARA, the Minister may prescribe control measures that may relate to • (b) the utilization and protection of land which is cultivated…. • (g) the utilization and protection of the vegetation • (h) the grazing capacity of veld, expressed as an area of veld per large stock unit • (i) the maximum number and the kind of animals which may be kept on veld

5.4 Management framework for the Mining Sector

Mining practices must be suitably managed and monitored to prevent and mitigate impacts on both water quantity, mainly through water consumption in the mining processes, and water quality, through unmanaged point discharges (e.g. from tailings dams, slime dams overflows or runoff) in the SWSAs.

Mining can also result in significant impacts on groundwater, particularly with the generation of acid mine drainage (AMD) and social impacts (Ashton & Dabrowski, 2011; McCarthy, 2011; Dabrowski et al., 2015; Naidoo, 2015; Oberholster et al., 2016; WRC, 2016). Although acid mine drainage from gold mines has received much attention (DWAF, 2013; Ambani & Annegarn, 2015), open cast and extensive shallow coal mining can have significant impacts through acid main drainage (Colvin et al., 2011; McCarthy, 2011). Mine dewatering activities can also have a significant impact on groundwater resources and groundwater-dependent ecosystems. The extent of mining, particularly open-cast mining, combined with its disproportionate impacts on water quality, is therefore a significant concern because of its potentially adverse impacts on water security (Colvin et al., 2011).

Sustainable prospecting and mining operations must prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources.

A sustainable mining operation will demonstrate the following sound management practices:

- **Optimum resource utilisation**
- **Leading environmental practices**
- **Stakeholders and community engagement**
- **Economic development, including the provision of sufficient funds for rehabilitation and water treatment.**
- **Health and Safety excellence to achieve the vision of Zero Harm**

The Department of Water and Sanitation (the then Department of Water Affairs and Forestry) has developed a series of Best Practice Guidelines (BPGs) for Water Resource Protection in the South African mining industry in line with International Principles and Approaches towards sustainability (Figure 7).

Section 3 of this report provides a brief introduction to the legal provisions aimed at protecting water and the catchment areas that produce that water and gives a summary of required permits/licences and authorisations.

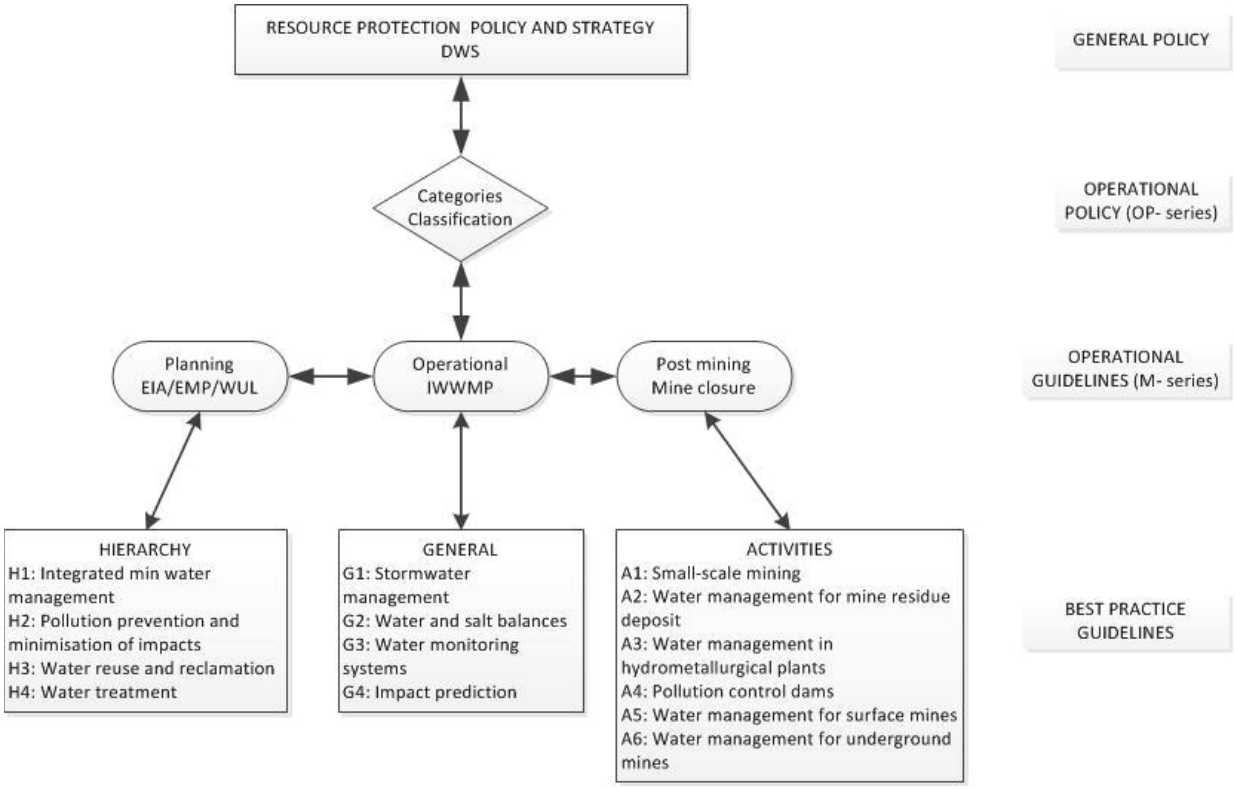

Figure 7: Schematic Diagram of the Mining Sector Resource Protection and Waste Management Strategy

The following table provides management guidelines for the key impact resulting from land-use practice or activity in the mining sector and corresponding legal framework for the implementation of these management actions.

Table 6: Management guidelines for the mining sector

Key Impact Resulting from Land-Use Practice or Activity	Key Management Guidelines	Legal Framework and Existing Guidelines
Unmanaged point discharges from tailings dumps, slimes dams or mined areas and processing plants Discharge of contaminants via mine de-watering activities, including the release of metals and the addition of cyanide which may seep into groundwater systems	• Water resources must be protected through restrictions on the location, material, and the design, construction, maintenance and operation of separate clean and dirty water systems. • Careful location of residue stockpiles, residue dumps and tailings dams with regard to the likely pollution of water resources • Ensuring stability and adequate design of dump/soil and tailings sites to minimise erosion and uncontrolled seepages, drainage and runoffs;	• Mine-water regulations (Government Notice No. R. 704, 1999) • Draft Mine Water Management Policy • Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, and

Key Impact Resulting from Land-Use Practice or Activity	Key Management Guidelines	Legal Framework and Existing Guidelines
	• Any residue deposit, reservoir or any other facility may not be located within the 1:100-year flood-line or within a horizontal distance of 100 metres from the watercourse (whichever is the greatest) • With the exception of the mining of alluvial materials or sand winning operations, no mining operations may take place within the 1:50-year flood-line or within a horizontal distance of 100 metres from the watercourse (whichever is greatest). • Design, construct, maintain and operate any dam or tailings dam that forms part of dirty water systems to have a minimum freeboard of 0.8 metres above the full supply level. • Ensure implementation of the 2013 Mining and Biodiversity Guidelines.	South African National Biodiversity Institute, 2013. • Operational and Best Practice Guidelines (BPGs) for Water resource Protection in the South African mining industry, Department of Water and Sanitation.
Acid mine drainage caused by rising groundwater levels leading to decants, or diffusely through groundwater discharges	• The water quantity and quality of surrounding surface and groundwater resource must be monitored to meet the ecological requirements of freshwater systems and basic human needs of downstream communities. • Protection of water resources must be ensured through - the successful implementation of an adequate stormwater and wastewater management system, - ensuring that no residue or substance which causes or is likely to cause pollution of a water resource is placed or disposed of in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation, - minimising the flow of any surface water or floodwater into mine working areas, - adequate design of dam or any residue deposit or stockpile, - prevention of the erosion or leaching of materials from any residue deposit or stockpile. • Ensure implementation of the 2013 Mining and Biodiversity Guidelines.	• National Water Act [Act No. 36 of 1998] • MPRDA Pollution Control and Waste Management Regulations • Operational and Best Practice Guidelines (BPGs) for Water Resource Protection in the South African mining industry, Department of Water and Sanitation. • Mining and Biodiversity Guideline: Mainstreaming biodiversity into the mining sector. Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, and South African National Biodiversity Institute, 2013.

Key Impact Resulting from Land-Use Practice or Activity	Key Management Guidelines	Legal Framework and Existing Guidelines
Siltation: Mining operations produce large quantities of dust and finely powdered rock that are removed by rain and wind action into nearby rivers and wetlands, leading to a build-up of suspended solids and ultimately siltation.	• Dust control on the access road by spraying water or other nontoxic dust allaying agents and by limiting the speed of haul trucks or by other suitable approved means. • Creation of a green belt around the mining area to trap dust generated at the mine. • Rehabilitation of mine dumps	• Operational and Best Practice Guidelines (BPGs) for Water Resource Protection in the South African mining industry, Department of Water and Sanitation. • National Environment Management: Air quality Act (Act N0. 39 of 2004) • Dust Control Regulations (Government Notice No. R. 827, 2013)

5.5 Management framework for the control of Invasive Alien Plant Species

Alien invasive plants reduce South Africa's mean annual runoff (river flows) by at least 1 444 ^{3}/a, or 2.9% of the national total, and directly impact on habitat integrity and biodiversity through the replacement of species and loss of habitat (Le Maitre et al., 2016).They have significant impacts on rangeland productivity. Invasions of catchments and riparian and wetland habitats also modify seasonal flow distributions and water quality (Le Maitre et al., 2016; Chamier et al., 2012). They can result in the de-stabilization and erosion of riparian zones and banks, as the range of different natural riparian vegetation types which protect and stabilize riparian zones from the water margin to the bank top, are out-competed and replaced (Rowntree, 1991; Rowntree & Dollar, 1999; Bruton, 2010; Ruwanza et al., 2013; Tererai et al., 2013). Food chains, ecological pathways and habitat niches provided by indigenous fauna and flora communities are negatively affected or lost when indigenous species are replaced by invasive alien plant species[6].

Sustainable invasive alien plant species control consists of the systematic clearing of alien vegetation from the disturbed/natural area within a set period of time and prevention of further spread of existing and new invasive alien plant species into surrounding areas

Sustainable alien plant species control consists of the systematic clearing of invasive alien vegetation from the disturbed/natural area within a set period of time and prevention of spreading of existing and new invasive alien plant species on surrounding disturbed/natural sites. Every land owner and land management agency, including all organs of state has to produce a plan for the management of their invasions on their land. Guidelines on the preparation, content and implementation of alien species control plants are also available[7]. It is critical that these plans are based on:

[6] See http://www.invasives.org.za/ for more information.
[7] Guidelines for Invasive Species Management Plans http://www.invasives.org.za/

- An adequate assessment of the extent and density of invasions in the area covered by the plan
- Agreement on a goal for the plan which should include the desired state and a time frame for achievement of the goal
- A set of priorities for clearing which will focus the investment in clearing on those invaded areas which will yield the greatest benefits

Long-term planning and annual planning tools are being developed to help those involved understand the resources that will be required to achieve their goals and to execute their plans.

The following table provides management guidelines for the key impacts resulting from Alien Invasive Plant species and corresponding legal framework for the implementation of these management actions.

Table 7: Management guidelines for invasive alien plant species management

Impact resulting from land-use practice or activity	Management Guidelines	Legal framework
Colonisation of riparian areas and land areas by invasive alien plants	• Clear and prevent re-establishment and further spread of alien invasive plants within the riparian and land areas	• Conservation of Agricultural Resources Act [Act No. 43 of 1983]
Stream flow reduction and lowering of water tables	• Implement alien invasive plants eradication and management programme in compliance with the Alien and Invasive Species Regulations. • Prevent spreading of existing and new alien invasive plant species on disturbed and rehabilitated sites.	• National Environmental Management Biodiversity Act (Act 10 of 2004). • Working for Water Operational Standards8 and species-specific treatment recommendations9
Pollution of water-bodies and groundwater and adjacent lands due to herbicide treatments	• All herbicide treatments applied to alien Invasive plants must comply with the South African National Standards for handling, storage and disposal of Pesticides (SANS 10206:2010, Edition 2.2).	• South African National Standards for handling, storage and disposal of Pesticides (SANS 10206:2010, Edition 2.2) •

[8] https://www.environment.gov.za/sites/default/files/legislations/project_operation_standards.pdf. Note: an updated version of the Operational Standards Alien Invasive Plant Species.xls is available from https://sites.google.com/site/wfwplanning/implementation via a Dropbox account

[9] Working for Water species and herbicide list v4 (xls) Compiled by D. Sharp adapted from T. Bold and updated 2012 https://sites.google.com/site/wfwplanning/implementation
Sharp, D., 2011 Terrestrial herbicides and growth forms (V3)
https://sites.google.com/site/wfwplanning/implementation

Impact resulting from land-use practice or activity	Management Guidelines	Legal framework
	• Only herbicides registered for a particular plant species are to be used. • Where no herbicide has been registered, use the least hazardous herbicide registered for a similar plant species (i.e. another species of tree or shrub). • All herbicide treatments must be applied by a suitably qualified expert. • See also details on herbicides under the Forestry sector (**Section 5.2**).	

6. IMPLEMENTATION GUIDELINES FOR PLANNERS AND MANAGERS IN GOVERNMENT BODIES

This section focuses on ensuring that SWSA maps and assessments of their value should inform and guide strategic planning (e.g. SDFs, IDPs and zoning schemes) and that existing activities which adversely affect water quantity and quality are effectively managed and their impacts mitigated. Unlike most changes on the land, changes in water quantity and quality can propagate downstream to affect water-users and ecosystems or into groundwater in aquifers, and those impacts must be taken into account (Driver et al., 2011). This section needs to be read in conjunction with Section 5, which provides more information on the impacts of activities in the forestry, agriculture and mining sectors, and on alien plant invasions.

6.1 Planning and management in SWSAs

Strategic planning which takes a long-term view has been carried out at different levels in South Africa, including the National Planning Commission documents and processes, the National Water Resources Strategy, and Integrated Development Plans (IDPs), Spatial Development Frameworks (SDFs) at provincial and local government levels and zoning schemes at local government levels. This type of planning needs to be informed by a vision or view of the future state of the object of the planning exercise, in this case the desired state of the SWSAs. As noted previously, this vision needs to embrace the fact that these are lived-in and working landscapes with a range of established human activities. The key outcomes (Key management outcomes) provide some ideas of what needs to be done to ensure that water quantity and quality are protected to ensure water security. The Implementation Manual for Freshwater Ecosystem Priority Areas (Driver et al., 2011) describes the responsibility of government bodies for ensuring that protective measures for these freshwater ecosystems are implemented in detail. Their approach has much in common with what is needed for the protection of SWSAs.

The government bodies responsible for SWSA protection include:

- National government departments, especially:
    - Water and Sanitation
    - Environmental Affairs
    - Agriculture, Forestry and Fisheries
    - Mineral Resources
- Provincial government departments, especially:
    - Environmental Affairs and their respective Conservation Agencies
    - Agriculture
- Catchment Management Agencies and their water users
- District and Local Municipalities
- The private sector including companies and other landowners

National government

The mandate for ensuring that SWSAs continue to produce a sustained supply of high quality water is shared primarily between the departments of Water and Sanitation, Environmental Affairs and Agriculture, Forestry and Fisheries. The department of Mineral Resources is also important because of its jurisdiction over mining. Several other departments, such as the department of Rural Development and Land Reform, also play roles in land management. It is clear that protecting SWSAs is a shared mandate and their protection will require co-operative governance and alignment between several departments, particularly the key ones. The current project on the national level protection of SWSAs is examining the potential to use existing provisions in, or additions to, the Water Act and the National Environmental Management Act aimed at providing effective protection. The Interdepartmental Liaison Committee on Inland Water Ecosystems, convened by DWS, can provide a forum for the establishment of shared objectives and active collaboration in the protection of SWSAs.

Water and Sanitation

The DWS should ensure that SWSAs are integrated into the National Water Resources Strategy and national strategic planning for water resources and incorporated into the catchment management strategies developed by Catchment Management Agencies. They also need to ensure that the importance of SWSAs is taken into account in water resource classification, determination of ecological water requirements (e.g. ecological reserve), resource quality objectives and water use authorisations, including the conditions attached to licenses (DWA, 2011). Investments in and maintenance of departmental monitoring programmes should be given a higher priority in SWSAs (e.g. River Health Programme, now the River EcoStatus Monitoring Programme). In the case of forestry, the extent and location of the plantations of the large commercial forestry companies are regulated under the provisions of the National Water Act which cover Stream Flow Reduction Activities. This places limits on afforested areas based on the estimated impacts. However there are also large numbers of small growers and private land owners who have plantations of invasive species and many of these areas are poorly managed and are sources of invasions. In many cases the areas are less than 10 ha or comprised less than 1% of the property and so were not subject to a full impact assessment. Where such plantings occur within SWSAs, the department needs to prioritize stream flow reduction re-assessments based on the currently accepted method (Gush et al., 2002). There are plans to do a re-assessment of the stream flow reductions based on estimates of evaporation using remote sensing and this study needs to be actively supported by the department.

Environment Affairs

Environment Affairs should ensure that SWSAs are integrated into the National Biodiversity Framework, Bioregional Plans, Protected Area Expansion strategies and plans, biodiversity management plans and priorities for investment in natural resource management, including the control of invasive alien plant species and river, wetland and land restoration. The department can also play a key role in promoting land and water stewardship in the private sector, including incentives. It is also responsible for a number of international conventions which directly or indirectly address the importance of protecting water source areas as a key component of sustainable development and needs to ensure that those commitments are met. The department recently promulgated regulations for dealing with invasive species and needs to ensure that those are effectively implemented and applied both on state and private land. The department needs to find ways to engage in partnerships with the private sector to deal with invasions in SWSAs as they are having significant impacts on the water production of these areas (Le Maitre et al., 2018). Those interventions should apply an integrated approach to ensure that aquatic and terrestrial ecosystems in these areas are also restored and can continue to produce high quality water for local and downstream use.

As mentioned in Section 3 above, Section 24 (2A) of NEMA provides one of the most important opportunities for protecting SWSAs, as identified by the Centre for Environmental Rights. This particular provision in NEMA enables the Minister to prohibit or restrict the granting of environmental authorisations for a listed or specific activity in a specific geographical area, if this is necessary to protect environmental resources such as water quantity and quality.

The National Screening Tool, currently being developed by the Department of Environmental Affairs, is another important avenue through which the quantity and quality of water within SWSAs can be protected within the process of authorizing project-specific development. This tool is a geographical web-based application that allows for the pre-screening of potential sites for development, in terms of their environmental sensitivity (DEA, 2017). The footprint of the proposed development can then be amended in response to the outcome of the screening process (DEA, 2017). The nature of development permitted in a particular SWSA (or the boundaries of a protected area within a SWSA) should be included in this tool, as an important way of protecting water quality and quantity at the project-scale.

Agriculture, Forestry and Fisheries

This department has the responsibility of overseeing agriculture and forestry, two sectors which have impacts on water quantity and quality and are well represented within SWSAs (Le Maitre et al., 2018). The department needs to ensure that these companies and other growers of invasive tree species adhere to the Forest Act and related legal provisions and to the conditions included in their afforestation permits. In doing so they need to prioritize those SWSAs where much of the afforested land is located, and to deal effectively with illegal plantations. They also need to prioritize actions aimed at dealing with some of the former plantations and the plantation exit areas where no other government body has taken responsibility for managing the land, or that organization is failing to manage their land effectively. These areas are currently a significant source of invasions and an increasing fire hazard. Numerous woodlots were established in many of the former homeland areas (e.g. Ciskei, Transkei, KwaZulu, Gazankulu, Venda) to provide fuelwood and construction material and protect indigenous forest and woodlands. These woodlots are generally poorly managed or unmanaged and have become the source of invasions that are having significant impacts on water production (Le Maitre et al., 2016) and rangeland productivity. The department needs to undertake studies aimed at working with these communities to find ways of providing the benefits derived from these woodlots while ensuring that the invaded areas are cleared and the woodlots are confined to designated areas.

The large forestry companies are also certified by the Forestry Stewardship Council (FSC) whose standards include the maintenance of unplanted buffers along rivers and around wetlands, road construction and maintenance and management of invasive species within their properties. The FSC standards have been criticized for failing to deal adequately with the impacts of growing extensive plantations of invasive plant species, especially when they spread to adjacent lands. However the new standards, which are currently being finalized, will explicitly deal with escapees and require them to invest in clearing them and ensuring there are no new escapes. Many of the small growers are linked to the large companies and so need to comply with the FSC standards but the companies and the FSC need to ensure that this does happen in practice. Invasions by plantation species are often facilitated when they are burnt in fires, an increasing problem for the industry. As the department also has a mandate for fire management in non-urban areas (National Veld and Forest Fires Act, 1998) it needs to prioritize addressing fire risks within SWSAs.

The department also has a crucial and critical role in both promoting and regulating agriculture, especially given that much of the remaining natural vegetation in SWSAs is natural pasture (rangeland) and extensive areas are under cultivation. The Conservation of Agricultural Resources Act, 1983 and its regulations are

aimed at the conservation and sustainable utilization of natural resources, particularly soils, maintaining or enhancing the productivity of agricultural land, protecting water sources and controlling invasive species. It also has a LandCare programme that is aimed at the management of natural resources in a sustainable manner. However, the department is perceived as failing to effectively implement its legal mandate and with providing very limited funding for key programmes such as LandCare. The department needs to prioritize the implementation of its mandate in SWSAs and invest more in LandCare projects in SWSAs. Although it has regulations dealing specifically with the utilization and protection of vleis, other wetlands and water courses it has not implemented these properly, resulting in the extensive degradation and loss of these systems (Nel et al., 2011). Effective interventions would also support the implementation of the recommendations for freshwater ecosystem priority areas (Driver et al., 2011). The department needs to ensure that the protection and restoration of these systems within SWSAs (e.g. through adequate buffers, Macfarlane et al., 2010) is prioritized. Permits for the cultivation of virgin land in SWSAs need to be thoroughly evaluated and the permitted cultivation methods must ensure that these areas do not contribute to erosion and sedimentation and other impacts on water quality. A large proportion of both surface and groundwater is used in irrigated agriculture and the department needs to promote and actively support initiatives aimed at improving efficiencies and minimizing other adverse impacts (e.g. organic farming, biological control). There are many private sector initiatives aimed at minimizing the impact of agriculture and the department needs to support those, possibly by providing incentives for farmers to apply them.

Department of Mineral Resources

The DMR is responsible for overseeing mining and granting mining rights and permits. The Mineral and Petroleum Resources Development Act (Act No 28 of 2002; RSA, 2002) states that the holder of a mining right or permit is responsible for any environmental damage and pollution, and the rehabilitation of the environment affected by mining to its natural state, until a closure certificate has been issued. However, this does not deal with the legacy of the many mines that closed before the Act was promulgated. The department plans to rehabilitate 220 derelict, ownerless and dangerous mine sites in the period between 2014 and 2019. The department should give special attention to the rehabilitation of abandoned, derelict and ownerless mines in SWSAs that are having adverse effects on water quality. The Water Act and NEMA also require holders to ensure that mining activities do not lead to degradation and pollution, as do the industry standards applied by most of the companies. The DMR need to ensure that mining that can lead to the production of large volumes of acid mine drainage (e.g. some forms of coal mining, Ashton and Dabrowski, 2011; Colvin et al., 2011, McCarthy, 2011) is not permitted in SWSAs or is rigorously controlled to minimize the impacts. Impact assessments for mining permits in SWSAs must assess the potential impacts on water sources, including pollution from dust and other sources. If mining is permitted to proceed, the Environmental Management Plan must include actions aimed at preventing, avoiding or minimizing these impacts. The *Regulations pertaining to Financial Provision for Prospecting, Exploration, Mining or Production Operations* published by the Minister of Environmental Affairs on 20 November 2015 (GN No. R. 1147),aims to determine and ensure appropriate financial provision for the costs of undertaking the management, rehabilitation and remediation of environmental impacts from prospecting, exploration, mining or production operations through the lifespan of such operations and latent or residual environmental impacts that may become known in the future. The strict monitoring and regulation of return flows from irrigated agriculture and acid mine drainage from some forms of coal mining is also essential to avoid non-point pollution (CSIR, 2011).

Department of Rural Development and Land Reform

The Spatial Planning and Land Use Management Act (SPLUMA) (No. 16 of 2013) is a national framework Act that regulates spatial planning as well as land use management, in the country. In terms of this Act, the formulation of national, provincial and municipal Spatial Development Frameworks (SDFs) are required (Chapter 4, Section 12 (1)). From a national perspective, the SDF which is currently being drafted by the Department of Rural Development and Land Reform (in collaboration with the Department of Planning, Monitoring and Evaluation) will take SWSAs into account.

Provincial and local government

The SWSA maps should inform provincial and municipal SDFs drafted in terms of SPLUMA, as mentioned above. Provincial SDFs are required to be consistent with the national SDF (SPLUMA, Chapter 4, Section 15 (2); while "providing a framework for coordinating municipal spatial development frameworks with each other where they are contiguous" (SPLUMA, Chapter 4, Section 16 (d)). The provincial SDF is also required to coordinate municipal SDFs with the provincial framework, as well as any regional SDFs that may exist (SPLUMA, Chapter 4, Section 16 (e)). These requirements for coordination present an opportunity to effectively include SWSAs within all scales of strategic planning, from the national to the local scale. Nevertheless, we recommend that any development limitations and/or requirements appropriate to various SWSAs, are formally adopted by DEA within an environmental management instrument (e.g. Environmental Management Frameworks referred to below). This is because Chapter 4 (Section 12(m)) of SPLUMA specifically requires SDFs to "take cognisance of any environmental management instrument adopted by the relevant environmental management authority".

Another important opportunity exists within municipal SDFs which are required to "include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial location of environmental sensitivities…." (SPLUMA, Chapter 4, 21(j)). Consideration of SWSAs, and any appropriate development restrictions needed to maintain water quality and quantity in these areas, should be included in such strategic assessments. Within the context of municipal land use management, it is important that management objectives (e.g. restrictions on development options) for SWSAs are integrated into the formulation of land use schemes. In terms of SPLUMA, such schemes are required, *inter alia,* to ensure minimal impact on natural resources; comply with environmental legislation and take account of any environmental instrument adopted by the relevant environmental authority (Chapter 5, Sections 24 (b) and 25 (d)). This again highlights the importance of any particular management requirements associated with SWSAs being well defined and formally adopted.

Environmental Management Frameworks (EMFs) are an example of an 'environmental instrument' into which the SWSAs may be integrated, as well as associated development limitations and/or management requirements. The Environmental Management Framework (EMF) Regulations of 2010, which were promulgated in terms of the National Environmental Management Act (NEMA) (No. 107 of 1998), define an EMF as: "a study of the biophysical and socio-cultural systems of a geographically defied area to reveal where specific land uses may best be practiced and to offer performance standards for maintaining appropriate use of such land" (DEA, 2010: Section 1 (1)). An EMF for a particular area (e.g. municipality) which may be initiated by the Minister or MEC (with the agreement of the Minister), includes a map of the geographical area, as well as the identification of environmental sensitivities and appropriate environmental management priorities (DEA, 2010: Sections 1 and 4). If an EMF exists for a specific area, it must be consulted when environmental authorisations for development projects in that area are considered (DEA, 2010: Section 5 (2)). This instrument therefore lends itself well to the inclusion of SWSAs – and the actions that

need to be taken to ensure the maintenance and enhancement of water quality and quantity – in strategic and project-level development decision-making.

It is important that all Environmental Impact Assessments (EIA) for development applications within all SWSAs deal explicitly with the impact such developments may have on the quantity and quality of the surface water and the groundwater. Such EIAs, which are currently undertaken in terms of the 2014 EIA Regulations (promulgated in terms of NEMA), require the compilation of a report that not only identifies the positive and negative impacts of the development on the environment (DEA, 2014: Appendix 3, Section 3(3) (h)(vii)), but also includes, *inter alia*, a map that superimposes the proposed development on the environmental sensitivities of the preferred site, indicating areas (including buffers) that should be avoided (DEA, 2014: Appendix 3, Section 3(3)(l)(ii)). This presents a specific opportunity to include a spatial representation of ecological sensitives pertaining to SWSAs in the EIA process. In summary, SWSAs (and any associated land use limitations and/or management requirements) should:

- Be reflected spatially in provincial and municipal SDFs; informing the desired patterns of land use set out in the final map which integrates information and priorities from different sectors (if consultants are employed to develop or review SDFs, it is important that their terms of reference explicitly refer to the need to include SWSAs and to use the SWSA maps to inform the development options identified). Be integrated into the formulation of municipal land use schemes. For example, the spatial planning categories or zones must be defined so that they appropriately restrict land uses and development options to minimise or avoid adverse impacts on water quantity and quality.

- Integrated into any Environmental Management Frameworks (EMFs) compiled for specific areas.

Catchment Management Agencies

Catchment Management Agencies have to develop catchment management strategies aimed at exercising their responsibilities together with their stakeholders who include water-user associations, other water users, and conservation agencies. These strategies specify the principles that will be used to allocate water to existing and prospective users, taking into account all matters relevant to the protection, use, development, conservation, management and control of water resources. This clearly will include ensuring that the SWSAs are protected so that they continue to produce sustained supplies of high quality water for water users and ecosystems within and downstream of their Water Management Areas. Provincial conservation agencies should actively participate in the development of catchment management strategies by providing guidance to Catchment Management Agencies on the protection of SWSAs, and through inputs to Bioregional plans. They can also play a role in directing investments by DEA Natural Resource Management and LandCare in invasive alien plant control and restoration.

6.2 Management of urban water-related infrastructure

Urban areas have a range of impacts on both water quantity and quality, many of which are significant and need to be addressed. Hardened areas (e.g. roofs, roads, parking areas) produce large volumes of stormwater which can have significant downstream impacts on watercourse and wetlands. The stormwater is often of spoor quality and can include large quantities of solid waste and human waste from informal areas and result in significant impacts downstream. The maintenance or upgrading of water-water treatments plants, stormwater management systems and the regulation of other point-sources of pollutants (e.g. industrial discharges) in the municipalities where SWSAs are located is crucial to protect water quality (CSIR, 2011; DWS, 2013; Sershen et al., 2016) and should be prioritised in the assessment and allocation of

municipal infrastructure grants. Pollution with solid waste, such as plastics, should be prevented, by ensuring that all urban areas have effective waste disposal and stormwater management systems. Stormwater volumes can be large and it can actually be a useful resource; one way of reducing storm runoff is to encourage home owners and businesses to capture and use rainwater. There are many possibilities for managing water runoff from urban and industrial areas which could be implemented by following water-sensitive urban design principles and practices (Armitage et al., 2014). Adopting the proposed groundwater management framework for local municipalities (Riemann et al., 2012) would be a good start.

6.3 SWSAs and protected areas

Only 11% of the surface-water SWSAs (about 18.2 million ha) are under some level of formal protection in terms of the National Environmental Management: Protected Areas Act (Act 57 of 2003) (Le Maitre et al., 2018). In many cases the protected areas were established to protect mountain catchments to sustain the provision of high quality water, notably the montane nature reserves and mountain catchment areas in the Western Cape and the nature reserves along the Drakensberg escarpment in KwaZulu-Natal and in Mpumalanga and Limpopo provinces. Twenty-five of the groundwater SWSAs have no formally protected areas, including a number which are the primary source of groundwater for settlements (e.g. Carnarvon, Loxton, Sishen/Kathu). Furthermore, a total of 32 SWSAs, covering about 91 000 ha in total, include conservation areas which are areas of private land which have been legally protected through an agreement between a government authority and the private landowner(s). These legal agreements range from formal and binding stipulations which are included in title deeds, to contracts, and to informal agreements.

The low proportion of SWSAs in protected areas, and the very uneven distribution of those protected areas, makes them highly vulnerable to unwise development and the adverse effects of existing activities. Some people and authorities see formal protection of the remaining natural areas as the best option for increasing water security, but the resources available to manage these areas are limited and conservation agencies are struggling to manage the areas already under their jurisdiction. Most of the area still under natural vegetation is privately owned, so a better option may be to introduce incentives aimed at getting land owners to manage such areas appropriately.

The current project on the legislative requirements for the protection of surface water SWSAs, being run by the Centre for Environmental Rights, is focusing largely on adapting or using existing legislation. Alongside formal legal tools, innovative thinking is needed to explore options and mixes of options that could be applied to ensure that these areas are effectively protected. The approaches put forward for developing cross-sectoral approaches for freshwater biodiversity (Roux et al., 2007) suggest some options that could be explored, as does the literature on bridging the gaps between scientists, planners and land managers (Roux et al., 2006). Others include proactive private-public partnerships which promote conservation and rehabilitation such as biodiversity stewardship, clearing of invasive alien plants, and rehabilitation of degraded land and wetlands. A key outcome should be to ensure that people across these landscapes are introduced to the importance of the SWSAs both for their own livelihoods and well-being, and for those living elsewhere, and to engender landscape stewardship.

7. RECOMMENDATIONS

During the preparation of this Management Framework and Implementation Guidelines we identified a number of critical gaps that need to be addressed if the SWSAs are to be adequately protected. We need to find ways of achieving effective co-operative governance of the SWSAs because they fall under the jurisdiction of various national departments, a potentially different mix of departments at provincial level and then come together again under local government. Water resource governance is a national competence and some functions are devolved to Catchment Management Agencies which are not spatially congruent with other administrative units. Environmental resource governance is a joint national and provincial competence. Mineral resources are a national competence. These are just some examples, but they illustrate the potential for the governance of these areas to fall between government bodies. This is why we have emphasised that the management of these areas must be seen from the perspective of their national importance for water and food security. They are important for a large proportion of our people and the economy, and governance arrangements must be designed to give them a level of protection which is consistent with their importance. One of the key outcomes needs to be a concerted effort to ensure that water and environmental management officials in the various spheres of government are informed about this work and that it needs to be taken into account in their decision making in the same way as it has been done for conservation planning.

This study has identified SWSAs that are considered nationally important but they also need to be identified at other levels as well, including provincial and local government level, for the Water Management Areas overseen by Catchment Agencies and potentially for Catchment Management Forums. The same methods that have been used to identify surface water and groundwater WSAs in this study (Le Maitre et al., 2018) could also be applied over smaller areas to identify where most of their water is produced. National legislation can be used for protecting these areas but planning measures such as zonation can also be used to provide protection. We recommend that these assessments are undertaken as soon as possible to ensure that these areas can be identified and targeted for management and planning interventions should they be necessary.

Another critical gap is in the formation of the partnerships between various government agencies, the private sector and the traditional landowners to secure the effective protection of these areas. There are many such initiatives at the local scale but protecting the sustained provision of high quality water over these extensive landscapes is going to require a far-reaching change in the way we view and construct partnerships. Catchment Management Agencies could potentially develop such partnerships and this is what is envisaged as a means of ensuring that we effectively protect and restore our freshwater ecosystems (Driver et al., 2011; Sherwill et al., 2007). This approach could be a useful model for such partnerships as are some of the proposals made about landscape approaches to promoting ecosystem resilience and biodiversity conservation (Cadman et al., 2010) which could include Catchment Management Forums.

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Appendix 1: The areas considered strategically important at the national level for surface-water or groundwater supplies, or both.

The data presented in this section are from the outputs of a study of the most important areas for water production in South Africa (Le Maitre et al., 2018). In the case of the surface water production they also include parts of Lesotho and Swaziland. Lesotho is particularly important because water produced in its strategic water sustains the Orange River system as well as supplying Gauteng with most of its water.

A. Surface-water SWSAs with the estimated MAR and extent.

Name	MAR (million m^3)	Percent of national MAR	MAR (m^3 per ha)	Area (km^2)
Amatole	333	0.67	1662	2 001
Boland	2 182	4.41	3588	6083
Eastern Cape Drakensberg	2 673	5.40	1671	15 997
Ekangala Drakensberg	1 412	2.85	1646	8 582
Groot Winterhoek	1 002	2.02	1931	5 191
Kouga	77	0.16	1262	613
Langeberg	343	0.69	1989	1 722
Maloti Drakensberg	2232	4.51	1859	12 003
Mbabane Hills	2237	4.52	2234	10 015
Mfolozi Headwaters	277	0.56	1438	1 925
Mpumalanga Drakensberg	1 929	3.90	2304	8 374
Northern Drakensberg	2 448	4.94	2376	10 302
Outeniqua	580	1.17	1929	3 005
Southern Drakensberg	4 317	8.72	2135	20 225
Soutpansberg	532	1.07	2267	2 345
Swartberg	96	0.19	1239	775
Table Mountain	127	0.26	2730	465
Tsitsikamma	708	1.43	2203	3 213
Upper Usutu	722	1.46	1166	6 191
Upper Vaal	122	0.25	872	1 401
Waterberg	99	0.20	957	1 033
Wolkberg	506	1.02	1937	2 614
Total	24 954	50.39	2011	124 075
South Africa	49 520		391	1 267 814

B. Groundwater SWSAs with the estimated recharge, extent and relative contribution, and criteria met.

Name	Recharge (million m^3/a)	Area (km^2)	National recharge (%)
Bo-Molopo Karst Belt	5268	144.76	0.4%
Cape Peninsula and Cape Flats	599	59.54	0.2%
Central Pan Belt	3368	53.62	0.2%
Coega TMG Aquifer	1682	32.28	0.1%
Crocodile River Valley	2163	38.92	0.1%
De Aar Region	2475	32.54	0.1%
Eastern Kalahari A	2010	26.38	0.1%
Eastern Kalahari B	2656	37.83	0.1%
Eastern Karst Belt	1984	108.08	0.3%
Far West Karst Region	1382	65.77	0.2%
George and Outeniqua	727	95.81	0.3%
Giyani	438	5.33	0.0%
Great Kei	1416	124.48	0.4%
Ixopo/Kokstad	7150	792.17	2.3%
Kroondal/Marikana	795	24.38	0.1%
Kroonstad	799	11.68	0.0%
KwaDukuza	2352	176.95	0.5%
Letaba Escarpment	2151	165.54	0.5%
Lower Mzimvubu	1199	186.54	0.5%
Northern Ghaap Plateau	6274	82.56	0.2%
Northern Highveld	1345	70.98	0.2%
Northern Lowveld Escarpment	5168	457.56	1.3%
Northwestern Cape Ranges	3638	287.66	0.8%
Nyl and Dorps River Valley	2036	57.53	0.2%
Overberg Region	2261	71.57	0.2%
Phalaborwa	433	3.86	0.0%
Richards Bay GW Fed Lakes	606	91.54	0.3%
Sandveld	4010	85.85	0.2%
Sishen/Kathu	4827	40.94	0.1%
Southern Ghaap Plateau	6542	67.58	0.2%
Southwestern Cape Ranges	2749	629.47	1.8%
Soutpansberg	2573	247.19	0.7%
Transkei Middleveld	5607	554.99	1.6%
Tulbagh-Ashton Valley	3560	184.29	0.5%
Upper Keurbooms	1223	115.44	0.3%
Upper Sand (Polokwane) Aquifer System	966	16.45	0.0%
Ventersdorp/Schoonspruit Karst Belt	2875	114.81	0.3%
Vivo-Dendron	2555	14.46	0.0%
West Coast Aquifer	4586	106.16	0.3%
Westrand Karst Belt	1090	63.27	0.2%
Zululand Coastal Plain	3305	347.17	1.0%

Appendix 2: Protection levels for the SWSAs based on protected area data

The data for the protected areas was taken from the National Protected Area Expansion Strategy and downloaded from the online Biodiversity GIS database: http://bgis.sanbi.org. The Upper Vaal, Upper Usuthu and Mfolozi Headwaters have no formally protected areas.

Table A2.1: Formally protected areas in the SWSAs excluding Lesotho and Swaziland.

Name	Type	Protected Area (km²)	Not protected	Total Area (km²)	Protected Area (%)	Combined Area (km²)	Combined PA (km²)	Total protected (%)
Amatole	sw	39	2 039	2 078	1.89			
Bo-Molopo Karst Belt	gw	98	5 083	5 181	1.90			
Boland	sw	848	1 776	2 624	32.31			
Boland & Northwestern Cape Ranges	swgw	60	114	173	34.47			
Boland & Overberg Region	swgw	28	186	214	13.16			
Overberg Region	gw	236	1 766	2 002	11.81			
Boland & Southwestern Cape Ranges	swgw	1 750	922	2 672	65.48			
Tulbagh-Ashton Valley	gw	403	1 834	2 237	18.00			
Boland & Tulbagh-Ashton Valley	swgw	152	396	547	27.73			
Southwestern Cape Ranges	gw	4	52	57	7.81	10 527	3 481	33.07
Central Pan Belt	gw	19	3 246	3 265	0.58			
Crocodile River Valley	gw	7	1 738	1 744	0.39			
De Aar Region	gw	3	2 471	2 475	0.13			
Eastern Cape Drakensberg	sw	165	8 991	9 157	1.81			
Eastern Karst Belt	gw	69	1 915	1 984	3.48			
Ekangala Grassland	sw	665	7 044	7 709	8.63			
Far West Karst Region	gw	80	1 302	1 382	5.82			
Giyani	gw	12	426	438	2.78			
Groot Winterhoek	sw	959	572	1 531	62.67			
Northwestern Cape Ranges	gw	103	854	957	10.75			

Name	Type	Protected Area (km²)	Not protected	Total Area (km²)	Protected Area (%)	Combined Area (km²)	Combined PA (km²)	Total protected (%)
Groot Winterhoek & Northwestern Cape Ranges	swgw	1 578	910	2 488	63.43			
Sandveld	gw	23	3 545	3 568	0.66			
Groot Winterhoek & Sandveld	swgw	112	312	424	26.33			
Groot Winterhoek & Tulbagh-Ashton Valley	swgw	514	189	702	73.15	9 670	3 289	34.01
Kouga	sw	442	146	588	75.14	20 196	6 770	33.52
Kroondal/Marikana	gw	92	703	795	11.58			
Langeberg	sw	785	904	1 688	46.48			
Langeberg & Tulbagh-Ashton Valley	swgw	26	7	34	78.40	1 722	811	47.10
Maloti Drakensberg	sw	39	70	109	35.63			
Mbabane Hills	sw	458	1 822	2 280	20.09			
Mfolozi Headwaters	sw	136	1 789	1 925	7.05			
Mpumalanga Drakensberg	sw	410	6 516	6 925	5.91			
Mpumalanga Drakensberg & Northern Lowveld Escarpment	swgw	294	844	1 138	25.85			
Northern Lowveld Escarpment	gw	338	2 556	2 893	11.68	10 957	1 042	9.51
Nyl and Dorps River Valley	gw	324	1 551	1 875	17.28			
Northern Ghaap Plateau	gw	20	6 254	6 274	0.32			
Northern Drakensberg	sw	793	7 523	8 316	9.54			
Outeniqua	sw	771	1 910	2 681	28.75			
George and Outeniqua	gw	22	135	156	13.90			
Outeniqua & George and Outeniqua	swgw	209	362	571	36.66	727	231	31.77
Phalaborwa	gw	130	274	404	32.14			
Richards Bay GW Fed Estuary	gw	10	595	606	1.71			
Southern Ghaap Plateau	gw	8	6 534	6 542	0.12			
Southern Drakensberg	sw	1 750	8 589	10 339	16.93			
Southern Drakensberg & Ixopo/Kokstad	swgw	622	6 131	6 753	9.21	17 092	2 372	13.88
Soutpansberg	gw	22	1 227	1 249	1.79			

Name	Type	Protected Area (km²)	Not protected	Total Area (km²)	Protected Area (%)	Combined Area (km²)	Combined PA (km²)	Total protected (%)
Soutpansberg	sw	27	991	1 019	2.69			
Soutpansberg & Soutpansberg	swgw	15	1 286	1 301	1.16	3 569	65	1.81
Swartberg	sw	500	275	775	64.50			
Table Mountain	sw	105	196	301	34.96			
Table Mountain & Cape Peninsula and Cape Flats	swgw	63	208	271	23.12			
Cape Peninsula and Cape Flats	gw	9	319	328	2.82	900	177	19.68
Tsitsikamma	sw	1 002	2 472	3 474	28.84			
Tsitsikamma & Coega TMG Aquifer	swgw	6	30	35	16.14	3 509	1 007	28.71
Coega TMG Aquifer	gw	294	1 342	1 637	17.97			
Upper Usutu	sw	2	5 355	5 357	0.03			
Upper Sand (Polokwane) Aquifer System	gw	18	920	938	1.92			
Ventersdorp/Schoonspruit Karst Belt	gw	43	2 734	2 777	1.56			
Vivo-Dendron	gw	30	2 085	2 115	1.40			
Waterberg	sw	149	854	1 003	14.81			
West Coast Aquifer	gw	244	4 253	4 497	5.43			
Westrand Karst Belt	gw	287	803	1 090	26.37			
Wolkberg	sw	67	495	561	11.88			
Wolkberg & Letaba Escarpment	swgw	66	882	948	6.99			
Wolkberg & Northern Lowveld Escarpment	swgw	316	785	1 101	28.71	2 610	449	17.20
Zululand Coastal Plain	gw	1 326	1 979	3 305	40.13			
Total		*20 198*	*132 382*	*152 580*	*13.24*			

Table A2.2: SWSAs with conservation areas, excluding areas which fall into Lesotho or Swaziland.

Name	Type	Protected Area (km^2)	Not protected	Total Area (km^2)	Protected Area (%)
Bo-Molopo Karst Belt	gw	87	5 083	5 268	1.64
Boland	sw	28	1 776	2 652	1.06
Boland & Overberg Region	swgw	5	186	220	2.48
Overberg Region	gw	39	1 766	2 041	1.91
Boland & Southwestern Cape Ranges	swgw	8	922	2 680	0.31
Tulbagh-Ashton Valley	gw	10	1 834	2 247	0.46
Boland & Tulbagh-Ashton Valley	swgw	2	396	549	0.40
Southwestern Cape Ranges	gw	12	52	69	17.47
Central Pan Belt	gw	103	3 246	3 368	3.06
Crocodile River Valley	gw	419	1 738	2 163	19.36
Ekangala Grassland	sw	56	7 044	7 765	0.72
Northwestern Cape Ranges	gw	1	854	958	0.13
Groot Winterhoek & Northwestern Cape Ranges	swgw	19	910	2 507	0.74
Sandveld	gw	18	3 545	3 586	0.51
Groot Winterhoek & Tulbagh-Ashton Valley	swgw	27	189	730	3.77
Kouga	sw	25	146	613	4.10
Kroonstad	gw	54	746	799	6.74
Langeberg	sw	1	904	1 689	0.03
Mbabane Hills	sw	11	1 822	2 291	0.47
Mpumalanga Drakensberg	sw	280	6 516	7 205	3.88
Mpumalanga Drakensberg & Northern Lowveld Escarpment	swgw	31	844	1 169	2.63
Northern Lowveld Escarpment	gw	4	2 556	2 898	0.14
Nyl and Dorps River Valley	gw	161	1 551	2 036	7.91
Northern Drakensberg	sw	23	7 523	8 339	0.28
Outeniqua	sw	12	1 910	2 693	0.45
Phalaborwa	gw	29	274	433	6.73
Southern Drakensberg & Ixopo/Kokstad	swgw	16	6 131	6 768	0.23
Soutpansberg	gw	22	1 227	1 271	1.72
Soutpansberg	sw	25	991	1 043	2.37
Soutpansberg & Soutpansberg	swgw	1	1 286	1 301	0.06
Tsitsikamma	sw	5	2 472	3 479	0.15
Coega TMG Aquifer	gw	10	1 342	1 646	0.59
Upper Usutu	sw	31	5 355	5 388	0.57
Upper Sand (Polokwane) Aquifer System	gw	28	920	966	2.86
Ventersdorp/Schoonspruit Karst Belt	gw	98	2 734	2 875	3.41
Vivo-Dendron	gw	441	2 085	2 555	17.25
Waterberg	sw	30	854	1 033	2.94
West Coast Aquifer	gw	89	4 253	4 586	1.94
Wolkberg	sw	3	495	565	0.61
Wolkberg & Letaba Escarpment	swgw	1	882	948	0.07
Total		**2 265**	**85 356**	**101 394**	**2.23**


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